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Estimation of organic waste and waters carrying capacity for lobster cage culture development in North Lombok District, West Nusa Tenggara Province

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Abstract. Lobster cultivation has prospects to be developed in North Lombok waters, West Nusa Tenggara Province. In addition to being profitable, lobster farming also has the potential to produce waste that can obstruct the sustainability of the aquaculture activity itself. The study of estimation of organic waste from lobster farming activities and anthropogenic waste was carried out to obtain information on the carrying capacity of waters for the development of lobster culture. This research was conducted in May 2018 and May until August 2019. This study used the survey method. Data collected includes primary data and secondary data. Measurement of water quality parameters was carried out at twenty-three observation points in situ for temperature, salinity, pH, dissolved oxygen, brightness, turbidity, and pH, also laboratory analysis for nitrate, ammonia, and phosphate. The estimation of a waste load from aquaculture activities refers to the mass balance model based on data from proximate analysis of feed, feed digestibility, nutrient retention, feed conversion ratio, fish biomass production, and total organic particles. Estimation of carrying capacity refers to the total nitrogen load, both from lobster culture and anthropogenic activities. The results of the study indicate that the waters of North Lombok are potential areas for the development of marine culture because of the condition of water quality in a standard threshold of sea quality. Lobster cultivation in floating net cages (FNCs) for 6 months produced waste including 213.58 kg of N and 44.07 kg of P entering the waters and anthropogenic waste including 185 62.00 kg of N and 88 793.96 kg of P. Based on the N waste load approach, the carrying capacity of the environment in North Lombok waters for the development of lobster culture in floating net cages is 2 276 FNC units. If the productivity of 1 unit of KJA in one lobster maintenance cycle for 6 months is 0.17 tons, then the optimal production of lobster is 386.80 tons.
Key Words: organic waste, carrying capacity, spiny lobster cage culture, development, water quality.

Introduction. Lobster is one of the most popular seafood ingredients in the world and has high market demand in more than 90 countries worldwide (Hart 2009; Lee et al 2016). Demand for this commodity will continue to increase along with the growth of world population and changes in consumption patterns of the world community that is turning to seafood. At present, lobster farming in floating net cages (FNC) has been developed commercially in Asian countries, such as Vietnam, the Philippines, Malaysia, Thailand and Indonesia (Arcenal 2004; Van Hung & Tuan 2009; Priyambodo & Sarifin 2009; Jones 2010). In Indonesia, most lobster culture activities are enlargement activities by capturing seed (puerulus) from nature, because until now there is no availability of lobster seeds from hatchery activities (Setyono 2006; Junaidi et al 2018a). Lombok Island is the only island with abundant availability of lobster seeds (puerulus) (Priyambodo & Sarifin 2009). Lobster ongrowing culture in floating net cages (FNCs) began to develop since 2000 on the island of Lombok (Mustafa 2013; Junaidi & Heriati 2017). At that time, many natural seeds were found attached to buoys and other materials related to the cultivation of seaweed and grouper (Erlania et al 2016; Priyambodo & Sarifin 2009), then the seeds are taken for cultivation activities ongrowing culture in the FNC (Junaidi & Heriati 2017).

More than 90% of lobster seeds caught by fishermen in Lombok Island are species *Panulirus homarus* (sand lobster), 10% *P. ornatus* (pearl lobster), and a small number of *P. versicolor* (bamboo lobster) and *P. longipes* (batik lobster) (Jones 2010). Puerulus which is captured then goes through an enlargement process using FNCs for 8-10 months maintenance period until it is ready to be harvested with a lobster weight range of 115-140 g (Petersen et al 2013). During the maintenance of lobster, it is given feed in the form of fresh trash fish which is a byproduct of fishing activities using traps (Priyambodo & Sarifin 2009). The use of trash fish as food has weaknesses including the high feed conversion ratio (FCR) so that fresh fish is needed in large quantities to support lobster growth (Tuan & Van Hung 2009). High water content in trash fish also makes the rest of the feed more prone to decay and susceptible to disease (Kim et al 2007; Ridwanudin et al 2018). Thus, organic material waste from aquaculture activities, especially the use of trash fish feed that is not well controlled will cause eutrophication or enrichment of waters from the elements nitrogen and phosphate, which will have a negative impact on the seabed and water column (Wu et al 1994; Lee et al 2015), so that it can affect the carrying capacity of aquatic environments for aquaculture development lobster.

