FRESHWATER SYSTEMS · CAGE AQUACULTURE

Cage Culture and Organic Matter Loading in Lake Victoria

Assessing how cage-culture husbandry contributes to the organic matter load of Kenya's Winam Gulf, and what it means for sustainable aquaculture management.

REFERENCE	ISSUED	REGION
C82_5(1)	**May 2026**	**Winam Gulf, Lake Victoria**

FRESHWATER SYSTEMS

427
kg m^{-3} mean stocking biomass observed across surveyed cages

≈45,800
tonnes of organic waste generated per year (estimate)

74%
of farms are less than five years old

4%
of farms monitor water quality, although 89% are trained

Background

Lake Victoria is a shared resource whose basin supports more than 40 million people through a wide range of ecosystem services. As wild fish catches decline and catch-per-unit-effort falls, many fishers have turned to cage aquaculture to sustain livelihoods, employment, food security and human health. Over-exploitation, destructive fishing methods, invasive species such as Nile perch and water hyacinth, climate change and eutrophication have all reduced fish abundance and diversity, accelerating this shift towards cages.

Globally, cage culture is a recognised source of organic matter loading. Uneaten feed, fish droppings and other biological wastes accumulate beneath and around the cages, and as fish farming intensifies the deposition of feed residues and metabolic wastes grows with it. In Lake Victoria much of this expansion has proceeded without clear policy guidance, raising concerns about decaying material settling beneath cages and altering water quality, sediment composition, local biogeochemical processes and the surrounding biotic community in both temperate and sub-tropical lakes.

Objective: to quantify the contribution of cage-culture husbandry to organic matter loading in nearshore Lake Victoria, and to identify the management actions needed to keep the sector sustainable.

Methods

A combined socio-economic and water-quality survey covered 27 cage-culture farms in the Kenyan portion of Lake Victoria. Production parameters (stocking biomass, feed regime, and the number and volume of cages) were recorded for each farm, and surface-water quality was measured at the Anyanga and Ogal cage sites, including chlorophyll-*a*, dissolved oxygen (DO), total nitrogen (TN) and ammonium (NH_4-N). Organic-waste generation was then estimated from the observed biomass using a conservative daily feed rate and typical feed-loss ranges.

Key Findings

A young, fast-growing sector with a monitoring blind spot

Most farms are recent entrants to the sector, and although 89% of operators had received training, only 4% routinely monitor water quality. This knowledge-to-practice gap reflects inadequate equipment and weak institutional support rather than any unwillingness on the part of farmers. Farms with more cages may gain economies of scale in input procurement, but they also face proportionally larger waste-management challenges, and the mix of small and medium operations points to a heterogeneous sector that needs differentiated management.

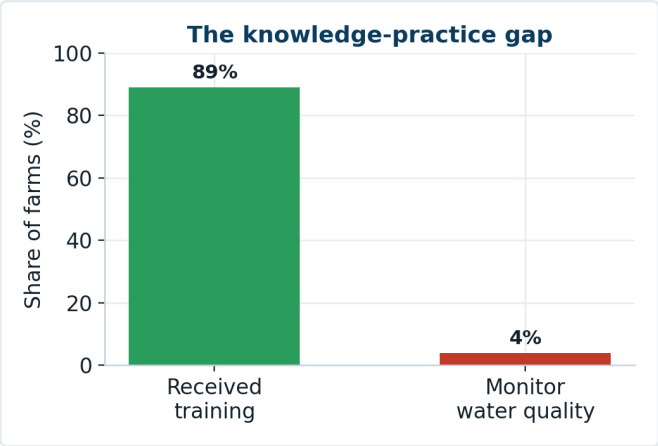


Figure 1. Training reaches most operators, but routine water-quality monitoring almost never follows. This is the sector's central capacity gap.

