WATER AND WASTEWATER MONITORING

Field Testing

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Chapter Description

- Aims
  - Student explain the method for analysing water sample on site.
  - Student measure temperature, transparency, pH, conductivity, dissolve oxygen, thermo-tolerant coliforms and quality assurance in the field.

- Expected Outcomes
  - Student should be able to explain the method for analysing water sample on site.
  - Student should be able to measure temperature, transparency, pH, conductivity, dissolve oxygen, thermo-tolerant coliforms and quality assurance in the field.

- Other related Information
  - Environmental Protection Agency
  - Natural Resources Conservation Service

- References

  - Burden, Foerstner, McKelvie, and Guenther (2002) **Environmental Monitoring Handbook**, The McGraw-Hill Companies, Inc.
  - Jamie Bartram and Richard Balance. 1996. **Water Quality Monitoring: A Practical Guide to Design and Implementation of Freshwater Quality Studies and Monitoring Programmes**, CRC Press.

WATER PARAMETER: IN SITU

- Temperature
- Transparency
- pH
- Conductivity
- Dissolved Oxygen
- Thermotolerant

TEMPERATURE

- Water sample will gradually reach the same temperature as the surrounding area
- For each 10°C (18°F) rise in temperature the metabolic rate doubles
- Controls the reaction rate of chemicals
- Influences solubility of gases in water
- Influences toxicity of ammonia and therapeutant
- Optimum temperature for tilapia growth is 85-88 °F

THERMOMETER

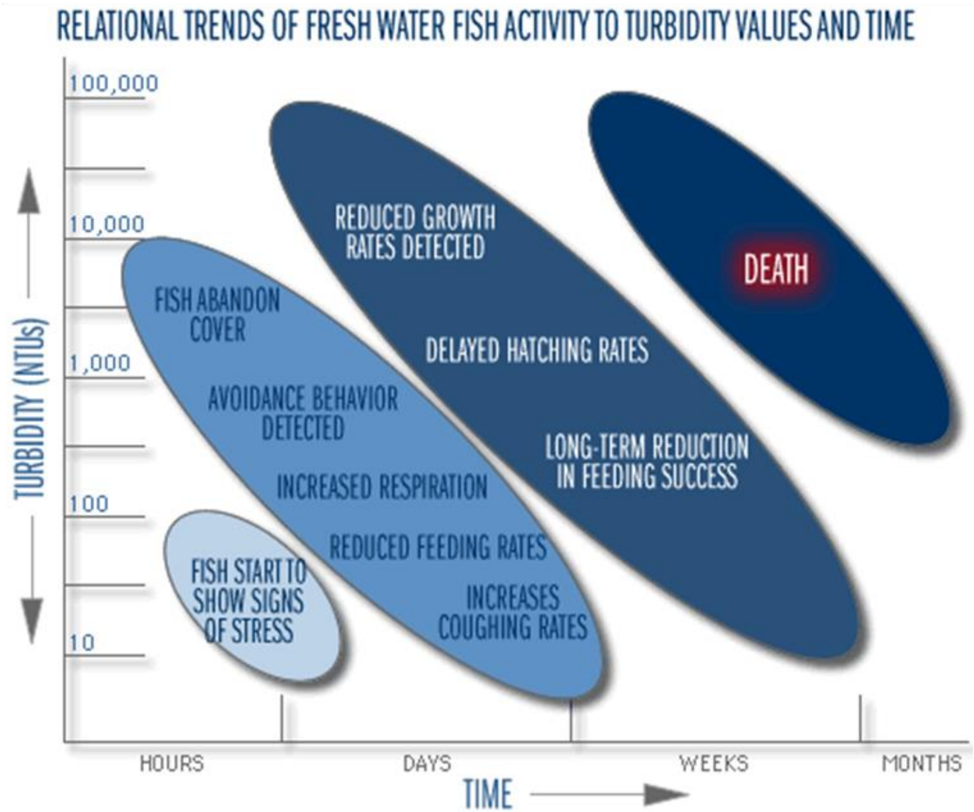
Source: http://lahta-olgino.ru

TURBIDITY

- Turbidity measures the cloudiness caused by the presence of suspended solids, such as clay and silt particles from erosion or runoff, re-suspended bottom sediments & microscopic organisms in the water.
- The greater the amount of total suspended solids in the water, the murkier it appears and the higher the measured turbidity.
- Turbidity can greatly affect water quality in many ways. Some examples include reducing the amount of light available for plant growth, damaging sensitive gill structures in fish and aquatic organisms, as well as increasing their susceptibility to disease, and preventing proper egg and larval development.

