NOAA Teacher at Sea
Mary Anne Pella-Donnelly
Onboard NOAA Ship *David Starr Jordan*
September 8 – 22, 2008

NOAA Teacher at Sea: Mary Anne Pella-Donnelly
NOAA Ship: *David Starr Jordan*
Mission: LUTH Survey (Leatherback Use of Temperate Habitats)
Date: September 15, 2008
Geographical area of cruise: Pacific Ocean –San Francisco to San Diego

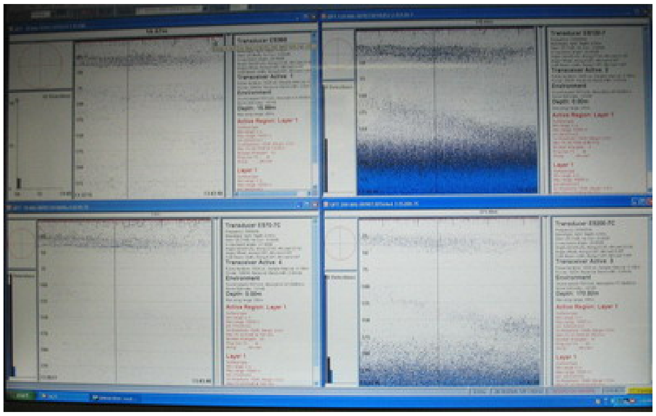
Weather Data from the Bridge
Latitude: 3720.718 N
Longitude: 12230.301
Wind Direction: 69 (compass reading) NW
Wind Speed: 12.0 knots
Surface Temperature: 15.056

Science and Technology Log
A lot of physical science is involved in oceanographic research. An understanding of wave mechanics is utilized to obtain sonar readings. This means that sound waves of certain frequencies are emitted from a source. The concepts to understand in order to utilize acoustic readings are:

1. Sound and electromagnetic waves travel in a straight line from their source and are reflected when they contact an object they cannot pass through.

2. Frequency is defined as the number of waves that pass a given point per second (or another set period of time). The faster the wave travels, the greater the number of waves that go past a point in that time. Waves with a high frequency are moving faster than those with a low frequency. Those waves travel out in a straight line until they contact an object of a density that causes them to reflect back.

3. The speed with which the waves return, along with the wavelength they were sent at, gives a 'shadow' of how dense the object is that reflected the wave, and gives an indication of the distance that object is from the wave source (echo sounder). As jellyfish, zooplankton and other organisms are brought up either with the bongo net or the trawl net, examinations of the acoustic readings are done to begin to match the readings with organisms in the area at the time of the readings. On the first leg of the survey, there were acoustic patterns that appeared to match conditions that are known to be favorable to jellyfish. Turtle researchers have, for years, observed certain characteristics of stretches of ocean water that have been associated with sea nettle, ocean sunfish and leatherbacks. Now, by combining acoustic readings, salinity, temperature and chlorophyll measurements, scientists can determine what the exact oceanographic features are that make up 'turtle water'.



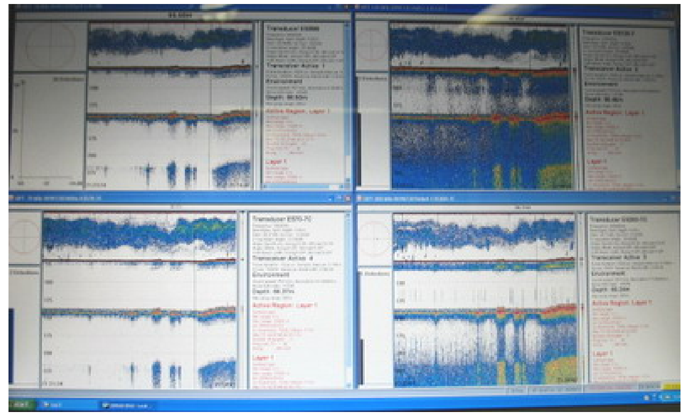


Photo 1. Computer generated images showing acoustic scattering at night.

Photo 2. Computer generated images showing acoustic scattering during the day.