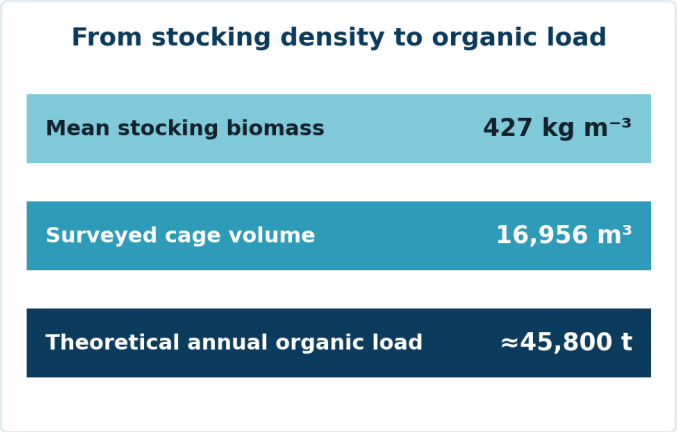


Figure 2. From a mean stocking biomass of 427 kg m^{-3} across 16,956 m^3 of surveyed cages, the theoretical annual organic load reaches roughly 45,800 tonnes.

Waste generation scales with feed input

At a conservative daily feed rate of about 1 to 2% of biomass, each cage consumes roughly 4.3 to 8.5 kg of feed per day during the moderate growth phase. With typical broadcast feeding losing 20 to 40% of that feed, between 0.9 and 3.4 kg per cage is lost daily as uneaten feed, before faecal waste is added. Scaled across all surveyed cages, this produces the estimated 45,800 tonnes of organic load per year.

Elevated productivity signals heavy nutrient enrichment

Mean chlorophyll-*a* ranged from 95.5 to 105.9 µg L^{-1} at Anyanga and from 96.4 to 114.9 µg L^{-1} at Ogal, values characteristic of eutrophic to hypertrophic conditions. Surface DO ranged from 5.5 mg L^{-1} at Anyanga to 6.8 mg L^{-1} at Ogal, while total nitrogen averaged 1,330.3 µg L^{-1} (range 856.9 to 2,538.7 µg L^{-1}). The higher readings at Ogal likely reflect localized enrichment from river inflows, shoreline settlements and cage activity, all of which raise nitrogen and phosphorus availability.

