JURNAL PERIKANAN
UNIVERSITAS GADJAH MADA
Terakreditasi Ristekdikti No: 158/E/KPT/2021

ISSN: 2502-5066 (Online)
ISSN: 0853-6384 (Print)
Vol. 25 (1), 19-24
DOI 10.22146/jfs.80968

Estimation of Carrying Capacity for Floating Net Cage Cultivation Activities in Pekalongan Coastal Waters

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Submitted: 05 January 2023; **Revised:** 18 Februry 2023; **Accepted :** 03 May 2023

ABSTRACT Floating cage fish farming is an aquaculture activity that is mostly carried out on the coast of Pekalongan. The purpose of this study was to estimate the carrying capacity of Pekalongan coastal waters as a floating net cage aquaculture activity zone. The research method used is descriptive qualitative and quantitative descriptive by calculating the indicators of Trophic Status Index (TSI), phosphorus, feed conversion ratio, and the carrying capacity level of the waters. The results showed that chlorophyll-a values ranged from 6.44-8.24 µg/L, total phosphorus 12.44-14.80 µg/L, feed conversion ratio 1.10-1.25, TSI (Trophic Status Index) values 48.2-54.6, harvested biomass 120-157 kg/ floating net cages (KJA). The carrying capacity of the waters for KJA cultivation is 145.43 tons of fish/year, and the number of existing KJA for cultivation is 110 KJA. The conclusion from the results of this study is that the carrying capacity on Pekalongan coastal waters when used as a floating net cage aquaculture activity zone is estimated to be able to accommodate approximately 145.43 tons of fish/year or the equivalent of 121 KJA. Currently, there are 110 KJA plots in the Jeruksari coastal waters, which means that the maximum carrying capacity of the waters that can be used for KJA cultivation is 11 KJA.

Keywords: Biomass; carrying capacity; feed; phosphor; TSI

INTRODUCTION

The Pekalongan coastal area is a zone that is prone to being affected by tidal floods (Pratama, 2019). One of the causes of the tidal floods that occur throughout the year is the impact of global climate change (Amores *et al*., 2021). The impact of climate change forces people in coastal areas to be able to adapt as an adjustment effort. One form of adaptation that is carried out is to develop adaptive fish farming activities (Ariadi & Syakirin, 2022).

Adaptive fish farming activities are carried out as a form of conversion of non-productive land functions in coastal areas (Ariadi *et al*., 2022[b]). One form of adaptive cultivation that is carried out is by carrying out fish farming activities using the floating net cage method (Kunda *et al*., 2021). Floating net cage fish farming activities have begun to be developed in the Jeruksari Village area, Pekalongan Regency in recent years. The commodities cultivated include *Chanos chanos*, *Lates calcarifer*, and *Oreochromis niloticus*.

The coastal area is a confluence zone between freshwater and marine ecosystems which has the potential for run off waste pollution (Salo & Salovius-Lauren, 2022). Therefore, an assessment of the carrying capacity status on the environment is needed as a form of adaptation impact (Ariadi *et al*., 2022[a]). Some of the problems that arise in coastal waters are the water eutrophications (Vea *et al*., 2022). Eutrophication is the nutrients enrichment due to waste runoff in aquatic ecosystems (Ariadi *et al*., 2022[c]).

Fish farming activities must pay attention to the carrying capacity of the waters so that pollution impacts do not occur on the surrounding environment. The carrying capacity level on waters can be assessed from several indicators such as the presence of nutrients, water quality, and several other limiting factors (Aida & Utomo, 2018). Determination of carrying capacity can also be used as the main basis for determining stocking density of fish that can be maintained at a cultivation site (Ariadi *et al*., 2022[d]). Based on the background above, the purpose of this research is to estimate of carrying capacity level of Pekalongan coastal waters as a floating net cage aquaculture activity zone.

MATERIALS AND METHODS

Materials

This research was conducted in Jeruksari Village, Tirto District, Pekalongan Regency in December 2022 using a qualitative and quantitative descriptive method.

