Hydrology Protocols for Mosquito Bundle

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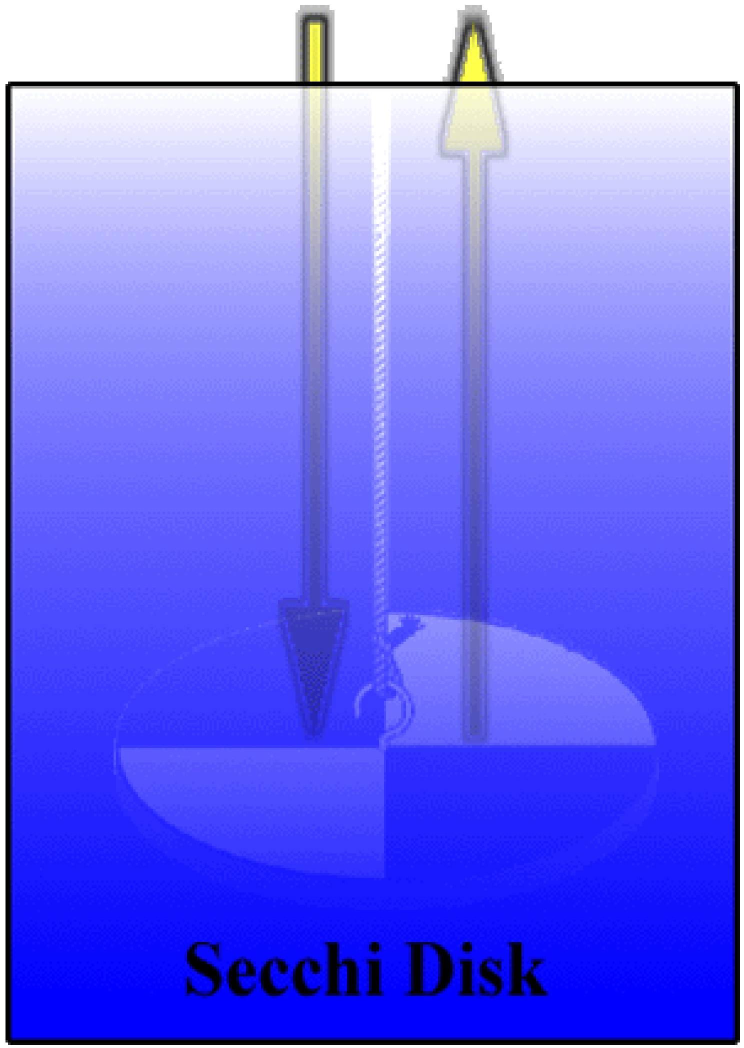
Transparency, cm

Transparency is measured by using a *Secchi disk* or a *transparency tube*.

Why measure transparency?

Measures Light Penetration Through The Entire Water Column



Transparency Varies With The Amount of Substances in The Water

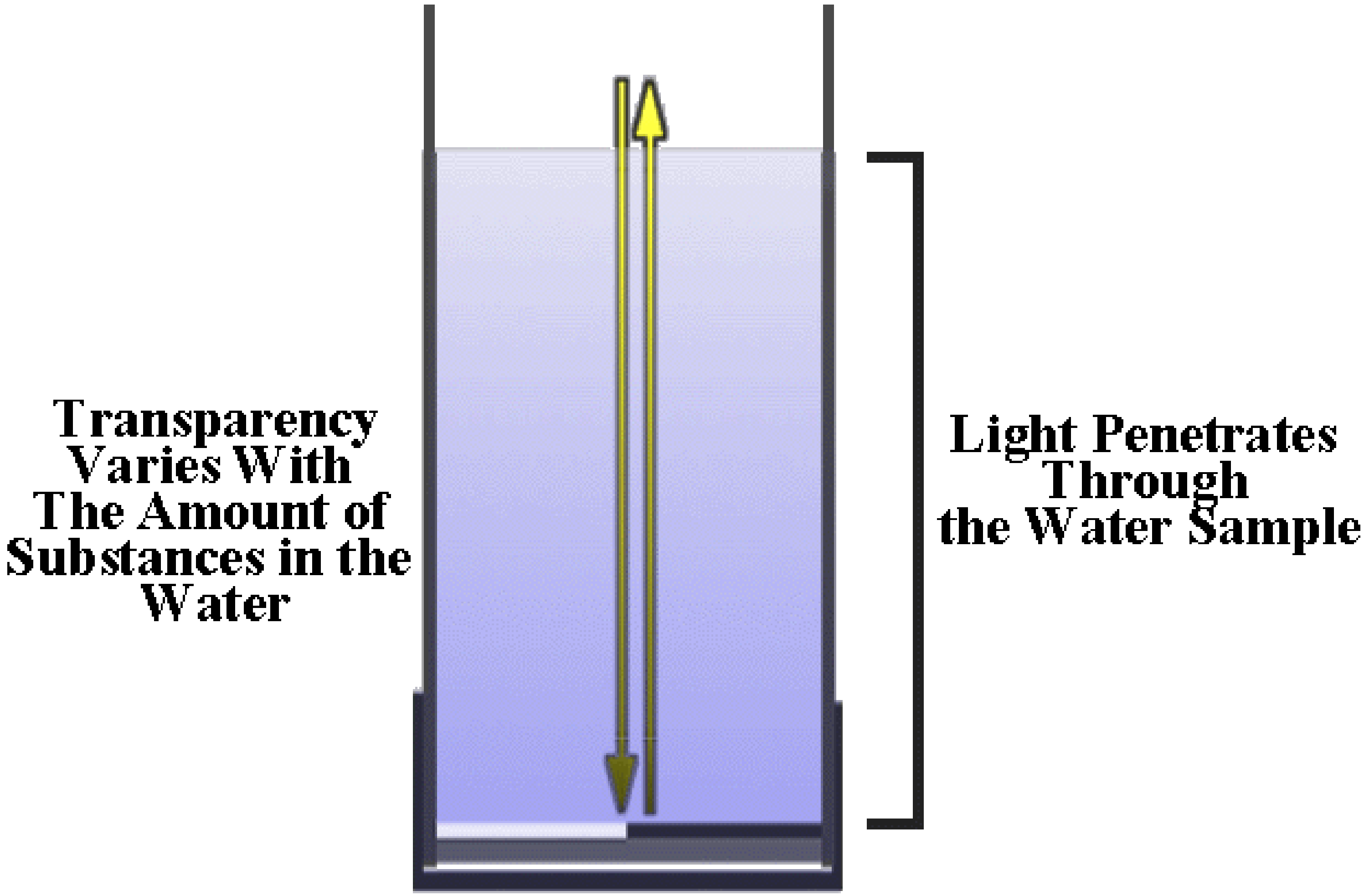
Secchi Disk Reading

- Record the cloud cover (%)
- Stand so that the Secchi disk will be shaded or use an umbrella
- Lower the disk slowly into the water until it just disappears.
- Mark the rope with a clothespin at the water surface or relative to the surface you are standing on.

