Water quality guidelines for Aquaponics

- Fish component –

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When growing fish in your aquaponics system, it is important to maintain a good water quality. As an aquaponics grower you have the responsibility to keep your plants and fish healthy.

Water quality considers several parameters. Temperature and pH first come to mind, followed by dissolved gases (Oxygen and carbon dioxide) and dissolved nutrients such as ammonia (NH3), nitrite (NO2) and nitrate (NO3). Check how these parameters are relevant to the fish species that you want to produce.

Parameter	**Range**	**Tilapia optimum**	
Dissolved Oxygen (DO, mg/l)	4-20	4-8	Species dependent, TGP-dependent
Temperature (°C)	15-30	26-28	Species dependent
pH	6.0-8.0	7.0	dependent on TAN, alkalinity and CO2
Total Ammonia Nitrogen (TAN, mg/l)	0-5.0	<2.0	dependent on pH
Nitrite (NO2, mg/l)	0-1	<1.0	dependent on salinity and hardness
Nitrate (NO3, mg/l)	0-500	<150	Fish and plant species dependent,
Suspended solids (TSS, mg/l)	0-80	<25	
Carbon Dioxide (CO2, mg/l)	20-60	<60	Dependent on pH, salinity and alkalinity
Alkalinity (as mg/l CaCO3)	50-300	150	
Phosphorous (P, mg/l)	0-3.0	<3.0	
Total Gas Pressure (TGP, %)	95%-105%	100%	

Water quality monitoring

In order to make sure the system is operating correctly; water quality must be monitored. Typical water quality monitoring schedules are:

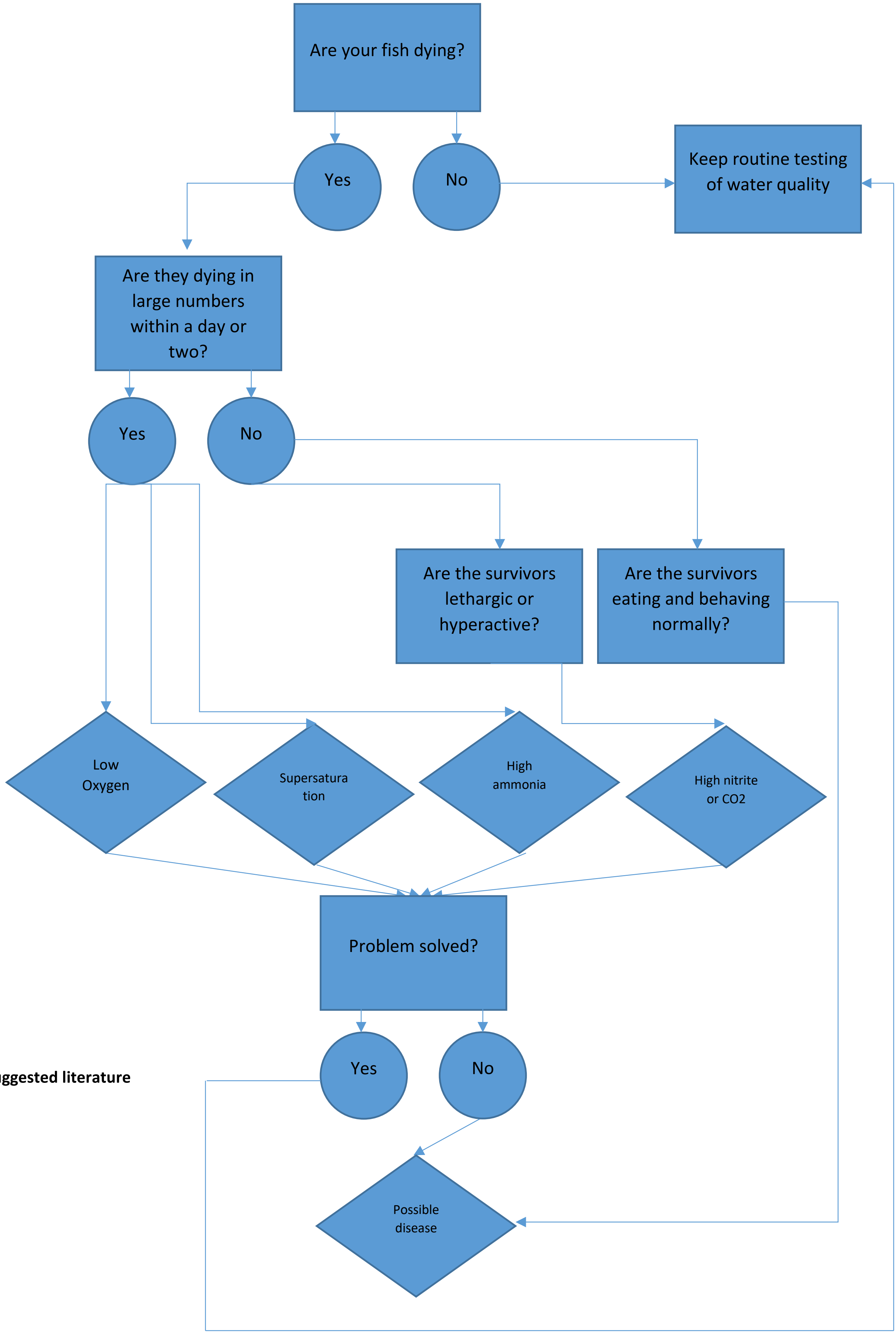
Daily: Temperature (thermometer), pH during nitrification startup (dip-strip or colorimetric methods), TSS (visual), DO (probe).