Methods

Parameters observed included water physics parameters (brightness) and water chemistry parameters (chlorophyll-a, temperature, and dissolved oxygen), water productivity, feed conversion ratio, total phosphorus, carrying capacity, fish production in floating net cages and the number of aquaculture cages in the coast of Jeruksari Village, Pekalongan Regency. In addition, secondary data collection was also carried out in the form of area and depth of floating net cages through interviews with fish farmers. Determination of research location points was carried out based on the location and presence of fish farming cages in the coastal waters of Jeruksari Village which is describe in Figure 1.

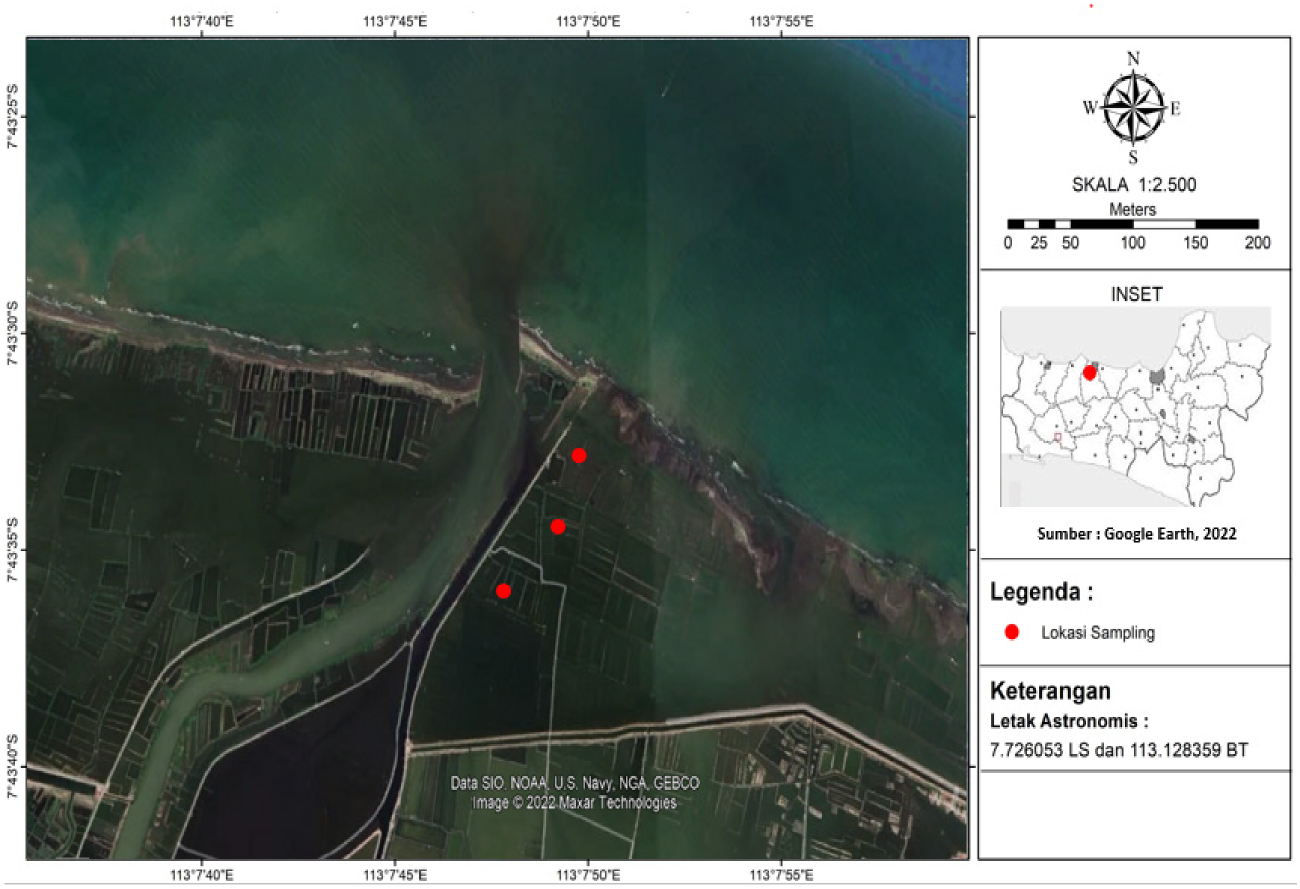

Figure 1. Location and presence of fish farming cages in the coastal waters of Jeruksari Village.

