EcoPonics
Ecofood from Aquaponics

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WATER QUALITY

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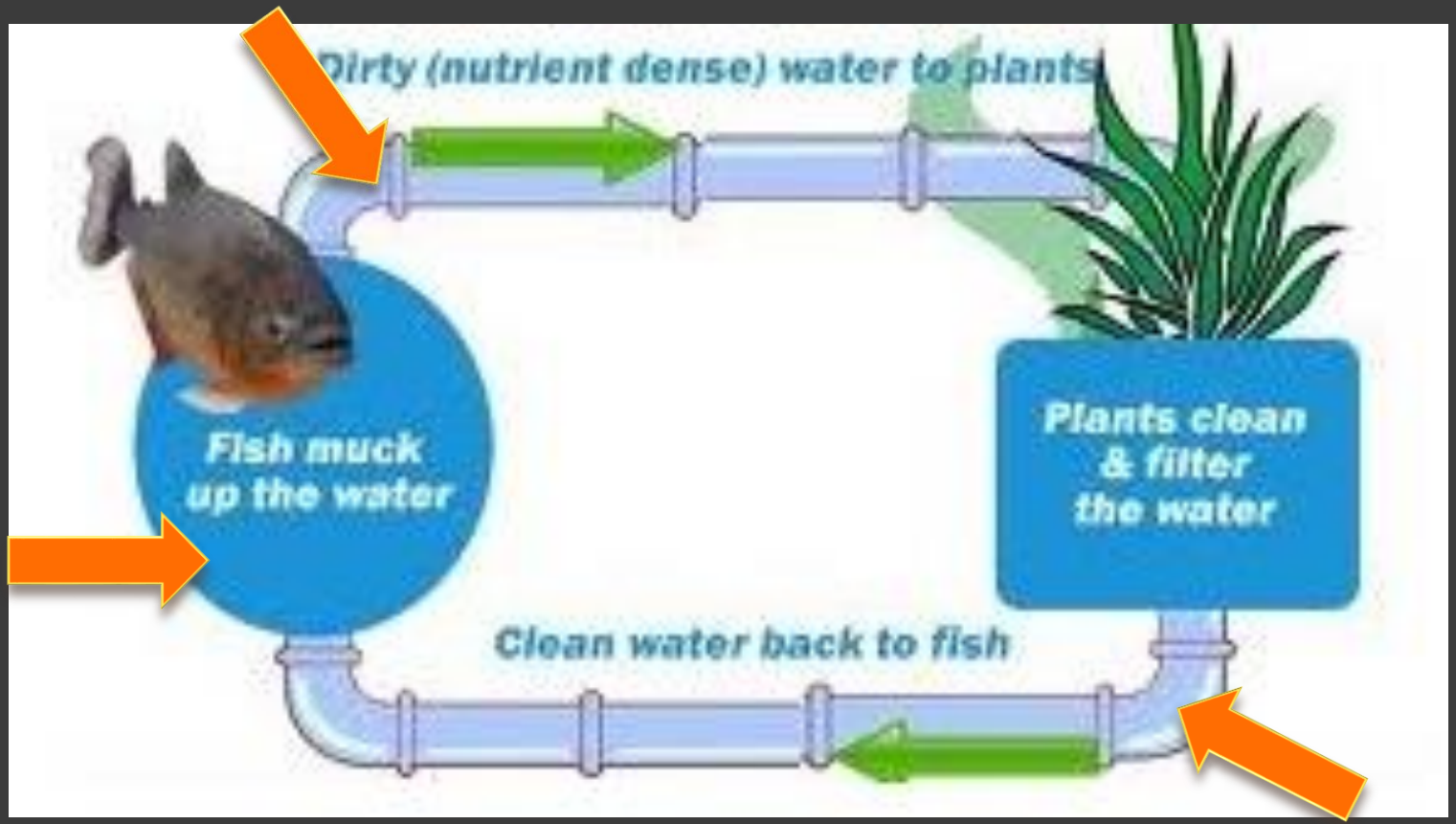
Water quality in aquaponics



The water quality on each part of the system affects the other

Balance aquaculture and hydroponics? Needs of the fish balanced with needs of the plant

