Original Research Article

GROWTH AND HEALTH STATUS OF SPINY LOBSTERS AND SNUBNOSE POMPANO WITH MULTILEVEL FLOATING NET CAGE SYSTEM

ABSTRACT

The cultivation of multilevel floating net cages (MFNC) systems is believed to be able to increase production capacity without increasing the horizontal area of the cultivation area. Research on the effect of using MFNC on the growth and health performance of spiny lobsters and snubnose pompano has never existed, so a study was conducted with the aim of comparing the growth and health performance of spiny lobsters and snubnose pompanoin floating net cage (FNC) and MFNC cultivation systems. The research method used was a field experiment with a comparative analysis of spiny lobsters and snubnose pompanocultivation with different cultivation systems, namely the MFNC and FNC systems with 3 replications. The rearing lasted for 2 months and was fed trash fish as much as 5% of the biomass every day. Parameters of spiny lobsters and snubnose pompanogrowth performance observed included weight growth, carapace length growth, total length growth, and specific growth rate. The health status of spiny lobsters observed quantitatively was the total hemocytes counts and hemolymph glucose levels, and snubnosepompano by counting erythrocytes and blood leukocytes. The results showed that there was no difference in growth performance, survival and health status of spiny lobsters and snubnose pompano reared using MFNC and FNC systems based on paired two sample for means, because p value > 0.05 for all growth parameters survival and health status. Thus, the use of a multilevel floating net cage system in lobster cultivation can increase FNC productivity and be efficient in optimal space utilization and does not affect water quality, especially the parameters of temperature, pH, dissolved oxygen and salinity.

Comment [A1]: Snubnose pompano

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Keywords: [blue economy, lobster estate, environmentally friendly]

1. INTRODUCTION

[The use of floating net cages (FNC) in marine waters is growing along with the development of mariculture technology, especially for growing cultivation commodities that have high economic value. The development of cultivation commodity cultivation businesses using the FNC system apart from having an impact on the social and economic aspects of society [1]. Aquaculture activities that are growing rapidly can cause pollution to the environment and disrupt the balance of the ecosystem [2]. Uneaten food residue and the metabolism of cultivated commodities are sources of nutrient and organic material pollution in waters [3], and if it exceeds the carrying capacity, eutrophication or enrichment of the waters will occur [4]. The increase in aquaculture activities has recently become a concern for various parties, especially the impact on the aquatic environment [5]. The impact of aquaculture activities must be minimized or even eliminated.

The strategy for developing aquaculture is the use of appropriate cultivation methods that can encourage the development of aquaculture systems with high levels of productivity and environmentally friendly operating systems. Existing productive and environmentally friendly

FNC technological innovations include SMART FNC, namely feed storage and water recirculation techniques [6] and stratified double floating net cage (SDFNC) [7], [8]. Apart from FNC technological innovation, aquaculture systems such as water recirculation systems with plant biofilters[9], polyculture[10], silvofishery[11], integrated multi-trophic aquaculture (IMTA) [2] is an example of implementing environmentally friendly aquaculture in several locations in Indonesia. However, its implementation is still not optimal, because generally the cultivating community focuses more on developing one species (monoculture), and often environmental aspects are not given serious attention.

Ekas Bay, East Lombok Regency, Indonesia is one of the priority locations for national lobster cultivation. The Indonesia Ministry of Maritime Affairs and Fisheries will optimize Ekas Bay as a lobster cultivation village in the lobster estate program scheme with blue economy principles(Budiyanto, 2021). The principles of the blue economy aim to create an environmentally friendly industry, so that sustainable and sustainable management of natural resources can be created [5], [13]. Cultivating lobster and pomfret fish using a multilevel floating net cages (MFNC) is a productive and environmentally friendly cultivation practice. The MFNC cultivation system is believed to be able to increase production capacity without increasing the horizontal area of the cultivation area [7], [8]. Snubnose pompano are cultivated in the upper net with the consideration of swimming at the surface, while lobsters tend to be at the bottom so they are placed in the lower net.