Determination of water fertility level

To determine the level of water fertility, it is calculated based on the value of the trophic status index (TSI) from the formula introduced by Carlson (1977).

$$TSI = (TSI\text{-}SD + TSI\text{-}TP + TSI\text{-}Chl)/3$$

174 / 5.000

Note:

TSI-SD = 60 – 14.41*Ln [SD]

Where SD = water brightness

TSI-TP = 4.15 + 14.42*Ln [TP]

Where TP = total phosphorus

TSI-Chl = 30.6 + 9.81*Ln [Chl]

Where Chl = chlorophyll-a content

Calculation of the carrying capacity of waters

Determination of the level of carrying capacity of waters is determined based on the nutrient abundance load approach in the waters introduced by Beveridge (1996) such as:

$$DDP = TAL : TLP$$

Note:
DPP = Carrying capacity of waters (tons of fish/year),
TAL = (Total allowable P load) = L_{fish} x A (kg P/year),
TLP =Total P released into the waters (kg P/ton fish).

$$L_{fish} = \frac{a(P)*Z*e}{(1\text{-}Rfish)}$$

$$DDP = \frac{a(P)*Z*e}{(1\text{-}Rfish)} \times A : TLP$$

$$TAL = \frac{a(P)*Z*e}{(1\text{-}Rfish)} \times A$$

Note:

L_{fish} = load P per unit area (kg m^{-2} year-1),

A = Reservoir surface area (m^2),

Z = average depth of reservoir waters (m),

ϱ = rinsing rate = Q_0/V,

QO = average volume of water discharged from the reservoir/year ($m^3 year^{-1}$),

V = Reservoir water volume (m^3),

A(P) =(P)f-(P)i,

Pf = maximum acceptable IP in reservoir waters (50 mg m^{-3}),

Pi = average concentration of P in the study (40 mg m^{-3}),

Rfish = the proportion of P that dissolves into the sediment,

X = the proportion of P that enters the bottom waters.

RESULTS AND DISCUSSION

Water productivity rate

The water productivity rate is calculated based on the presence of chlorophyll-a parameters, total phosphorus, and TSI calculations. The trophic status index level is the easiest method to use to assess water productivity rate (Ding *et al.*, 2021). The values of chlorophyll-a and total phosphorus in the waters of the study locations were 6.44-8.24 μg L^{-1} for chlorophyll-a and 12.44-14.80 μg L^{-1} for total phosphorus. The total phosphorus value can be present in Figure 2.

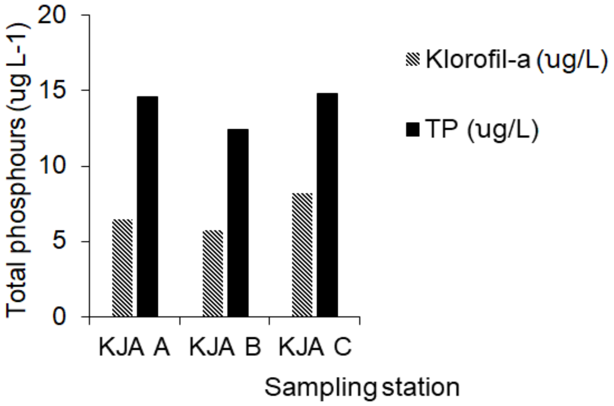

Figure 2. Value of total phosphorus.