Carrying capacity can be interpreted as the maximum production of a species or population that can be accommodated by the ecosystem (Legovic et al 2008). Carrying capacity consists of four parameters, namely (1) physical carrying capacity associated with place limits on the size and number of cultivation units affected by geographical, planning, and infrastructure factors; (2) social carrying capacity associated with socially unacceptable impacts such as reducing visual amenity and access; (3) carrying capacity of production is defined as the maximum stock density that can be harvested sustainably; and (4) ecological carrying capacity is defined as the number of cultivation units developed without causing ecological impacts (Mckindsey et al 2006; Byron et al 2011). In relation to aquaculture, the carrying capacity is defined as the capacity of an aquatic environment to support a number of biomass weights to be able to live and grow optimally in an aquatic environment determined for fisheries aquaculture activities. Thus, the estimated carrying capacity of the environment for the development of lobster culture in the FNCs is the number of FNC units that can be operated in a certain area without causing environmental degradation (Junaidi 2016b).

North Lombok District is one of the coastal districts in the province of West Nusa Tenggara, with geographic sea waters located in the Lombok Strait and the Flores Sea covering an area of 503.24 km^2 or around 38.33% of the total area with a coastline of about 125 km. There are 3 groups of islands known as Gili Matra (Meno, Trawangan and Water) which is a marine tourism area that is very well known to foreign countries as a beautiful and charming tourist destination. Aside from being used as a conservation and tourism area, some of the North Lombok Regency's aquatic resource potentials are used as aquaculture and capture fisheries. Marine aquaculture activities in the waters of North Lombok Regency are already underway and are limited to a number of systems and aquaculture commodities, with grouper commodities (*Epinephelus* sp.), seaweed (*Eucheuma cottonii*), pearl shells (*Pinctada maxima*) and lobsters (*Panulirus* sp.) (Junaidi et al 2018a).

The rapid population growth and increase in coastal development activities cause high ecological pressure on coastal ecosystems and resources, thus threatening the existence and sustainability of the ecosystem, both directly (eg. land conversion activities) and indirectly (for example the presence of waste pollution from anthropogenic activities) (Bengen 2001; Murtiono et al 2016). Sources of waste pollution from activities in North Lombok regency are generally dominated by settlement and agricultural activities that produce organic waste containing nitrogen and phosphorus and have the potential to cause eutrophication in waters. The potential contamination originating from aquaculture activities (internal loading) and activities on land (external loading) are of particular concern in relation to the development of lobster culture. Analysis of the carrying capacity of the aquatic environment is needed in the management of loster aquaculture in the waters of North Lombok Regency. Study of organic wastes from lobster and anthropogenic waste activities aims to obtain information on the carrying capacity of the waters for the development of lobster culture in floating net cages in the waters of North Lombok Regency.

Material and Method

Study area. This research was conducted in May 2018 and May-August 2019 in the waters of North Lombok Regency, West Nusa Tenggara Province. The research location extends to positions 116°6'38"-116°14'33" East Longitude and 8°14'42"-8°22'2" South Latitude, which includes four sub-districts from south to north, namely Pemenang, Tanjung, Gangga and Kayangan Districts (Figure 1).