Weekly: pH, alkalinity, TAN, NO2, NO3

When problems are expected (water quality troubleshooting)

Each water quality parameter will affect the fish stock differently. The following table gives an overview of the water quality problems by level of importance, with possible root causes.

Parameter (problem)	Clinical signs	Possible causes	Solutions
Low dissolved oxygen	Lethargy and piping (fish swimming close to the surface)	Aeration or water flow are insufficient. Fish overcrowding or overfeeding.	Add more air and flow, stop feeding and move some fish to other tanks.
Gas supersaturation (gas bubble disease)	Gas bubbles in eyes and gills, cranial swelling and popped eyes.	Leaky pipes on the suction end of pumps sucking air into the pipeline. Excess oxygen addition. Waterfalls close to pumps may introduce bubbles in the pipelines.	Check and eliminate any possible sources of air intrusion into the system. Aerate water profusely to vent pressurised gases.
Temperature stress (hypothermia and hyperthermia)	Hypothermia: fish become inactive and depressed. Hyperthermia: fish stop feeding.	Water heater or chiller failure. Undersized heaters of chillers.	Size cooling or heating systems appropriately, Cover water surfaces with tarps. Apply insulation to tanks and pipes.
Ammonia poisoning	Fish become hyper-excited -bolting and jumping-. Fish stop feeding.	Biofilter failure, undersized biofilter or too much feeding.	Stop feeding and perform water exchanges. Find the root cause of a possible biofilter failure.
Nitrite poisoning	Pale or brown gills. Brown blood, dyspnoea (fish cannot breathe even with adequate oxygen levels)	Impending biofilter failure or immature biofilter. Solids accumulation in the system. Ozonation system failure.	Stop feeding a do water exchanges. Do not disturb the fish. Find the root cause of biofilter failure. Adding 2-6 gr of salt per litre of water reduces toxicity.
Nitrate poisoning	Growth retardation, poor feed conversion and erratic swimming behaviours	Nitrate accumulation occurs naturally in systems with high recycling rates.	Increase water exchange rates in the system or add more plants.
pH extremes	pH itself generally does not affect the fish directly, but it influences other water quality parameters. Check for clinical signs for ammonia toxicity and excess CO2 when pH swings.	Complete loss of system pH buffering capacity. Accidental addition of pH modifiers. Excessive degassing of water (pH rises) or loss of system degassing capacity (pH lowers)	Restore alkalinity to at least 100 mg/l (of CaCO3). Gradually adjust pH to normal levels. Adjust the degasser's air flow.
Excess CO2	Hypercarbia, hypoxia signs, retarded growth, lack of appetite.	Excess CO2 only occurs at high system loadings with little or no degassing or when CO2-rich source waters are used.	Reduce feeding, perform water exchanges and/or install CO2 degassers toxicity. Proceed with caution.



Suggested literature

Water quality in aquaponics is of course not only determined by the fish, but also the plants play an important role in finding the best balance. If you want to know more, we recommend studying the following sources:

Colt , J., & Huguenin , J. (2002). *Design and Operating Guide for Aquaculture Seawater systems.* Elsevier Science.

Lekang, O. I. (2013). *Aquaculture Engineering.* John Wiley and Sons .

Mischke, C. (2012). *Aquaculture Pond Fertilizaton - Impacts of nutrient Input on Production* . John Wiley and sons .

Noga, J. E. (20110). *Fish Disease, Diagnosis and Treatment* . Wiley-Blackwell .

Timmons, M., & Ebeling, J. (2010). *Recirculating Aquaculture* . Cayuga Aqua Ventures .

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