LOESS (or LOWESS)

N-STEPS Objectives

Provide regions, states, and tribes with support related to nutrient criteria development

Provide access to expert assistance with issues related to nutrient criteria development and implementation

Improve communication nationwide.

What Is It?

Loess stands for locally estimated scatterplot smoothing (lowess stands for locally weighted scatterplot smoothing) and is one of many non-parametric regression techniques, but arguably the most flexible. A smoothing function is a function that attempts to capture general patterns in stressor-response relationships while reducing the noise and it makes minimal assumptions about the relationships among variables. The result of a loess application is a line through the moving central tendency of the stressor-response relationship. Loess is essentially used to visually assess the relationship between two variables and is especially useful for large datasets, where trends can be hard to visualize.

Example Question: Is there some non-linear trend hidden among the noisy relationship between chlorophyll and total phosphorus?

How is it Applied to Nutrient Criteria Development?

Nutrient criteria development involves three main processes: identifying relationships between biological responses and nutrient stressors, examining these relationships, and establishing nutrient and/or biological thresholds or criteria.

By combined with scatterplots, locally weighted scatterplot smoothing (LOESS) is used to examine biological attribute changes along a nutrient gradient. It is designed to address nonlinear relationships where linear methods do not perform well. Loess fits a regression line through the moving central tendency of a biological attribute along the nutrient gradient. As a result, the trend of biological attribute changes along a nutrient gradient can be observed in a scatterplot with a large dataset. Loess can be used to examine the threshold change of biological community along a nutrient gradient, if a threshold exists.

How does it work?

Loess is fairly straightforward. A specific width of points along the x axis is selected (the bandwidth or tension) adjacent to the point being predicted, and a low degree polynomial equation (often just linear) is fit through that subset of the data. More weight is given to points closest to the value being predicted. This resulting equation is then used to predict the value for the selected point. The data are then shifted one point to the right and the process continues, with a new prediction for the second point, and so on. The resulting points are then connected together with a line. The user can control how wide a band of points are used – the smaller the bandwidth, the fewer points that are used and the less smooth the final line. Users can also adjust the type of line-fitting that is used – weighted least squares is the most common. Users can also adjust what types of weights are used.

Some Assumptions:

- Very few
- Need a lot of data – the more the better

Data Requirements

Independently collected numeric data in the form of paired observations are best. These are typically continuous numeric data, although discrete numeric data can be used. As with correlation and regression, the greater the range of environmental conditions encompassed the better.

What should you look for and report?

One should look for a line that represents the smoothest trend in the data while minimizing random noise. Users should report the bandwidth that was used. One could also report the weights that were applied, if known, and what type of fit was used (linear or some higher order polynomial). There are typically few evaluation parameters to report.

Pros

- Simple and flexible
- No assumptions about the relationships between variables
- Valuable for visualizing complex relationships
- Users can estimate new values to the fit and validate models if needed

Cons

- Requires densely sampled datasets
- No ready formula is produced, so it is hard to transport the results
- Computationally intensive – but not a problem for most computers
- Sensitive to outliers

Alternatives

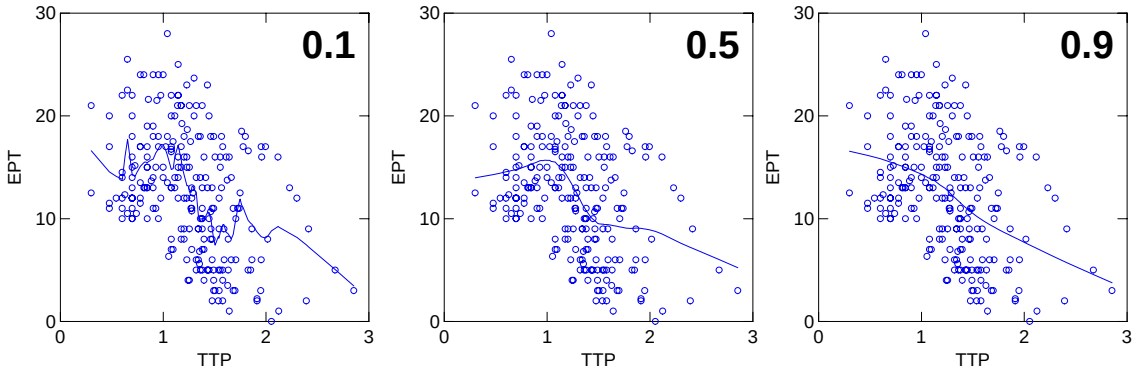
Linear and Non-linear Regression
Generalized Linear Models
Generalized Additive Models
Other non-parametric regression and smoothing techniques

Citations

Cleveland, W.S.1979.Robust Locally Weighted Regression and Smoothing Scatterplots. Journal of the American Statistical Association 74:829-836

Cleveland, W.S. and Devlin, S.J. 1988. Locally Weighted Regression: An Approach to Regression Analysis by Local Fitting. Journal of the American Statistical Association 83:596-610

NIST/SEMATECH e-Handbook of Statistical Methods, 4.1.4.4. Loess (aka Lowess) http://www.itl.nist.gov/div898/handbook/pmd/section1/pmd144.htm



Loess plots with different bandwidths