NOAA Teacher at Sea
Katie Turner
Onboard NOAA Ship MILLER FREEMAN
July 10 – 31, 2008

NOAA Teacher at Sea: Katie Turner
NOAA Ship MILLER FREEMAN
Mission: Eastern Bering Sea Pollock Survey
Geographical area of cruise: Bering Sea
Date: Friday, July 25, 2008

Weather Data from the Bridge
Visibility: 10 nautical miles
Wind Direction: 075
Wind Speed: 13 knots
Sea Wave Height: 1-2 feet
Swell Wave Height: 3 feet
Seawater Temperature: 7.1˚C.
Present Weather Conditions: Cloudy, 9.3˚C, 94% humidity

Science and Technology Log

After spending 3 weeks at the dock in Dutch Harbor, MILLER FREEMAN finally began the cruise with less than a week left to complete the study. We pulled away from the dock Thursday afternoon, 24 July, and sailed to nearby Captain's Bay to calibrate the acoustic instruments.

Bald eagles are abundant around the port in Dutch Harbor.

Background

Acoustics is the scientific study of sound: its generation, transmission, and reception. Sound travels in waves at known rates, and the physical properties of the material the waves travel through affect the speed of sound. These properties of sound waves enable their use in medical diagnosis, testing critical materials, finding oil-bearing rocks underground, and counting fish in the ocean.

Sound travels through seawater of average salinity about 5 times faster than through air (~1,500 m/s, or about 15 football fields in one second). Many animals that live in the ocean rely on sound more than vision for communication and survival. You are probably already familiar with echolocation and communication vocalizations in whales and porpoises.

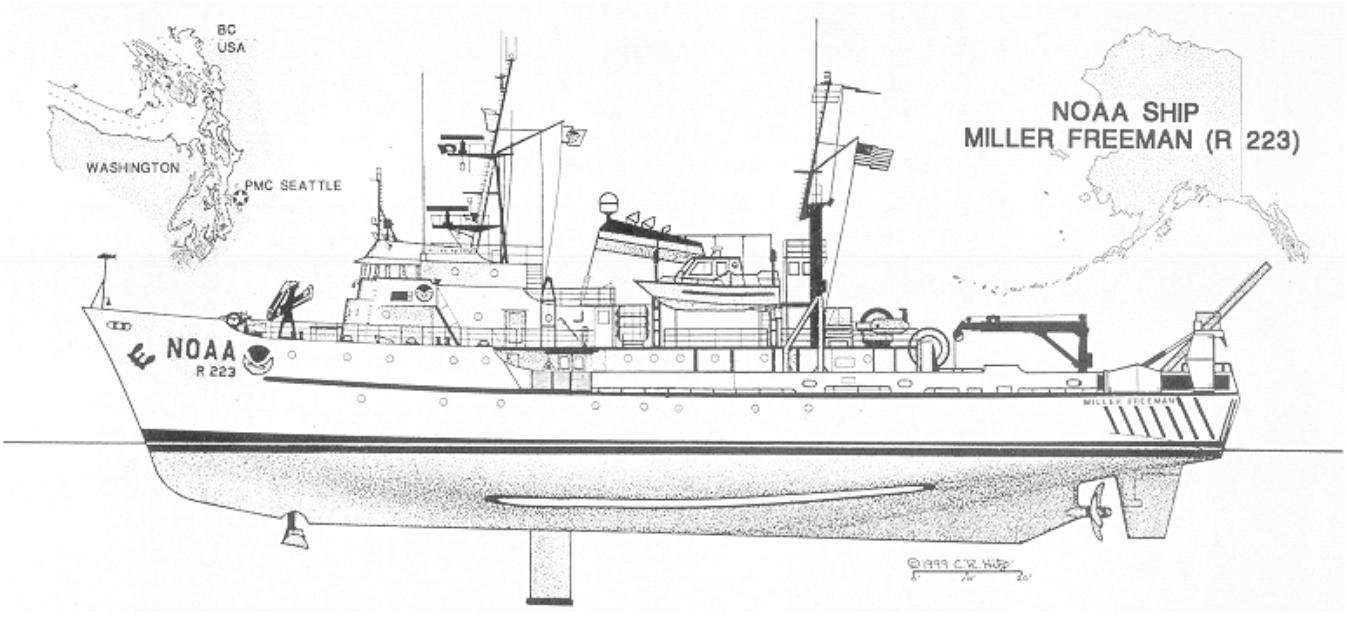
The speed of sound in water increases as temperature and salinity increase. It also increases with depth due to the increase in pressure. Therefore, in order to know the speed of sound at a given location in the sea, you need to know the temperature, salinity, and depth.

