WATER RESOURCES COMMISSION

Technical Guidelines for Sustainable Cage Aquaculture

Version 2

October 2019

1. Introduction

Aquaculture is growing rapidly in the nation and offering opportunities to contribute to poverty alleviation, employment, community development, reduction of exploitation of natural resources, and food security in tropical and subtropical regions. Many proponents engage in aquaculture without requisite information. This document gives guidelines and requisite information for cage aquaculture. The objective of the document is to provide technical and practical steps for both regulators and proponents to facilitate the issuance of permits, licenses and certificates, while protecting the environment and human health, and investment of proponents.

The guidelines provide information on:

- Regulatory institutions
- Relevant institutions
- Site selection guide
- Prohibited siting areas
- Materials for use in cage aquaculture
- Fish production guide
- Farm management guide
- Permits/licenses checklist
- Water quality monitoring
- Sediment quality monitoring
- Ghana raw water quality guidelines for aquaculture use

The information is based on environmentally friendly methods and best practices for the location, buffers, framework for monitoring water quality in and around cage aquaculture activities. Information on water and sediment quality monitoring framework and checklist are also provided.

2. Regulatory Institution

A number of Institutions need to be consulted before the commencement of any cage aquaculture investment. The mandatory regulatory institutions, which issue permits include:

- Water Resources Commission;
- Environmental Protection Agency;
- Fisheries Commission; and
- Ghana Maritime Authority.

3. Relevant Institutions

Other institutions which do not give permits but must give no objection if the proponents wish to use their facilities or consult for technical and research activities include:

- Volta River Authority;
- Ghana Water Company Limited;
- Ghana Irrigation Development Authority;
- Water Research Institute; and
- Other relevant institutions as in specific cases.

Please note that even though chiefs and land owners may agree with your project, the required Government administrative processes must be adhered to, to avoid losing your investment.

4. Site Selection Guide

The depth of the water at the selected site should be such that the distance between the bottom of the cage and the substrate or bottom sediment should be a minimum of 2 meters. This will help keep cage waste away from the fish. Additionally, sites for cage aquaculture should have the following characteristics:

- Good water quality (refer to table on page 6 for the Ghana Raw Water Quality Guidelines for Aquaculture);
- Absence of harmful algae;
- Absence of pathogens that cause fish diseases;
- Good water exchange, average current velocity should be between 10 and 20 cm/s;
- Substrate at the site of the proposed operation should be low in organic matter. A maximum concentration of 9 mg/kg may be applied;
- Record of existing benthic communities (the collection of organisms living in lake bottoms) at the selected site will have to be collected before the establishment of the farm;
- A good distance from other cage aquaculture and other water users. A separation distance (buffer) of 1 km for all farms is required.
- Not close to commercial crop farming areas (refer to buffer zone policy via this link: http://www.wrc-gh.org/dmsdocument/92).

5. Prohibited Siting Areas

Cages should not be sited in the following areas:

- Navigational routes of water bodies;
- Sensitive installations such as domestic water intake points, hydropower plants, etc.;
- Stagnant water bodies, or water bodies with little outflows e.g. Lake Bosomtwe;
- Stagnant sections of large lakes with limited water exchange; and
- Core zones of ramsar sites and within Forest Reserves.

Caution on siting

It must be noted that cage aquaculture farms situated just before and or below the spillways of dams are liable to damage during spills, which may be occasional or annual. Farms situated in such places should take precautionary measures in case of such events. The WRC is not liable to pay compensation to any such farm in the likelihood of damage to property due to spillage or improper siting

6. Materials For Cage Construction

Cage structures must be strong enough to withstand wind and water currents while holding stocks securely. For durability and reduced environmental impacts, the following qualities for materials appropriate for construction of cages are recommended:

- Strong and light in weight;
- Rot and weather resistant;
- Rustproof and fouling resistant;
- Easily worked on and repairable;
- Smooth textured and non-abrasive to fish; and
- Drag free.

7. Production Process Guide

The production process involves the acquisition of fingerlings from hatcheries or own production of fingerlings from brood stock, stocking of cages and application of the right quantities and quality of feed.

It is recommended that:

- Brood stocks and fingerlings should be obtained from suppliers certified by Fisheries Commission;
- Stocking densities of cages may range from 50 - 250 fingerlings/m^3. This will be site specific. Sites with good water exchange could be allowed higher stocking densities, whilst farms with poor water exchange allowed lower stocking densities;

- Feed plays a key role in any aquaculture process. It is the main source of nutrient enrichment or pollution in the water bodies. Proper feeding technology should be applied with regard to quantity and feeding method. Overfeeding should be avoided. Feed used on the farms should:
    - Be properly evaluated by relevant mandated institutions for the absence of bacteria, and other feed contaminants, likely to affect the health of fish and human population;
    - Have a Veterinary Health Certification;
    - Be water stable and palatable to the fish; and
    - Be dry extruded and pelleted.

More detailed technical advice/information regarding sustainable production of fish should be sought from the Fisheries Commission.

8. Farm Management Guide

Effective management of fish farming activities and their impacts on the environment forms an integral part of sustainable development of the sector and to avoid loss of investment the following are recommended:

- Registration of aquaculture farms with relevant institutions (see checklist below); ensuring that the quality of effluent discharges from land-based aquaculture activities falls within the permissible limits stipulated in the of Ghana Standards Authority's Environmental Protection Requirements for Effluent Discharge (refer to page 9 for the standards in relation to land-based aquaculture operations)
- Preventing the occurrence of fish disease through the use of pathogen-free water supply, the use of certified pathogen-free stocks, and strict attention to basic rules of bio security
- Reduction of fish escapes.
- Monitoring water and sediment quality (see below for parameters to be monitored); and

9. Permits/Licenses Checklist

The necessary permits and licenses should be obtained before proceeding with the installation and stocking of cages. Depending on the location of farm, no objection notices may also have to be obtained.