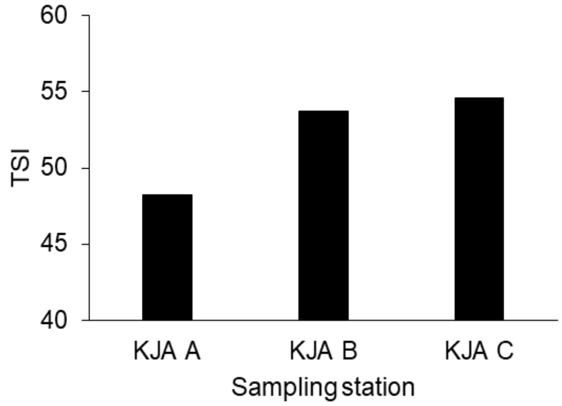

Figure 3. The range of TSI values in cages.

The level of water productivity rate is calculated using the TSI calculation method, the result is that the value of TSI in KJA A is 48.2, TSI in KJA B is 53.7, and TSI in KJA C is 54.6. TSI value in KJA A only reached 48.2 due the slightly slower growth rate of fish biomass compared to the other two KJA. The average TSI value in cages is 52.17. The waters of fish farming cages on the Jeruksari Village coast are still classified as mild eutrophic. The TSI value in the mild eutrophic category ranges from 50-60 (Aida & Utomo, 2018). The range of TSI values in research cages can be present in Figure 3.

Feed conversion ratio (FCR) value

The value of the FCR is used to determine of P total analysis that passes into the waters. The FCR value in the study KJA ranged from 1.10-1.25 or the average FCR value in the KJA was 1.15. This means that to produce 1 kg of fish biomass, 1.15 kg of feed is needed. The FCR data in each cage can be present in Table 1.

Tabel 1. Feed conversion ratio.

Location	Feed Amount/ KJA (Kg)	Yields per KJA (Kg)	FCR	Cultivation Time (month)
KJA A	150	120	1.25	6
KJA B	147	132	1.11	6
KJA C	172	157	1.10	5

Estimation of water carrying capacity for KJA

The indicators used in calculating the carrying capacity of waters are phosphorus content, water depth, water volume, and water area. Based on the results of calculations using the formula for calculating the level of carrying capacity of waters (DDP), it is found that the waters carrying capacity for KJA cultivation activities is 145.43 tons of fish/year. From the results of interviews with fish farmers in Jeruksari marine cage, the average per year yield obtained per plot of cages was 1200 kg/year. If calculated by the number of KJA active this is equivalent to 132 tons of fish/year or close to the maximum capacity of the KJA carrying capacity in Jeruksari waters. This means that the

Table 2. Carrying capacity of KJA waters.

Parameter	Value
Water area (A)	226 Ha ***
Water depth (Z)	4.4 m ***
Cage water volume (V)	19.22 x 10^{5}m^3 *
Volume average. water released in cages/year (Q$_0$)	57.85 x 10^{5}m^3/years *
Water rinsing rate	3.52 *
Maximum acceptable P of waters (Pf)	50 mg/m^3 **
P content in waters (Pi)	43.34 mg/m^3 ***
Feed conversion (FCR)	1.15 ***
Total P that escapes into the waters (TLP)	12.59 kg P/ton fish ***
Allowable total load P (TAL)	2218 Kg P/th ***
Carrying capacity of waters for KJA (DDP)	145.43 tons fish/years ***
The number of KJA according to the carrying capacity	110 plots ***
The number of KJA at the time of the study	110 plots ***

Source : * Ditjen Sumberdaya Air (2010) ; ** Beveridge (1996); *** Research result intensity level of KJA cultivation in Jeruksari coastal waters is close to the maximum value of the carrying capacity.

Water productivity rate

The average water productivity rate in KJA waters was 52.17 or still in the mild eutrophic or good category, the chlorophyll-a value was 6.44-8.24 µg L^{-1} and total phosphorus was 12.44-14.80 µg/L. The productivity rate of the waters in the KJA location is still very suitable for use as a medium or location for fish farming activities. Phosphorus is a limiting factor in aquaculture ecosystems that will determine of aquatic productivity rate (Sari *et al.*, 2022). High phosphorus levels indicate that aquatic ecosystems have been polluted by anthropogenic waste (Kurniati *et al.*, 2021).