Water quality could be measured at several points depending on WHY measured

PARAMETERS TO BE MEASURED AND WHY

- pH , Temperature
- alkalinity
- DO
- ammonia/ammonium
- nitrate/nitrite
- BOD/COD
- phosphate

Note: ammonia is pH, temperature and life-stage dependant

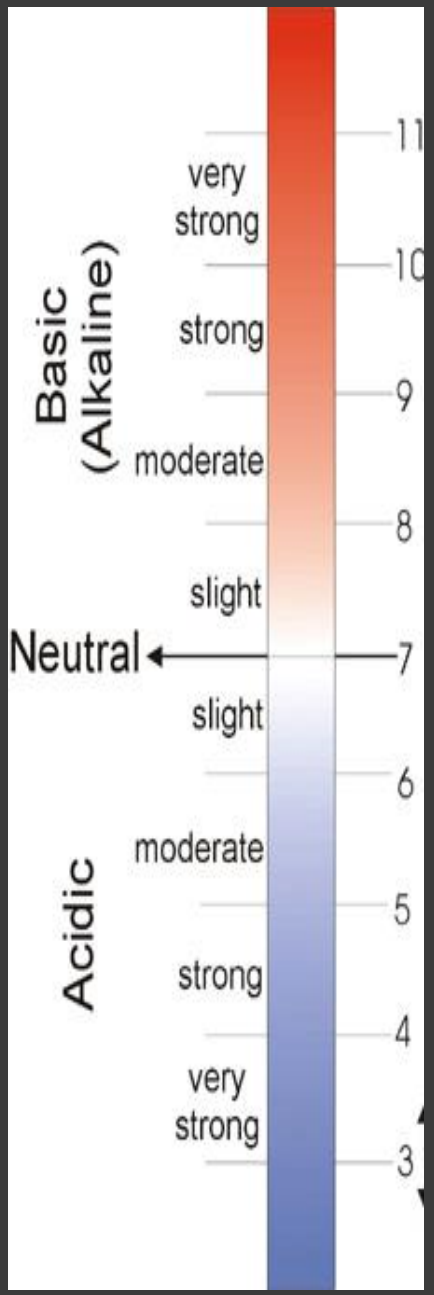
- pH
- alkalinity
- DO
- ammonia/ammonium
- nitrate/nitrite
- phosphate
- macronutrients: K, Ca, Mg
- Fe, B
- BOD/COD