The MFNC system applied in this research is a modification of the FNC that has been used in lobster cultivation in Ekas Bay. Modifications were made to divide the net horizontally into two levels or parts, namely the top and bottom and there was no contact between the lobster and snubnose pompano. The use of different FNC systems will certainly affect different levels of stress as a physiological response to cultivated biota. The stress response is one of the physiological variables that influences the level of health, growth, reproduction, feed efficiency and survival of lobsters [14]. There has never been any research regarding the effect of using MFNC on the growth performance and health of lobsters and snubnose pompano, so it is necessary to carry out research with the aim of comparing the growth performance and health of lobsters in FNC and MFNC cultivation systems in Ekas Bay, East Lombok Regency, West Nusa Tenggara Province, Indonesia.]

2. MATERIAL AND METHODS

[The research was carried out in September – November 2022 in Ekas Bay, Ekas Buana Village, East Lombok Regency, Indonesia (Figure 1). The research used a field trial method with comparative analysis between lobster and snubnose pompano cultivation using the FNFC and FNC systems. The number of FNC used consists of 9 units, of which 3 units are multi-level floating net cages (MFNC), each measuring 3 x 3 x 3 m. To create MFNC, the horizontal space is divided into 2 levels with each level measuring 1.5 m (Figure 2). Installation of the net in the middle is done by cutting a 3 x 3 m polyethylene (PE) net, then knitting it with plastic rope with a diameter of 2 mm on each side of the net. The mesh size used is 0.5 cm, where the net size is for the size of lobster and snubnose pompano seeds until harvest. After the three tiered net cages have been prepared, they are then installed on the net frame with 6 other FNC holes (Figure 2).

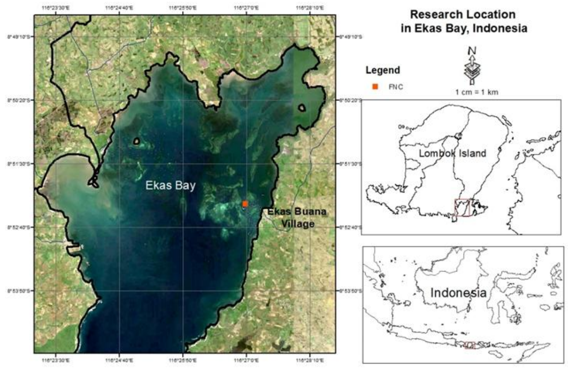

Figure 1. Research location in Ekas Bay, Indonesia

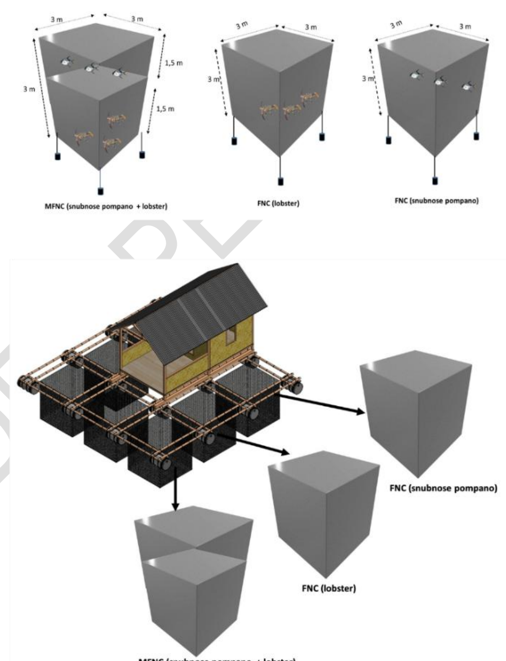

Figure 2. Multi-level floating net cage design

The research method used was a field experiment with comparative analysis between the MFNC and FNC cultivation systems where each treatment was repeated 3 times. Lobster, *Panulirushomarus* was obtained from rearing in the FNC for 1 year with a size of 160 – 180

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g, while snubnose pompano seed, *Trachinotusblochii* with a size of 4 – 6 g was obtained from the Marine Aquaculture Center (MAC) Sekotong. The lobsters and snubnose pompano that have been prepared are then stocked in MFNC and FNC, respectively 30 lobsters and 50 snubnose pompano per cage. Especially for MFNC, lobsters are stocked on the lower level, while the upper level is stocked with fish under the star. During maintenance, which lasted for 2 months or 56 days, the two biota were given food in the form of trash fish at 5% of the biomass every day.

