Technology Identifies Fish Species from Otoliths

An innovative use of near-infrared technology could provide essential information for sustainable fisheries management faster

Aim a beam of near-infrared light at an otolith, and it reflects a literal spectrum of information on the biological and environmental history of a fish.

NOAA Fisheries scientists are developing ways to use near-infrared spectroscopy (NIRS) analysis of otoliths (fish ear stones) to provide accurate information for sustainable fisheries management faster. NIRS has already proven its value as a time- and cost-effective method to determine the age of fish.

Now, for the first time, scientists have used NIRS analysis of otoliths to identify fish species and populations

. The new technique successfully differentiated 13 marine fish species from four large marine ecosystems around the country.

"Our study shows the potential of NIRS as a fast and reliable method of identifying fish species and populations," said Irina Benson, Alaska Fisheries Science Center biologist. She led the study with Age and Growth Program colleague Thomas Helser and Beverly Barnett of the Southeast Fisheries Science Center. "This technology could provide information for stock assessment and management faster than traditional methods. It expands the possibilities for collecting data to support ecological studies. It is a big step forward for NOAA Fisheries' strategic initiative to develop NIRS technology for fisheries science."

Near-infrared analysis of otoliths differentiated 13 species from four large marine ecosystems around the United States.

Biography of a Fish

Otoliths are small calcified structures in the inner ear of a fish, also known as ear stones. Otoliths help fish with hearing and balance. Their value to scientists, however, lies within their layers. An otolith grows incrementally over the lifetime of a fish, recording a timeline of information about the fish's biology and environment.

These layers can be counted visually under a microscope to determine the age of a fish. That is the traditional method for ageing many commercial species to support fisheries management.

Otolith pairs (two per individual fish) from an assortment of Bering Sea fish species. Walleye pollock (top left) and Pacific cod (top right) are among the species analyzed with NIRS as part of the current study. Note: otolith sizes are not on a relative scale.
Photo: NOAA Fisheries.

Recent developments of more sophisticated and sensitive instruments have allowed scientists to explore the microchemical information contained in otoliths. Trace chemicals reflect water properties and physiological changes the fish experienced throughout its life.From this information scientists can reconstruct a history of the fish's movements, diet, habitat use, and environmental conditions in addition to its age.

Near-Infrared Spectroscopy

NIRS is widely used in industry and science. For example, in the dairy industry, NIRS is used to determine the butterfat content of milk. In others, such as agriculture and pharmaceuticals, it is used as an efficient, accurate, and non-destructive way to measure product quality. In neuroscience, NIRS is being used to map cognitive brain function.

To determine the age of a fish using NIRS technology, near-infrared light is focused on an otolith. The amount and wavelengths of light absorbed by the otolith are measured and recorded by a machine called a spectrometer. These spectral data reflect the molecular make-up of the otolith, which is correlated with fish age.

Scientists at the Alaska Fisheries Science Center's Age and Growth Program conducted the first extensive feasibility study using NIRS to age walleye pollock

. NIRS age estimation was almost 10 times more efficient than traditional microscope techniques.

It promises a faster, reliable method to meet the growing demand for fish age data. **(to page 28)**