pH – the master variable

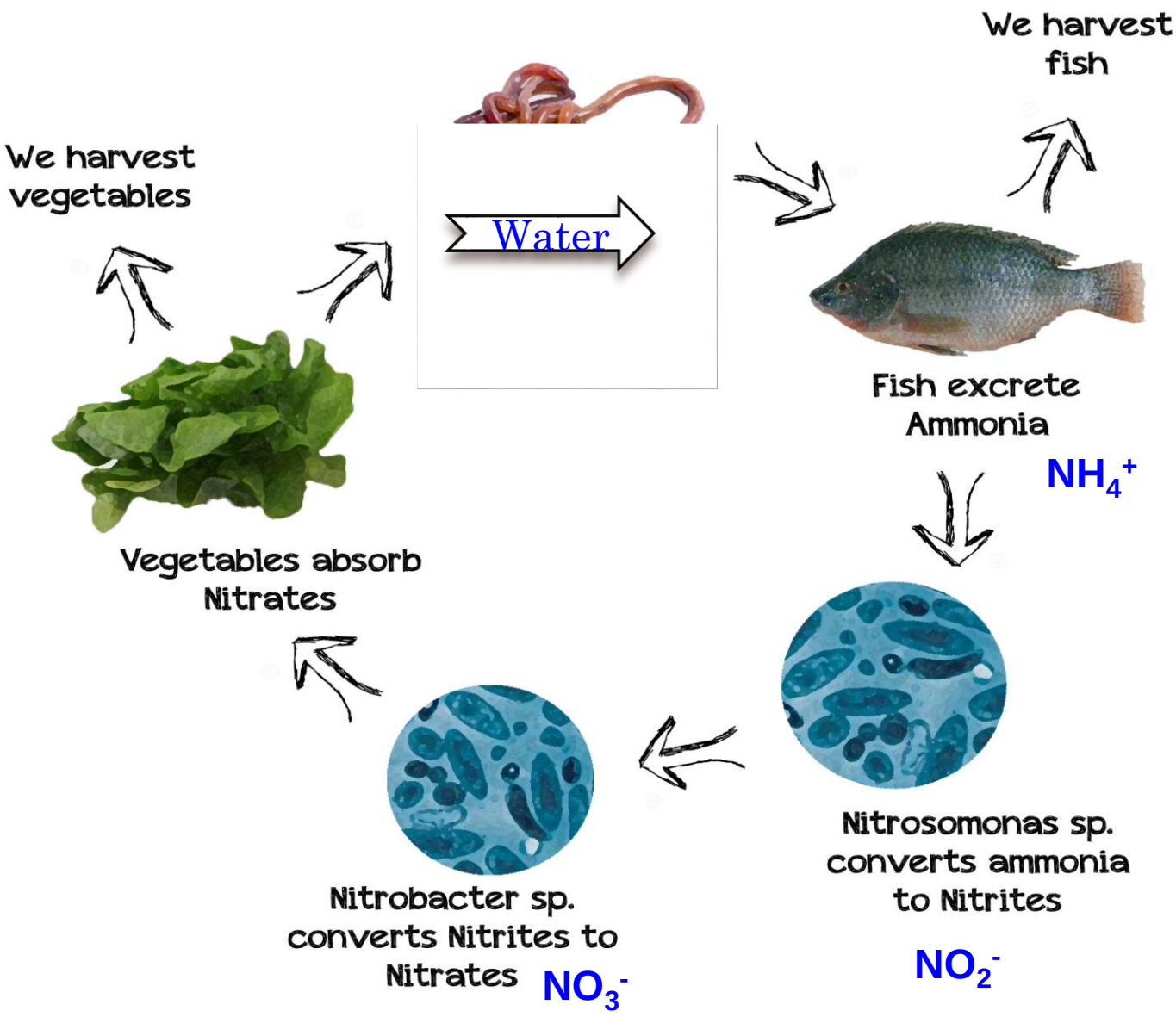
- pH is a measure of acidity
- influences water quality parameters: e.g. % NH_3 vs. NH_4^+
- Acceptable range for fish culture, usually pH 6.5 to pH 9.0

- Guidelines for warm water fish suggest :
  - pH<4.0 acid death point;
  - pH 4.0 – 5.0, no production
  - pH 6.5 - 9.0, desirable range for fish production,
  - pH 9.0 - 11.0, Slow growth,

- Plants prefer slightly acidic environments, pH 5.5 - 6.5
- COMPROMISE: **pH 7**



(PHILMINAQ, ….: Lawson 1995, Tarazona and Munoz, 1995)


We harvest fish
We harvest vegetables
Water
Fish excrete Ammonia
NH_4^+
Vegetables absorb Nitrates
Nitrosomonas sp. converts ammonia to Nitrites
NO_2^-
Nitrobacter sp. converts Nitrites to Nitrates
NO_3^-

Acidity, CO_2 ammonia and pH

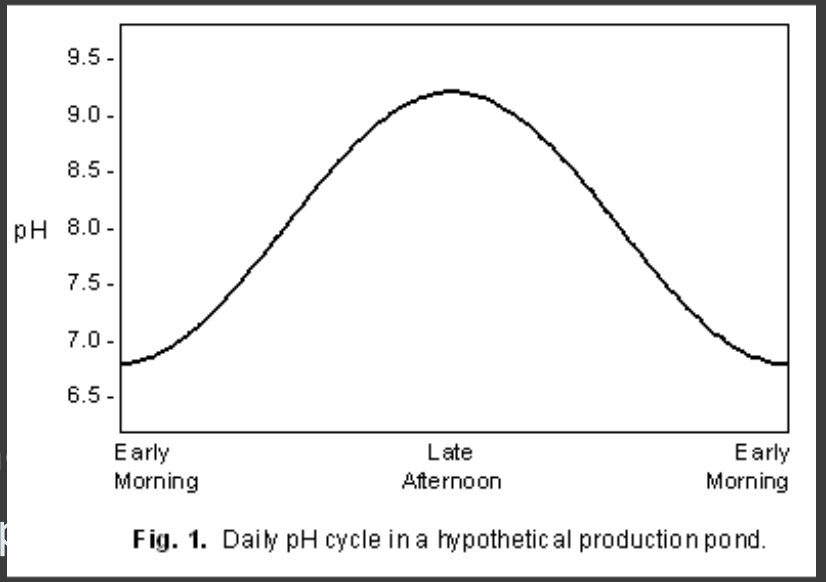


Fig. 1. Daily pH cycle in a hypothetical production pond.

