Response to Anonymous Referee #1 (original comments in black, responses in blue)

This manuscript studies the spatial variations in dissolved inorganic nitrogen (DIN) and phosphorus (DIP) in Sansha Bay, an intensive mariculture system, and investigates the contribution of mariculture activities to nutrient variations. A cruise survey was conducted over the Bay in May 2020, sampling and analyzing water temperature, salinity, chlorophyll a, inorganic nutrient concentrations (N, P, and Si), and total alkalinity. Some samples of the cultivated fish, kelp, and oysters from the Bay were also collected to measure their N and P content. A two-endmember mixing model and a mass balance model were subsequently applied to 1) explain the observed spatial variations in DIN and DIP within the Bay; and 2) estimate how much the fish feed from the cage farming systems contribute to the nutrient budget as well as how much the kelp and oyster production remove the nutrient from the system.

I think this manuscript addresses an important topic and falls within the scope of the journal. However, the manuscript is not well structured and has major shortcomings in the mass balance model estimation and interpretation. There are also some language issues, partially making it hard to follow the story. Please see my detailed comments below.

[**Response**]: We appreciate that the Reviewer valued our study. We are also grateful for the critical comments from the Reviewer as per the mass balance model estimates and their interpretation, which are addressed in details in our responses as of below. Briefly, (1) we clarify that we constructed two mass balance models, one for the fish farming system and one for the entire Sansha Bay. We are rewriting "Section 2.4 Budget of N and P in the fish farming system" to optimize the descriptions of the source and sink terms of nutrients and presentations of each parameter in the mass balance equation. (2) We adjust the structure of Sections 3.3 & 3.4 as follows:

3.3 Nutrient budget in the mariculture system

- 3.3.1 Nutrient release from the fish farming system
- 3.3.2 Model sensitivity analysis for nutrient release
- 3.3.3 Nutrient removal by fish, macroalgae and oyster harvesting

3.4 Nutrient budget in Sansha Bay

(3) We are having a native English speaker to polish the language.

Major comments

1. An important assumption adopted by this manuscript is that the N and P in feed input (I_N,P) are equivalent to fish production (P_f) multiplying the feed conversion ratio (FCR) (Eq. 6). The FCR is not defined in the manuscript, so I have to speculate it based on other literature. The ratio is commonly defined as the weight of feed intake divided by the weight gained by the animal. It follows that the P_f in Eq. 6 should be the weight increase of the cultivated fish within the interested time period of the budget calculation (the time period is not specified in the manuscript). Therefore, directly assigning the total fish production in 2020 to P_f in Equation 6 will overestimate the actual feed input.

[**Response**]: The feed conversion rate is defined as the amount of feed required to produce 1 kg of wet weight fish product (Olsen and Olsen, 2008; Wang et al., 2012; Qi et al., 2019), which is clearly defined in the revision. The period for setting up the budget is the year of 2020, which is been specified in the revision.

We concur with the Reviewer that calculating feed input based on the net fish weight gain within a specific period would be more accurate. However, obtaining precise weight gain data is impractical due to the variation in fish sizes across different cages and their distinct growth cycles. Consequently, it is a common practice to use total production for calculating feed input, as noted in earlier studies by Olsen and Olsen (2008), Wang et al. (2012), Qi et al. (2019), and Gao et al. (2022). Nevertheless, we acknowledge the potential uncertainties this method introduces, as highlighted by the Reviewer. We have quantified these uncertainties, which are approximately 6%, primarily attributed to the initial and harvested weights of the fish (Chen et al., 2018; Ji et al., 2021). These assessments of uncertainty have been incorporated into the revised manuscript.

2. Descriptions of the mass balance model are confusing and missing important information to understand the estimated N and P budgets.

[**Response**]: We apologize for any confusion. In the revision, we are rewriting “Section 2.4 Budget of N and P in the fish farming system” to enhance the clarity of the descriptions concerning the source and sink terms of nutrients. We are also refining the presentation of each parameter in the mass balance equation to improve readability.

- What’s the relationship between feed loss ratio LR, feed input (I), and the total waste discharge (L)?

[**Response**]: The feed loss (F_{loss}) equals to the feed input (F_{input}) multiplied by the feed loss rate (R_{loss}), $F_{loss}=F_{input}\times R_{loss}$.

