Making Electric Field Measurements

Electric field patterns are mapped by measuring voltage gradient (usually Volts/cm) at distances and directions from the electrodes.

Equipment

Measuring voltage gradients requires a voltage gradient probe and a meter. See *Voltage Gradient Probe construction.pdf.*

Methods

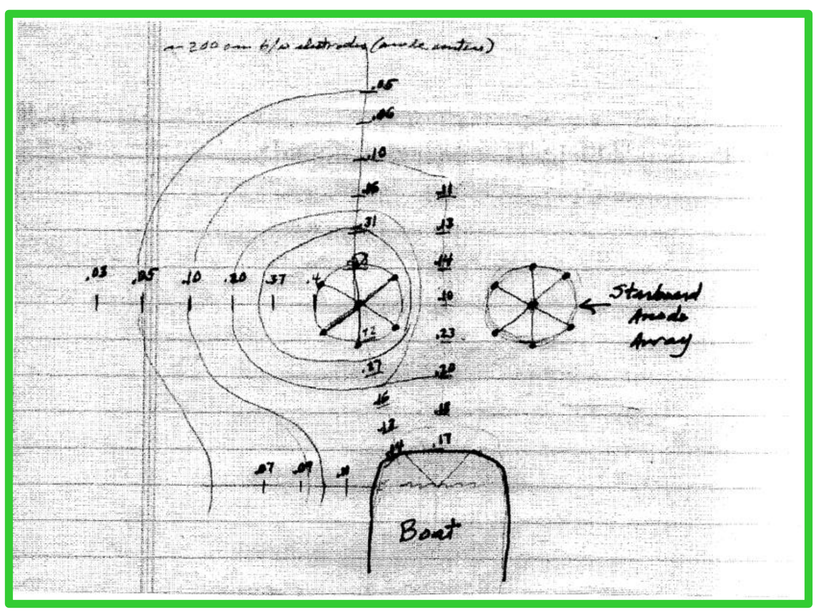
Deploy the electrofishing gear in typical sampling habitat (try to use an average depth) and place the electrodes in typical position. Record ambient water conductivity. Select a waveform of interest (AC, DC, PDC, frequency, duty cycle, and voltage) and record specifics. Measure distance from the center of an electrode. Make separate maps for opposite polarity electrodes (anodes and cathodes if using DC or PDC). Measuring aids include a tape measure or a PVC pipe marked off in centimeters (pictured below).

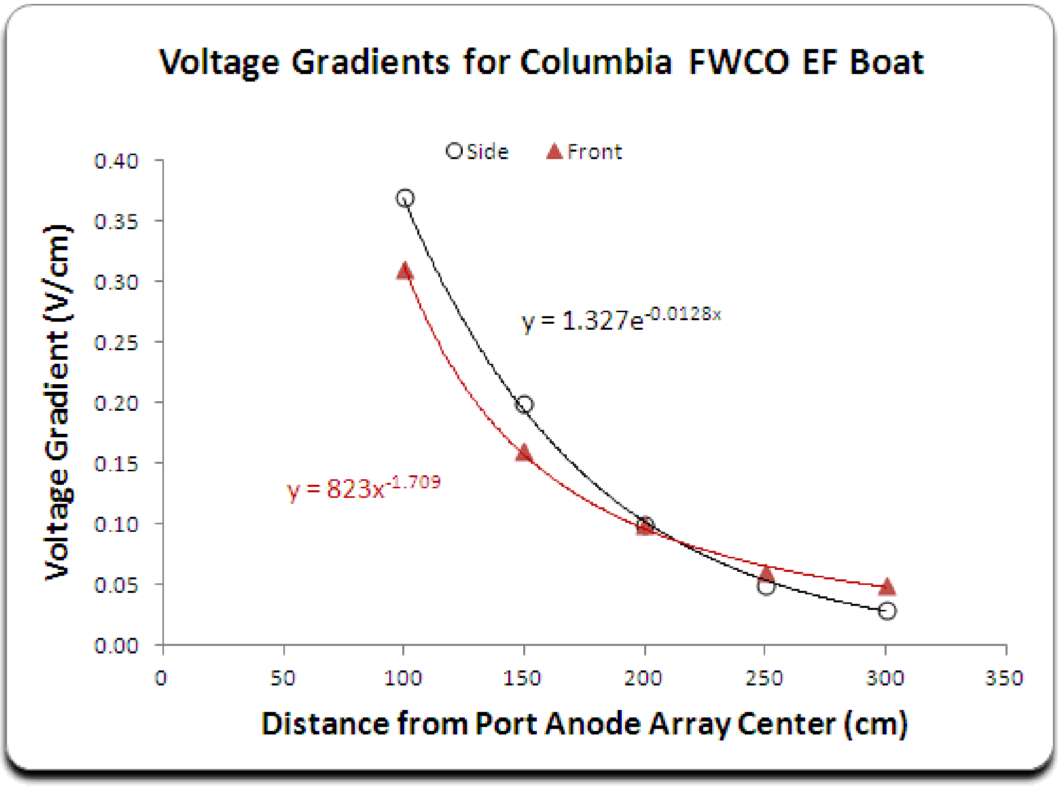
At pre-determined distances and/or at voltage gradients of interest, record voltage gradient at distance and direction from an electrode. Direction can be straight-ahead, directly lateral, aft, or some oblique angle.