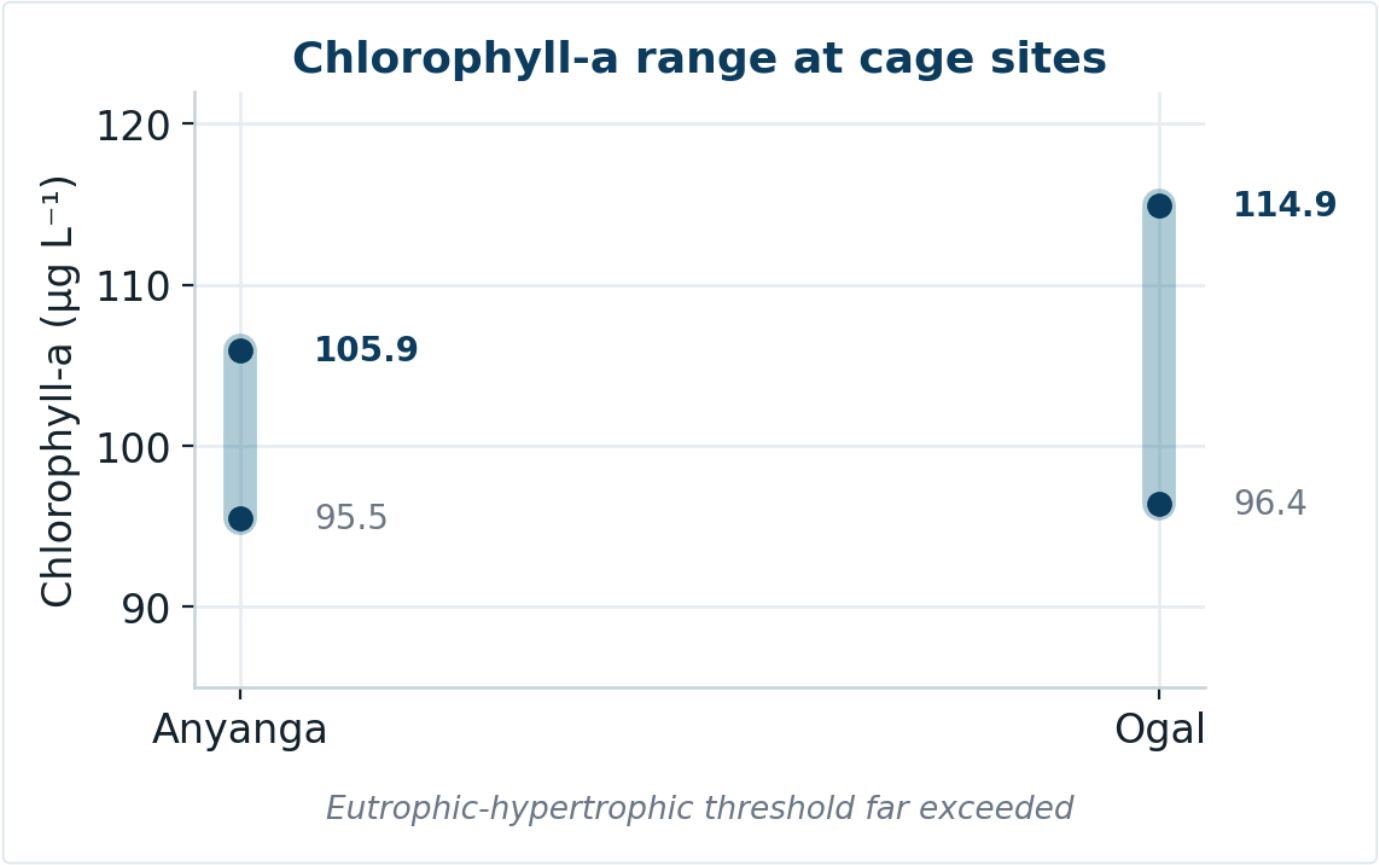


Figure 3. Chlorophyll-*a* ranges recorded at the Anyanga and Ogal cage sites, both far above the eutrophic threshold and indicating intense phytoplankton productivity.

Conclusions

- The cage sector is expanding rapidly (74% of farms under five years old) yet generates an estimated 45,800 t of organic waste annually with minimal environmental monitoring.
- Consistently high chlorophyll-*a* at Anyanga and Ogal reflects intense productivity driven by nutrient enrichment from both catchment inputs and cage activity.
- Nutrient concentrations are higher inside cage clusters than at control points, confirming localized enrichment, while the tight coupling of TP, SRP, nitrite, nitrate, silica, turbidity and DO points to active internal loading and organic-matter mineralization.
- Lake Victoria's littoral zones remain under significant eutrophication pressure, requiring sustained management to protect ecological integrity and fisheries productivity.

Recommendations

1. Make feed recording and monthly water-quality monitoring mandatory at all cage sites, and provide the equipment and extension support to make this possible.
2. Enforce stocking-density limits (below 100 fish m^{-3}) and standardized feeding guidelines (32 to 35% protein for grow-out).
3. Consolidate farms into managed aquaculture zones, with support differentiated for small and medium operators.
4. Pilot feed-efficiency technologies such as feeding trays and automatic feeders to cut waste from about 30% to below 10%.

5. Develop sustainable-certification programmes that link best practice to premium market pricing.

6. Act within the 12-month window before unsustainable practices entrench, and scale enforcement of wastewater-discharge and source-control regulations.

Authors: Nyaundi, J., Mwainge, V., Nyambura, T., Aura, C.M., Nyamweya, C., Babu, J., Guya, F., Ongore, C., Mwamburi, J., Last, J., Basweti, G., Wawiye, P., Owili, M., Gichuru, N., Mrombo, N., Nyaboke, H., Odoli, C., Achiya, J., Mwanchi, J., Awandu, H., Onsongo, K. & Bruno, O.

KMFRI Headquarters
P.O. Box 81651-80100, Mombasa
Tel: +254 (041) 475151/4
director@kmfri.go.ke

KMFRI Kisumu Centre
P.O. Box 1881-40100, Kisumu
Tel: +254 (0)770 567 443
kisumucentre@kmfri.go.ke

Online
www.kmfri.go.ke
ISO 9001:2015 Certified
Freshwater Systems Directorate

Suggested citation: Nyaundi, J. et al. (2026). Cage Culture and Organic Matter Loading in Lake Victoria, Kenya. KMFRI Factsheet C82_5(1).