- What's the relationship between I_f (in Equation 7) and I (Equation 5)? Some statements in the manuscript suggest I = I_f * number of individual fish, while some suggest that I is the feed input.

[**Response**]: "I_f" represents the feed intake (F_{intake}), while "I" represents the feed input (F_{input}). Feed intake equals feed input minus feed loss, $F_{intake}=F_{input}-F_{loss}$. In the revision we will clarify this.

- My comment 1 also applies to the estimation of G_f in Equation 7.

[**Response**]: Please refer to our responses to Major Comment 1.

- The same parameter C_N,P is adopted for the N and P content of feed as well as the fish, which is misleading.

[**Response**]: In the revision we differentiate $C_{N,P}$ for feed, fish, kelp, oyster shell, and oyster soft tissue, replacing $C_{N,P}$ with $C_{NP,feed}$, $C_{NP,fish}$, $C_{NP,kelp}$, $C_{NP,shell}$, $C_{NP,tissue}$, respectively.

- Missing important information to evaluate the mass balance model. I don't have knowledge about the aquaculture species here, including fish (L. crocea), oysters (C. angulate), and kelp (L. japonica). What are their common growing seasons and practices? Do their N and P content as well as assimilation efficiency change at different life stages? Are the ratios of soft tissue and shell of oysters considered constant? Are these variations in parameters accounted for in the budget calculation? If not, what are the introduced uncertainties in the budget calculations?

[**Response**]: In the revision we will provide the information that the Reviewer asked for.

(1) the growing seasons and practices of aquaculture species are supplemented in "Section 2.1 Study area and maricultural practices" as follows:

L. crocea is cultured in cages throughout the year, with fish larvae of 2.5 cm-3.0 cm in length introduced into the cages twice a year (April to May and October to December) at a density of about 10000 per cage (Ji et al., 2021; Liu et al., 2022). As the fish grow, they are regularly sorted into different cages, with densities approaching 600 fish m^{-2} for fish weighing 100-200 g and 160 fish m^{-2} for those weighing 500 g (Liu et al., 2022). Generally, they can reach commercial size for harvesting within 8-13 months. The macroalgae are cultivated using suspended lifting ropes in the water, alternating cultivation between kelp and gracilaria from December to May and June to October each year without supplemental feeding (Ji et al., 2021). Considering that the production of kelp is an order of magnitude higher than that of gracilaria, this study only selected the kelp production of 1.888×10^5 tons in 2020 (http://tjj.ningde.gov.cn/xxgk/tjxx/tjnj/) for subsequent analysis. Similarly, oysters are cultured year-round in water using raft aquaculture method, with an annual production of 1.368×10^5 tons in 2020 (http://tjj.ningde.gov.cn/xxgk/tjxx/tjnj/).

(2) Yes, the N and P contents of aquaculture species at different life stages vary with their lipid, muscle, and skeletal contents, without a clear trend based on a literature review (Guo et al., 2018). However, this changes in contents do not affect our estimations because we are calculating the removal of N and P resulting from the mariculture species at the mature harvest stage. Therefore, in our study, it is reasonable to select the mature mariculture species intended for harvest to determine the N and P contents.

Yes, the assimilation efficiency of aquaculture species varies at different life stages (Liu et al., 2016). Therefore, we conducted sensitivity analysis on the assimilation efficiency of trash fish feed in Section 3.3 and in Figure 9(c) of our manuscript. The result indicated that a slight variation in the assimilation efficiency from 80 % to 90 % did not cause significant differences in the model predictions (all less than 10 %).

(3) Yes, we took the ratios of soft tissue and shell in mature oyster roughly constant. As mentioned above, we determined the dry matter proportion using mature oysters, taking the average of several collected samples.

(4) In our model estimation, we didn’t consider the variation in N and P content across different life stages of mariculture species because our primary focus is on the N and P contents of species at the mature harvest stage. The uncertainty in the budget calculation is propagated from the standard deviations (SD) of the measurements of the multiple parameters in the equation.

3. Regarding the N and P budget estimation, it is unclear what source/sink terms are measured, what terms are hypothesized or derived (based on what assumptions), how the measured DIN and DIP concentrations from the cruise survey were related to the calculation, and what contribute to the presented uncertainties in the budget. The presented budgets in Figure 8 are thus very confusing.