Secchi Disk Reading (continued)

- Lower the disk another 10 cm into the water, then raise the disk until it reappears. WHY?
- Mark the rope with a clothespin at the water surface (or edge of the dock or bridge).
- There should now be two points marked on the rope. Record the length of the rope between the marks and the Secchi disk.

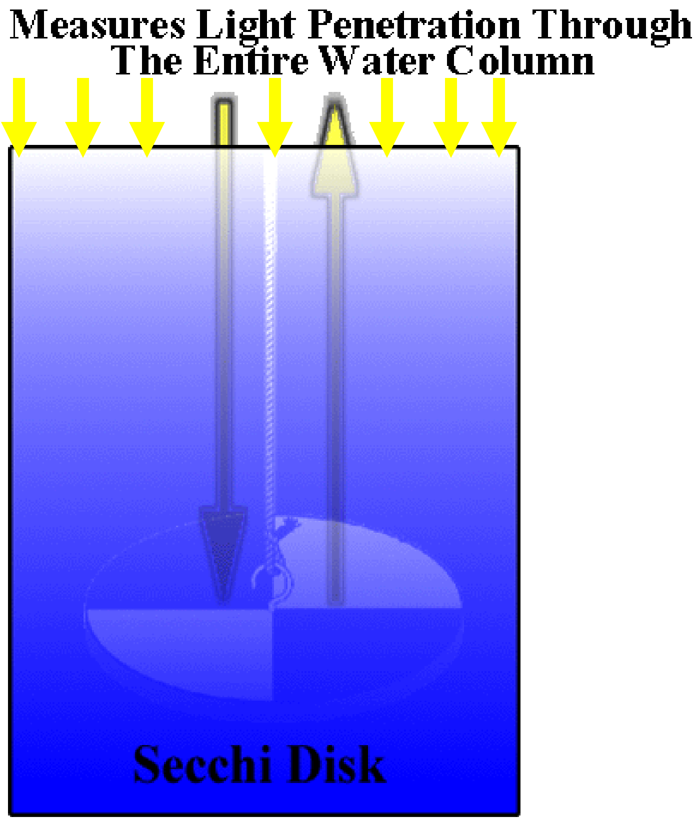
Transparency Tube

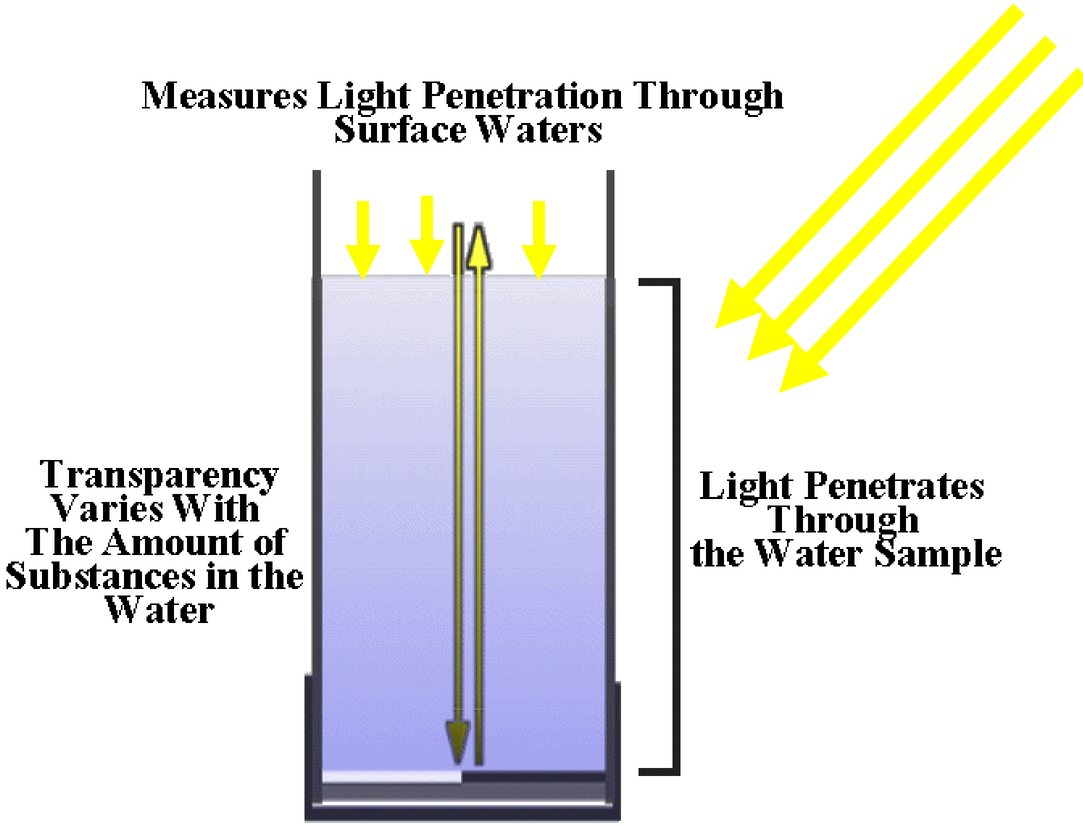


Transparency Tube Reading

- Pour the sample water into the tube until the image at the bottom of the tube is no longer visible when looking directly through the water column to the image.
- Rotate the tube while looking down.
- Record this depth of water to the nearest 1 cm. Take three separate measurements.