Permits/Licenses:

- Certificate of incorporation and Certificate to commence business

- Registration with Local Government Authority (MMDAs)
- Environmental Permit (Environmental Protection Agency)
- Water Use Permit (Water Resources Commission)
- Fisheries License (Fisheries Commission)
- Certificate on Feed (Fisheries Commission)
- Certificate on Fingerlings (Fisheries Commission)

***Location based no objection notices from**:*

- Volta River Authority (for the use of the Volta Lake)
- Ghana Irrigation Development Authority (for use of their reservoir)
- Ghana Maritime Authority (for rivers with navigational routes).

10. Water Quality Monitoring

Quarterly

- pH
- Chemical Oxygen Demand
- Nutrients
- Suspended Solids
- Dissolved Oxygen

Annually

- Algae (Cyanophyta (blue-green algae, Chlorophyta (Green algae)
- Euglenophyta
- Cryptophyta (Dinoflagellates)
- Bacillariophyta (Diatoms)
- Chlorophyll a

11. Sediment Quality Monitoring

Biennially (once every two years)

- Sulphide
- Redox potential (Eh)
- Macroinvertebrates
- pH
- Total Nitrogen
- Total carbon
- Organic matter
- Total phosphorus

- Trace metals (Cu, Zn)

12. Ghana Raw Water Quality Guidelines For Aquaculture Use

No.	Parameter	Guideline	Effects On Cultured Fish
1	Alkalinity (mg/l)	20-100	Production is optimal within this range
2	Aluminum (mg/l)	<0.03	No adverse effects on aquatic life at pH > 6.5
3	Ammonia (mg/l)	0.0 - 0.03	No health or sub-lethal effects on fish in warm climates
4	Arsenic (mg/l)	0.0 - 0.05	No known adverse effect
5	BOD_5 (mg/l)	<15	No known adverse effect
6	CO_2 (mg/l)	< 12	Continuous exposure causes no adverse effects. Protective to most species
7	COD (mg/l)	<40.0	No known adverse effect
8	Chlorine (mg/l)	2 – 10	No known adverse effect
9	Colour (Pt-Co units)	30-40	No known adverse effect
10	Dissolved Oxygen (mg/l)	5-8	Optimal DO concentration for growth
11	E. coli (E. coli/g)	0 – 10.0	Fish-flesh for human consumption should not exceed the limit of 10 E. coli of fish flesh.
12	Hydrogen Sulphide (mg/l)	<0.001	No known adverse effect
13	Iron (mg/l)	<0.01	No known adverse effect
14	Lead (mg/l)	<0.01	No known adverse effect
15	Manganese (mg/l)	<0.1	No known adverse effects; recommended minimal value for pond culture
16	Mercury (µg/l)	<1	No known adverse effects on fish populations.
17	Nitrate (mg/l)	<50	No known adverse effects on fish
18	Nitrite (mg/l)	0.0 - 0.25	Safe for warm water fish

No.	Parameter	Guideline	Effects On Cultured Fish
19	Nuisance Plants (%)	< 10% of surface area of fishpond should be covered by aquatic plants	
20	Oils, Greases and Refined Products - benzine (mg/l)	<0.3	
21	Oils, Greases and Refined Products - petroleum (mg/l)	1	
22	Oils, Greases and Refined Products - gasoil (mg/l)	0.004	
23	pH (pH units)	6.5 – 9.0	Most species will tolerate and reproduce successfully within this pH range. Production is optimal
24	Phosphates (mg/l)	<0.1	No known adverse effect
25	Phosphorus (mg/l)	<0.1	Ensures the protection of all aquatic organisms; no changes in trophic status likely
26	Salinity (mg/l)	< 3.0	No known adverse effects on freshwater fish
27	Sulphides (mg/l)	<0.001	Optimal growth of many fish species
28	Temperature (°C) - Clarias sp.	28 – 30	Target Water Quality Range for growth
29	Temperature (°C) - Clarias sp.	27 – 30	Target Water Quality Range for egg and larval development
30	Temperature (°C) - Oreochromis sp.	28 – 30	Target Water Quality Range for growth
31	Temperature (°C) - Oreochromis sp.	24 – 28	Target Water Quality Range for egg and larval development
32	Total Dissolved Solids (mg/l)	<2	No known adverse effects on freshwater fish

No.	Parameter	Guideline	Effects On Cultured Fish
33	Total Hardness (mg/l)	20 – 100	No known adverse effects; recommended range for most freshwater fish
34	Total Suspended Matter (mg/l)	<20,000	No Known adverse effects on turbid water species
35	Total Ammonia Nitrogen (mg/l)	<1.0	No Known adverse effects on turbid water species
36	Turbidity (mg/l)	<40	No known adverse effect
37	Zinc (mg/l)	<0.005	No known adverse effect

13. Ghana Standards Authority Effluent Discharge Requirements for Land-based Aquaculture Operations

No.	Parameter	Maximum Permissible Levels
1	pH	6-9
2	Temperature (°C)	<3 (°C) above ambient
3	Turbidity (NTU)	75
4	TDS (mg/l)	1000
5	TSS (mg/l)	50
6	BOD5 (mg/l)	50
7	COD (mg/l)	25
8	Ammonia-Nitrogen (mg/l)	1
9	Nitrate as Total Nitrogen (mg/l)	20
10	Oil and Grease (mg/l)	5
11	Sulphide (mg/l)	1.5
12	Phosphate (mg/l)	2
13	Total coliform (MPN/100 ml)	400
14	Faecal coliform MPN/100 ml)	10