[**Response**]: In the revision we clarify the source/sink terms of the two mass balance models (one for the fish farming system and one for the entire Sansha Bay), as well as how each term and parameter in the budget are determined and provide a more detailed description of the uncertainty contributors. The measured DIN and DIP from the cruise survey are utilized in the calculation of the mass balance model for the entire Sansha Bay.

4. It's unclear how the nutrient removal by oyster production is calculated. The C and N content of the dry tissue and shell of oysters were measured but the data was not presented in the manuscript. In the calculation of nutrient removal, the production of oyster soft tissue and shell were applied but we can't tell whether the dry weight or wet weight of the production was adopted. If it's the wet weight, the calculated removal will be a substantial overestimation.

[**Response**]: The nutrient removal via oyster harvesting was calculated by multiplying the annual production of oyster with the dry weight ratios of oyster soft tissue and shell, and by the N and P contents in them, respectively.

The N and P contents data for oyster soft tissue and shell are summarized in Table S1 of Supporting Information.

We adopted the dry weight of oyster soft tissue and shell in our calculations. And, in the revision we clarify the data position and calculation details.

5. The manuscript also compares different nutrient fluxes, including nutrient input from fish farming, nutrient removal by kelp and oyster aquaculture, nutrient discharge from rivers, and nutrient exchange between the bay and the shelf. It's unclear to me what time scale this comparison focuses on. It seems to be over a year. If so, it's problematic to use the observations of nutrient concentration in May 2020 to represent the entire year when calculating the riverine nutrient input and the nutrient exchange flux. Plus, the flow rates also change in different months.

[**Response**]: We acknowledge the Reviewer's concern on the time scale. In the manuscript, the time scale for comparing nutrient fluxes is the entire year of 2020. Indeed, we extrapolated the data from May 2020 to the entire year for comparison. Here, we address this concern by presenting results from different time scales.

On a monthly scale in May 2020, we calculated the DIN flux from river input and exchange with the offshore coastal waters to be 217 tons and 529 tons, respectively. On a yearly scale for the year 2020, by extrapolating the May data to the entire year, we obtained the DIN flux from river input of 2561 tons yr^{-1}. To validate this extrapolated data, we utilize statistical data from 2020 (Table R1), revealing the monthly river discharge (https://slt.fujian.gov.cn/xxgk/tjxx/swxb/) and the monthly average concentration of DIN (https://sthjt.fujian.gov.cn/zwgk/sjfb/hjsj/) of the Jiaoxi Stream to be $(1.47 \pm 1.20)\times10^8$ m^3 and 79.06 ± 27.07 μmol L^{-1}, respectively. With these data, we calculate the annual DIN flux from river input to be 1956 ± 1724 tons yr^{-1}.

The variations in monthly river discharge and nutrient concentration introduce significant uncertainty into river input estimates. However, the extrapolated flux falls within this error range, indicating that the assumption based on May data extrapolation is reasonable.

Table R1. Monthly river discharge and DIN concentration of the Jiaoxi Stream in 2020

Month	1	2	3	4	5	6	7	8	9	10	11	12
River discharge ($\times10^8$ m^3)	0.28	0.95	2.82	3.0	1.78	3.9	1.63	0.89	1.13	0.75	0.22	0.32
DIN (μmol L^{-1})	116.3	52.9	58.5	73.4	64.6	60.8	91.5	63.2	44.4	94.6	96.1	132.4

6. The presentation quality of the manuscript needs substantial improvement. Please check my specific comments below.

[**Response**]: We are making necessary revisions accordingly to ensure clarity and readability.

Specific comments

L13-14. No direct evidence to attribute the addition of DIN and DIP to "mariculture activities in Spring 2020”. Other sources are not excluded.

[**Response**]: We have to disagree with the Reviewer. With other sources duly considered, the addition of DIN and DIP in Sansha Bay is predominantly attributed to mariculture activities. According to Fig. R1 (Figure 10 in the manuscript), we can see that the DIN and DIP released by the fish farming system are significantly higher than the river input and exchange with offshore coastal waters. Additionally, the N released through denitrification and anammox in surface sediments is approximately 3379 tons yr^{-1} according to study by Han et al. (2021), which is significantly lower than the mariculture inputs.