Secchi Disks and Transparency Tubes are different measurements!!!





Quality Control

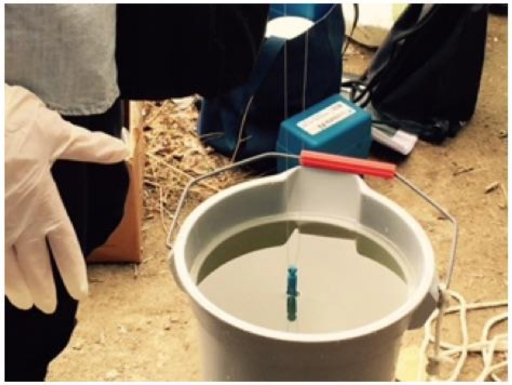
- Measurements must agree ± 10 cm
- If standing above water (on a bridge), record distance above water
- Do in a shadow & record cloud coverage
- Do the same time each time

Temperature, °C

Why measure temperature?

Temperature Measurement

- Immerse thermometer in water to a depth of 10 cm for 3-5 minutes.
- Read temperature at eye level (raise a few cm if necessary). Keep bulb in the water.
- Lower thermometer in water for 1 additional minute and check that the temperature is constant between the 2 readings.
- Record temperature. Take three temperature measurements.



Helpful Hint

Tie string to the thermometer. Tie the other end of the sting to the rubber band. Slip the rubber band around your wrist to prevent loss of the instrument.

Quality Control

Check the thermometer with ice solution (0 °C)

Salinity, ppt

Why measure salinity?

Major Constituents of Seawater (% by weight)

Chloride (Cl^-)	55.07%
Sodium (Na^+)	30.62%
Sulfate (SO_4^{2-})	7.72%
Magnesium (Mg^{2+})	3.68%
Calcium (Ca^{2+})	1.17%
Potassium (K^+)	1.10%
Bicarbonate (HCO_3^-)	0.40%
Bromide (Br^-)	0.19%
Strontium (Sr^{2+})	0.02%
Boron (B^{3+})	0.01%
Fluoride (F^-)	0.01%

Significant Values

- The average salinity of the world's oceans is 35 ppt.
- Freshwater has a salinity of <1 ppt (use conductivity meter.)
- Waters with salinity values between 1 - 25 ppt are called *brackish*.
- Waters with salinity greater than 40 ppt are called *hypersaline*.
- Salinity of *coastal waters* can vary diurnally due to tides





Salinity Hydrometer Method

- Addition of salts to pure water causes an increase in density.
- Salinity can be calculated by measuring the *specific gravity* of a water sample using a hydrometer, correct for T (°C) & convert to salinity.

$$\text{Specific Gravity} = \frac{\text{density of sample}}{\text{density of pure water}}$$



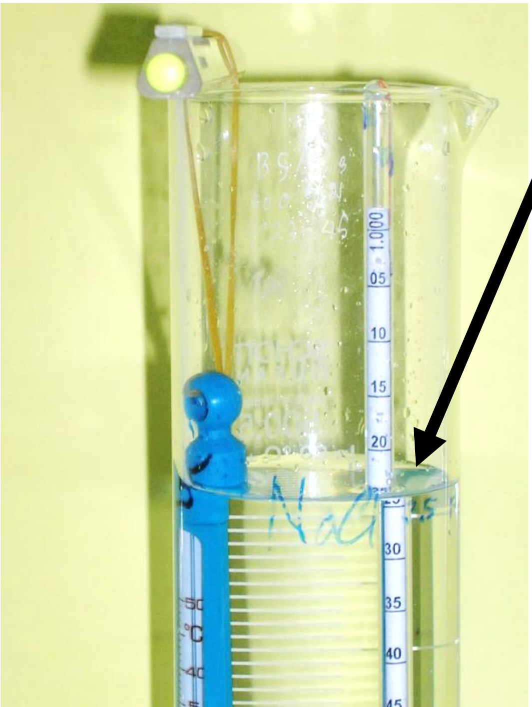


Hydrometer

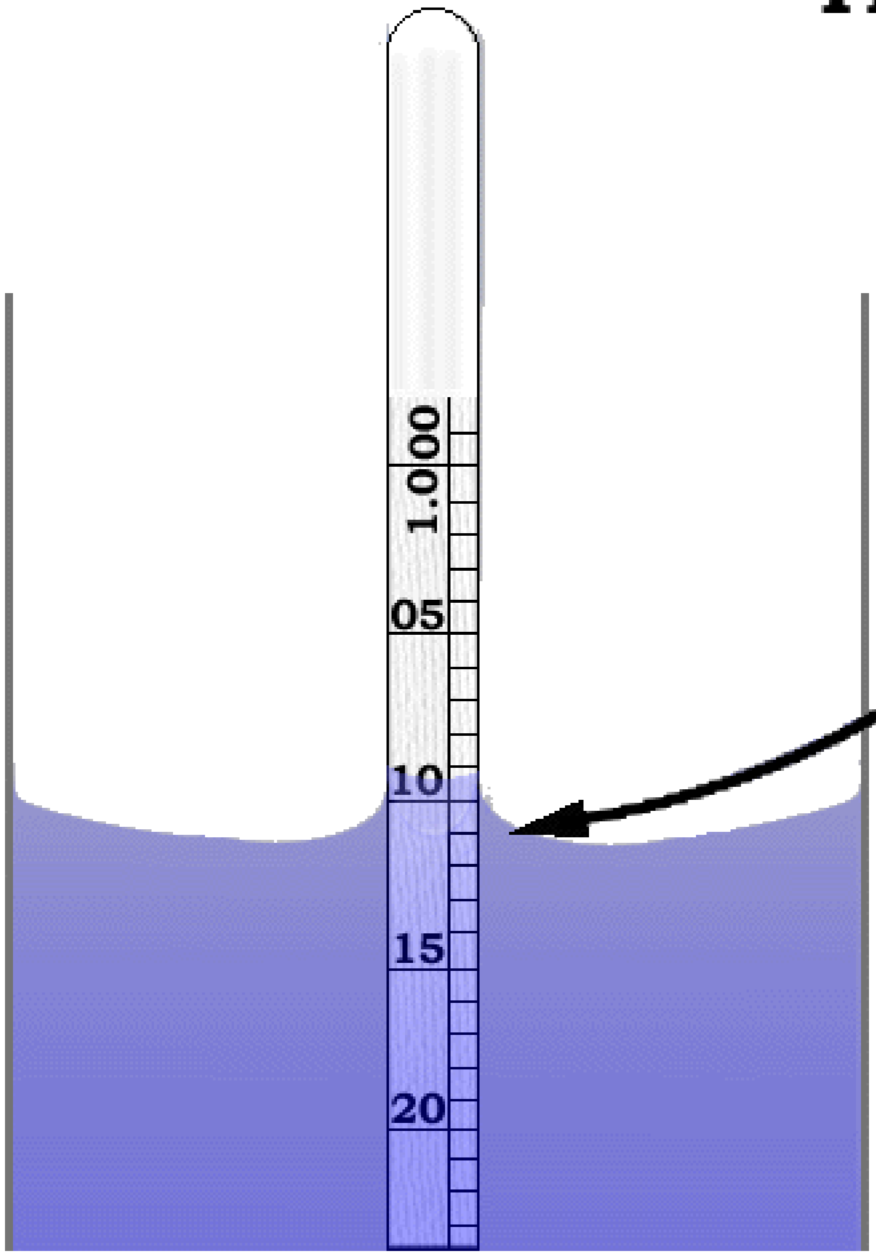
- Use clean hydrometer.
- Fill 500 mL graduated cylinder with sample.
- Determine T (°C) of sample.
- Place the hydrometer in cylinder and let settle. It should float freely.
- Read the specific gravity from the hydrometer scale (use bottom of the meniscus.)
- Determine salinity from table using specific gravity & T (°C) values.
- Read three times. The values should be ± 2 ppt of the average.