The productivity rate will be closely correlated with waterr carrying capacity rate. Waters with eutrophic conditions tend to have a low level of carrying capacity (Hao *et al.*, 2021). The existence of fertile waters will stimulate for phytoplankton growth and aquatic microorganisms biodiversity (Vinothkumar *et al.*, 2021). Aquaculture activities that are very at risk of nutrient build up are very likely to cause eutrophication.

The low TSI value in KJA waters indicates that the nutrient content, such as phosphorus and chlorophyll-a, is also low. The low TSI value is not only due to the lack of nutrients solubility, it is also caused by low levels of brightness (Aida & Utomo, 2018). The low brightness of the waters can be caused by sedimentation rates and frequent water circulation (Junior *et al.*, 2021). In aquaculture activities the water productivity rate will be largely determined by the physical and chemical conditions of the waters (Madusari *et al.*, 2022).

The results of this study showed a correlation between the low level of water productivity rate obtained due to the nutrient minimum concentrations and environmental physical factors. The ecosystem of KJA aquaculture waters allows dynamic changes in physico-chemical conditions due to its open cultivation system (Sager, 2009). Cultivation of floating net cages using an open cultivation system will cause water quality conditions to continue to fluctuate dynamically over time (Ariadi *et al.*, 2022^{b}).

Cultivation productivity rate

Indicators of the aquaculture productivity rate in the activity of raising fish in KJA can be seen from the amount of harvest and feed conversion ratio. For harvest productivity, an average of 136.3 kg/KJA was obtained and the value of the feed conversion ratio was 1.15, meaning that it was productive enough to be developed. Growth rates and cultivation performance are influenced by environmental conditions and the cultivation system used (Dewi *et al.*, 2016). Cultivation activities that take place intensively will provide a better productivity rate than ordinary cultivation systems (Ariadi *et al.*, 2019).

The FCR for cultivation activities is <1.5 (Ariadi & Wafi, 2020). The feed conversion ratio low the better it is because a smaller quantity of feed is needed to raise fish. The FCR value can be used as a control for the amount of feed we use in each cultivation cycle. The feed conversion ratio low is indicat that more feed is converted to meat and minimal feed waste is wasted into the cultivation environment (Besson *et al.*, 2016).

The harvest productivity value of the fish culture cycle is not only influenced by environmental conditions in the waters, but also by the fish genetic performance (Mandal *et al.*, 2021). The harvest productivity in KJA from the results of this study is also closely related to water productivity rate. The feed conversion ratio low has a correlation with a light nutrient pollution load, meaning that not much aquaculture waste is wasted into aquatic ecosystems. A part from having an impact on better water conditions, the impact of low feed conversion values is also beneficial for aquaculture operational cost more efficients (Abdo *et al.*, 2022).

The level of water carrying capacity for KJA cultivation

Based on the estimation of carrying capacity level on the waters for KJA cultivation activities, it is mathematically obtained a value of 145.43 tons of fish/year or equivalent to 121 KJA. The Jeruksari coastal water location, there are 110 KJA plots, meaning that the level of KJA cultivation capacity is close to the maximum carrying capacity value. The low level of cultivation carrying capacity is very possible due to eutrophic water conditions (Aida & Utomo, 2018). The fish farming pattern that is applied is then balanced by the existing water conditions, making the level of carrying capacity status of cultivation cannot be determined with certainty (Pilecky *et al.*, 2022).

Several research results related to fish farming activities in coastal areas have an average level of cultivation productivity that is better than landbased cultivation (Permatasari & Ariadi, 2021). KJA systems also tend to have lower levels of productivity and carrying capacity than conventional aquaculture systems. The water hydrodynamics level in the KJA pond also has an impact on cultivation carrying capacity level (Lin *et al.*, 2019).

