Improving Bioindicators: A New Weight-Length Model for Fish to Provide More Accurate Ecosystem Condition Assessment

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Bioindicators are a widespread and effective tool for evaluating ecosystem condition. Weight-length models are essential to using fish as bioindicators, providing estimates of expected weight for healthy fish of a given length. The traditional model, W(L)=aL^b , is widely used and fits many fish taxa. However, the leading coefficient a lacks clear physical meaning and yields error prone parameters, and the model overall yields parameters with undesirably high uncertainties. This study evaluated a proposed improvement, replacing a with scaling parameter L1: W(L)=1000〖(L/L1)^b. The primary hypothesis was that the improved model would have lower mean parameter uncertainties than the traditional model and smaller uncertainties in most data sets, yielding more accurate bioindicators. The models were compared for 160 data sets including 94 taxa containing 14,102 data points. Both linear-least squares and non-linear least squares regression techniques were used to produce best-fit parameters. The improved model yielded lower uncertainties for L1 and similar uncertainties to the traditional model for b. Thus the improved model is empirically better for producing expected weights for use in assessing aquatic ecosystem health. Lower uncertainties enable diagnosis of ecosystem health with fewer samples and earlier problem detection. The secondary hypothesis was supported: L1 is valuable as a new bioindicator because its value increases when fish are stressed by suboptimal ecosystem conditions. L1 was sensitive to the effects of the Deepwater Horizon oil spill in Lafourche Parish, Louisiana, oyster overharvesting in Calcasieu Estuary, Louisiana, and invasive species in Blue Mesa Reservoir, Colorado as well as in several other cases.

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