- Tank CO_2 concentrations and pH, are affected by **respiration** and **photosynthesis**.
- As daylight progresses, the rate of photosynth
  uptake. This removal of CO_2 causes the pond p
- pH is highest late in the afternoon
- High waste nutrient concentrations can promote dense phytoplankton blooms which remove all of the CO_2 during photosynthesis - water to become alkaline
  pH > 9.0.

Time	Tot/NH_3-N (mg/L)	Temp ℃	pH	UI/NH_3-N (mg/L)
0400 hr	2.7	28	7.0	0.019
1600 hr	2.7	30	9.0	1.2

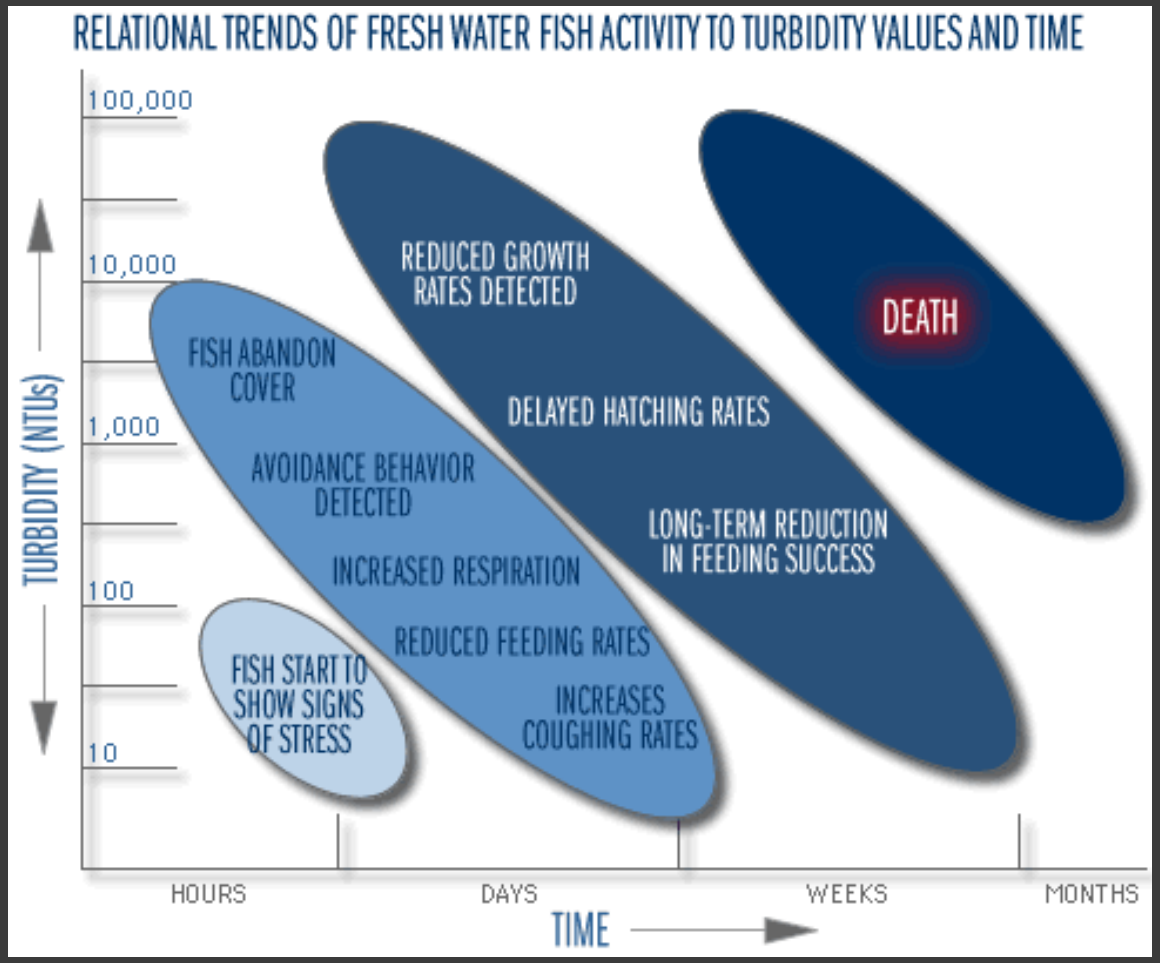
Table 1. pH changes the amount of total ammonia (Tot/NH3-N) present as un-ionized ammonia-nitrogen (UI/NH3-N),

