Quantifying Freshwater Ambient Conditions Complying with the Clean Water Act

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Preface

The original Water Pollution Control Act of 1899 based assessments on ambient water quality. In the 1948 revision the focus turned to point source pollutant discharges. In the 1972 revision (the Clean Water Act, or CWA) the objective to restore and maintain the physical, chemical, and biological constituents of the nation's waters was reinstated and requires ambient conditions as the assessment basis. Unfortunately, the EPA, Tribes, and states continue to set maximum concentration levels for specific inorganic ions and organic compounds when assessing water quality.

The basis for setting water quality standards is decades out of date, given our current understanding of environmental data and availability of recently developed statistical models. The use of a single maximum concentration limit (MCL) for individual chemical elements does not reflect natural ecosystem function nor provide accurate indications of whether regulated industrial activities adversely impact the specific designated beneficial uses of surface or ground waters at specific locations. Water is a complex mixture of chemicals, not individual inorganic ions and organic compounds, and concentrations vary with temperature, pH, flow rate, and location while binding and releasing on inorganic and organic substrata, and other factors. A sample of water represents a snapshot at a specific time and place. This is why aquatic ecologists have established data collection standards to minimize variability when measuring physical and chemical parameters of flowing and standing waters.

Ambient conditions fulfills §101.(a) of the 1972 Clean Water Act:

> The objective of this Act is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters.

While many have proposed qualitative or site-specific indicies and single-numbers to define ambient water quality they fail to be quantitative, applicable in every freshwater body, and based on technically sound and legally defensible statistical models.

Aquatic biota are much more reliable indicators of ambient water quality than are concentrations of chemical elements. The EPA considers aquatic life to be the highest and best use of water (that is, the use most sensitive to anthropogenic disturbance). Aquatic biota, along with the abiotic physical and chemical environments, form natural ecosystems. Benthic macroinverebrate communities[1] directly reflect the location's ambient conditions.

This book describes a method that quantifies the local biotic community explains how this process can be used to assess ambient conditions and distinguish inherent natural variability (including climate change) from chnages caused by human activities.

[1] The juvenile life stages of aquatic insects and other small invertebrates such as snails, amphipods, and water mites.

Introduction

Natural ecosystems are highly complex; we cannot have complete knowledge of their variability and interactions among all components. About 50 years ago, when environmental laws started to be created, ecologists were moving from qualitative descriptions of ecosystems, communities, and populations to quantative measures of their dynamics. At that time, appropriate statistical models did not exist, and computers were not as widely (or easily) used as they are today. To implement these statutes regulators had to assess and compare natural ecosystems in attempts to determine anthropogenic effects. The approach used then was to create methods producing a single numerical value assumed to summarize ecosystem quality and separate "good" from "bad" conditions. These species diversity and biotic integrity indices still are used today. And they still fail to describe ecosystem complexity, to quantify inherent natural variability, and to separate natural and anthropogenic changes to these systems. These faillings are overcome by applying appropriate, modern statistical models to biotic data.

An important benefit of robust statistical analyses of ecosystems is that they integrate components of each drainage basin and its stream network. This integration provides insights that regulators and other stakeholders can use to make informed decisions. These statistical analyses do not produce a dichotomous decision point (less than this number is good, greater than this number is bad), but allow the use of Best Professional Judgment and adjustments as more data and knowledge become available.