There are other factors that are important to consider as well. As sound travels through seawater it loses energy because of spreading, scattering and absorption. When sound waves strike bubbles, particles suspended in the water column, organisms, the seafloor, and even the surface, some of the energy bounces off or is scattered. When the sound energy is scattered at angles greater than 90 degrees it is referred to as backscatter.

Fish Assessment

Scientists use acoustics to measure fish abundance in the ocean by emitting sound waves at specific frequencies and then measuring the amount of backscatter. Different organisms and other objects will have a characteristic backscatter that is dependent on many biological factors as well as the physical properties of the medium. The most important biological factor is presence and the size of a swim bladder, but also the organism's size, shape and orientation. If scientists know the backscatter signature of the target species (which can be determined experimentally or by mathematical models), they can use sound to identify and measure certain fish populations in the ocean.

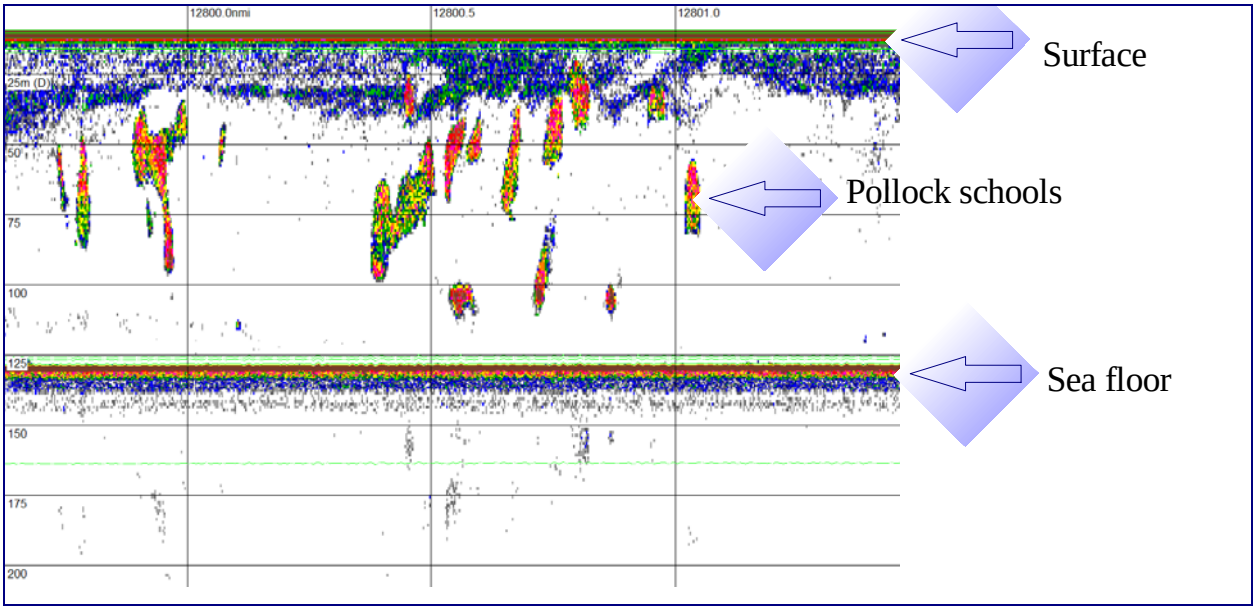
Onboard the ship, sound waves are emitted from an instrument called a transducer, which is located in the centerboard of the ship.



