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# CALCIUM AND PHOSPHATE CONCENTRATIONS IN COASTAL WATERS AT THE PARIGI DUA FLOATING NET CAGE AQUACULTURE SITE, BANDA NAIRA, CENTRAL MALUKU, INDONESIA

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## ABSTRACT

This study assessed calcium (Ca) and phosphate concentrations in seawater at the Parigi Dua floating net cage (FNC) aquaculture site in Nusantara Village, Banda Naira, Central Maluku, Indonesia. Seawater samples were collected at a depth of 8 m during August–September 2025. Calcium and phosphate were measured using Hanna HI758 Calcium Checker and Hanna HI713 Phosphate Checker instruments, respectively, while supporting water-quality parameters were measured in situ. The mean water temperature was 28.3 °C, salinity 30 ppt, pH 7.78, and dissolved oxygen (DO) 5.3 mg $L^{-1}$. Calcium concentrations were reported to range from 418 to 600 mg $L^{-1}$, with a mean of 509 mg $L^{-1}$. Phosphate concentrations were 0.11 mg $L^{-1}$ in August and 0.90 mg $L^{-1}$ in September, giving a reported mean of 0.505 mg $L^{-1}$. This mean is substantially higher than the 0.015 mg $L^{-1}$ phosphate criterion cited by the original study from Indonesian Government Regulation No. 22/2021. The findings identify phosphate enrichment as a priority for follow-up monitoring around the aquaculture site. However, the descriptive design and limited temporal sampling do not establish the source of phosphate or demonstrate that aquaculture was its cause. Further work should include replicated sampling across stations, depths, tides, and seasons, alongside quality assurance and source assessment.

***Keywords****:* calcium; phosphate; floating net cages; coastal water quality; aquaculture; Banda Naira

## INTRODUCTION

Floating net cage (FNC) aquaculture is an important approach to fish production in coastal and island settings. Its environmental performance depends in part on the exchange of water and the balance between nutrient inputs and the assimilative capacity of the receiving ecosystem. Uneaten feed and fish excretion can release nutrients to surrounding waters, while currents, mixing, biological uptake, and other land- and sea-based activities influence local concentrations. Water-quality monitoring is therefore an important component of responsible aquaculture management (Boyd, 2015).

Calcium is a major dissolved constituent of seawater and is involved in a range of biological processes, including skeletal and shell formation in calcifying organisms. Phosphorus, commonly

measured in water as phosphate, is an essential nutrient for primary production. When available phosphorus becomes excessive relative to local ecosystem conditions, it may contribute to nutrient enrichment and eutrophication. Interpretation should nevertheless consider the chemical form measured, background conditions, hydrodynamics, and other nutrients rather than treating a single concentration as proof of ecological impact.

Parigi Dua, in Nusantara Village, Banda Naira, Central Maluku, Indonesia, supports floating net cage activity. Site-specific information on calcium and phosphate concentrations can provide an initial baseline for local monitoring. This study therefore aimed to measure calcium and phosphate concentrations at the Parigi Dua FNC site during August–September 2025 and describe these results alongside basic water-quality parameters.

## MATERIALS AND METHODS

### Study site and sampling period

The study was conducted in coastal waters at Parigi Dua, Nusantara Village, Banda Naira, Central Maluku, Indonesia, during August and September 2025. Water samples were collected at a depth of approximately 8 m, corresponding to the depth of the floating net cage enclosure. The source report does not provide geographic coordinates, the number of sampling stations, the number of replicate samples, or exact sampling dates; these details should be added from field records before submission.

### Water sampling and field measurements

Seawater samples were placed in labelled sample bottles and transported in a cool box to the Banda laboratory. Temperature, salinity, pH, and dissolved oxygen were measured in situ using a thermometer, refractometer, pH meter, and dissolved oxygen meter, respectively. Current speed was measured using a modified current-measuring instrument. The source report does not specify the analytical detection limits, calibration procedures, replicate measurements, or sample preservation duration.

### Calcium and phosphate analysis

Calcium was measured using a Hanna HI758 Calcium Checker, and phosphate was measured using a Hanna HI713 Phosphate Checker, as reported in the study materials. Measurements followed the general colorimetric workflow described in the source report: preparation of the instrument blank or zero reading, addition of the sample and designated reagent, reaction for the prescribed period, and instrument reading. Before submission, the authors should confirm the exact reagent protocols and reporting units against the instrument manuals and laboratory records, especially whether the phosphate result is expressed as $PO_4^{3-}$ or as phosphorus (P).

### Data analysis

Data were analysed descriptively. Monthly values and reported means were summarized in tables and compared with the water-quality criterion cited in the original report from Government Regulation of the Republic of Indonesia No. 22 of 2021. No inferential statistical analysis was conducted. Because the available source summary does not include the full calcium monthly dataset, the reported calcium range and mean are presented without reconstructing monthly values.

## RESULTS AND DISCUSSION

Mean water temperature was 28.3 °C, salinity was 30 ppt, pH was 7.78, and dissolved oxygen was 5.3 mg $L^{-1}$. The reported current speed averaged 0.025 m $s^{-1}$. Monthly measurements are summarized in Table 1.