Hydrometer

- Hydrometer should bob freely
- Measure temperature (hang thermometer from top)
- Read at bottom of meniscus



The reading on the hydrometer is 1.011



Conversion table

Look up the specific gravity and water temperature on the Conversion Table to find the salinity of the water.

Table HY-SA-2: Salinity (parts per thousand) as a function of specific gravity and temperature (as of 9/2005)

	Temperature of Water (°C)																
Observed Reading	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
0.998																	
0.999																	
1.000																	
1.001	2.0	1.9	1.9	1.8	1.8	1.5	1.5	1.5	1.5	1.5	1.5	1.8	1.8	1.9	1.9	2.0	2.1
1.002	3.3	3.2	3.2	3.1	2.9	2.9	2.9	2.8	2.8	2.9	2.9	2.9	3.1	3.2	3.3	3.4	3.6
1.003	4.6	4.5	4.4	4.2	4.2	4.1	4.1	4.1	4.1	4.1	4.2	4.2	4.4	4.5	4.6	4.7	4.9
1.004	5.8	5.7	5.5	5.5	5.4	5.4	5.4	5.4	5.4	5.4	5.5	5.5	5.7	5.8	5.9	6.1	6.2
1.005	7.1	7.0	6.8	6.7	6.7	6.7	6.6	6.6	6.7	6.7	6.7	6.8	6.8	7.0	7.1	7.2	7.5
1.006	8.3	8.1	8.1	8.0	7.9	7.9	7.9	7.9	7.9	8.0	8.0	8.1	8.1	8.3	8.4	8.5	8.8
1.007	9.4	9.4	9.3	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.3	9.4	9.4	9.6	9.7	9.8	10.1
1.008	10.7	10.6	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.6	10.6	10.7	10.9	11.0	11.1	11.3
1.009	11.9	11.8	11.8	11.7	11.7	11.7	11.7	11.7	11.8	11.8	11.9	11.9	12.0	12.2	12.3	12.4	12.6
1.010	13.2	13.1	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.1	13.1	13.2	13.3	13.5	13.6	13.7	13.9

Quality Control & Calibration

- 35 ppt standard:
  - 17.5 g NaCl (table salt) into a 500-mL graduated cylinder.
  - Fill the cylinder to 500-mL with distilled water and mix
- Prepare a blank using 500 ml of distilled water.
- Follow the directions for a water sample.
- Check technique every six months.

Check to see if hydrometer is accurate!!!!!