To minimize the impact of phosphorus (P) waste generated by fish farming activities, the best way is to reduce the use of high protein feed and regulate the amount of fish stocking density. In addition to the feed method, the cultivation system applied will also affect for carrying capacity level in the waters for aquaculture activities (Ariadi *et al.*, 2021). A water carrying capacity level will have a broad impact on more sustainable aquaculture activities.

CONCLUSIONS AND RECOMMENDATION

Conclusion

The carrying capacity of Pekalongan coastal waters when used as a floating net cage aquaculture activity zone is estimated to be able to accommodate approximately 145.43 tons of fish/year or the equivalent of 121 KJA. Currently, there are 110 KJA plots in the coastal waters of Jeruksari, which means that the maximum carrying capacity of the waters that can be used for KJA cultivation is 11 KJA.

Recommendation

Land use for floating net cage cultivation activities in Jeruksari Village coastal area is expected not to exceed the carrying capacity of the waters of 121 cage plots or 145.43 tons of fish/year so that the surrounding aquatic environment is not polluted.

ACKNOWLEDGEMENT

The authors would like to thank the Research and Community Service Department of Pekalongan University, for funding this research with Excellent Grant Research

in SK No. 581/B.06.01/LPPM/XI/2022.

All authors are well constributing to this article manuscript. TYM is main idea for research. HA is manuscript for all aspect. L is data analysis. W is responsible for translating the manuscript production. M and AF is collected and measured in the field and laboratory analysis.

REFERENCES

Abdo, S.M., M.A. El-Liethy, H.S. Doma, G.E. El Taweel & G.H. Ali. 2022. Chlorine as an integrated approach for environmental health and hygiene: A case study on evaluation of the performance of waste stabilization ponds located at 11 governorates in Egypt. Emerging Contaminants. 8: 243-253. https://doi.org/10.1016/j.emcon.2022.04.002

Aida, S.N & A.D. Utomo. 2018. Pendugaan daya dukung perairan untuk budidaya ikan dalam keramba jaring apung di Waduk Pondok, Ngawi Jawa Timur. Bawal. 10 (3): 197-208. http://dx.doi.org/10.15578/bawal.10.3.2018.197-208

Amores, A., M. Marcos, R. Pedreros, G. Le Cozannet, S. Lecacheux, J. Rohmer, J. Hinkel, G. Gussmann, T. Van der Pol, A. Shareef & Z. Khaleel. 2021. Coastal flooding in the Maldives induced by mean sea-level rise and wind-waves: From Global to Local Coastal Modelling. Frontiers Marine Science. 8: 665672. https://doi.org/10.3389/fmars.2021.665672

Ariadi, H & M.B. Syakirin. 2022[a]. Pembuatan keramba floating cage pada daerah rawan banjir rob di Pesisir Pekalongan. Pena Abdimas. 2: 8-13. http://dx.doi.org/10.31941/abdms.v2i0.1933

Ariadi, H., A. Wafi & S. Supriatna. 2020. Water quality relationship with FCR value in intensive shrimp culture of vannamei (*Litopenaeus vannamei*). Samakia: Jurnal Ilmu Perikanan. 11 (1): 44-50. https://doi.org/10.35316/jsapi.v11i1.653

Ariadi, H., B.D. Madusari & D. Mardhiyana. 2022[c]. Analisis pengaruh daya dukung lingkungan budidaya terhadap laju pertumbuhan udang vaname (*L. vannamei*). Enviro-Scienteae. 18 (1): 29-37. http://dx.doi.org/10.20527/es.v18i1.12976

Ariadi, H., H. Soeprapto, J. Sihombing & W. Khairina. 2022[b]. Analisa model causal loop pemanfaatan keramba budidaya ikan adaptif dan potensi pengembangannya. Jurnal Perikanan Unram. 12 (4): 504-512. https://doi.org/10.29303/jp.v12i4.343

Ariadi, H., M. Fadjar & M. Mahmudi. 2019. The relationships between water quality parameters and the growth rate of white shrimp (*Litopenaeus vannamei*) in intensive ponds. Aquaculture, Aquarium, Conservation & Legislation. 12 (6): 2103-2116.