ALKALINITY

- Alkalinity buffers pH changes that occur naturally as a result of photosynthetic activity of the chlorophyll-bearing vegetation.
- Components of alkalinity such as carbonate and biocarbonate will complex some toxic heavy metals and reduce their toxicity markedly

DO, BOD, COD

- Too little oxygen over prolonged periods can cause stress, disease and mortality
- Dissolved oxygen affected by temperature and salinity
- DO decreases as temperature increases
- chronic problems with DO could be due to too much organic matter/algal growth/turbidity
- BOD and COD are measures of how much oxygen is being used for breakdown of the substances…


RELATIONAL TRENDS OF FRESH WATER FISH ACTIVITY TO TURBIDITY VALUES AND TIME
100,000
10,000
1,000
100
10
TURBIDITY (NTUs)
REDUCED GROWTH RATES DETECTED
DEATH
FISH ABANDON COVER
DELAYED HATCHING RATES
AVOIDANCE BEHAVIOR DETECTED
LONG-TERM REDUCTION IN FEEDING SUCCESS
INCREASED RESPIRATION
REDUCED FEEDING RATES
FISH START TO SHOW SIGNS OF STRESS
INCREASES COUGHING RATES
HOURS
DAYS
WEEKS
MONTHS
TIME

MEASUREMENT AND FREQUENCY

- pH ➔ daily to weekly
- DO – continuously/ at least daily – 30 day average for adult, 7 day average for early stage
- alkalinity , weekly unless there is a chronic problem with pH/buffering, should be greater than 20mg/L $CaCO_3$
- ammonia/ammonium – dependant on pH, T ˚C and life-stage
- nitrate/nitrite = none for aquatic life, but high loads can lead to eutrophication which can lead to reduced DO
- BOD/COD, usually… 6-monthly, esp if a chronic problem with DO and turbidity
- phosphate – more than 100µg/L can lead to eutrophicaiton
- macronutrients: K, Ca, Mg
- micronutrients: Fe, B