pH

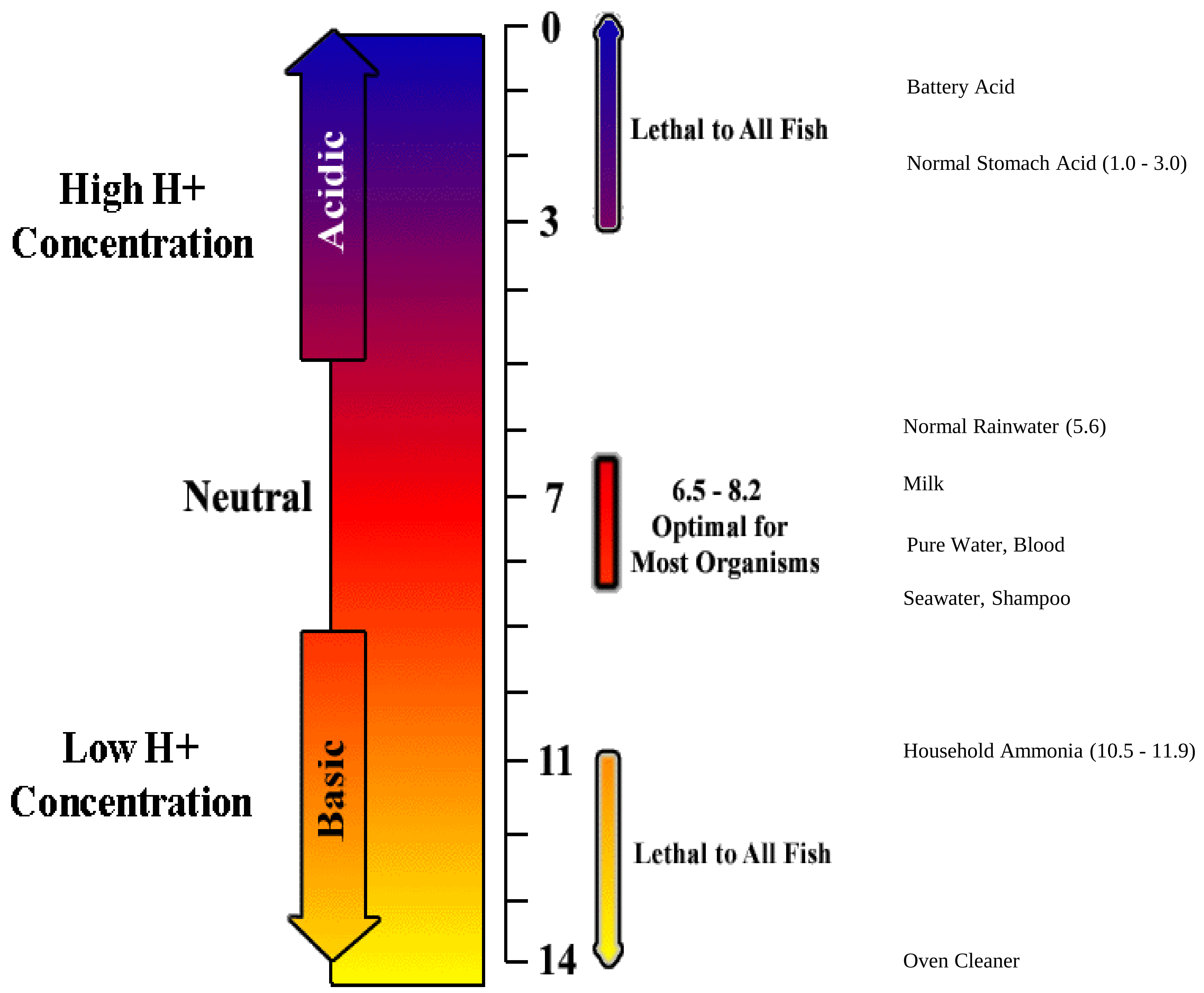
Why measure pH?

What is Water pH?

$$H_2O \rightleftharpoons H^+ + OH^-$$

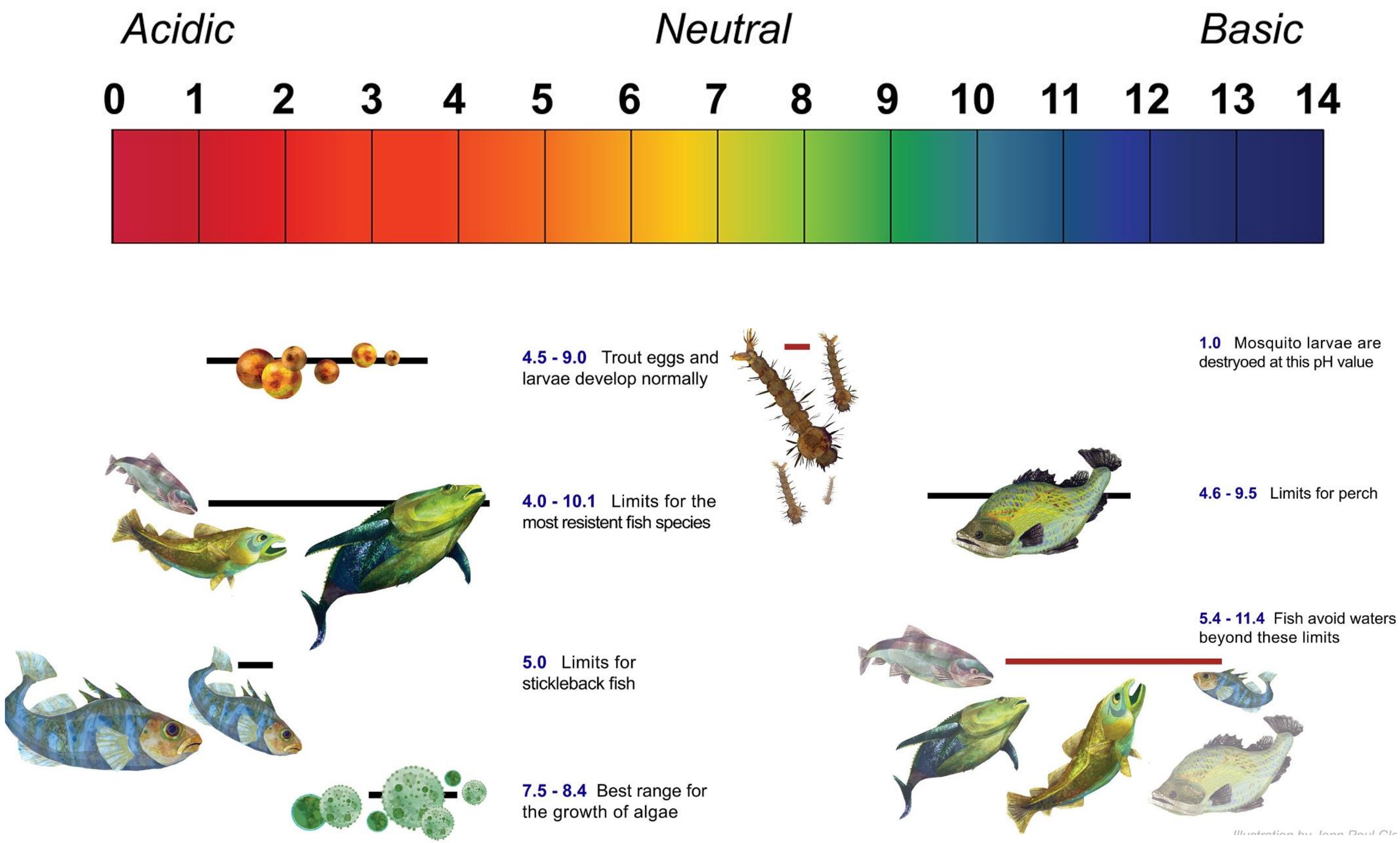
acid — proton — base

pH is a measurement of the proton content of the sample.



