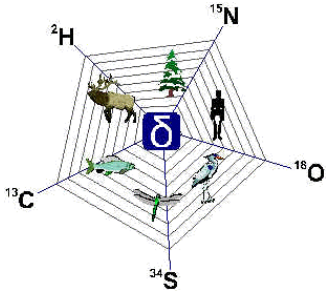
US Army Corps of Engineers®
Engineer Research and Development Center

Applying Stable Isotopic Analysis to Ecological Problems

Problem

It has become critical for scientists to investigate individual and community ecology, as well as large-scale, long-term ecosystem function and processes in order to track sediment transport within watersheds and to determine bioaccumulation levels within food webs. These investigations require precise measurements of the relative abundance of stable isotopes of the lighter elements (i.e., carbon, hydrogen, nitrogen, oxygen, and sulfur).



Description

ERDC researchers use a Finnigan Delta S Plus stable isotope mass spectrometer (IRMS) to precisely measure the relative abundances of the light elements carbon, hydrogen, nitrogen, oxygen, and sulfur. Light element isotopic ratios in bulk samples are rapidly determined using an elemental analyzer as the front end on the mass spectrometer. Automated analysis of hydrogen and oxygen isotopic ratios for hydrological applications can be performed every 7 minutes using the pyrolysis front end. When capillary gas chromatography is used as the front end, the isotopic ratios of every resolved peak can be obtained (i.e., compound-specific isotope mass spectrometer). These measurements allow researchers to delineate pathways and measure the kinetics of important environmental processes.

In the Coshocton, Ohio watershed, land usage was correlated with light element stable isotopic ratios and biogeochemical markers to track sediment transport within the watershed. In San Francisco Bay, salt marsh trophic structure was delineated based on differences in the isotopic ratios of the C4 plant *Spartina foliosa*, the C3 plant *Salicornia virginica*, and the algal phytobenthos. This information was used to determine the bioaccumulation of mercury up these aquatic food webs.

Expected Products

Research on the use of stable isotopes in ecological studies will result in improved technology for measuring the relative abundance of stable isotopes of the lighter elements. This research will also produce improved methods for understanding long-term ecosystem functions and processes. Research results will be documented in technical reports such as the one listed below that discusses use of stable isotopes in an ecological study:

Best, E. P. H., Fredrickson, H. L., McFarland, V. A., Hintelmann, H., Jones, R. P., Lutz, C. H., Kiker, G. A., Bednar, A. J., Millward, R. N., Price, R. A., Lotufo, G. R., and Ray, G. A. (2005) "Pre-Construction Biogeochemical Analysis of Mercury in Wetlands Bordering the Hamilton Army Airfield Wetlands Restoration Site," ERDC/EL TR-05-15, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

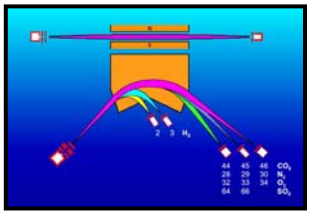
Best, E. P. H., Fredrickson, H. L., Hintelmann, H., Clarisse, O., Dimock, B., Lutz, C. H., Lotufo, G. R., Millward, R. N., Bednar, A. J., Furey, J. (2007) “Pre-construction biogeochemical analysis of mercury in wetlands bordering the Hamilton Army Airfield (HAAF) wetlands restoration site. Part 2,” ERDC/EL TR-07-21, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Potential Users

Potential users of this research include watershed and ecosystem managers who need to measure the relative abundance of stable isotopes in order to understand long-term ecosystem functions and processes.

Projected Benefits

ERDC research into stable isotope approaches and methodologies will increase our understanding of the following:



- Trophic relationships.
- Sources and cycling of nutrients.
- Isotope hydrology.
- Origin, transport, and fate of contaminants.
- Sediment transport.
- Nutrition.
- Wildlife habitat use research in marine, terrestrial, and aquatic systems.

Program Manager

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Participating ERDC Laboratories

Environmental Laboratory