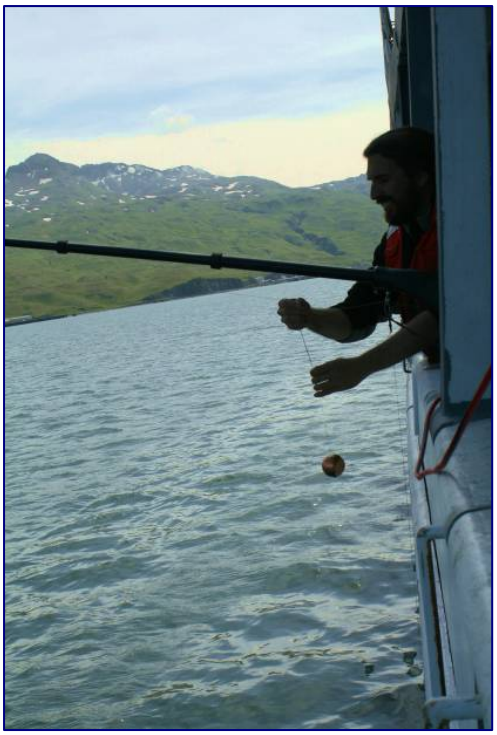
A line diagram of MILLER FREEMAN showing the location of the centerboard below the hull.

Picture of the transducers in the centerboard, which is lowered when the ship is at sea. Lowering the transducer away from the hull reduces the noise interference of bubbles running along the hull while underway.

The transducer generates sounds directly beneath the ship into the water column below (pings). When these sound waves are backscattered from the fish below back to the transducer, they are converted to an electrical signal that is sent to the scientist's computer. There, a profile can be created that represents the fish in a graphical image.



The computerized image created from acoustic data showing schools of fish.



Chief Scientist, Patrick Ressler, attaches calibration spheres to the line that will be lowered beneath the ship.

Before making any actual measurements during this study, it is necessary to calibrate the acoustic instruments on board the ship. Calibrations of instruments and other measuring devices are done by using a known standard to compare the output of the instrument. So for example, if I wanted to calibrate a stick as a measuring device, first I would compare its length to a known standard such as a ruler.

We anchored in Captain's bay, on both bow and stern to keep the ship from moving much, and spheres with known acoustic properties were suspended beneath the ship at a known distance below the transducers. Acoustic data were then collected on backscatter from the spheres. Knowing the distance to the spheres, their acoustic qualities (how they will backscatter the sound), and the physical qualities of the medium (seawater temperature and salinity) allowed the scientists to standardize their equipment.

While acoustic calibrations were performed by the scientists, the survey technicians collected seawater temperature and salinity. The way these properties are measured is standard practice on research vessels. An instrument package called a "CTD" measures conductivity (which is converted to salinity), temperature, and depth. Sensors for each of these make up the package, and are mounted on a metal frame called a rosette. The rosette is lowered into the water column by a crane, and the data collected is transmitted via a cable to a computer on board.

Once the calibration and CTD measurements were completed, we pulled anchor and headed northwest

Above: Survey Technician Tayler Wilkins monitors the CTD data transmission while communicating with the crane operator as the rosette is lowered through the water column. The computer automatically produces a profile of temperature and salinity with depth.

Left: Survey Technicians retrieve the CTD rosette.

into the Bering Sea to meet up with NOAA Ship OSCAR DYSON. We expect to reach our rendezvous point by late Friday to begin our study.

Personal Log
The long stay in Dutch Harbor made the departure that much more exciting. I am looking forward to what little time is left. The crew of MILLER FREEMAN have all made me feel welcome, and have been helpful in answering my questions and educating me on shipboard operations.

New Terms
acoustics, calibration, backscatter, centerboard, transducer, CTD rosette

Learn more:
http://www.acoustics.washington.edu/intro.php
http://oceanexplorer.noaa.gov/explorations/sound01/background/acoustics/acoustics.html