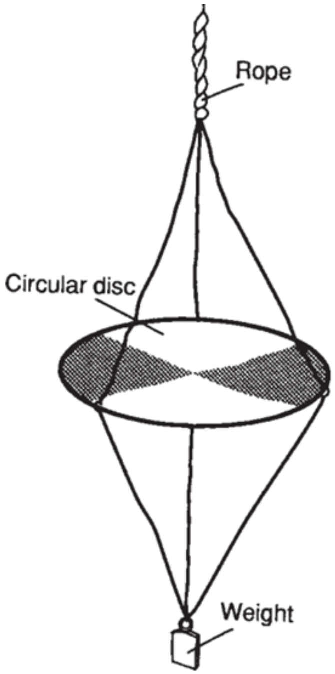
TURBIDITY

- Measured in Nephelometric Turbidity Units (NTU)
- Estimates light scattering by suspended particles
- Photocell set at 90º to the direction of light beam to estimate scattered rather than absorbed light
- Good correlation with concentration of particles in water

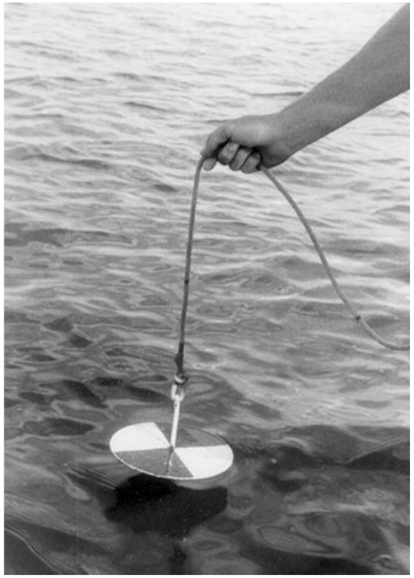


Schematic adapted from "Turbidty: A Water Quality Measure", Water Action Volunteers, Monitoring Factsheet Series,
UW-Extension, Environmental Resources Center. It is a generic, un-calibrated impact assessment model based on Newcombe, C. P., and J. O. T. Jensen. 1996. Channel suspended sediment and fisheries: a synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management. 16: 693-727.

TRANSPARENCY



- Transparency simply means how deep a person can see into the water of lakes and large rivers
- Transparency is measured by Secchi-disk, an 8-inch diameter metal disk painted in alternate black and white quadrants.
- The disk is lowered into the water until the observer loses sight of it. The disk is then raised until it reappears. The depth of the water where the disk vanishes and reappears is the Secchi disk reading.
- Transparency is important to understanding how water clarity may be affected by algae and sediment at different times of the year.



TURBIDITY TUBE

- Turbidity can also be measured by using a turbidity tube. You can see the miniature secchi disc located in the bottom of the tube. Sample water is added to the turbidity tube and then slowly removed until the black and white pattern is visible.

TURBIDITY METER

Source: http://www.delagua.org

HF Scientific MicroTPI – Turbidity Meter

Source: https://www.ecrent.com

YSI 556 MPS

PH

pH is a measure of acidity (hydrogen ion concentration) in water

Acid < 7

Neutral 7

Alkaline > 7

MEASUREMENT OF PH

- <u>Three methods</u>:
  - ✓ pH indicator paper
  - ✓ liquid colorimetric indicators
  - ✓ electronic meters

PH INDICATOR PAPER

LIQUID COLORIMETRIC INDICATORS

(reasonably simple, accurate but physical or water characteristic intervention)

Indicator	pH range
Universal	4.0–11.0
Bromocresol green	3.6–5.2
Methyl red	4.4–6.0
Bromocresol purple	5.2–6.8
Bromothymol blue	6.0–7.6
Phenol red	6.8–8.4
Thymol blue	8.0–9.6
Phenolphthalein	8.6–10.2