The growth and survival performance of lobsters and snubnose pompano were analyzed by taking samples on days 14, 28, 42 and 56 of rearing. Growth performance parameters include weight growth (WG), carapace length growth (CLG), total length growth (TLG) and specific growth rate (SGR) calculated using the Solanki *et al*. (2012) dan Prabu *et al*. (2021)[15], [16]. Lobster health status by counting total hemocytes counts (THC) using a haemocytometer with the procedure of Campa-Córdova *et al*. (2002) and Blaxhall & Daisley (1973)[17], [18]and hemolymph glucose (HG) were measured using the Wedemeyer & Yasutake (1977)[19]. Health status of snubnose pompano by counting total erythrocytes counts (EC) and leukocytes counts (LC) according to the procedure of Campa-Córdova *et al*. (2002) and Blaxhall & Daisley (1973)[17], [20]. Blood samples were taken on day 0 (initial) and day 56 (final). Statistical data analysis was carried out using the SPSS version 16.0, testing the t-test (paired sample test) at the test level α = 0.05.]

3. RESULTS AND DISCUSSION

[3.1. Growth and Survivalof Lobster

Weight growth (WG), carapace length growth (CLG), specific growth rate (SGR) and survival (SR) of lobsters reared in floating net cages (KJA) and multilevel floating net cages (KJAB) can be seen in Table 1.In Table 1, it can be seen that there is no difference in the growth and survival performance of lobsters rearedin KJA and KJAB based on the paired two samples for means, because the p value is > 0.05 for all growth and survival parameters. Although the average increase in individual weight (Ave W) and carapace length (Ave CL) of lobsters reared in MFNC higher than in FNC (Figure 3).

Table 1. Growth performance and survival of lobsters reared in floating net cages (FNC) and multi-tiered floating net cages (MFNC) cultivation

Parameters	FNC	MFNC	*p value**
WG (%)	28.30±5.53	29.75±2.72	0.761
CLG (%)	36.73±1.75	35.90±5.36	0.852
SGR (%/hari)	0.45±0.08	0.48±0.04	0.052
SR (%)	100±0.00	100±0.00	-

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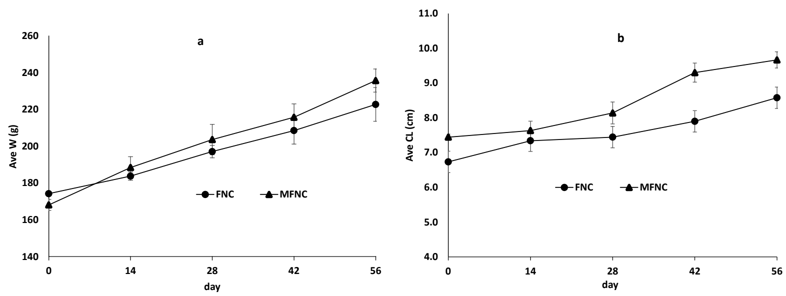

Figure 3. Average increase in weight (a) and carapace length (b) of lobsters during rearing

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3.2. Growth And Survival of Snubnose Pompano

Weight growth (WG), total length growth (TLG), specific growth rate (SGR) and survival (SR) of reared in floating net cages (FNC) and multilevel floating net cages (MFNC) can be seen in Table 2.In Table 2, it can be seen that there is no difference in the growth and survival performance of snubnose pompanoreared in FNC and MFNC based on the paired two samples for means, because the p value is > 0.05 for all growth and survival parameters. Although the average increase in individual weight (Ave W) and total length (Ave TLG) of snubnose pompanoreared in FNC is higher than in MFNC (Figure 4).

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Table 2. Growth performance and survival of snubnose pompanoreared in floating net cages (FNC) and multi-tiered floating net cages (MFNC) cultivation

Parameters	FNC	MFNC	*p value**
WG (%)	111.64±5.25	127.54±8.69	0.157
TLG (%)	129.74±29.13	150.17±1.85	0.419
SGR (% day^{-1})	1.38±0.04	1.52±0.07	0.052
SR (%)	84.33±2.49	82.33±1.89	0.225