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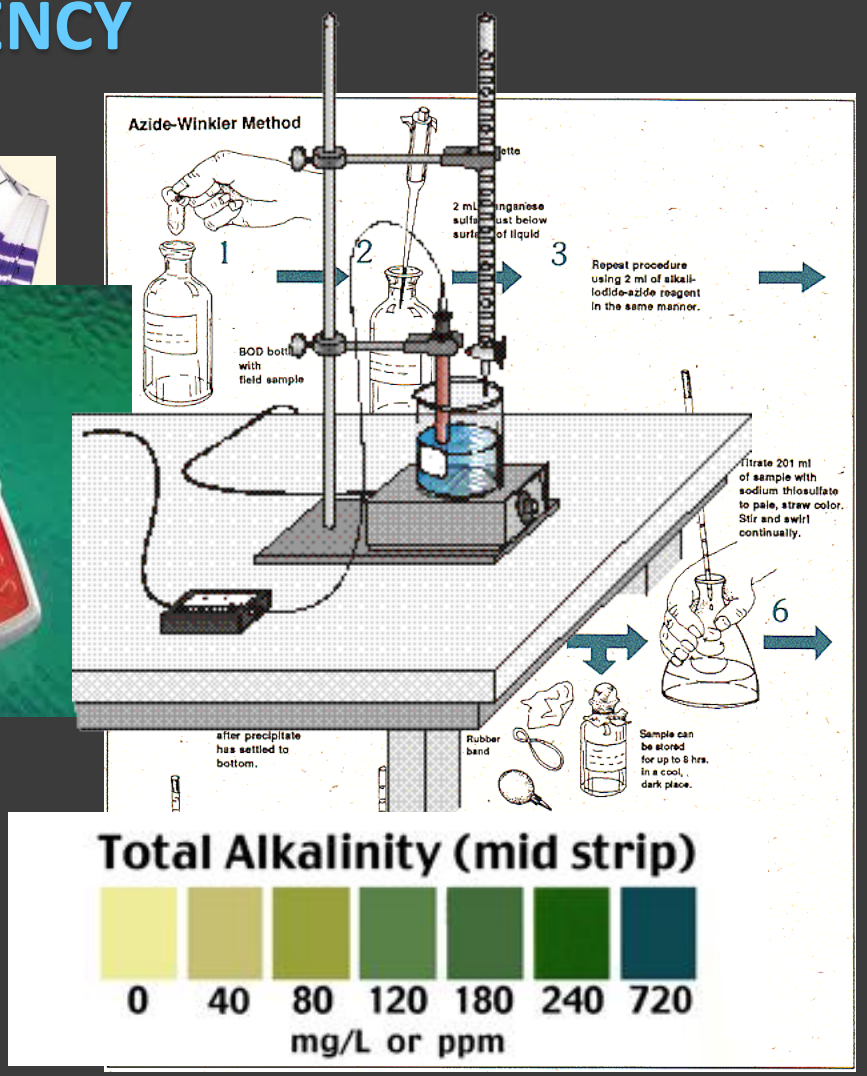


MEASUREMENT AND FREQUENCY

- pH
- DO
- alkalinity
- ammonia/ammonium → electrode; colour reaction – test kit
- nitrate/nitrite → colour reaction – test kit; colour reaction - laboratory
- BOD/COD → Laboratory
- phosphate → colour reaction – test kit; colour reaction - laboratory
- macronutrients: K, Ca, Mg → Laboratory
- micronutrients: Fe, B → Laboratory

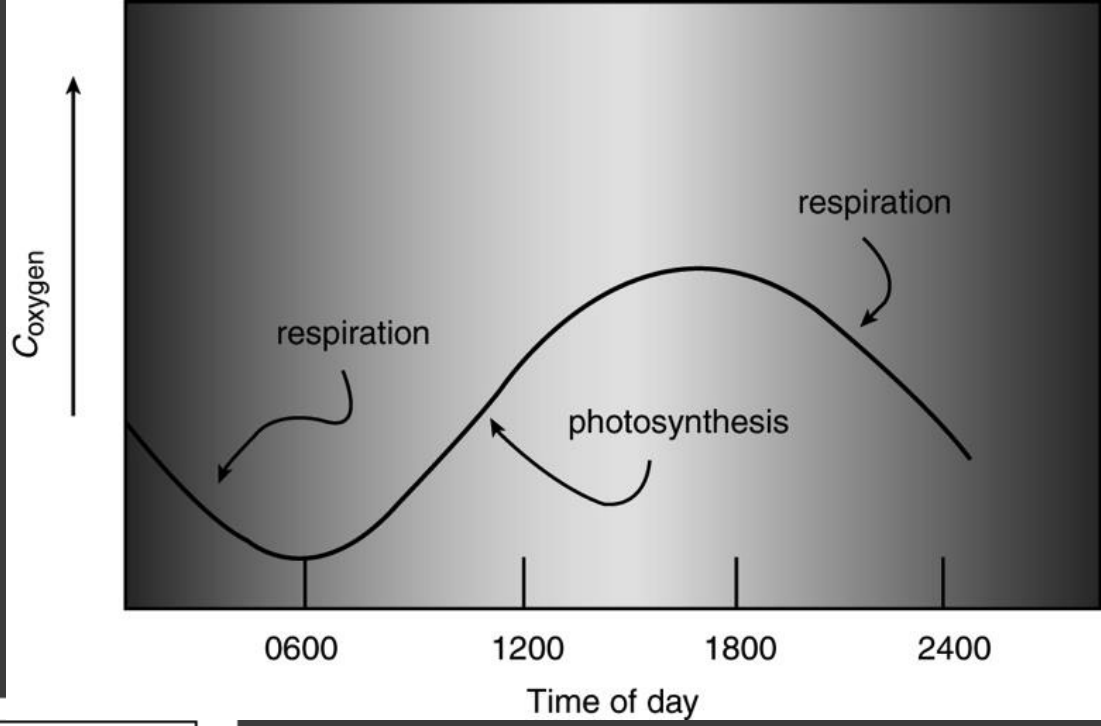
How often should I measure…?