PH METER

- Accurate, fast and free from interferences

Source: https://www.ecrent.com

CONDUCTIVITY

- **Conductivity** is a measure of how well water can transmit an electrical current.
- Higher value means water is a better electrical conductor
- Increases when more salt (e.g., sodium chloride) is dissolved in water
- Indirect measure of salinity
- Units are μmhos/cm at 25^{o} C or μsiemens/cm

CONDUCTIVITY AND TOTAL DISSOLVED SOLIDS

In water, conductivity determined by types and quantities of dissolved

solids. (Commonly called Total Dissolved Solids = TDS)

	EC (µS/cm)	TDS (mg/L)
Divide Lake	10	4.6
Lake Superior	97	63
Lake Tahoe	92	64
Grindstone Lake	95	65
Ice Lake	110	79
Lake Independence	316	213
Lake Mead	850	640
Atlantic Ocean	43,000	35,000
Great Salt Lake	158,000	230,000
Dead Sea	?	~330,000

CONDUCTIVITY MEASUREMENT

Conductivity is measure by conductivity meter

When *conductivity* of the sample has been measured, the calculation Is:

$$\text{Conductivity} = \frac{C_m \times K_c}{0.019(t-20)+1}\ \mu\text{mhos cm}^{-1}$$

When *resistance* of the sample has been measured, the calculation is:

$$\text{Conductivity} = \frac{10^6 \times K_c}{R_m[0.019(t-20)+1]}\ \mu\text{mhos cm}^{-1}$$

where K_c = cell constant (cm^{-1})
C_m = measured conductivity of sample at t°C (μmhos cm^{-1})
R_m = measured resistance of sample at t°C (ohms)
t = temperature of sample (°C).

DISSOLVED OXYGEN

- **Dissolved oxygen** is molecular oxygen freely available in water and necessary for the respiration of aquatic life and the oxidation of organic material.
- Dissolved oxygen is measured by DO meter.

DISSOLVED OXYGEN

- First limiting factor for growth and fish health
- Solubility decreases with increasing temperature and elevation
- Respiratory rate increases with increasing temperature, activity and feeding
- In general the minimum DO should be ≥ 60% of saturation or ≥ 5 ppm (mg/L)
- > 2 ppm in biofilter effluent

DISSOLVED OXYGEN AND WATER TEMPERATURE

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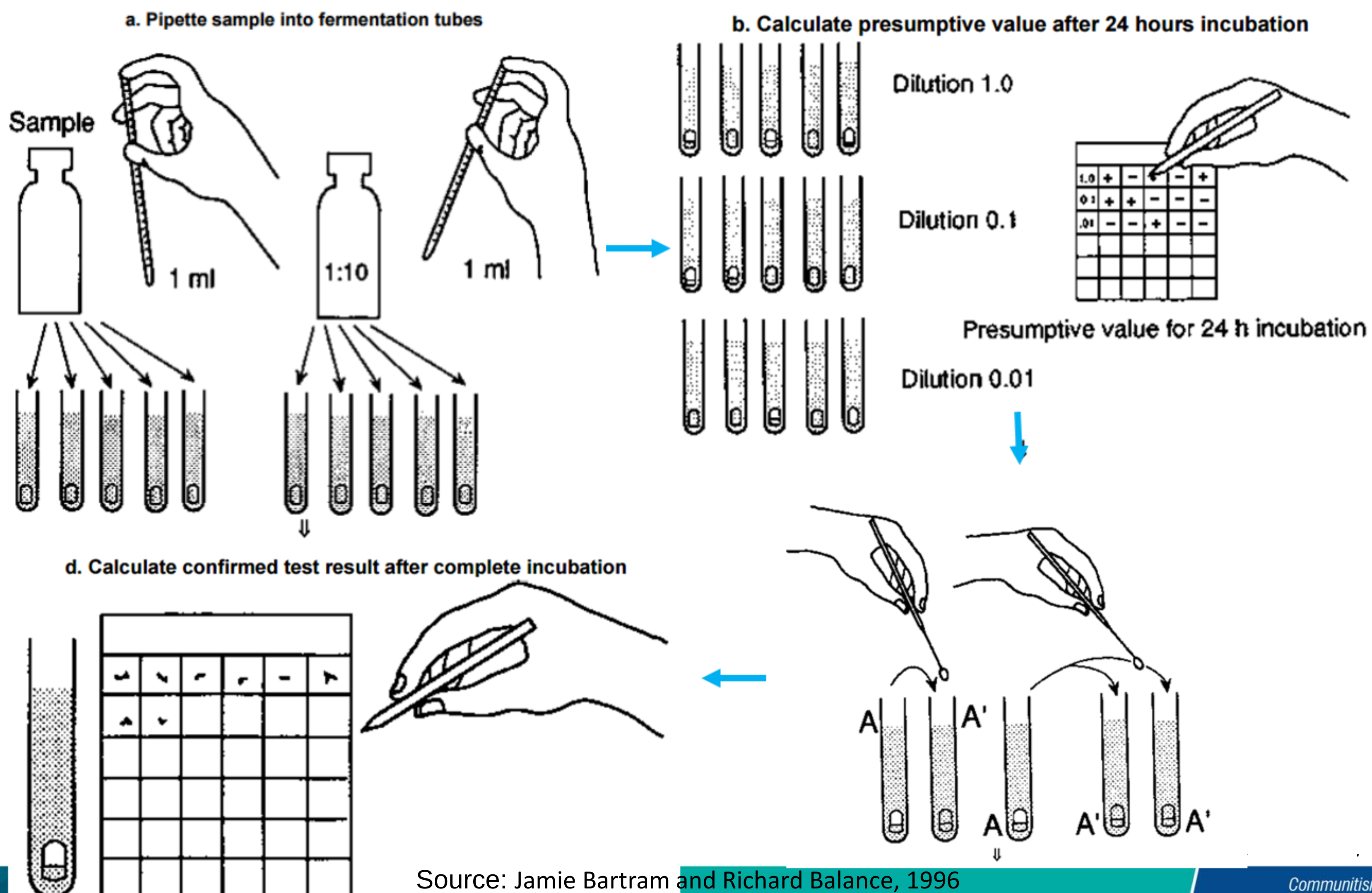
Stratification can cause dissolved oxygen and temperature to vary at different depths in the same system.

