**Notes on Dissolved Oxygen Estimation:**

Basic equation:

Consider an extensive stream where the flow is uniform. The mass balance equation for oxygen is

where t is time, V is the control volume, C is the pointwise oxygen concentration, , are the mass fluxes in the x (longitudinal), y (lateral), and z (vertical directions) respectively (due to advective and dispersive transport), and S are all the local sources and sinks for oxygen (biotic and abiotic).

Assumptions:

Uniform flow implies that

Integrate with respect to z and define fluxes per unit ground area A assuming the channel is rectangular of depth H:

where is the flux of oxygen with the atmosphere, is the depth-averaged concentration, and the term represents all production and removal of oxygen (say by plants, mircobes, fish, sediments, etc…).

The model:

We seek a description of B(t) from (t) using

To do so, a link between and C is required. One model is a bulk gas transfer given by

where is the oxygen saturation (varies with water temperature), and is the gas transfer velocity that can be inferred from a number of turbulence theories. If so, then

Provided that water depth, concentration, k, and water temperature are available, can be inferred and analyzed for different environmental conditions (e.g. as a function of light, temperature, or other chemical compounds such as N from fertilizer runoff, etc….)

The micro-eddy model (in the absence of bubbles) stipulates that where c1 is a coefficient, Sc is molecular Schmidt number for oxygen, is the kinematic viscosity of water, and is the turbulent kinetic energy dissipation rate.

In the absence of wind at the water surface, the where c2 is a similarity coefficient and u\* is the friction velocity.

Last, the friction velocity can be determined from , where g is the gravitational acceleration and So is the bed slope.

Revisions:

Revisions can be made to include large eddies, bubbles, and winds – but my preference is to start simple.

So, with c1 and c2 determined from laboratory studies, B(t) can be determined for all rivers.

It is emphasized that the B(t) is only an overall bulk, aggregate, or effective source/sink term and must be viewed as a lumped quantity. However, if the goal is to distinguish why different ecosystems experience differing patterns of oxygen fluctuations, it may be sufficient – as it links measured concentration time series, water level, water temperature, and channel properties (e.g. So) to overall sources or sinks (or production/consumption of oxygen).

The final summary result: