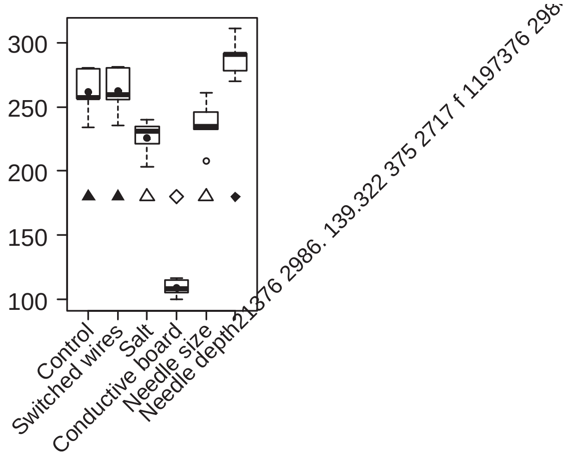

Figure 2

Boxplots of repeated resistance and reactance measurements taken from five pink salmon (*Oncorhynchus gorbuscha*) (control) and when an additional variable was added to the procedure (deviation). Specific deviations were 1) switched wires: the signal and detector leads were switched; 2) salt: two cups of seawater (31 practical salinity units) were poured under the fish; 3) conductive board: the fish was placed on a stainless steel conductive board; 4) needle size: the 28 gauge needles were replaced with larger 14 gauge hypodermic needles; and 5) needle depth: BIA electrode needles were placed in the fish in the same orientation as that used in the control, except needles were inserted to a depth of 1 mm. Open circles (○) represent outliers determined by a Grubbs test. Closed circles (O) represent mean values. Different symbols indicate differences determined by the statistical tests applied.

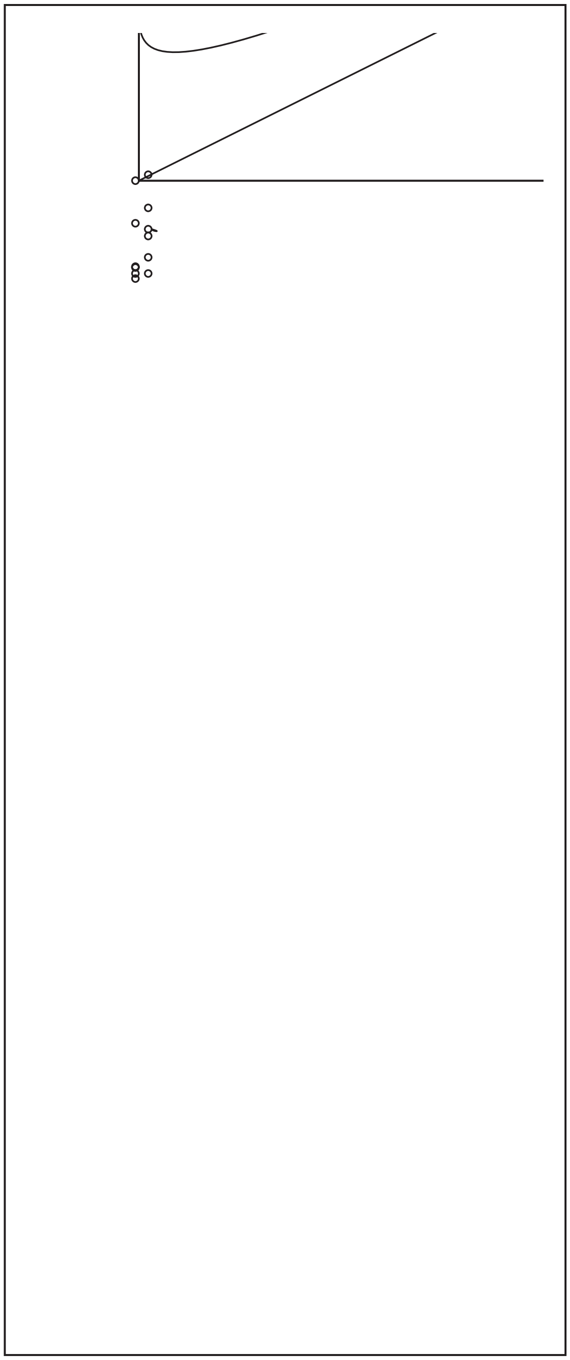

Figure 6

Boxplots describing resistance (**A**) and reactance (**B**) measurements in four groups of live brook trout (*Salvelinus fontinalis*) for different electrode locations and stomach fullness (n=5 per group), where full=full stomach, empty=empty stomach.