High H+
Concentration
Acidic
Neutral
Low H+
Concentration
Basic
0
3
7
11
14
Lethal to All Fish
6.5 - 8.2
Optimal for
Most Organisms
Lethal to All Fish
Battery Acid
Normal Stomach Acid (1.0 - 3.0)
Normal Rainwater (5.6)
Milk
Pure Water, Blood
Seawater, Shampoo
Household Ammonia (10.5 - 11.9)
Oven Cleaner

Importance of pH to Aquatic Life



pH Measurement Instruments

- pH paper
  - Precision 0.5 pH increments
- pH meter
  - Can use three pH buffers (pH 4, 7, 10) & precision of $\pm$ 0.2 pH unit
- Both require the water sample to have conductivity values > 200 μS/cm.
- For samples conductivity < 200 μS/cm, add NaCl

pH paper

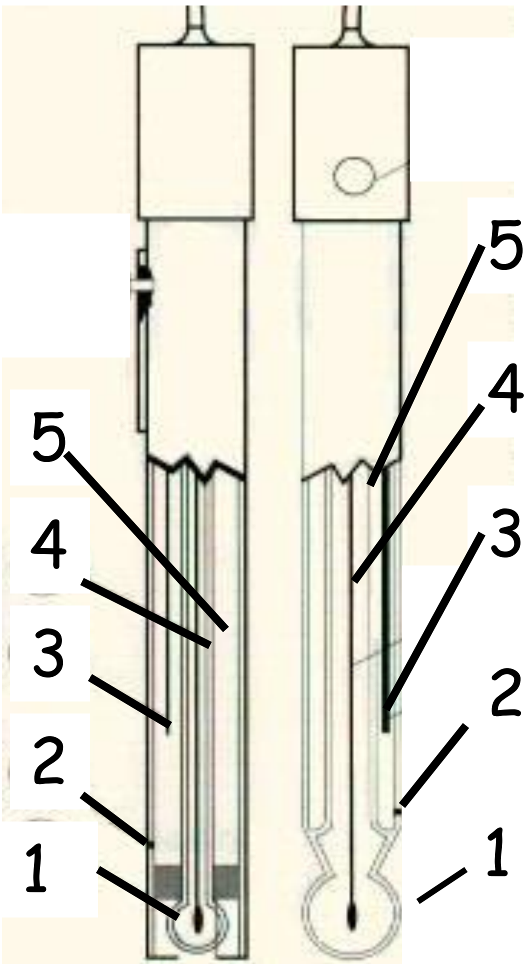
Rinse a container at least twice with sample water.

Partially fill the beaker sample.

Dip one strip of indicator paper into the sample water (read manufacturer's directions).

Remove the paper from the water and compare the resultant color with the color chart for pH paper.

pH: *Easy to measure; Hard to get correct*



From Hanna Instruments

5 *Electrolyte gel.* Will become depleted of electrolytes over time

4 *pH Internal Element*: Supplies a voltage based on the pH value of the sample.

3 *Internal Reference*: Supplies a constant equilibrium voltage.

2 *Reference Junction*: Acts as a liquid path electrical conductor.

1 *Sensitive Membrane Glass*: Performs actual measurement. Must be kept hydrated

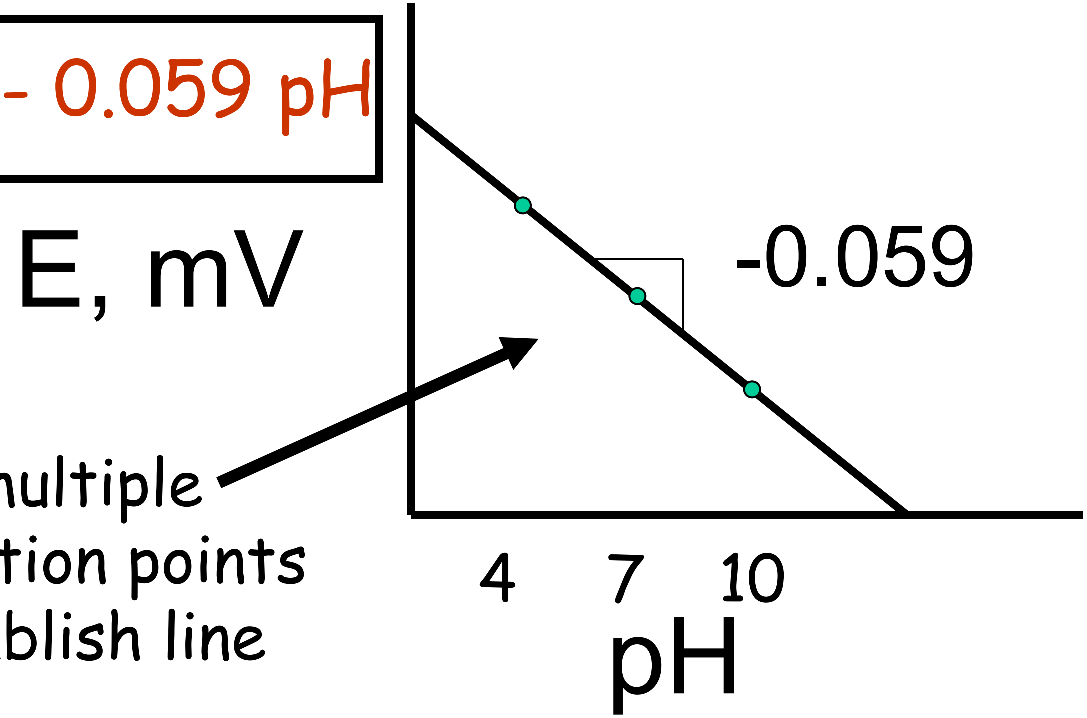
Basic pH principles

Nernst Equation:

$E = E_0 - (RT/zF) \ln (a(RED)/a(OX))$

For standard conditions (25°C, 1 atm H_2)

$E = E_0 - 0.059 \text{ pH}$



Need multiple calibration points to establish line

pH meter Calibration

Use pH 4, 7, and 10 buffer

Condition the electrode.

Rinse the electrode twice with distilled water and blot dry.

Follow probe instructions for order of buffers.

Gently stir the buffer solution and wait for the display to stabilize. Establish pH value.

Rinse electrode again & use other pH buffers

Instrument Reading - pH Meter

CALIBRATE!!!!!!!!!!!