Acoustic data, consisting of the returns of pulses of sound from targets in the water column, is now used routinely to determine fish distribution and abundance, for commercial fishing and scientific research. This type of data has begun to be used to quantify the biomass and distribution of zooplankton and micronekton. Sound waves are continuously emitted from the ship down to the ocean floor. Four frequencies of waves are transmitted from the echo-sounder. The data is retrieved and converted into computerized images. Both photo 1 and photo 2 give the acoustic readings. The “Y” axis is depth down to different depths, depending on the location. The frequencies shown are as follows for the four charts on the computer screen; top left is 38kHz, bottom left is 70 kHz, top right is 120kHz and bottom right is 200 kHz. In general the higher frequencies will pick up the smallest particles (organisms) while the lowest reflect off the largest objects. Photo 1 shows a deep-water set of images, with small organisms near the surface. This matches the fact that zooplankton rise close to the surface at night. Photo 2 gives a daylight reading. It is more difficult to interpret. The upper one-fourth is the acoustic reading and the first distinct horizontal line from the top represents the ocean floor. Images below that line are the result of the waves bouncing back and forth, giving a shadow reading. But the team here was very excited: for this set of images shows an abundance of organisms very near the surface. And the trawl that was deployed at that time resulted in lots and lots of jellyfish. They matched. Periodically, as the acoustic data is collected, samples are also collected at various depths to ‘ground truth’ the readings. This also allows the scientists to refine their interpretations of the measurements. The technology now can give estimates of size, movement and acoustic properties of individual planktonic organisms, along with those of fish and marine mammals. Acoustic data is used to map the distribution of jellyfish and estimate the abundance in this region. By examining many acoustic readings and jellyfish netted, the scientists will be able to identify the acoustic pattern from jellyfish.

The sensor for the acoustic equipment is mounted into the hull, with readings taken continually. Background noise from the ship must be accounted for, along with other types of background noise. Some events observed on board, such as a school of dolphins being sighted, can be correlated (matched) to acoustic readings aboard the ship. Since it is assumed that only a portion of the dolphins in a pod are actually sighted, with the remaining under the surface, the acoustic correlation gives an indication of population size in the pod. The goal of continued acoustic analysis is to be able to monitor long term changes in zooplankton or micronekton biomass. This monitoring can then lead to understanding the migration, feeding strategies and monitor changes in populations of marine species.

Personal Log

Several small birds have stopped in over the week, taking refuge on the *Jordan*. Many bird species make long migrations, often at high altitude, along the Pacific flyway. Some will die of exhaustion along the way, or starvation, and some get blown off their original course. Most ships out at sea appear to be an island, a refuge for tired birds to land on. They may stay for a day, a week, or longer. Their preferred food source may not be available however, and some do not survive on board. Some die because they are just too tired, or perhaps ill, or for unknown reasons. We have had a few birds, and some have disappeared after two days. We hope they took off to finish their trip. Since we were in site of land all day today, it could be the dark junco headed to shore. 'Our' common redpoll did not survive, so he was 'buried at sea', with a little ceremony. About half an hour ago, a stormy petrel came aboard. He did not seem well, but after a bit of rest, we watched him take off. We wish him well.

A Leach's storm petrel rests on the trawl net container.

Karin releases a petrel from nets he flew into.

A Wilson's warbler rests on the flying deck.

Words of the Day
Acoustic data: sound waves (sonar) of certain frequencies that are sent out and bounce off objects, with the speed of return an indication of the objects distance from the origin
Echo sounder: device that emits sonar or acoustic waves
Dense or density: how highly packed an object is measured as mass/volume
Distribution: the number and kind of organisms in an area
Biomass: the combined mass of a sample of living organisms
Micronekton: free swimming small organisms
Zooplankton: small organisms that move with the current
Pacific flyway: a general area over and next to the Pacific ocean that some species of birds migrate along

Animals Seen Today
Leach's Storm-petrel *Oceanodroma leucorhoa*
Herring gull *Larus argentatus*
Heermann's gull *Larus heermanni*
Common murr *Uria aalge*
Humpback whale *Megapterea novaeangliae*
California sea lion *Zalophus californianus*
Sooty shearwater *Puffinus griseus*
Brown pelican *Pelecanus occidentalis*
Harbor seal *Phoca vitulina*
Sea nettle jellies *Chrysaora fuscescens*
Moon jellies *Aurelia aurita*
Egg yolk jellies *Phacellophora camtschatica*

Questions of the Day
Try this experiment to test sound waves. Get two bricks or two, 4 inch pieces of 2 x 4 wood blocks. Stand 50 ft opposite a classroom wall, and clap the boards together. Have others stand at the wall so they can see when you clap. Listen for an echo. Keep moving away and periodically clap again. At some distance, the sound of the clap will hit their ears after you actually finish clapping. With enough distance, the clap will actually be heard after your hands have been brought back out after coming together.

1. Can you calculate the speed of the sound wave that you generated?
2. Under what conditions might that speed be changed?
3. Would weather conditions, which might change the amount of moisture in the air, change the speed?