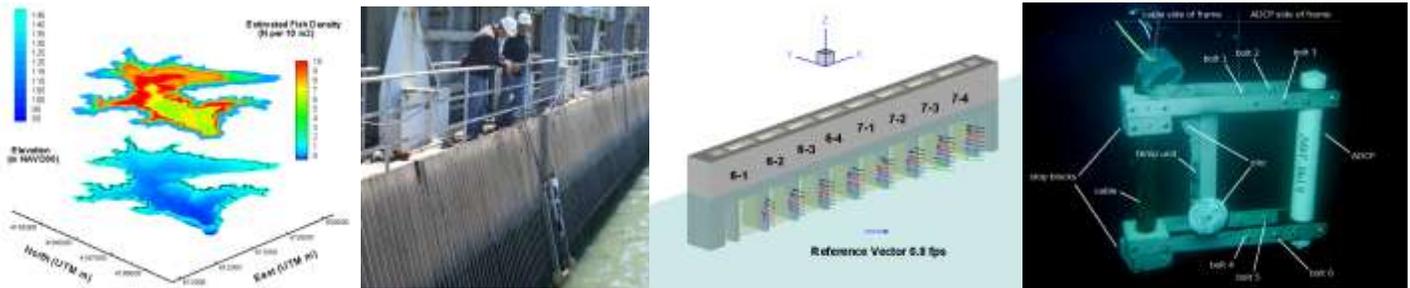


ACOUSTICS AND REMOTE MONITORING



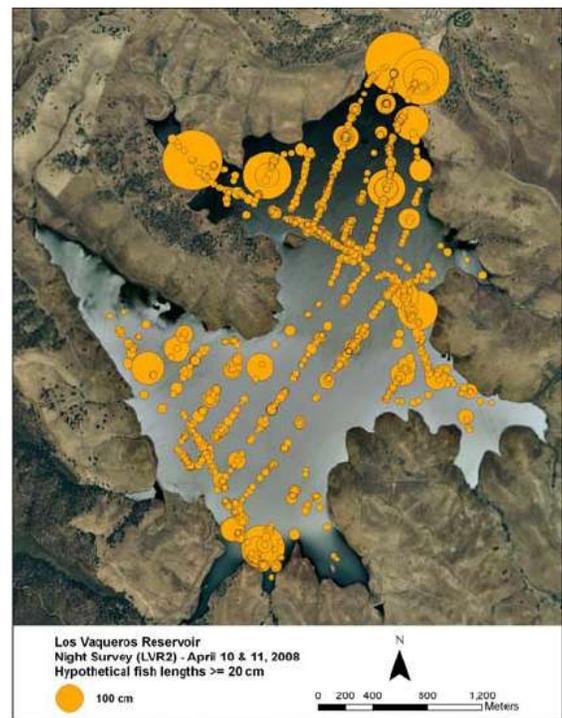
Tenera Environmental provides consulting services that include the use of a wide range of acoustics and video methodologies for assessment of fisheries, marine life and oceanographic elements. Remote sensing equipment includes:

- Nortek Aquadopp Current Profilers
- Nortek Velocimeters
- Sontek ADP Current Profilers
- BioSonics Scientific Echosounders
- SoundMetrics Dual Frequency Identification Sonar (DIDSON)
- Imagenex Sidescan Sonar

Our expertise includes **Fisheries Acoustics** for accurate assessment of fish abundance, distribution or behavior at hydropower dams, estuaries, and in ocean applications. We offer **Hydrographic Mapping** for habitat assessment of bottom topography. Our ability to provide **Current Measurements** increases knowledge about the aquatic environment. These three areas are linked with a geographical information system (**GIS**) to provide concise and accurate products.

Fisheries acoustics uses sonar technology to estimate the number or biomass of fish, or to study fish behavior, distribution and habitat. Hydrographic mapping uses single and multiple beam sonar to assess bottom type and topography. Current measurements can provide point velocities and water column profiles. Sonar is a non-invasive method that can be used in water too turbid for video; can be automated and, when used appropriately, provide reliable data economically.

Common applications are fish enumerations around offshore intake structures, monitoring fish behavior at hydroelectric dams and other structures, or bathymetry maps that include sidescan imagery. Current measurements can provide information about river flows, intake approach velocities, coastal ocean currents and inputs for biological and physical modeling.



Services:

- project design, budget estimation, deployment and management
- technical review
- data collection
- acoustic data processing and analysis
(fish tracking, echo integration, substrate typing, bathymetric data analysis, remote acquisition, autonomous deployments)
- GIS mapping, spatial analysis, and modeling

Our clients come from private industry, government agencies, and universities. They include power companies that need to monitor environmental effects on fish, like entrainment or avoidance, and to determine the extent that structures impact aquatic life. Our remote sensing projects include:

Bathymetry - Port San Luis Harbor, Morro Bay Power Plant, Moss Landing Power Plant, Potrero Power Plant, Pittsburg Power Plant, Contra Costa Power Plant, West Basin Desalination, Laguna Lake, Pitkins Curve, South San Diego Bay, Conoco Phillips Refinery

