Fish Acoustics at the Great Lakes Environmental Research Lab

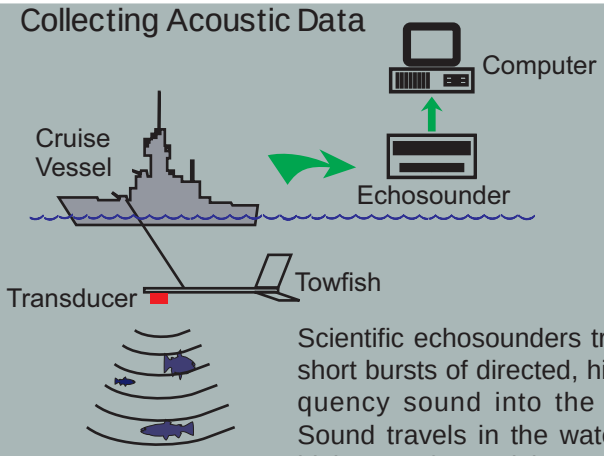
Fish acoustics is the use of transmitted sound to detect fish. Sound travels quickly and efficiently through water and reflects from fish and other organisms. The returning echoes contain information on fish size, density, and spatial distribution (the way fish are arranged in the water column). The schooling behavior of pelagic (open water) fish causes them to have patchy distributions, making conventional sampling techniques (e.g. nets) difficult to use. Acoustics has several advantages including:

- Rapid and continuous sampling of the water column over large areas.
- Cost-effectiveness.
- Low fish avoidance.
- Non-invasive.

Goals of GLERL's fish acoustic programs include:

- Monitor the seasonal movements of important prey fish species (e.g. bloater, alewife, salmon).
- Measure fish distributions over large areas.
- Link fish spatial distributions with habitat quality and food abundance.

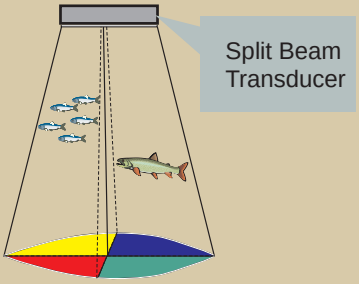
Collecting Acoustic Data



Scientific echosounders transmit short bursts of directed, high-frequency sound into the water. Sound travels in the water at a high rate of speed (1500 meters per second) and reflects from fish.

Calculating fish densities from acoustic data requires information on the amount of sound energy scattered by individual fish (target strength). The air bladder is the primary sound-scattering component of fish. Changes in the shape and orientation of the air bladder strongly influence the target strengths of individual fish.

Locating Fish within the Acoustic Beam



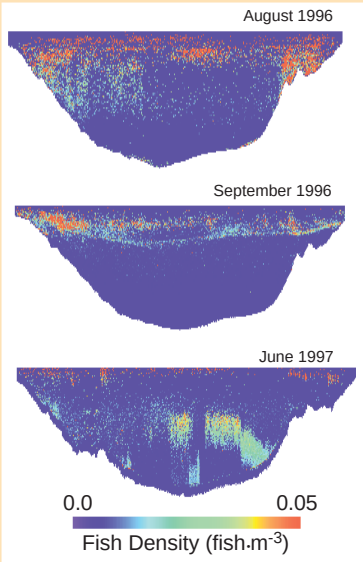
Split beam transducers measure acoustic signals on four independent receivers that correspond to the quadrants of a circular transducer face. Differences in the time of arrival of an individual echo to each quadrant may be used to locate the off-axis angle of a fish target and its position within the acoustic beam and help determine fish size.