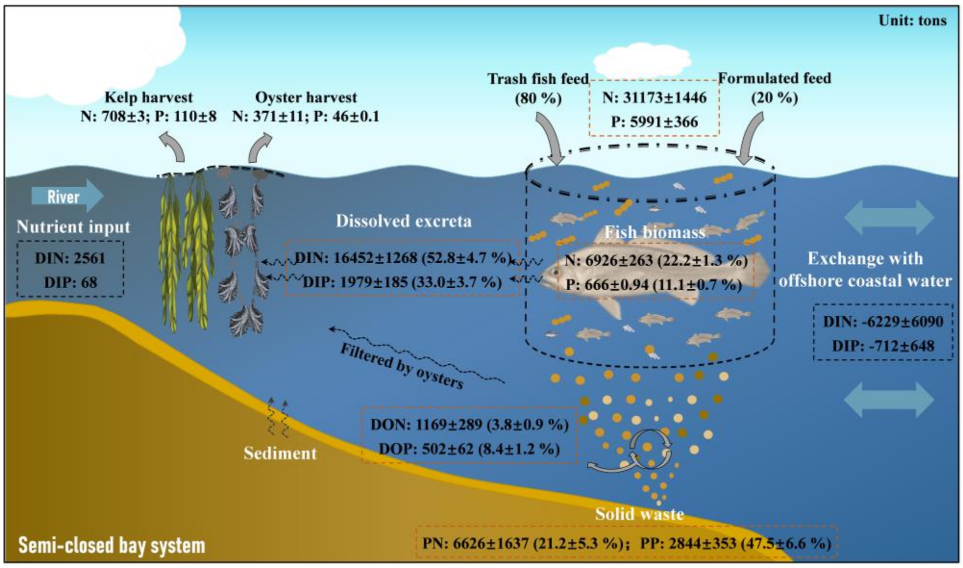

Figure R1. Conceptual diagram illustrating the nutrient transformation of different species resulting from mariculture in the semi-enclosed bay system, which was influenced by river input and offshore coastal water exchange.

L16-18. What’s the time scale for this comparison? Please make it clearer.

[**Response**]: The time scale for comparing nutrient fluxes is the entire year of 2020. It has been clarified in the revision.

L19-21. The logic is weak here. The preceding sentence describes how promising kelp and oyster production can remove nutrients, while here advocates adjusting feed strategies and feed conversion rates to mitigate eutrophication. Can’t see how these two sentences can be connected with a “therefore”.

[**Response**]: We move the sentence “the co-culture strategy involving kelp and oyster production in 2020 can removed (1.08 ± 0.01)×10^3 tons of N and (1.56 ± 0.08) ×10^2 tons of P, respectively." to after the sentence "A mass balance model estimated an annual release of N and P from the fish farming system fed with mixed trash fish feed and formulated feed of (2.42 ± 0.15)×10^4 tons and (5.33 ± 0.37)×10^3 tons, respectively." to address the feed strategies.

L40. Please explain how feed conversion rate (FCR) is defined, otherwise, it's difficult to interpret the listed range.

[**Response**]: Feed conversion rate is defined as the amount of feed required to produce 1 kg of wet weight fish product. And, we change the sentence to "One commonly cited factor contributing to this problem is the high feed conversion rate (R_{conv}, the amount of feed required to produce 1 kg of wet weight fish product), i.e., the low utilization efficiency of fish feeds (Nederlof et al., 2021)." for clarification.

L41-42. These percentages are higher than those listed in the abstract. Does it suggest that Sansha Bay has a higher feed conversion rate?

[**Response**]: Yes, Sansha Bay does have a higher feed conversion rate value. But, two issues have to be clarified: a higher released percentage corresponds to a higher feed conversion rate value; the percentages in L41-42 (Norwegian salmon farming system) and those mentioned in the abstract (Sansha Bay system) represent different forms of nutrient.

The percentages (58-62 % of N and 79-81 % of P) mentioned in the Norwegian salmon farming system (L41-42) include the release of all forms of nutrients (including dissolved and particulate, inorganic and organic). However, the data presented in our abstract refer to the release of inorganic nutrients (DIN and DIP). According to the calculations (Fig. R1, i.e., Fig. 10 in the manuscript), the percentages of all forms of N and P released into the environment were ~77.8% and ~88.9% in Sansha Bay, respectively, which are higher than those in Norway salmon farming system. Therefore, the higher released percentages in Sansha Bay correspond to higher feed conversion rate values.

