1.4) INSTRUCTOR'S GUIDE TO INTERPRETING WATER QUALITY DATA FROM THE USGS

Answers to Questions 1-12:

1. Seasonal patterns:
   a. Discharge (no)
   b. Temperature (yes)
   c. Conductance (no)
   d. Dissolved oxygen (yes)
   e. Nitrogen, phosphorus (no)
   f. *E. coli* (no)
   g. Suspended sediments (no)
2. Relation to discharge:
   a. Conductance: decrease
   b. Nitrogen: increase
   c. Phosphorus: increase
   d. E. coli: increase
   e. Suspended sediments: increase
   f. Dissolved oxygen: no noticeable effect
3. Increase because more runoff results in more discharge.
4. Decrease because the electrolytes are usually diluted by the rain.
5. Increase because runoff flushes the coliform bacteria into the surface waters.
6. Diurnal patterns:
   a. Low pH at night/dawn.
   b. High pH in afternoon.
   c. Low temperature is night/dawn.
   d. High temperature in afternoon.
   e. Lowest O_2 at night/dawn.
   f. Highest O_2 in afternoon.
7. The process of photosynthesis removes CO_2 from the water. This increases pH.
8. Dissolved O_2 is lowest at dawn because photosynthesis does not occur at night.
9. Low dissolved O_2 events: 2015-2016 (Chesterville) and 2019-2020 (Anacostia)
10. Sligo Creek had no problems with low O_2.
11. Seasonal patterns of dissolved O_2: lowest in summer & highest in winter.
12. Land use:
    a. Riverdale has a higher population density.
    b. Residences and businesses.
    c. Agriculture and woodland.
13. Riverdale is suburban and Crumpton is rural.
14. Storm water, residential wastes, pet wastes,…
15. Answers will vary, but must relate to suburbs & cities.
16. Chicken farms, chemical fertilizers,…
17. Answers will vary, but must relate to agriculture.

Logistics: This is an individual assignment, but some students may need help discerning seasonal and diurnal patterns in the graphs. I have not provided a link for land use because land use maps are easy to look up online.

Degree of Difficulty: 1—Once students get the hang of it, this lab becomes relatively straightforward.

1.5) NET PRIMARY PRODUCTIVITY AND BIOLOGICAL OXYGEN DEMAND

Objective: In this activity you will estimate net primary productivity in pond samples by comparing dissolved oxygen dynamics in light and dark bottles. You will also determine over time the effect of phytoplankton on BOD. **Video instructions:** https://vimeo.com/70477473

Introduction: Anyone who has managed a retail business knows that sales revenue is not the same as net profit. This is analogous to the difference between gross and net primary productivity by producers. Just like animals and other consumers, plants and algae also participate in cellular respiration and thereby consume a significant portion of the oxygen, adenosine triphosphate (ATP), and sugar they produce through photosynthesis. This is the cost of doing business.

Because algae usually produce surplus amounts of oxygen, it seems logical that bodies of water with thick densities of phytoplankton should also have higher levels of dissolved oxygen. In fact, during warmer months the opposite is true because much of the oxygen produced by algae does not stay in the water.

The dissolved oxygen "reserve" that remains in the water as the result of photosynthesis during daylight hours is particularly critical in the summer. This is because warm water holds less oxygen, and higher temperatures also increase the BOD of most aquatic organisms. At night, only respiration takes place; and under hypereutrophic conditions, algae can become the single largest consumer of oxygen.

In the absence of adequate aeration or water exchange, oxygen levels may fall to less than 1 ppm before dawn, resulting in an "algae crash" that kills nearly all of the aquatic life in the affected area. Algae crashes are not limited to small bodies of water such as ponds and lakes. Every summer, large "anoxic zones" in many coastal waters such as the Chesapeake Bay and the Gulf of Mexico spread out for hundreds of square miles, thereby destroying valuable habitat for crabs and oysters.

Part A: Net Primary Productivity

1) Fill two flasks to the brim with green water and then seal the top of each flask with a stopper to remove all exposure to the air. If you are using *Elodea* or *Spirogyra* as a substitute for green water (Fig. 2), use an electronic balance to make sure biomass is divided equally between both flasks. Try to get between 3-4 grams algae per flask. The mass of *Spirogyra* is obtained by picking up the algae and letting the water drip out for about 5-10 seconds (no squeezing!).
2) Fill and seal a second pair with tap water. This will serve as your control.
3) Wrap one flask from each group in aluminum foil or dark paper so that absolutely no light enters the flask. Place each wrapped flask in a clear beaker with water so that any heat that is absorbed by the water in the beaker passes to the wrapped flask (Fig. 1). This helps ensure that the light and dark flasks have the same temperature.
4) Measure temperature and dissolved oxygen at time 0. Place the flasks in front of the fluorescent lamp (Fig.1) and measure again after 30 and 60 minutes. If some water is lost while testing for oxygen, add more of your original water sample so that there is no air space when you seal your flask. Record your data into a table (Tables A-1 and A-2).
5) Use the formulas below to calculate net and gross primary productivity for the 60- minute time intervals:
   a. light flask (O_2 gain):

      O_2 ppm at 60 minutes – O_2 ppm at 0 minutes = net 1° productivity

   b. dark flask (O_2 loss):

      O_2 ppm at 0 minutes – O_2 ppm at 60 minutes = total respiration

   c. light and dark flasks (O_2 gain + O_2 loss):

      net 1° productivity + total respiration = total 1° productivity