Ariadi, H., M.B. Syakirin, H. Pranggono, H. Soeprapto & N.A. Mulya. 2021. Kelayakan finansial usaha budidaya udang vaname (*L. vannamei*) pola intensif di PT. Menjangan Mas Nusantara, Banten. AKULTURASI: Jurnal Ilmiah Agrobisnis Perikanan. 9 (2): 240-249. https://doi.org/10.35800/akulturasi.v9i2.36918.

Ariadi, H., M.B. Syakirin, S. Hidayati, B.D. Madusari & H. Soeprapto.2022[d]. Fluctuation effect of dissolved of TAN (Total Ammonia Nitrogen) on diatom abundance in intensive shrimp culture ponds. IOP Conference Series: Earth and Environmental Science 1118 (1): IOP Publishing. https://ui.adsabs.harvard.edu/link_gateway/2022E&ES.1118a2001A/doi:10.1088/1755-1315/1118/1/012001

Besson, M., J. Aubin, H. Komen, M. Poelman, E. Quillet, M. Vandeputte, J.A.M. van Arendonk & I.J.M. De Boer. 2016. Environmental impacts of genetic improvement of growth rate and feed conversion ratio in fish farming under rearing density and nitrogen output limitations. Journal of Cleaner Production. 116 (3): 100-109. https://doi.org/10.1016/j.jclepro.2015.12.084

Beveridge, M.C.M. 1996. Cage Culture. Fishing News Books Ltd. Fornham Survey. England.

Dewi, R.R.S.P.S., B. Iswanto & I. Insan. 2016. Produktivitas dan profitabilitas budidaya ikan lele (*Clarias gariepinus*) hasil seleksi dan non-seleksi pada pemeliharaan di kolam tanah. Media Akuakultur. 11 (1): 11-17. http://dx.doi.org/10.15578/ma.11.1.2016.11-17

Ding, Y., J. Zhao, W. Peng, J. Zhang, Q. Chen, Y. Fu & M. Duan. 2021. Stochastic trophic level index model: A new method for evaluating eutrophication state. Journal of Environmental Management. 280: 111826. https://doi.org/10.1016/j.jenvman.2020.111826

Direktorat Jenderal Sumberdaya Air. 2010. Baku Mutu Kualitas Air. Kementerian Pekerjaan Umum dan Perumahan Rakyat. Jakarta.

Hao, A., S. Kobayashi, N. Yan, D. Xia, M. Zhao & Y. Iseri. 2021. Improvement of water quality using a circulation device equipped with oxidation carriers and light emitting diodes in eutrophic pond mesocosms. Journal of Environmental Chemical Engineering. 9 (2): 105075. https://doi.org/10.1016/j.jece.2021.105075

Junior, A.P.B., D. Lee Flickinger & G.G. Henry-Silva. 2021. Sedimentation rates of nutrients and particulate material in pond mariculture of shrimp (*Litopenaeus vannamei*) carried out with different management strategies. Aquaculture. 534: 736307.

Kunda, M., D. Pandit & A.H. Al-Rashid. 2021. Optimization of stocking density for mono-sex Nile tilapia (*Oreochromis niloticus*) production in riverine cage culture in Bangladesh. Heliyon. 7 (1): e08334.https://doi.org/10.1016%2Fj.heliyon.2021.e08334

Kurniati, R.I., P.S. Komala & Z. Zulkarnaini. 2021. Analisis beban pencemar total nitrogen dan total fosfat akibat aktivitas antropogenik di Danau Maninjau. Jurnal Ilmu Lingkungan. 19 (2): 355-364. https://doi.org/10.14710/jil.19.2.355-364

Lin, H., Z. Chen, J. Hu, A. Cucco, Z. Sun, X. Chen & L. Huang. 2019. Impact of cage aquaculture on water exchange in Sansha Bay. Continental Shelf Research. 188:

103963. https://doi.org/10.1016/j.csr.2019.103963

Madusari, B.D., H. Ariadi & D. Mardhiyana. 2022. Effect of the feeding rate practice on the white shrimp (Litopenaeus vannamei) cultivation activities. Aquaculture, Aquarium, Conservation & Legislation-International Journal of the Bioflux Society. 15 (1): 473-479.