L47. Suggest replacing "Thus" with "For example"

[**Response**]: Modified as suggested.

L77. What does "semi-quantitatively" mean?

[**Response**]: Here, semi-quantitative refers to quantifying changes in nutrients attributable to physical mixing and non-mixing processes through the endmember mixing model. In the revision, we delete this word to avoid confusion.

L95. What is tidal prism referred to?

[**Response**]: Tidal prism refers to the volume of water that enters or exits a bay during one tidal cycle (Wang et al., 2011). This term is commonly used to describe the total amount of water exchange due to tidal action within a specific area. We add the explanation statement as follows: "The tidal prism (the volume of water enters or exits the bay during one tidal cycle) is ~2.68×10^9 m^3 (Wang et al., 2011), and the water depth within the bay ranges from a few meters to 90 m.".

L105. What does seawater half-exchange time mean?

[**Response**]: The half-exchange time is defined by the time required for half of the seawater within the bay to be replaced by seawater from the offshore coastal waters under the influence of tidal and residual currents (Lin et al., 2017; Lin et al., 2019). In the revision the definition is provided.

L115. The unit m^3 should be m^2.

[**Response**]: Here the unit m^3 represents the volume of the deep-water cages. In the revision, we change "area" to "extent" for clarity.

L116-117. Are these fish of different wet weights co-cultured? Are densities part of the estimation for the budget?

[**Response**]: No, fishes with different wet weights are cultured in different cages. The cultivation process of *L. crocea* is roughly as follows: The *L. crocea* larvae are mainly cultivated in indoor cement tanks. When the larvae reach the juvenile stage of 2.5 cm-3.0 cm, they can be moved into the cages for cultivation. Then, as the fish larvae grow, they are periodically sorted into different cages (Liu et al., 2022).

No, density data are not part of the budget estimate. Mentioning density here is intended to express the large scale of mariculture in this area.

L127. oyster production didn't show a linear increase in Figure 2b.

[**Response**]: We agree with the Reviewer. The original sentence intended to convey that the abrupt increase in oyster production in 1997 was due to changes in statistical methodologies. For enhanced clarity, we have revised the sentence as follows: “Due to changes in the statistical methodology for oysters, which now includes the shell weight, since 1997, there was a sudden numerical increase in oyster production in that year. This was followed by a declining trend, which eventually transitioned into a phase of fluctuating stability starting in 2013 (Fig. 2(b)).”.

L129. DIN didn’t show a steady increase. It started to decline in 2006.

[**Response**]: We agree with the Reviewer and have updated the statement accordingly, adding detailed explanations in the revision. Although we can only estimate the long-term trend of DIN from data collected in individual years, we observed a significant overall increase compared to 1984. Deviations from linear growth are primarily noted in the data from 2006 and 2010. In 2006, the DIN concentration in April was significantly higher than in other years. As there is no corroborating data, we speculate this might be due to unutilized DIN or differences in river discharge. Historical data indicate that the peak period for algal blooms in the East China Sea typically occurs in May and June (Li et al., 2023). Since algal blooms consume substantial nutrients, DIN concentrations are likely elevated in April, before the onset of widespread blooms. In 2010, the higher DIN data was mainly attributed to the inclusion of measurements from Jiaoxi Stream stations, which have higher DIN concentrations (Liu, 2013).

L113-132. Should provide more information about the common growing seasons and practices of cultivated fish, kelp, and oysters in Sansha Bay. The starting and lasting time of aquaculture will affect the nutrient dynamics. Such knowledge is needed to help readers understand the nutrient budget analyses.

[**Response**]: We add this information as per the Reviewer's suggestion. Please refer to our response to Major Comment 2 where we have detailed our revisions on mariculture species information.

L144-145. This statement suggests that DIN in April 2006 was higher than that in May 2006. Any supporting evidence?

[**Response**]: We do not have concrete evidence to explain the higher nutrient concentrations in April 2006. However, we provide possible reasons in our response to Comment L129.

L148. What does "measured continuously" mean? Continuously in time?