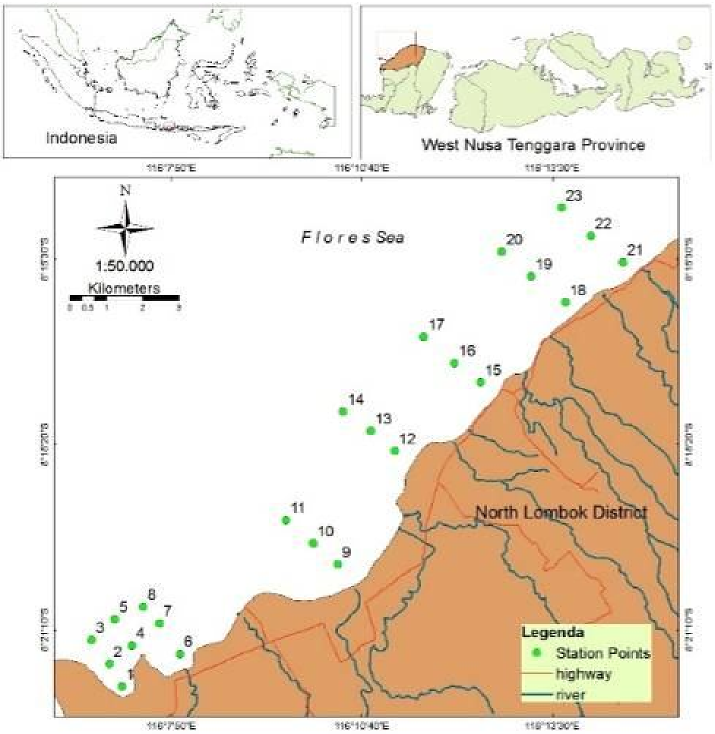

Figure 1. Location of research in North Lombok Regency, West Nusa Tenggara Province and distribution of water quality observation stations.

Data collecting. The method used in this study is a survey method. Data collected includes primary data and secondary data. Primary data include water quality data consisting of physical and chemical parameters, amount of feed, and tides obtained from measurements in the field. Secondary data includes physical data of the waters, maps of the aquatic environment, scientific publication data, data from relevant agencies.

Water quality measurement. Water quality data collection was carried out in May 2018 at 23 stations scattered randomly at the study site. Each observation and sampling station has its coordinates determined by a GPS device. Water quality parameters collected include: temperature, salinity, pH, dissolved oxygen (DO), brightness, turbidity, nitrate (NO_3-N), ammonia (NH_3), and phosphate (PO_4-P). The parameters of temperature, salinity, pH, DO, and brightness were measured directly in the field using a refractometer, pH-meter, oxy-meter, and secci disk, while the other parameters were analyzed in the Bioecology Laboratory of the Aquaculture Study Program at the University of Mataram. The method of taking, handling, and analyzing water samples refers to the standard method (APHA 2005).

Estimation of lobster aquaculture waste (internal loading). The internal loading is represented by the amount of waste that goes into funds from lobster farming activities that was removed from lobster feces and uncaptured food. The estimated total organic matter entering the water is calculated using the method proposed by Barg (1993) and

Iwama (1991) with reference to the total food uncaptured and the amount of faeces, with the formula:

$$O = TU + TFW$$

where: O = total output of particulate organic matter; TU = total food uncaptured, obtained by formula:

$$TU = TF \times UW$$

where: TF = total food fed, UW is percentage uncaptured feed waste/100 (i.e., ratio of total food uncaptured to total food fed). Total faecal waste (TFW), obtained by formula:

$$TFW = F \times TE$$

where: F = faecal waste production, which can be estimated from studies on the digestibility of main diet components, TE = total eaten food, obtained by formula:

$$TE = TF - TU$$

Estimation of total N and P waste (TN and TP) is based on data on N and P content in trash fish feed, and in lobster carcasses (Beveridge 1984; Barg 1993). Estimation of total N and P refers to the methods of Ackefors & Enell (1990) in Barg (1993), calculated using the following formulas:

$$KgP = (A \times Cdp) - (B \times Cfp)$$
$$KgN = (A \times Cdn) - (B \times Cfn)$$

where: A = wet weight of dry trash fish used (kg), B = wet weight of lobster produced (kg), Cd = phosphorus (Cdp) and nitrogen (Cdn) content of dry trash fish, expressed as % of wet weight, Cf = phosphorus (Cfp) and nitrogen (Cfn) content of the lobster, expressed as % wet weight.

Estimation of anthropogenic waste (external loading). Estimation of waste loading from economic activities on land refers to the method developed by the Land Ocean Interaction in the Coastal Zone (LOICZ) Project (Dupra et al 2000). Quantitative estimation of the burden of waste from economic activities from the mainland (upland) includes (1) settlements, and (2) livestock. The amount of organic waste (Total N and P) originating from settlements (population) and livestock (number of livestock) that are around the waters is calculated trought BPS estimation data. Data on population and livestock were obtained from BPS (2018) data. Estimation of total nitrogen (TN) and total phosphate (TP) from anthropogenic waste is calculated by multiplying the level of activity with the waste coefficient (N and P).