THERMOTOLERANT

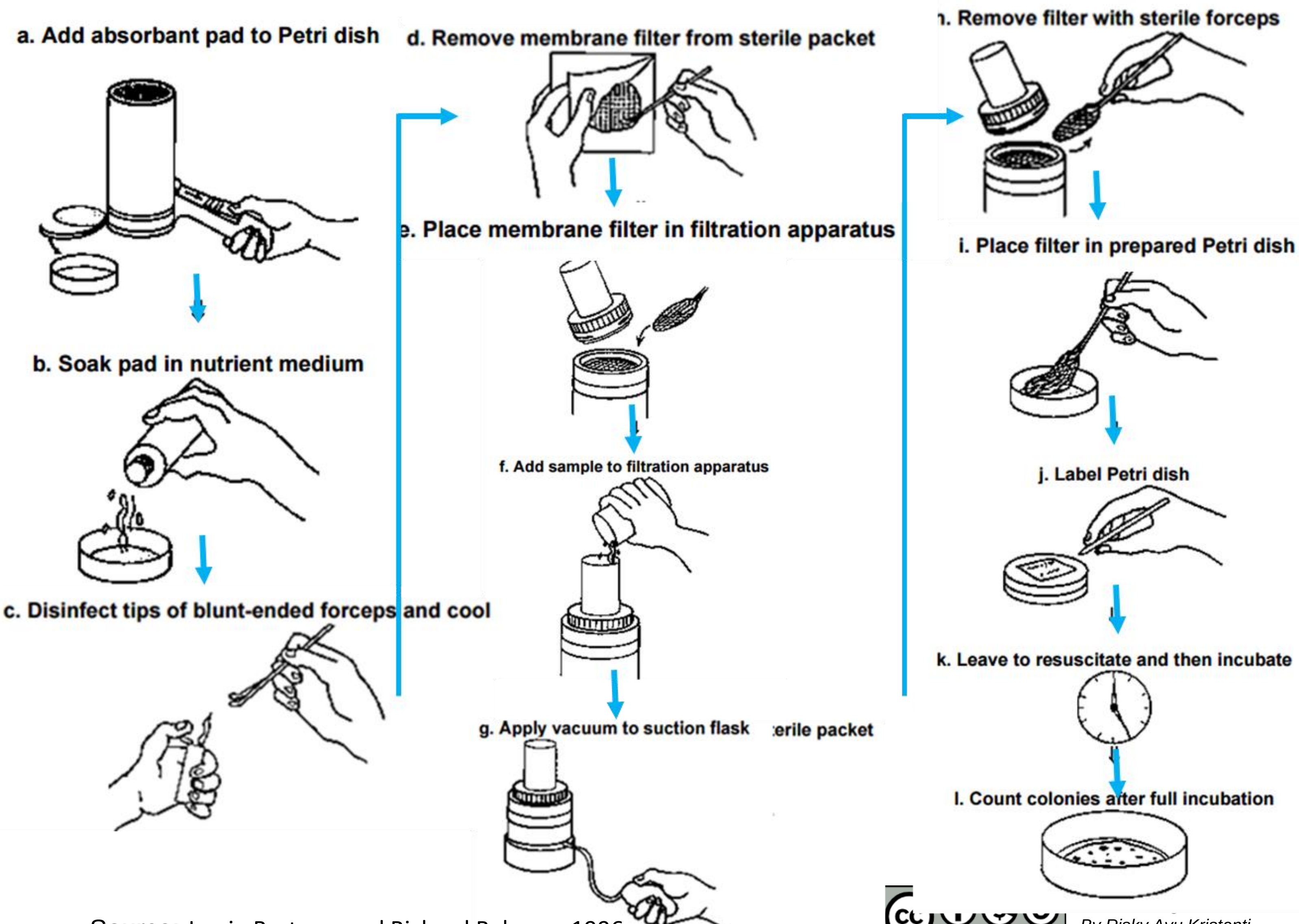
- Thermotolerant is the presence of faecal bacteria in water
- Fecal or thermotolerant coliforms are able to grow at higher incubation temperatures (44 or 44.5°C) and ferment lactose to produce acid and gas
- Same origin from the intestinal tract of a warm-blooded animal
- Example: *Escherichia coli*
- Measured by multiple fermentation tube technique and membrane filter techniques