[**Response**]: Yes, measured continuously refers to collecting data continuously in time. We change this sentence to "Water temperature and chlorophyll a (Chl-*a*) concentrations were measured continuously in time using a multi-parameter instrument (YSI Model 5065, YSI Co., USA).".

L165-166. Is it necessary to provide the detail of where the reference material is obtained, in terms of reproducing these analyses?

[**Response**]: Yes, it is necessary to provide sources of standard substances. Nevertheless, we provide reference (Cai et al., 2004) to simplify the source information in the revision.

L169-170. These are very important parameters. More information regarding the biological samples is needed, e.g., weights of these biological samples (considering that individual organism's N and P contents might vary depending on the weight), how many individual fish and oysters were sampled, how much kelp and fish feed were collected for the measurement.

[**Response**]: The suggestions are taken. In "Section 2.2 Sampling and method of analysis" of the revision, we provide the information regarding the weight of samples, as well as details on sample processing and determination.

L182. Average over time or water depths?

[**Response**]: Here, the average values represent the data at different depths for station S25. We change the sentence to "Due to the good vertical mixing, the average value at different depths of station S25 characterized by high salinity and low nutrient concentrations was selected as the seawater endmember.".

L188. percent -> percentage

[**Response**]: Modified as suggested.

L215-216. Does this apply to Sansha Bay only or generally to all mariculture? Please make it clearer and provide a reference.

[**Response**]: This applies generally to all mariculture (Reid et al., 2009; Wang et al., 2012; Qi et al., 2019). With a series of feeding management applications, such as improving waste pellet detection mechanisms using machine vision and observing the feeding behavior of fish, the feed loss is lower than in the past. We provide references and change the sentence to "Feed loss (F_{loss}) is a significant source of particulate organic waste, but now the loss is lower than before with better feeding management (Reid et al., 2009; Wang et al., 2012; Qi et al., 2019).".

L261. Insert "at different depths" after "nutrient concentrations"

[**Response**]: Modified as suggested.

L432, L436, L467. "consumption" is a bit misleading. Suggest replacing it with "demand".

[**Response**]: Modified as suggested.

L444. Delete "however".

[**Response**]: Modified as suggested.

There are many long sentences, making it difficult to follow the story. Each of them can be broken into two or even more shorter sentences to improve the clarity. Below I provide line numbers for some of them:

L9-12; L54-57; L60-63; L66-68; L134-136; L174-178; L298-302; L451-454.

[**Response**]: Thanks for the Reviewer's suggestions. We modify all the long sentences to improve the clarity. As follows:

L9-12: We change the sentence from "This study focuses on one of the world's highest density mariculture sites, Sansha Bay, Fujian Province, China, featuring integrated multi-trophic aquaculture practices involving croaker, kelp and oyster, based on examination of nutrient distributions and releases." to "This study explores the integrated multi-trophic aquaculture practices in Sansha Bay, Fujian Province, China, one of the world's highest density mariculture sites. It focuses on the cultivation of croaker, kelp and oyster, analyzing the nutrient distributions and releases.".

L54-57: We change the sentence from "Macroalgal cultivation is often included in IMTA systems to alleviate environmental impacts, as it allows efficient nutrient recycling and transformation, because of its pronounced nutrient absorption and storage capacity in tissues, while also offering an ecologically friendly option." to "Macroalgal cultivation is often included in IMTA systems as an ecologically friendly option to alleviate environmental impacts. It plays a crucial role in nutrient recycling and transformation, primarily because of its pronounced nutrient absorption and storage capacity in tissues.”.

L60-63: Based on the context, we delete the sentences L60-63 from the original and replace them with: “Although these studies assessed the purification effects of macroalgae and oysters on mariculture environment, they ignored how mariculture activities affect the nutrient balance of the entire marine ecosystem. In practice, it is necessary not only to evaluate the impact of IMTA systems on nutrient cycles based on the feed type, the cultivation species and the feeding strategy, but also to consider the nutrient budget of the entire study area by integrating river inputs and exchange with the offshore coastal waters.”.

L66-68: We change the sentence from “We here focus on Sansha Bay located in Fujian Province, China, one of the highest density IMTA system worldwide, featuring the world’s largest croaker (*L. crocea*) cage culture as a case study to shed light on the interactions between a mariculture system and the environment (Song et al., 2023).” to “We here focus on Sansha Bay located in Fujian Province, China, one of the highest density IMTA system worldwide. This system features the world’s largest croaker (*L. crocea*) cage culture (Song et al., 2023), serving as a case study.”.