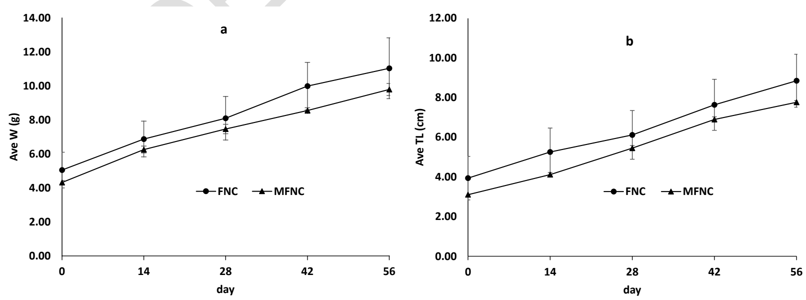

Figure 4. Average increase in weight (a) and total length (b) of snubnose pompanoduring rearing

3.3. Health Status of Lobster and Snubnose Pompano

The health status of lobsters is by calculating total hemocytes counts (THC) and hemolytic glucose (HG) levels and snubnose pompano by erythrocytes counts (EC) and leukocytes counts (LC). THC, HC of lobster and EC and LC of snubnose pompanoat the initial and final of rearing with the MFNC and FNC systems can be seen in Tables 3 and 4.In Tables 3 and 4, it can be seen that the health status of lobsters ~~of~~ reared in FNC and MFNC is no different based on the paired two samples for means, because the p value is > 0.05 for THC and HC. Likewise, regarding the health status of thesnubnose pompano, a p value > 0.05 was obtained for EC and LC.

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Table 3. Total hemocytes counts(THC) and total hemocytes counts(HC) of lobster at the initial and final of rearing

	initial		final	
	THC (x10^4 selml^{-1})	HC(mgdl^{-1})	THC (x10^4 selml^{-1})	HC(mgdl^{-1})
FNC	59.67±21.14	31.33±6.18	80.00±36.29	21.00±1.41
MFNC	48.33±5.25	28.00±4.97	72.33±11.47	20.33±0.47
		P value	0.749	0.423

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Table 4. The erythrocytes counts (EC) and leukocytes counts (LC)ofsnubnose pompanoat the initial and final of rearing

	initial		final	
	EC (10^4 selmm^{-3})	LC (selmm^{-3})	EC (10^4 selmm^{-3})	LC (sel/mm^{-3})
FNC	155,17±10,54	9766,67±1068,94	194,67±10,22	28083,33±3709,97
MFNC	136,50±4,02	8900,00±334,17	183,83±4,09	13825,00±686,78
		P value	0,354	0,022

3.4. Water Quality

The water quality observed during the maintenance of lobsters and pomfret fish using the KJAB and KJA systems which include temperature, pH, dissolved oxygen and salinity can be seen in Table 5.

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Table 5. Average temperature, pH, dissolved oxygen and salinity during maintenance

Water quality parameters		0^{th} day	14^{th} day	28^{th} day	42^{th} day	56^{th} day
Temperature (^{o}C)	FNC	28,87±0,05	28,63±0,00	28,93±0,05	28,93±0,05	28,90±0,00
	MFNC	28,63±0,19	28,63±0,05	28,80±0,08	28,90±0,00	28,80±0,08
pH	FNC	7,43±0,05	7,54±0,01	7,56±0,04	7,59±0,01	7,59±0,01
	MFNC	7,53±0,00	7,53±0,00	7,50±0,00	7,63±0,00	7,50±0,00
Disolved oxygen (mg/L)	FNC	5,40±0,00	5,40±0,00	5,17±0,09	5,17±0,09	5,40±0,00
	MFNC	5,37±0,05	5,37±0,05	5,17±0,05	5,57±0,05	5,37±0,05

Salinity (ppt)	FNC	36,00±0,00	35,00±0,00	35,00±0,00	35,00±0,00	35,00±0,00
	MFNC	35,67±0,47	35,67±0,47	35,67±0,47	32,00±0,00	32,00±0,00

3.5. Discussion

The practice of cultivating lobsters using the KJAB system is a solution to overcome the biggest problems in the aquaculture sector which is oriented only on production capacity without paying attention to environmental carrying capacity, and a lack of product diversification [21].Product diversification through polyculture activities, namely the cultivation of more than one type of fish in an integrated manner. In principle, there are several things related to commodities that must be regulated so that there is no competition in obtaining feed. Apart from that, it is hoped that each pet commodity can utilize each other so that circulation occurs in one cultivation location.