Table 1. Water-quality parameters measured at the Parigi Dua FNC site in August and September 2025.

| Parameter | August 2025 | September 2025 | Mean |
|---|---|---|---|
| Temperature (°C) | 27.9 | 28.7 | 28.3 |
| Salinity (ppt) | 30 | 30 | 30 |
| Current speed (m $s^{-1}$) | 0.03 | 0.02 | 0.025 |
| pH | 8.10 | 7.47 | 7.78 |
| Dissolved oxygen (mg $L^{-1}$) | 5.4 | 5.2 | 5.3 |

The source report gives a calcium concentration range of 418–600 mg $L^{-1}$ and a mean of 509 mg $L^{-1}$. The available summary does not provide clearly legible monthly calcium values, so these are reported as the study's summary statistics rather than recalculated results. The values should be checked against the original laboratory sheets before submission.

Phosphate concentration was reported as 0.11 mg $L^{-1}$ in August and 0.90 mg $L^{-1}$ in September (Table 2). The reported mean was 0.505 mg $L^{-1}$, calculated as the arithmetic average of the two monthly values. Thus, the September result was approximately eight times the August result.

Table 2. Phosphate concentrations reported for the Parigi Dua FNC site

| Parameter | Concentration (mg $L^{-1}$) | Reported mean (mg $L^{-1}$) |
|---|---|---|
| Phosphate, August 2025 | 0.11 | |
| Phosphate, September 2025 | 0.90 | |
| Phosphate, two-month mean | - | 0.505 |

The mean temperature (28.3 °C) and salinity (30 ppt) describe warm, marine conditions during the sampling period. Mean pH was 7.78 and mean dissolved oxygen was 5.3 mg $L^{-1}$. These summary values provide useful context, but two monthly observations are insufficient to characterize daily fluctuations or seasonal variability. Dissolved oxygen in particular can vary with time of day, water movement, stocking density, feeding, and organic matter decomposition. Follow-up monitoring should therefore use standardized sampling times and repeated measurements.

The reported mean calcium concentration was 509 mg $L^{-1}$. Calcium is naturally abundant in seawater and supports physiological functions in marine organisms, including calcification. However, a concentration described as "high" should be interpreted against a suitable regional reference, analytical method, and unit basis. The present study did not include a reference station outside the FNC area, nor did it measure calcium across a broader spatial gradient. Consequently,

the results cannot establish whether the observed concentration was elevated relative to local background seawater or whether the FNC activity affected calcium levels.

The reported phosphate mean of 0.505 mg $L^{-1}$, together with the increase from 0.11 mg $L^{-1}$ in August to 0.90 mg $L^{-1}$ in September, indicates that the site warrants closer investigation of nutrient conditions. The original report compared the mean with a 0.015 mg $L^{-1}$ criterion cited from Government Regulation No. 22/2021. This comparison suggests a substantial exceedance if the measured analyte, unit basis, and applicable regulatory category are the same. The authors must verify the exact standard and whether it applies to the analyte as reported before making a formal compliance claim.

Uneaten feed and fish excretion are plausible nutrient sources at FNC sites. The source report also notes nearby port and cold-storage activities as possible contributors. Nevertheless, the current study did not quantify feed inputs, fish biomass, effluent, or other source-specific indicators, and it did not sample reference sites. The data therefore identify a potential nutrient-enrichment signal but do not demonstrate its source or establish eutrophication. Phosphate speciation, nitrogen concentrations, chlorophyll-a, transparency, and biological indicators would help determine whether the measured concentration is associated with ecological effects.

This study provides an initial, site-specific snapshot, but several limitations constrain interpretation: the sampling period covers only two months; station and replicate numbers are not reported in the available summary; monthly calcium values are not fully available; and method validation, detection limits, and quality-control procedures are not described. The phosphate reporting basis also requires confirmation. Future studies should include multiple stations inside and outside the FNC area, replicated samples at defined depths, seasonal sampling, and measurements across tidal and daily cycles. Field blanks, calibration checks, duplicate samples, and laboratory confirmation would improve confidence in the results. Measurements of dissolved inorganic nitrogen, total phosphorus, chlorophyll-a, and sediment organic matter could further support assessment of nutrient dynamics.

## CONCLUSION

At the Parigi Dua floating net cage site in Banda Naira, the study reported mean water temperature of 28.3 °C, salinity of 30 ppt, pH of 7.78, dissolved oxygen of 5.3 mg $L^{-1}$, and current speed of 0.025 m $s^{-1}$ during August–September 2025. Calcium was reported at 418–600 mg $L^{-1}$, with a mean of 509 mg $L^{-1}$. Phosphate concentrations were 0.11 mg $L^{-1}$ in August and 0.90 mg $L^{-1}$ in September, with a reported mean of 0.505 mg $L^{-1}$. The phosphate results warrant verification and more intensive monitoring, particularly confirmation of the analyte basis and applicable regulatory threshold. Given the descriptive design and limited sampling, the findings should be treated as preliminary and do not establish a causal link between aquaculture activity and phosphate concentration.

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