Immerse the electrode in sample water so that the entire glass probe is immersed –*not the entire meter.*

Stir gently & let the display value stabilize.

Read the display value on the meter.

Record value on in the *Hydrology Data Sheet* as pH.

Measure 3 times, The three pH values should be ± 0.2 of each other.

pH Measurements

Appear easy – but take time & care for data to be useful

Always condition electrode if dry

Always calibrate if used 24 hrs after last calibration

Always date buffer solutions once opened

pH probes age, so discard when no longer are stable

Storage

Long term (>24 hrs):

- remove membrane cap & rinse and store with sponge in cap

Short term (<24 hrs):

- store in 1 inch specified liquid

If dry, rehydrate before use

Dissolved Oxygen, ppm

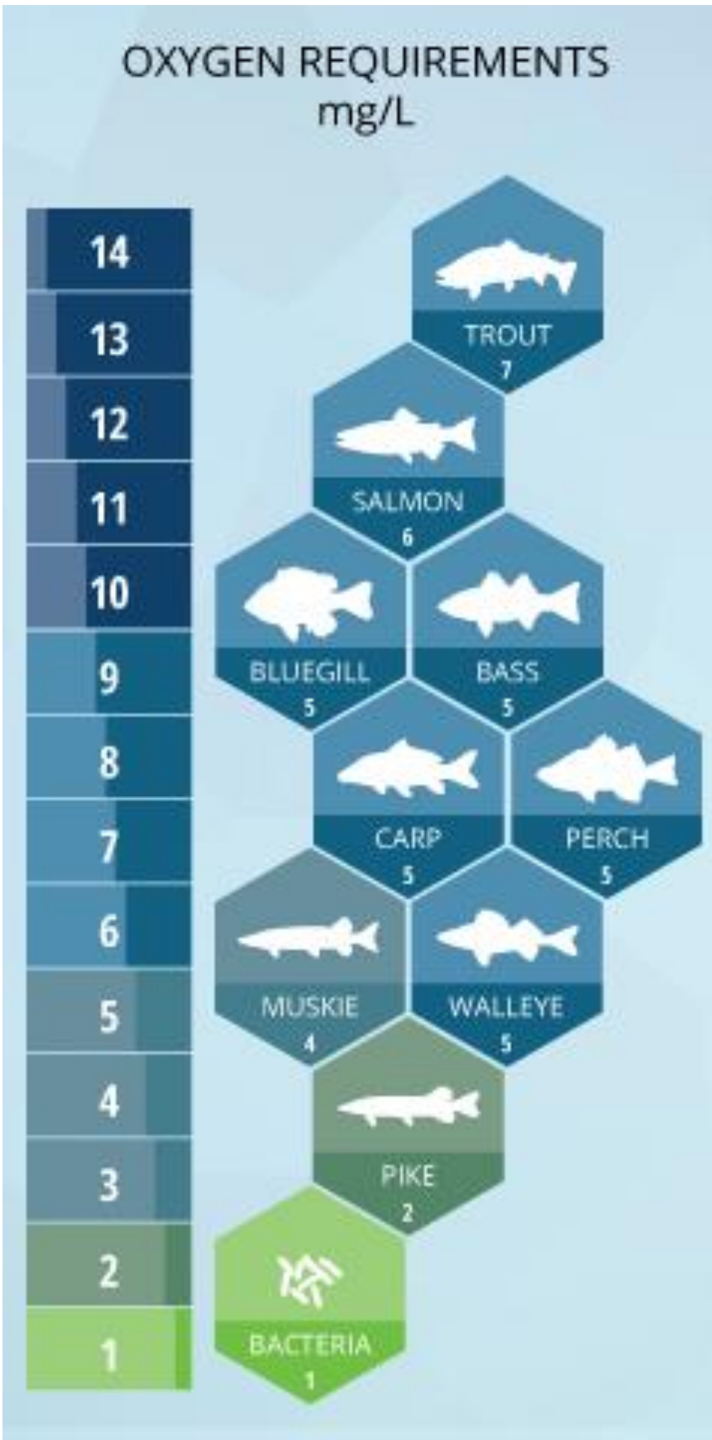
Why measure dissolved oxygen?

Dissolved Oxygen

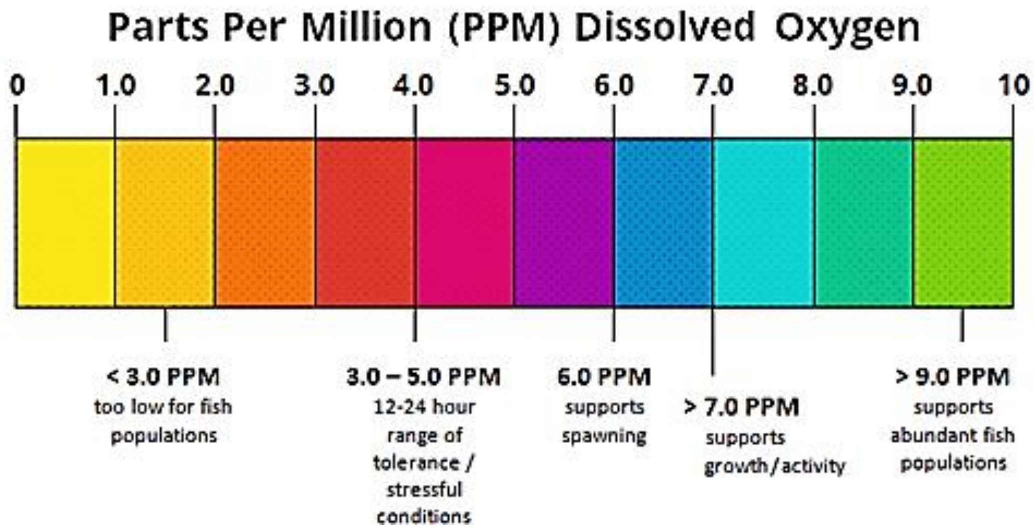
In water, roughly five of every million molecules are dissolved oxygen (O_2), mg/L (ppm by mass)