Taking a measurement: place the bottom of the probe in the water to a consistent depth (e.g., 50% of submergence distance of droppers). If using DC or PDC, orient the anodic (red) end of the probe toward the anode or the cathodic probe end toward the cathode. Rotate the probe slowly until a maximum reading is obtained. If using a 1 cm probe electrode separation distance, then directly read V/cm from the multimeter display.

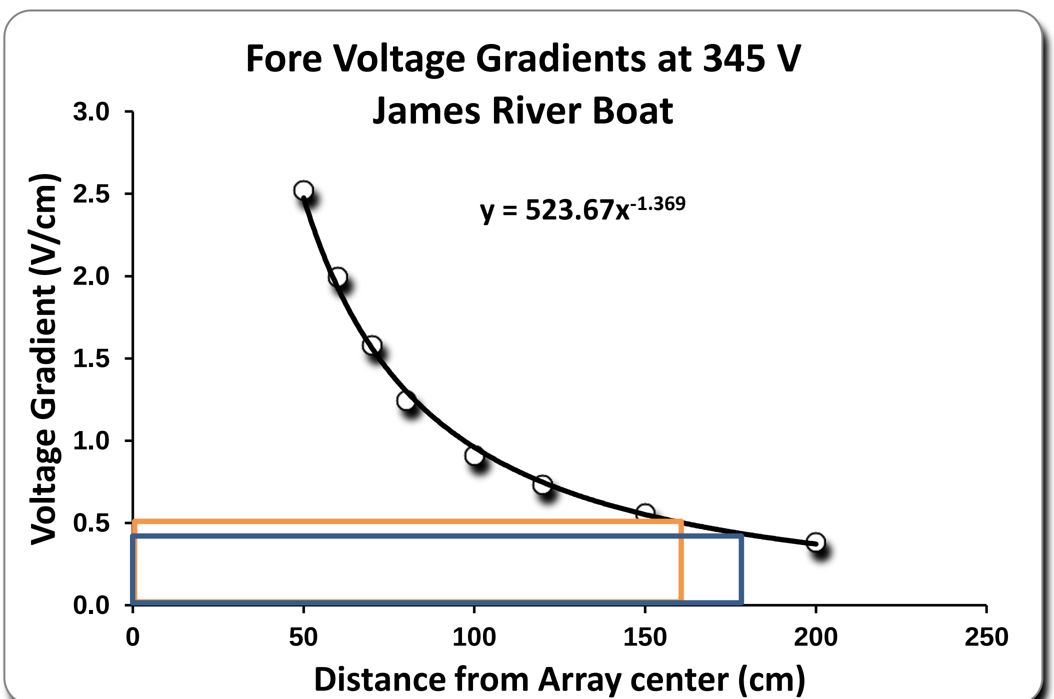
Analysis

Analysis can take the form of a plan-view map (right) or a graph (below).





In the above graph example of a boat boom dropper array electric field, a forward (Front) and lateral (Side) pattern is plotted and fit with exponential prediction equations. Prediction equations allow estimation of distance from electrode center or surface for voltage gradients of interest (as immobilization threshold values). For example, the following graph and re-arranged equations indicate the distance from anode center that the 0.4 and 0.5 V/cm gradients occur.



Distance from anode center to 0.4 V/cm point = $\left(\frac{0.4}{523.67}\right)^{\frac{1}{-1.369}}$ = 189 cm

Distance from anode center to 0.5 V/cm point = $\left(\frac{0.5}{523.67}\right)^{\frac{1}{-1.369}}$ = 161 cm

Note: all voltage gradients can be converted to power density (D) by the equation:

D = $(\text{V/cm})^2$ x (Water Conductivity in µS/cm)

Example:

Ambient water conductivity = 200 µS/cm

Peak voltage applied to electrodes = 345 V

At 161 cm forward from the anode boom center, the voltage gradient is 0.5 V/cm and the power density is $(0.5)^2$ x 200 = 50 µW/cc.