Estimation of carrying capacity. The estimation of carrying capacity of the waters for the development of lobster culture in North Lombok Regency is carried out using an approach that refers to the load of N waste from the cultivation system that is wasted into the aquatic environment. Nitrogen levels produced from aquaculture activities cause a nutrient enrichment in the waters. High and low levels of nutrients in the waters are determined by several factors, namely the volume of the body of water, flushing rate, and tidal fluctuations (Barg 1993), with the following formula:

$$Ec = \frac{N \times F}{V}$$

where: Ec = equilibrium rise in concentration (level of hypernutrification), N = daily output of soluble nitrogenous waste, F = flushing time of the waterbody in days, V = volume of the waterbody.

Flushing time (F) is the time (number of days) needed by the waste to settle in a body of water so that the water environment becomes clean. Determination of flushing time is determined by using the formula:

$$F = \frac{1}{D} \; ; \quad D = \frac{Vh - Vi}{T \times Vh}$$

where: F = flushing time, D = dilution rate, Vh - Vi = volume exchanged every tide (m^3); Vh = high water volume of waterbody (m^3); Vi = low water volume of waterbody (m^3); T = tide period, in day.

The volume calculation is done at mean high water spring (MHWS) and at the mean low water spring) (MLWS), tidal data refers to the data http://www.ioc-sealevelmonitoring.org/ with use the following formula:

$$Vh = A \times hi;\ Vi = A \times ho$$

where: A = surface area of water (m^2); hi and ho = depth in MLWS and MHWS (m); Vh = high water volume of waterbody (m^3); Vi = low water volume of waterbody (m^3).

Calculation of pollution load is based on measurements of water discharge and concentration of waste generated from feed and land (Marganof et al 2007) with the following formula:

$$BP = Q \times C$$

where: BP = pollution load (kg yr^{-1}); Q = volume of waterbody (m^3); C = concentration of waste N (NH_3) (mL^{-1}).

Concentration of waste studied there are two different concentration values, namely concentrations that enter the waters with existing concentrations. Therefore, to determine the total concentration of waste that enters the waters, it is carried out with a calculation model according to Bramana et al (2014) as follows:

$$Q3.C3 = Q1.C1 + Q2.C2$$

Based on the calculation model above, we obtain the total value of the concentration of waste entering the water (C3) as follows:

$$C3 = \frac{Q1.C1 + Q2.C2}{Q3}$$

where: C1 = concentration of N waste that enters the waters (mL^{-1}); C2 = N concentration at the location (mL^{-1}); C3 = total concentration of N in the waters (mL^{-1}); Q1 = volume of waterbody entering (m^3); Q2 = volume of waterbody on site (m^3); Q3 = total volume of waterbody (m^3).

Results

Water quality conditions. Tide prediction for the closest station to the waters of North Lombok Regency is 8.3° S and 106.1° E, the tidal type in these waters is classified as a double dominant mixed tide, which experiences two tides for 24 hours. The lowest tidal range is seen at the tide of neap tide, which is 38 cm while the highest range reaches 145 cm at the spring tide. With average tidal elevations ranging between +50 cm and -50 cm (Figure 2).

Based on the suitability analysis of lobster culture locations using GIS analysis, the locations included in the very suitable category cover an area of 1226.7 ha, but only about 122.67 ha of potential waters are effectively utilized for lobster farming activities in the FNCs (Junaidi et al 2018b). The results of water quality measurements at the study site are shown in Table 1.

Table 1

Water quality North Lombok Regency

Parameters	*Unit*	*Range*	*Average*	*Quality standards (Kepmen LH No. 51 2004)*
Temperature	^oC	30.7-31.7	31.06±0.27	27-32
Brightness	m	4.0-22.0	14.3±5.3	> 3
Turbidity	NTU	0.13-0.45	0.3±0.07	< 5
pH		8.0-8.2	8.09±0.5	7.0-8.5
Salinity	ppt	29-32	30.5±0.8	30-35
Dossolved oxygen (DO)	mg L^{-1}	6.8-8.7	7.46±0.41	> 5
Nitrate (NO_3-N)	mg L^{-1}	0.152-0.165	0.158±0.003	0-0.008
Ammonia (NH_3)	mg L^{-1}	0.970-0.151	0.123±0.026	0.3-1
Phosphate (PO_4-P)	mg L^{-1}	0.026-0.042	0.033±0.004	0-0.015

