Trend direction assessment can be used to determine how likely it is that water quality is improving, declining, or being maintained.

Trend direction assessment reports the likelihood of a given outcome as a percentage, as opposed to hypothesis testing for "statistical significance."

Communicating the likelihood of an outcome is typically easier for stakeholder groups, like policymakers and the public, to understand.

When scientists present information to stakeholders—farmers, land managers, policymakers, or the public—they sometimes lose their audience mid-explanation. Graham McBride, a Principal Scientist focused on water quality at New Zealand’s National Institute of Water and Atmospheric Research, has been there. It often happens when scientists get into the details of statistical tests regarding their research. They describe findings in terms of p-values and significance.

This is notoriously confusing for those who do not use those tests frequently. For situations where stakeholder groups and scientists are working to improve something, like water quality or air quality, there may be a better way to analyze and present data that improves both the reporting of the science and how it is communicated to stakeholder groups.

McBride recently published an article in the Journal of Environmental Quality (https://doi.org/10.2134/jeq2018.03.0101) describing the use of trend direction assessment (TDA) rather than hypothesis testing. He is advocating for trend assessors to use TDA to provide information that is easier to interpret and communicate when determining if a situation is improving or in decline. He explains the development of this assessment procedure was inspired by a little-known paper in Psychological Methods, by Jones and Tukey. It was the last paper authored by Tukey, who many will...

Trend Direction Assessment for Water Quality

by Tracy Hmielowski

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recognize as one of the 20th century’s most influential statisticians.

McBride uses the question, “Has water quality improved?” to demonstrate the use of TDA. The article gives a detailed description of the steps with the first being identifying the direction of change. For water quality, not all improving variables will have the same direction; some variables may increase (e.g., clarity) while others will decrease (e.g., dissolved P).

One thing that will resonate with those who have struggled to explain results to broad stakeholder groups is that the language used to describe the results changes. Instead of talking about significance and rejection of hypotheses, results are based on the likelihood of a given outcome as a percentage. So, a 1 to 5% likelihood can be categorized as an “extremely unlikely outcome” while a 95 to 99% likelihood is an “extremely likely outcome.”

“My experience is that such probabilities are readily understood by policymakers and public groups, and they are seen to be useful,” McBride says. “But tests of nil hypotheses are not readily understood.”

The language used to describe TDA results is closer to what we use day to day. Imagine that your friend is getting over a cold. You ask them if they are feeling better, and they respond with “After considering how often I’ve coughed today vs. two days ago, I cannot reject the hypothesis that I am getting better.” It takes a minute to wrap your brain around that, right? It would make more sense for them to say, “I’m coughing a lot less than I was the other day, so it’s likely I’m on the mend.” Similarly, being able to tell stakeholders, “It is very likely that we are observing a decrease in dissolved P” or “It is unlikely water clarity has improved in the past six months” will be easier for everyone to interpret.

To show how the TDA approach works, McBride includes three example data sets: two small data sets (one with high confidence and the other low confidence) and a large data set with variable confidence. These examples also demonstrate how uncertainty in the results can indicate a need for additional data, rather than simply being considered not significant.

McBride does not suggest that hypothesis testing has no place in science, but questions the practice of testing hypotheses that postulate exact equality between different populations, such as “The trend slope is exactly zero.” This new approach, focusing on assessing trend direction, should be useful for many researchers working with policymakers and other stakeholder groups. It can be used on existing monitoring data to view it through a new lens and improve how the results are communicated in the future. Additionally, the TDA approach is useful for anyone trying to determine if conditions are being maintained. Agronomists and soil scientists may use this approach to ask, “Is soil health improving?” Conservation and restoration professionals could ask, “Are we increasing biodiversity?” or “Are we maintaining this critical habitat?”

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