Great Lakes Fish Acoustics

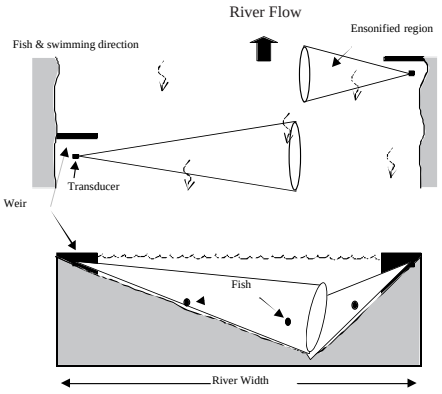
Acoustic studies of fishes are providing important information on prey fish abundance and spatial distributions. GLERL researchers are particularly interested in how fish spatial distributions can be incorporated into predator-prey models, habitat quality measures, and food web models.

Fish Spatial Distributions

Fish densities along a cross-lake transect section in Western Lake Ontario. Note the seasonal shifts in spatial distributions. Data from cross-lake transects have been used to measure lake-wide biomass of planktivorous fish, determine habitat quality for piscivorous fish, and estimate food consumption by planktivorous fish.



Acoustics in Great Lakes Tributaries



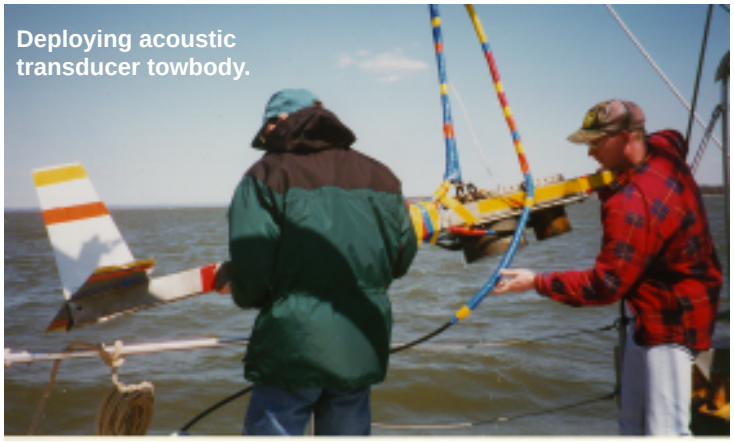
Fixed acoustic systems in tributaries (rivers) of the Great Lakes are providing important information on the number of adult salmon that use these tributaries to spawn and the number of naturally produced smolt that eventually make it to the lake. This information is used to determine to what degree natural reproduction of salmon contributes to the lake populations. Above is an example of a fixed-riverine deployment of two transducers for counting adult and juvenile salmon. The top figure shows the aerial coverage and the bottom figure shows the cross-sectional coverage of the river.

Great Lakes Environmental Research Laboratory ● 2205 Commonwealth Blvd. ● Ann Arbor, MI 48105 ● 734-741-2235

Rev. 4/00

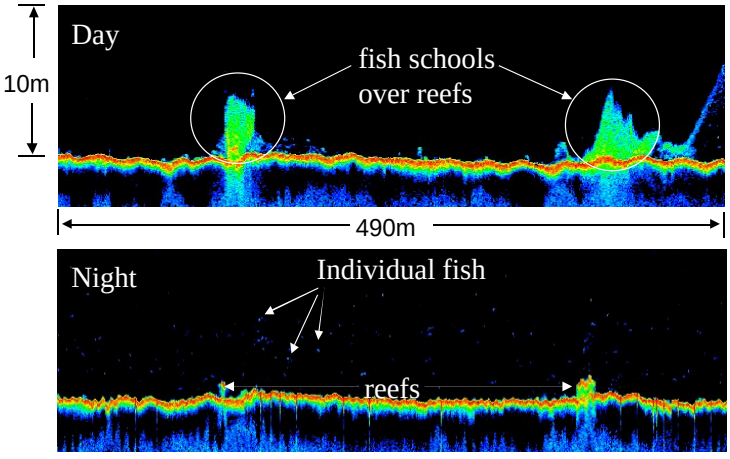
Fish Acoustics in Estuarine and Marine Ecosystems

Acoustics research programs in estuarine and marine systems are focused on relating fish spatial distributions to physical features (e.g., temperature, salinity, reefs), quantifying food supply for top predators (e.g., striped bass, grouper) and linking fish with water quality models. Funding for this acoustics research has been provided by the Environmental Protection Agency (EPA), the National Oceanic and Atmospheric Administration (NOAA), The National Science Foundation (NSF), and the Florida Sea Grant College Program.