MULTIPLE FERMENTATION TUBE TECHNIQUE (MFT)



Source: Jamie Bartram and Richard Balance, 1996

MEMBRANE FILTER TECHNIQUE (MF)



Source: Jamie Bartram and Richard Balance, 1996

COMPARISON MFT AND MF TECHNIQUE

Multiple fermentation tube technique	Membrane filter technique
Slower: requires 48 hours for a positive	More rapid: quantitative results in or presumptive positive about 18 hours
More labour-intensive	Less labour-intensive
Requires more culture medium	Requires less culture medium
Requires more glassware	Requires less glassware
More sensitive	Less sensitive
Result obtained indirectly by statistical approximation (low precision)	Results obtained directly by colony count (high precision)
Not readily adaptable for use in the field	Readily adapted for use in the field
Applicable to all types of water	Not applicable to turbid waters
Consumables readily available in most countries	Cost of consumables is high in many countries
May give better recovery of stressed or damaged organisms in some circumstances	

DISINFECTING EQUIPMENT IN THE FIELD

- **Dry heat**: The flame from a gas cigarette-lighter, for example, can be used to disinfect forceps for manipulation of membrane filters. It must be a butane or propane gas lighter, not one that uses gasoline or similar liquid fuel, which would blacken the forceps.

- **Formaldehyde**:This gas is a powerful bactericide. It may be generated by the combustion of methanol (but no other alcohol) in a closed space where oxygen becomes depleted. In the field, this is a convenient way to disinfect the filtration apparatus between uses. A minimum contact time of 10 minutes is recommended.

- **Disinfecting reusables**:The two main items of reusable equipment, Petri dishes (glass or aluminium) and bottles, may be disinfected by immersion in boiling water for a few minutes, by dry heat sterilisation in an oven or by heating in a pressure cooker for at least 20 minutes.

- **Disposal of contaminated material**: Autoclaving (or pressure cooking) of contaminated material is impractical in the field. Contaminated materials such as membrane filters and pads may be burned.

Conclusion of The Chapter

– Field testing includes six parameters, including temperature, transparency, pH, conductivity, dissolved oxygen and thermotolerant

Reference

Jamie Bartram and Richard Balance. 1996. **Water Quality Monitoring: A Practical Guide to Design and Implementation of Freshwater Quality Studies and Monitoring Programmes**, CRC Press.