

Measures of genetic diversity are effective tools for evaluating environmental condition

Mark Bagley, Susan Franson, Suzanne Christ, Eric Waits
Office of Research and Development, National Exposure Research Laboratory, Cincinnati Ohio

*Year of Water:
Thirty Years of Progress
Through Partnering*

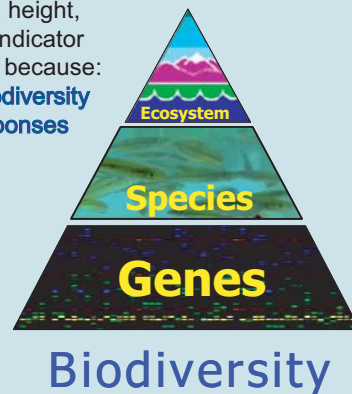
How can we evaluate the biological integrity and long-term sustainability of natural ecosystems?

These qualities are difficult to assess with existing ecological indicators. In essence, we need to quantify the "buffering capacity" of natural ecosystems and component populations against environmental changes. The US EPA is currently evaluating measures of genetic diversity as indicators of biological integrity and sustainability of populations.

What is genetic diversity and why is it important?

Genetic diversity is variation in the heritable characteristics of individuals of a species (e.g., eye color, height, resistance to pathogens). It is a useful indicator of biological integrity and sustainability because:

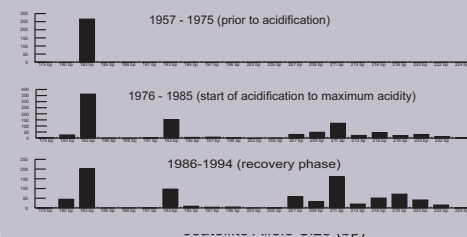
- It is a **fundamental component of biodiversity**
- Genetic diversity **limits potential responses** to future stressors
- Recent changes in genetic diversity are indicative of **population-level stresses**
- Geographic patterns of genetic diversity **define fundamental units of ecological analysis** (biological populations)



Recent and ongoing studies

Temporal patterns in fish genetic diversity at the Experimental Lakes Area, Ontario

Wholesale population genetic changes following experimental whole-lake acidification



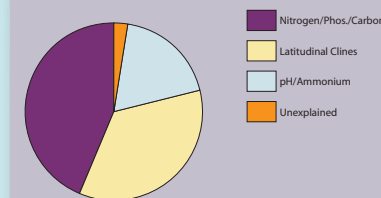
Regional patterns of fish genetic diversity in the Mid-Atlantic region of the USA

Regional patterns of fish genetic diversity in the Midwestern USA

Variables Associated with Reduced Genetic Diversity	Variables not associated with Genetic Diversity
Urbanization	Agriculture
Riparian Modification	Tissue metabolites associated with combustion byproducts (BAP)
Stream Channelization	Tissue metabolites associated with oil contamination (NAPH)
	Enzyme activity associated with polycyclic aromatic hydrocarbons (PAHs) (EROD assay)

Genetic diversity of fish in a coal mining region

Variables that significantly explain differences in genetic diversity



Temporal assessment of fish population sizes and gene flow in a polluted urban stream: Mill Creek, Ohio

How do we determine the utility of genetic diversity measures as ecological indicators?

- Case studies that link spatial genetic diversity patterns with other measures of ecological condition at regional and watershed scales
- Evaluation of temporal and spatial trends in genetic diversity in relation to known environmental exposures
- Evaluation of the ability of genetic measures to be integrated into and improve existing ecological assessment protocols

What have we learned?

- Population genetic measures are **critically important for defining populations**. To measure risk to populations, we must first define the populations
- Genetic diversity differs greatly within defined fish populations, and is associated with recognized differences in environmental quality
- While we know that genetic diversity affects the vulnerability of populations, we still don't know how useful these measures are for predicting future sustainability. This will be the focus of much future research

DNA markers and sequences