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The advantages of polyculture cultivation are the possibility of obtaining more than one commodity and implementing optimal space utilization, increasing the carrying capacity of land, improving environmental quality which can reduce the risk of crop failure compared to monoculture cultivation systems, and increasing added value for cultivators[22]. The choice of species in the polyculture of lobster and pomfret fish is because they both have different niches. Lobsters tend to be at the bottom of the cages while snubnose pompanotend to be at the surface, thus allowing farmers to get several cultivation products in the same area without increasing the size of the cultivation area. Thus, cultivating lobsters with snubnose pompanousing a multi-level floating net cage system (MFNC) is believed to be able to increase production capacity without increasing the horizontal area of the cultivation area.

In general, it can be explained that the MFNC cultivation system does not affect the growth performance of lobsters and snubnose pompano. Growth in simple terms can be formulated as an increase in length and weight over time, where growth is a complex biological process with various factors that influence it. These factors can be classified into 2 large parts, namely internal (intrinsic) and external (extrinsic) factors [23]. Internal factors include heredity, sex, age, parasites and disease. External factors that influence growth are mainly food and water temperature. The relationship between carapace length and weight describes lobster growth patterns [23], [24]. Broadly speaking, there are 2 types of growth patterns, namely isometric growth (weight gain is balanced with increase in body length) and allometric growth (weight gain is not balanced with increase in body length) [25], [26]. Allometric growth patterns are divided into 2, namely positive allometric (if the increase in weight is greater than the increase in length) and negative allometric (if the increase in weight is smaller than the increase in weight).

Lobsters in Ekas Bay have a negative allometric growth pattern [24], so that lobster length growth is more dominant than weight growth. Several research results in other areas, such as Yogyakarta and Bali, also show the same growth pattern [23], [27]. The same growth patterns in different areas can be caused by the similarity of water characteristics in supporting the availability of food and suitable habitat for lobsters. The growth pattern of snubnose pompano cultivated at BPBL Batam is negative allometric. These results are the same as the results obtained in the research of [28], snubnose pompano (*Trachinotusovatus*) originating from cultivation activities in marine cages in the South China Sea [28]; and those maintained in KJA in Brunei [28].

The specific growth rate (SGR) of lobsters reared using the floating net cage (FNC) cultivation system was 0.45 ± 0.08 % day^{-1} and multilevel floating net cages (MFNC) was 0.48 ± 0.04 % day^{-1} with 100% survival. The SGR value and lobster survival were not significant between the two cultivation systems. The SGR and survival values are relatively the same compared to the SGR values for lobsters reared in floating net cages in India with SGR values ranging from 0.48 – 0.82 % day^{-1} and survival of 75 % [29].However, it is lower than the SGR value for lobster, *Panulirusornatus*, which ranges from 0.94 – 1.18% day^{-1} and survival is 81%[30]. The specific growth rate (SGR) of snubnose pompanoreared using the floating net cage (FNC) cultivation system was 1.38 ± 0.04 $\%day^{-1}$ and multilevel floating net cages (MFNC) was 1.52 ± 0.07 $\%day^{-1}$ and survival 82-84%. The SGR value and survival of snubnose pompanowere not significant between the two cultivation systems. The SGR value of the snubnose pompanoas a result of this research is higher than the SGR value of the snubnose pompanokept in round HDPE cages which ranges from 0.86 – 0.90$\%day^{-1}$ with a density of between 5 – 15 $fishm^{-3}$ and a survival rate of 62 – 84% [31]. It is lower than the SGR value for snubnose pompanowhen given feed supplements containing organic minerals Cu, Zn, Mn and immunostimulants in the formulation, namely 2.28 – 2.65$\%day^{-1}$ and 100% survival[32].

When cultivating lobsters in multi-level floating net cages (FNC), apart from being able to increase production capacity without increasing the horizontal area of the cultivation area, another advantage of the MFNC system is that it minimizes energy use for movement, thereby producing more optimal biomass. The use of different FNC systems allows for different levels of stress as a physiological response. The stress response is a physiological variable that influences the level of health, growth, reproduction, feed efficiency and survival of lobsters [14]. The stress response can be evaluated objectively by observing behavior, or quantitatively by measuring changes in several physiological variables, such as oxygen use, blood composition, pH, hormones, ions, and hemocytes [33]. Physiological variables that can be used as indicators of stress in crustaceans are total hemocycte count (THC) and hemolytic glucose (HC)[32].