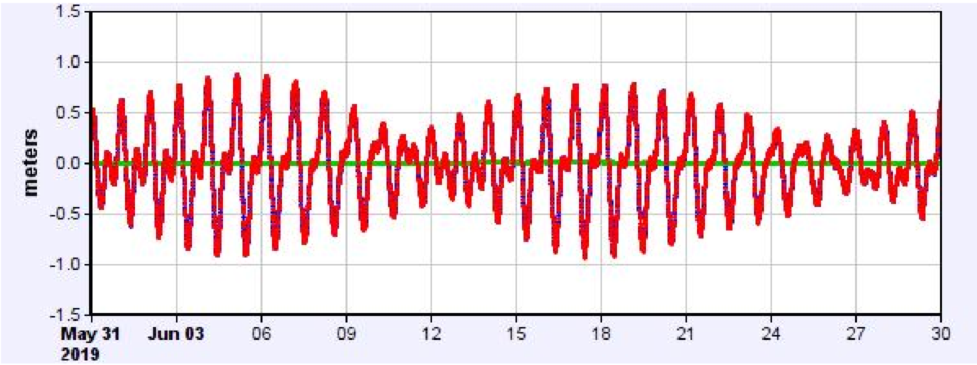

Figure 2. Tidal prediction results for 30 days in July 2019.

Lobster culture waste (internal loading). The approach to estimating aquaculture load applied in this study refers to previous research (Junaidi 2016a) and is the development of an estimation formula of the feed load that enters the water. Table 2 shows the parameter values for determining lobster culture waste load in cage. One cage unit consists of 9 cage plots measuring 3 x 3 x 3 m^3 densely stocking 200 ind $plot^{-1}$, where one cage unit is simultaneously stocked with lobsters, so that 1 cage unit contains 1 800 lobsters. During the maintenance period it is assumed that the lobster's survival rate is 80%, so at the time of harvesting it is estimated that the total lobster biomass is 1 440 ind. If the individual weight of a lobster is assumed to be 120 g ind^{-1}, then in one maintenance cycle (6 months) a total production of 0.17 tons of lobster is obtained and requires feed of 1 895.5 kg.

Table 2

The parameter value determines the waste load in lobster cage culture

Analyzed parameters	*Value*
Feed convertion ratio (FCR)	11.15
N feed content (%)	12.80
P feed content (%)	2.52
Initial weight (g ind^{-1})	20
Final weight (g ind^{-1})	120
Total food fed (kg)	1 895.5
Total food uncaptured (24%) (kg)	454.92
N content of lobster produced (kgN ton^{-1})	1 427.20
P content of lobster produced (kgP ton^{-1})	278.75
N digestiblity feed (%)	85.26
P digestibility feed (%)	88.92
N retention (%)	15.12
P retention (%)	14.64

Referring to Junaidi (2016a), the results of proximate analysis of trash feed used showed N content of 12.80% and P content of 2.52%, so there were 242.62 kg N and 47.39 kg P in lobster feed. The total amount of feed given is as many as 24% of uneaten food with levels of N 59.23 kg and levels of P 11.37 kg. Meanwhile, the food eaten will be wasted through feces, excretion and stored in meat. Waste load released from the consumption of trash feed given to lobsters entering waters is 213.58 kg N and 44.07 kg P. The total particle material produced is 987.93 kg or about 52.12% of the total trash feed used as much as 1 895.5 kg. In summary, the calculation of lobster culture waste can be seen in Table 3.

Table 3

Total N and P waste load from lobster farming

Parameters	*Amount (kg)*	*N (kg)*	*P (Kg)*
Total food fed	1 895.50	242.62	47.39
Eated food	1 440.58	184.39	36.01
Uneaten food	454.92	58.23	11.37
Feces		68.23	13.32
Retention		29.04	3.313
Excretion		87.13	19.38
Total waste	987.93	213.58	44.07

Anthropogenic waste (external loading). Estimation results show that anthropogenic activities on land (external loading) that contribute greatly are livestock and household activities in the waters of the North Lombok Regency, especially the Tanjung and Gangga Districts (BPS 2018). There are 6 rivers in both districts and flow and carry waste activities on land. The land area in Tanjung and Gangga Subdistricts is utilized as a rice field area of 1,987 ha, plantations covering 18,543 ha and the rest is used as settlements, offices, schools and others covering an area of 6,807 ha. Based on the Demographics of Tanjung and and Ganges Districts in North Lombok Regency in 2017, it shows that the population of Tanjung District is 48,411 people with male population composition of 23,838 2,928 people and women of 24,573 people. Gangga District is 42,799 inhabitants where male population is 20,929 people and female is 21,870 people. The results of the identification of the type and level of activity as well as the estimation of anthropogenic waste in the waters of North Lombok Regency especially Tanjung and Gangga District are described in Table 4.