L134-136: We move the relevant information of remote sensing data from the Figure 2 caption to the main text: “Based on Landsat and Sentinel-2 remote sensing data from 1999 to 2020, the support vector machine method (detailed in Text S1 of Supporting Information) was employed to classify cage and macroalgal culture distributions. The results showed mariculture gradually expanded from nearshore to offshore waters.”, and revise the sentence in the figure caption to: “Classification of cage culture and macroalgal culture in Sansha Bay from 1999 to 2020. Red represents cage culture and green represents macroalgal culture.”.

L174-178: We change the sentence to: “A two-endmember mixing model was used to construct the conservative mixing schemes between different water masses based on the TA-S diagram (Fig. 3). Because TA is assumed to be quasi-conservative in the absence of organic matter production/degradation and the exclusion of biogenic calcium carbonate production/dissolution processes (Zhai et al., 2014; Zhao et al., 2020). The model aims to quantify the addition or removal of nutrients on top of conservative mixing.".

L298-302: Regarding the long sentence here, we only split it into two sentences in the middle of the sentence.

L451-454: We change the long sentence to "The government of Ningde took measures to remove mariculture activities from the inner bay to the outer bay. However, it remains uncertain whether these measures will exacerbate HABs outbreaks outside the bay and reach a tipping point. Therefore, long-term monitoring and research on water quality are essential.".

Examples of poor or difficult language:

L37-38. incomplete sentence

[**Response**]: We change these sentences to "Many studies have reported instances of eutrophication in waters used for mariculture (Schneider et al., 2005; Skriptsova and Miroshnikova, 2011; Wang et al., 2012; Bouwman et al., 2013). One commonly cited factor contributing to this problem is the high feed conversion rate (R_{conv}, the amount of feed required to produce 1 kg of wet weight fish product), i.e., the low utilization efficiency of fish feeds (Nederlof et al., 2021).".

L38-41. poor logic

[**Response**]: We revise these sentences to improve their logic. As follows: "For example, Norwegian salmon farming industry has taken important steps to reduce the R_{conv} values. Approximately 58-62 % of N and 79-81 % of P from the total feed input in Norwegian farming industry were still released into the environment when R_{conv} ranged between 1.06-1.17 (Wang and Olsen, 2023).".

L47-51. "therefore" and "thus" in a row

[**Response**]: Following earlier suggestion, "thus" is replaced with "for example".

L63-65. poor logic

[**Response**]: We simplify and change the sentence to "In practice, it is necessary not only to evaluate the impact of IMTA systems on nutrient cycles based on the feed type, the cultivation species and the feeding strategy, but also to consider the nutrient budget of the entire study area by integrating river inputs and exchange with the offshore coastal waters.”.

L68. Is this the goal of this study or that of Song et al. (2023)?

[**Response**]: This is the goal of our study. We apologize for the misplacing the citation. The phrase “the world’s largest croaker (*L. crocea*) cage culture” is referenced from Song et al. (2023). We adjust the citation’s position in the revision.

L75-77. Redundant sentence. Can delete “proposed to” and “science-based”.

[**Response**]: Modified as suggested.

L206-208. Confusing.

[**Response**]: The original meaning of this sentence is to explain that in the fish farming system, nutrient waste mainly comes from two parts: one is the direct feed loss and the death of fish; the other part is the excretion and feces of the fish. Due to the unclear description of the calculation process of N and P budget, we rewrite Section 2.4 in the revision, please refer to Major Comment 2.

L439-431. Poor logic

[**Response**]: We change the sentence to “However, from a sustainable development perspective, as the proportion of trash fish feed usage increases, the release of DIN and PON-Feed into the environment will also increase (Fig. 9(a) in the manuscript), leading to negative impacts on water quality.”.

L466. The preceding sentence only describes the removal efficiency of kelp but not oysters. It can’t derive the conclusion following the “therefore”.

[**Response**]: We supplement the removal efficiency of oysters and change the sentence to “For each ton of kelp (dry weight) harvested, 22.5 kg N and 3.5 kg P can be removed from the water. Similarly, oysters can remove 5.1 kg N and 0.67 kg P.”.

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