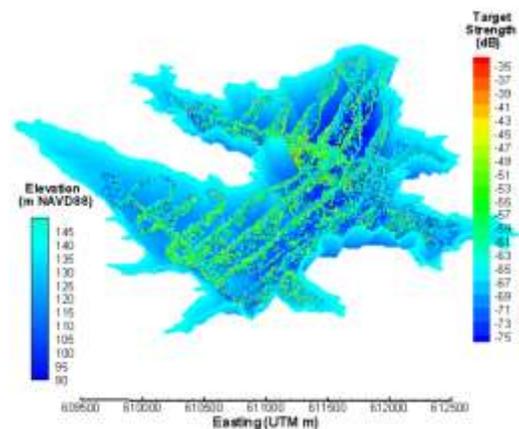
Current Meter Deployment and Analysis - Morro Bay, Morro Bay Power Plant, Diablo Canyon Power Plant, Platform Grace Mooring, Santa Monica Bay, San Pedro Bay, South Bay Power Plant, Moss Landing Power Plant, Sacramento River, San Joaquin River, Estero Bay

Fishery Acoustics - Scattergood Generating Station, Los Vaqueros Reservoir, Diablo Canyon Power Plant, Columbia River hydroelectric projects

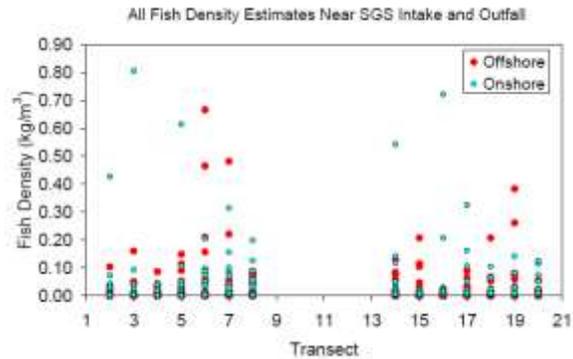
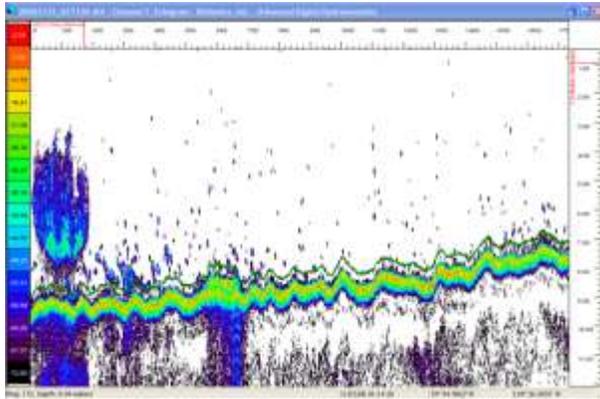
The theory of estimating **fish biomass** using **acoustics** is explained in a number of references including MacLennon and Simmonds (1991). Two broad categories of methods are echo counting/tracking and echo integration.

- **Los Vaqueros Reservoir Study**

- Fish Tracking
- AB Track
- R statistics
- ArcView
- Tecplot



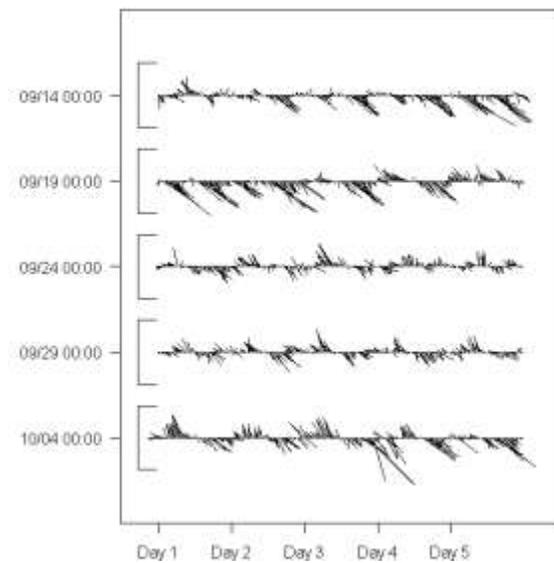
Echo tracking was used at the Los Vaqueros Reservoir for estimating the number and sizes of fish. The data from the echo tracking was overlaid with bathymetry data to determine the distribution of fishes relative to depth.



A BioSonics DTX split-beam echosounder was used to collect the acoustic backscatter from the water column near the Scattergood Generating Station ocean intake and outfall. The hydroacoustic data was analyzed to detect any fish density differences using echo integration, which relates the backscatter strength recorded by the echosounder to fish density by using a scalar called target strength that can be measured either in terms of individual fish or biomass.



Example current meter deployment



Current vectors showing speed and direction

Current measurements are necessary for monitoring environmental conditions associated with many projects. TENERA has successfully deployed **acoustic Doppler current profilers** and **velocimeters** in a number of challenging environments and with a wide variety of structures.

Please inquire how **TENERA Environmental** can assist your project planning and monitoring needs using a wide variety of remote sensing measurements. We are prepared to respond to challenging environmental conditions and questions.