Table 4

Anthropogenic waste load around the waters of North Lombok District

Economic activities	*Discharge coeffiecient*	*Level activities (kg yr^{-1})*	*Total N (kg yr^{-})*	*Total P (kg yr^{-1})*	*Refences*[1)]
Household activities					
Solid waste	1.86 kg N $person^{-1}$ yr^{-1}	91 210 person	169 651	33.75	Sorgeah (1974)
	0.37 kg P $person^{-1}$ yr^{-1}				Padilla et al (1997)
Domestic sewage	4 kg N $person^{-1}$ yr^{-1}		364 840		World Bank (1993)
	1 kg P $person^{-1}$ yr^{-1}			91.21	World Bank (1993)
Detergent	1 kg P $person^{-1}$ yr^{-1}			91.21	World Bank (1993)
Subtotal			534 491	216.17	
Livestock					
Cattle/buffalo/horse	43.8 kg N $head^{-1}yr^{-1}$	21 177 head	927 53	239.30	WHO (1993)
	11.3 kg P $head^{-1}yr^{-1}$				
Goat/sheep/pig	4 kg N $head^{-1}yr^{-1}$	6 709 head	26.84	144.24	WHO (1993)
	21.5 kg P $head^{-1}yr^{-1}$				
Poultry	0.3 kg N $bird^{-1}yr^{-1}$	56 279 bird	16.88	39.39	Valiela et al (1997)
	0.7 kg P $bird^{-1}yr^{-1}$				Valiela et al (1997)
Subtotal			971.27	422.93	
Total			1.505.76	639.24	

[1)] in Dupra et al (2000).

Based on the estimation results obtained data that the total amount of N (kg $year^{-1}$) is 1,505,763 and the total P (kg $year^{-1}$) is 639,239. The total N is mostly sourced from household waste amounting to 534,491 kg N $year^{-1}$, while waste from livestock is 971,272 kg N $year^{-1}$. Total P is mostly sourced from livestock waste which is 422,939 kg P $year^{-1}$, while household waste is 216,168 kg $year^{-1}$. Based on the assumption that only 25% of anthropogenic waste enters waters after going through land assimilation (Dupra et al 2000), the contribution of waste from anthropogenic activities is 0.25 x 1.505.763 = 376,440.75 kg N and 0.25 x 639,239 = 159,809.75 kg P per year. So if converted daily is 1,031.34 kg N day^{-1} and 437.83 kg P day^{-1}, the total amount of N and P from anthropogenic waste during 150 days of maintenance is 154,701 kg N and 65,675 kg P.

***Carrying capacity**.* The estimated carrying capacity with the N waste load approach in the waters of North Lombok Regency considers the load of waste originating from lobster cultivation activities in cage (internal loading) and the load of waste originating from anthropogenic activities on land (external loading). Carrying capacity with the N waste load approach is used to determine the sustainable use of coastal areas, especially for the development of lobster culture in the cage. Refer to the formula developed by (Barg 1993; Bramana et al 2014; Marganof et al 2007) it is known that the total N concentration in the waters is 0.104 mg L^{-1}. The total value of N concentration is the value of N in ammonia (NH_3-N) of total waste due to input from cultivation waste load and anthropogenic activities. The carrying capacity of waters is 0.196 mg L^{-1}, obtained from the difference between the water quality standard value for aquaculture activities (MNLH 2004) with the total value of N concentrations in the waters. Then to find out what is the maximum number of cage units that can be operated in these waters according to the carrying capacity, a calculation is done by dividing the carrying capacity of the waters by the value of the concentration of N entering the waters. In summary, the carrying capacity calculation can be seen in Table 5.