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The THC response of lobsters reared using the floating net cage (FNC) cultivation system was 80.00 ± 36.29 x 10^4 cells ml^{-1} and multilevel floating net cages (MFNC) was 72.33 ± 11.47 x 10^4 cells ml^{-1} and HC 21.00±1.41 mg dL^{-1} and 20.33±0.47 mg dL^{-1} respectively (Table 3). The THC value increased and the HC value decreased during maintenance which lasted 56 days, but within normal limits so it was able to reduce stress. The stress describes a condition where homeostasis is disrupted beyond its normal limits, where in this condition there is a reallocation of metabolic energy from investment activities (growth and reproduction) to activities to improve homeostasis, such as respiration, movement, hydromineral regulation, and tissue repair[32]. As a result, the utilization of feed energy for lobster growth, including the synthesis of immune material, can be disrupted. Hemocytes have an important role in the crustacean immune system, which can be used as an assessment of health through its characteristics and defense activity against infectious agents[34], [35].

The response of total erythrocytes (EC) and total leukocytes (LC) of snubnose pompanoreared using the floating net cage (FNC) cultivation system was 194.67 ± 10.22 x 104 $cellsmm^{-3}$ and multilevel floating net cages (MFNC) was 183. 83±4 x 104 $cellsmm^{-3}$ and LC were 28083.33±3709.97 $cellsmm^{-3}$ and 13825.00±686.78 $cellsmm^{-3}$ respectively (Table 4). EC and LC values increased during maintenance which lasted 56 days, but were within normal limits so they were able to reduce stress.

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The erythrocyte value of pomfret fish, *Colossomamacropomum*, which was fed food containing clove oil was 0.14 – 0.59 x 10^6 cells mm^{-3} and leukocytes 3.00 – 6.00 x 10^4 $cellsmm^{-3}$. Each type of fish has its own range of hematological values, in this case the erythrocyte cell value of the pomfret fish, *Colossomamacropomum*, looks low compared to the snubnose pompano, *Trachinotusblochii*. High or low numbers of erythocyte and leukocyte cells can be influenced by living habits and the type of fish[36]. Erythrocyte blood cells are an indication of the effects of stress. The greater the number of red blood cells, the more an organism can adapt and survive in environmental conditions that are low in oxygen. Meanwhile, hemoglobin plays a role in transporting oxygen to all parts of the organism's body. Active fish usually have high hemoglobin values. Leukocyte blood cells in fish play an important role in the defense system (immunity) as a result of stress, inflammation and parasitic infections. In healthy conditions, fish generally have a low white blood cell count[37].

Water quality, especially the parameters of temperature, pH, dissolved oxygen and salinity during the maintenance of lobsters and pomfret fish, are at normal limits. The optimum sea water temperature is between 26 - 29°C, salinity is in the optimal range between 25 - 40 ppt, regulated oxygen is more than 5 mg/l and pH is 7.8 - 8.4 [38], so it can be said The waters of Ekas Bay are classified as suitable as a cultivation area for lobster and pomfret fish. Thus, Ekas Bay is a potential area as a production center for superior aquaculture commodities with production levels, productivity and product quality in accordance with market demand through intensification and extensification. Apart from that, lobster and pomfret cultivation activities using a multilevel net cage system do not have an impact on water quality, especially the parameters of temperature, pH, dissolved oxygen and salinity.]

4. CONCLUSION

[There were no significant differences in the growth performance, survival and health status of lobsters and pomfret fish reared using the MFNC and FNC cultivation systems.The application of the multi-level floating net cage system (MFNC) in lobster cultivation is efficient in optimal use of space. The water quality of Ekas Bay is classified as suitable as a lobster and pomfret cultivation area and cultivation activities using a multi-level net cage system do not have an impact on water quality, especially the parameters of temperature, pH, dissolved oxygen and salinity. Therefore, lobster and pomfret cultivation in MFNC needs to be implemented in Ekas Bay as a solution to increase productivity as well as an environmentally friendly management system.]

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