Mandal, R., A. Das, D. Chattopadhyay, A. Hussan, S. Adhikari, B. Paul, F. Hoque, P. Chakrabarti & B.R. Pillai. 2021. Use of sewage in split doses to enhance water productivity for fish culture. Aquaculture and Fisheries. 6 (6): 609-616. https://doi.org/10.1016/j.aaf.2020.08.008

Permatasari, M.N & H. Ariadi. 2021. Studi analisis kelayakan finansial usaha budidaya udang vaname (*L. vannamei*) di tambak pesisir Kota Pekalongan. AKULTURASI: Jurnal Ilmiah Agrobisnis Perikanan. 9 (2): 284-290. https://doi.org/10.35800/akulturasi.v9i2.36923

Pilecky, M., M. Mathieu-Resuge, L. Zavorka, L. Fehlinger, K. Winter, D. Martin-Creuzburg & M.J. Kainz. 2022. Common carp (*Cyprinus carpio*) obtain omega-3 long-chain polyunsaturated fatty acids via dietary supply and endogenous bioconversion in semi-intensive aquaculture ponds. Aquaculture. 561: 738731. https://doi.org/10.1016/j.aquaculture.2022.738731

Pratama, M.B. 2019. Tidal Flood in Pekalongan: Utilizing and Operating Open Resources for Modelling. IOP Conf. Series: Materials Science and Engineering 676. Jakarta: IOP Publishing. https://doi.org/10.1088/1757-899X/676/1/012029

Sager, L. 2009. Measuring the trophic status of ponds: Relationships between summer rate of periphytic net primary productivity and water physico-chemistry. Water Research. 43 (6): 1667-1679. https://doi.org/10.1016/j.watres.2008.12.042

Salo, T & S. Salovius-Lauren. 2022. Green algae as bioindicators for long-term nutrient pollution along a coastal eutrophication gradient. Ecological Indicators. 140: 109034. https://doi.org/10.1016/j.ecolind.2022.109034

Sari, R.S., A.Y. Wulandari, L. Maslukah, K. Kunarso & A. Wirasatriya. 2022. Konsentrasi Ion Fosfat di Perairan Wiso, Ujungbatu, Jepara. Indonesian Journal of Oceanography. 4 (1): 88 - 95. https://doi.org/10.14710/ijoce.v4i1.13233

Vea, E.B., J. Bendtsen, K. Richardson, M. Ryberg & M. Hauschild. 2022. Spatially differentiated marine eutrophication method for absolute environmental sustainability assessments. Science of The Total Environment. 843: 156873. https://doi.org/10.1016/j.scitotenv.2022.156873

Vinothkumar, R., J.Y. Dar, V.S. Bharti, A. Singh, A. Vennila, I.A. Bhat & P.K. Pandey. 2021. Heterotrophic nitrifying and aerobic denitrifying bacteria: Characterization and comparison of shrimp pond and effluent discharge channel in aspects of composition and function. Aquaculture. 539: 736659. https://doi.org/10.1016/j.aquaculture.2021.736659

How to cite this article Mardiana, T.Y., H. Ariadi, L. Linayati, W. Wijianto, A. Fahrurrozi & M. Maghfiroh. 2023. Estimation of water carrying capacity for floating net cage cultivation activities in Pekalongan Coastal Waters. Jurnal Perikanan Universitas Gadjah Mada. 25 (1): 19-24. DOI https://doi.org/10.22146/jfs.80968