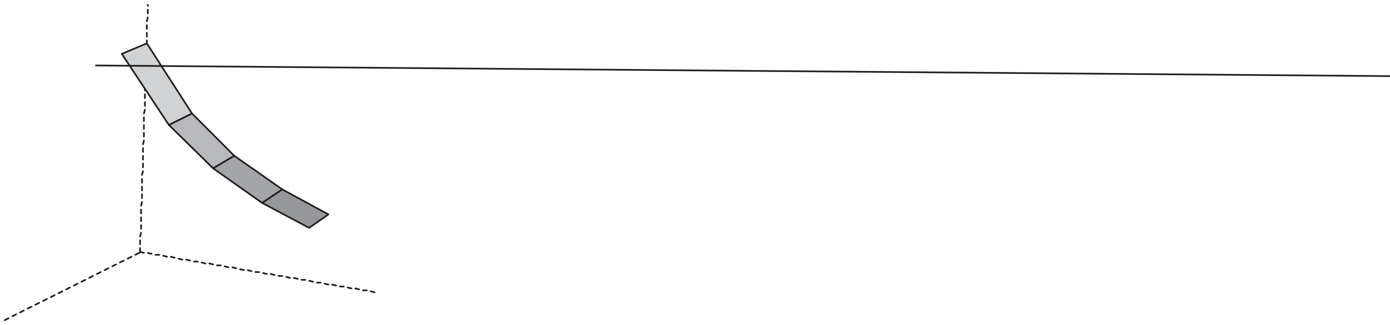

Figure 7

Comparisons of estimates of water mass parameters with resistance errors ranging from –58% to 10% (**A**) and with resistance errors ranging from –3% to 3% (**B**). The data were plotted in three-dimensional matrix plots with the x and y axes describing the range of values for either the length between detectors, R, X_c, or R in parallel, and with the z axis depicting the difference (as a percentage) between predicted estimates, with and without errors.

Figure 9

Comparisons of large (**A**) and small (**B**) resistance (R) and reactance (X_c) errors affecting phase angle [arctan/(X_c/R)]. Errors in resistance and reactance values are greater in A than in B. The data were plotted in three-dimensional matrix plots with the x and y axes describing the range of values for reactance and resistance, and the z axis depicting the difference (as a percentage) between phase angle, with and without errors.

resistant route, they tend to take them, and offering the current a path through seawater or a conductive board would allow the current to take a pathway that is the least resistant and that would possibly not even include the fish. This would result in a drop in R and X_c

an empirical approximation for X_c at a standardized temperature (0°C) is identical to that in Equation 1, except that $F = -2.8$.

Stomach fullness had no effect on response measurements within the half- or whole-body groups. The stomach and alimentary canal are encased by less conductive layers of muscle than the surrounding organs located in the peritoneal cavity (Pethig, 1979). Much like an insulated wire, these less conductive muscle layers will insulate the stomach contents even if the stomach contents are more conductive than the surrounding tissue. The insulation provided by the muscle layer reduces the chance that the current pathway will include stomach contents. Decreased R values (</cm) are seen in various animals in the peritoneal spleen, liver, and kidney, and relatively higher R values in nearby muscle tissue (Pethig, 1979). These insulating muscles, coupled with less resistant alternative pathways (i.e., organs), indicate that stomach fullness does not need to be accounted for in BIA measurements.

Sensitivity analyses show that significant deviations from the procedures found in Cox and Hartman (2005) can lead to unacceptable errors in predictive estimates of R and X_c, but nonsignificant deviations are more acceptable. The average of all significant errors in this study is 26% and would cause parameter estimates to be off by about 25% to 30%, which is too large for most biological studies. The nonsignificant error averages of <3% will cause parameter estimation errors to be around 2% to 4% (or about a 1:1 ratio), which may be acceptable in some studies. It should be noted that if several nonsignificant errors are encountered at the same time, they can be cumulative and result in an estimation error that is significant.

In all electrical volume equations, length between detectors (L_d) is a squared term in the numerator, making predictive estimates extremely sensitive to changes in L_d while also diluting the error effects on the denominator. Likewise, in parallel equations, the term R is either in the numerator (a(l)1 1 Tf [(i.0)23(i)-16(l0ee)5(l 26.3.011 Tf [(i)-8(s e)3(5)]T Tw ai)-15.0(g)182Tc w% (T1_1 1 Tf [(1)-5(

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