Table 5

Estimating the carrying capacity using N loads

Parameters	*Value*
Surface area of water (ha)	122.67
High water volume of waterbody (m^3)	14 720 400
Low water volume of waterbody (m^3)	12 267 000
Average volume of waterbody (m^3)	13 493 700
Flushing time (day)	1.5
Lobster culture waste	
• Food uncaptured (kgN)	0.32
• Feces (kgN)	0.38
• Excretion (kgN)	0.48
Anthropogenic waste (kgN)	1031.34
Total waste load (culture waste + anthropogenic waste) (kg)	1032.53
Concentration of N waste that enters the waters (mg L^{-1})	0.000086
N concentration at the location (mL^{-1})	0.123
Total concentration of N in the waters (mL^{-1})	0.104
Quality standard value (mL^{-1})	0.3
Carrying capacity (mL^{-1})	0.196
Total acceptable production (kg)	386.89
Total number of cage (unit)	2 276
Number of cage per ha (unit ha^{-1})	19

Discussion. Water quality is an important factor that needs to be considered in the context of land use both for fisheries, tourism, power generation, drinking water sources, or other activities. Monitoring the condition of water quality is an important stage in the management and use of land to support the sustainability of the business undertaken (GESAMP 2001; Radirta et al 2013). In general the waters of North Lombok Regency are potential areas for the development of marine culture. Physical-chemical characteristics of waters such as pH, salinity, brightness, temperature, dissolved oxygen and turbidity, still meet the threshold quality standards for marine biota, while nitrates and phosphates have exceeded the quality standard. High levels of nitrate and phosphate in addition to being influenced by external loading, lobster cultivation has the potential as a nutrient passenger in the waters from inedible feed and maintained lobster faeces that can cause a decrease in water quality as happened in Ekas Bay, West Nusa Tenggara Province (Junaidi 2016a).

Lobster culture waste load entering the waters does not differ much from the grouper aquaculture load, according to Mansur et al (2013) grouper fish farming activities in cage in the waters of Smeka Daun Kepulaun Seribu Island resulted in 243.9 Kg N and 54.1 Kg P in the waters, and in Ambon Dalam Bay of 237.1 kg N and 44.1 kg P (Murtiono et al 2016). The use of trash feed will produce a greater N and P waste load than commercial feed. Chu (1994) even stated that N waste produced from trash feed is 17 (seventeen) times higher than waste from commercial feed and only 8.1% N is utilized in the body of groupers. Although the protein content in trash feed is higher than commercial feed, commercial feed has a balance of other nutritional elements such as protein, fat, carbohydrates, vitamins and minerals so that it can affect the metabolism of the fish's body (Murtiono et al 2016)).

The high load of waste generated from lobster culture in cage, needs serious attention. Although economically trash fish feed is much cheaper than commercial feed, but the environmental impact due to the use of trash fish feed is quite real, where trash fish has a higher residual waste than commercial feed (Chu 1994). The load of cultured wastes discharged into water bodies contributes organic matter which causes enrichment of nutrients (hypernutrification) and organic matter to affect the level of fertility (eutrophication) and the feasibility of water quality for aquaculture fish life. Thus, the burden of cultivated organic waste affects the carrying capacity of the aquatic environment (Van der Wulp et al 2010).

Based on this calculation, the maximum number of cage units that can be operationalized is as many as 2 276 cage units. If the productivity of 1 unit of cage in one lobster maintenance cycle for 6 months is 0.17 tons, then the optimal production of lobster is 386.80 tons. Based on an analysis of the suitability of a lobster culture location with a geographic information system (GIS) (Junaidi et al 2018b), the location included in the very suitable category is 1226.7 ha, but only about 122.67 ha (10%) of that area can be utilized or the number of units cage of 19 units of cage ha^{-1}.

Conclusions. The results of the study indicate that the waters of North Lombok are potential areas for the development of marine culture because of the condition of water quality in a standard threshold of sea quality. Lobsters were cultivated in floating net cages for 6 months produce free of waste entering the waters of 213.58 kg N and 44.07 kg P and anthropogenic waste of 185 62.00 kg N also 88 793.96 kg P. Based on the N waste load approach, the carrying capacity of the environment in North Lombok waters for the development of lobster culture in floating net cages is 2 276 FNCs units. If the productivity of 1 unit of FNCs in one lobster maintenance cycle for 6 months is 0.17 tons, then the optimal production of lobster is 386.80 tons.

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