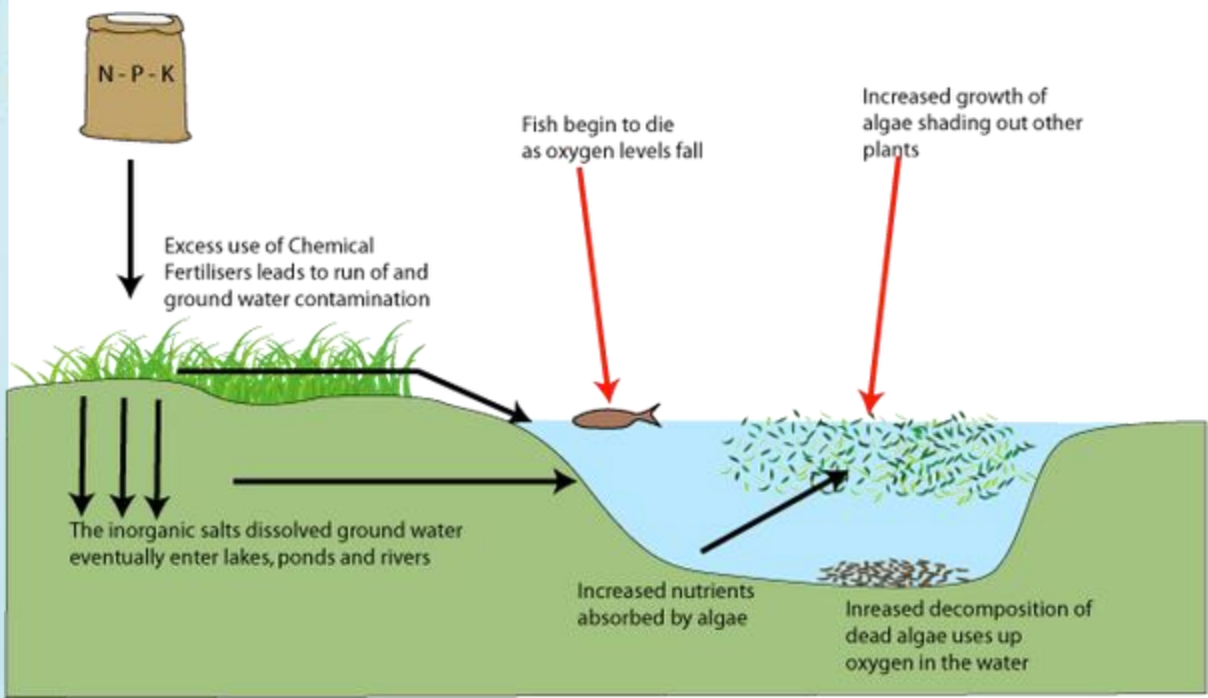
Dissolved oxygen levels of at least 5 - 6 ppm (mg/L) are usually required for fish.

Dissolved oxygen levels of below 3 ppm are stressful to most aquatic organisms.



Range of Tolerance for Dissolved Oxygen in Fish





The amount of oxygen that water changes with:

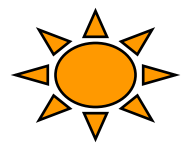
Temperature ($T\uparrow$, $DO\downarrow$)

Elevation (H (m) $\uparrow$, $DO\downarrow$)

Salt concentration ($C_{salt}\uparrow$, $DO\downarrow$)

Biological Influences and Dissolved Oxygen

As photosynthesis increases, oxygen levels increase:



$$CO_2 + H_2O \longrightarrow \text{Biomass} + O_2$$

As respiration increases due to decay or organic materials, oxygen levels decrease:

$$\text{Biomass} + O_2 \longrightarrow CO_2 + H_2O$$

Saturated Solutions

Saturated solutions: solutions in equilibrium with the atmosphere at a certain temperature. These can be made by shaking a partially filled bottle of distilled water for 5 min.

Can a sample be *supersaturated* (DO levels > saturation)?

Taking a Sample and testing

Rinse sampling bottle 3 times with sample water

Submerge bottle in water, fill & cap.

- If there are air bubbles in the bottle, empty and repeat

Preserve sample immediately. Test within 2 hours.

Repeat 3 times. Take the average to see if all values are within the precision of the kit. Discard outliers.

Sample Preservation and Sample Testing

Preservation:

- 1st - addition of a chemical that precipitates in the presence of dissolved oxygen
- 2nd - addition of a chemical that causes the solids to dissolve and produce a colored solution. **This should be done in the field.**

Sample Testing:

- Titration of preserved sample. **This can be done in the lab.**

DO chemicals

DO tritration

Fixed solution

Pale yellow

Add starch

endpoint

Winkler Titrations

To Preserve DO: Done in the field

$O_2 + 2\ Mn^{2+} + 2H_2O \longrightarrow 2Mn(IV)O_2 + 4H^+$ (pH >10)

Allow precipitate to settle (reaction goes to completion)

$2Mn(IV)O_2 + 4H^+ + 2I^- \longrightarrow Mn^{2+} + I_2$ (yellow) $+ 2H_2O$ (low pH)

DO is preserved

To Test Sample: This step can be done in the lab.

$Na_2S_2O_3 + 4I_2 + 5H_2O \longrightarrow 8I^- + 2SO_4^{2-} + 10H^+ + Na^+$ (the titration)

Starch $+ I_2 \longrightarrow$ blue (to improve endpoint determination)

Quality Control

Check technique by using a *DO saturated* solution of distilled water at known temperature every 6 months

Discard kit chemicals after expired or if contaminated.

To find the expected DO value for a saturated distilled water sample:

Step 1: Using Table HYD-P-1 find the solubility of oxygen (mg/L) that corresponds to the temperature of your sample. *Example: A temperature of 22 C has a corresponding DO solubility of 8.7 mg/L.*

Step 2: Using Table HYD-P-2 find the value that corresponds to your elevation. *Example: An altitude of 1,544 meters has a corresponding saturation calibration value of 0.83.*

Step 3: Multiply the solubility of oxygen found in Step 1 by the calibration value found in Step 2. *Example: At an altitude of 1,544 meters and a temperature of 22 C, 8.7 mg/L X 0.83 = 7.25 mg/L.*

Step 4: Compare this value to the DO value of the shaken distilled water.