Deploying acoustic transducer towbody.

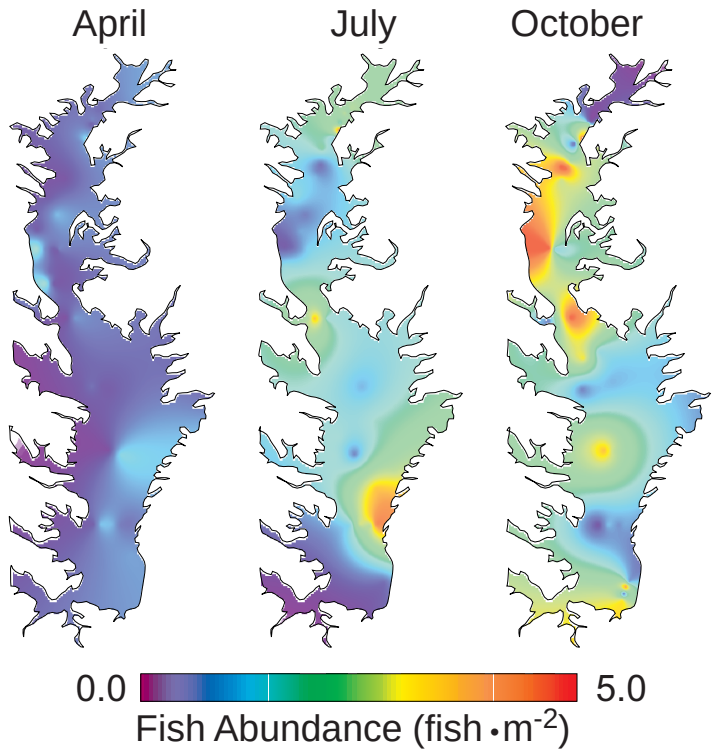
Pelagic fishes are an important component of the diet of gag grouper on reefs in coastal marine systems. The why, when and how pelagic fishes use these reefs are important for understanding the growth and production of grouper.

Below is a cross-sectional view of fish aggregating over artificial reefs in the Gulf of Mexico during the day (top) and dispersing off the reefs at night (bottom).

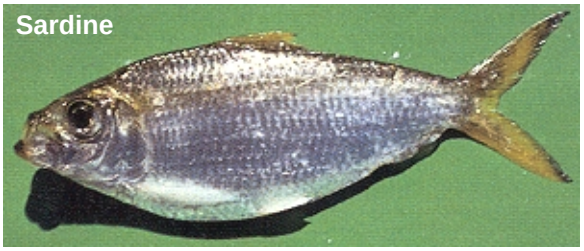


Visit the GLERL Web Site:
www.glerl.noaa.gov

Bay-wide Fish Abundance in Chesapeake Bay during April, July, and October 1996.

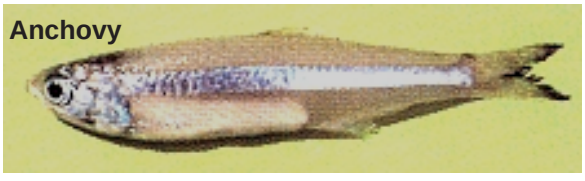


Fish densities along cross-bay transects were summed over the water column to provide estimates of fish abundance per m^2. Density data were then interpolated between transects to show bay-wide patterns of fish abundance.


Sardine


Scad


Herring


Anchovy

Pelagic fishes that are often found schooling above reefs during the day in the Gulf of Mexico.

Great Lakes Environmental Research Laboratory ● 2205 Commonwealth Blvd. ● Ann Arbor, MI 48105 ● 734-741-2235 Rev. 4/00