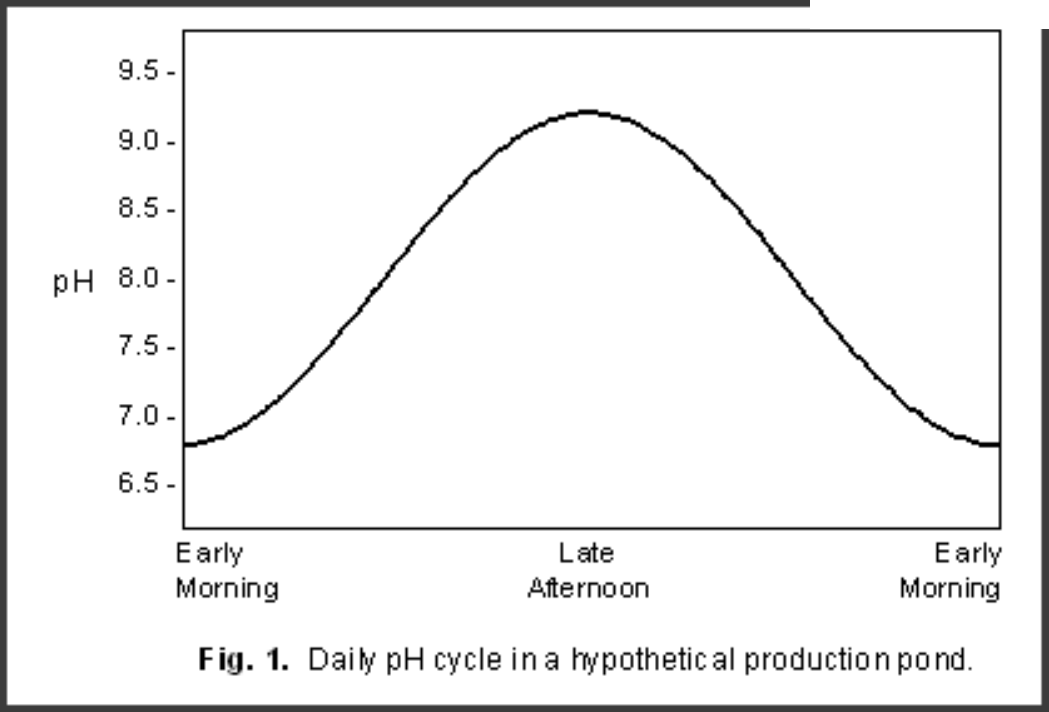
Parameter	recommended frequency of measurement	Guidelines	Reference
pH	continuous, or daily		
Ammonia NH_3 (unionised)/ NH_4^-	daily to weekly	measured as TAN, chronic exposure, pH 7, 17mg/l; acute – 1.9mg/l	USEPA
nitrate	weekly to monthly		
nitrite	weekly to monthly		
phosphate	weekly to monthly	0.01-3 mg/l P	
DO	continuous, or daily	>5mg/L, >6mg/L sensitive	
BOD	6-monthly		
COD	6-monthly		
Bacterial coliforms	6-monthly (?)		

WHAT ARE THE QUESTIONS

- What are the best conditions for different fish? different plants?
- What are the best combinations?
- conversion ratios? Calculations..
- water quality vs nutrition vs resource reuse
- What are the essential parameters to be measured : pH, DO, temperature, ammonia
- Standards – standards for aquaculture can be used to an extent…
- What is regulated.? How do we get there?

photosynthesis uses CO2 and produces O2





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