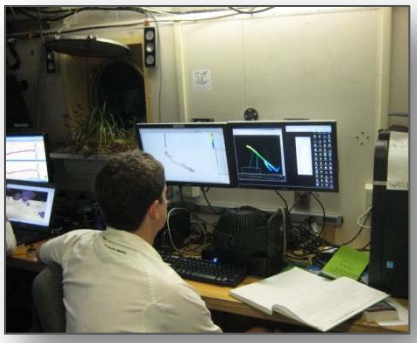
NOAA CORAL REEF CONSERVATION PROGRAM

Sea Floor Characterization of the U.S. Caribbean
2011 Field Season
Day 6: April 2, 2011

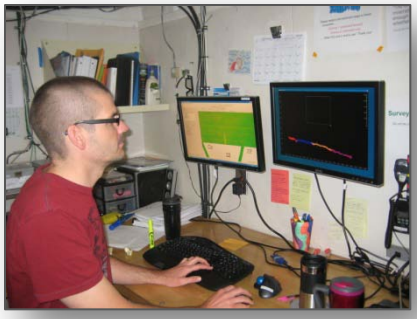
The Basic Theory of Multibeam Sonars

This is Will Sautter again from the Beam Team A. We have been sweeping the sea floor south of St. John all night and have been coming up with some clean data as the seas have been pretty calm. Multibeam Echo Sounding has many variables that affect the quality of the data acquired. First of all, the ship itself has to be calibrated to the individual sonar transducer, the ships heading, sensor location, and draft dynamics are entered into the software. These settings are unique for every ship and sonar. Then the general movement of the ship must be calculated for the acquisition of the data. This is the roll, pitch, and heave of the *Nancy Foster* while it is out at sea that must be accounted for while the ship is logging data.

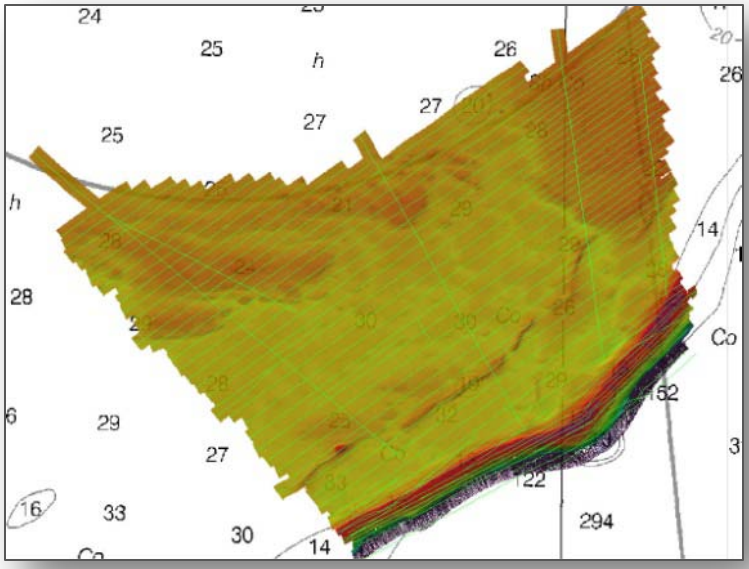


Will processing the night's sonar data.

The Foster is really top heavy and has a lot of wobble even in three foot seas. Walking in and out of passage ways can be tricky. If you do not expect the roll, you may fly through the door and crash into one of our computers or another crew mate! Good thing there are handrails everywhere, even in the showers! Pitch is how the ship deviates from going in a straight line, which can be difficult for the officers in high seas. They cannot just set the course on autopilot when we are running multibeam lines, someone has to be at the wheel and in direct contact with the Beam Team at all times. Heave is the up and down motion of the vessel as it goes over oncoming waves. We have had heave up to 6 feet from just three foot seas, as we roll over the crest and trough of a directly oncoming wave. It can feel like a sea saw or it can feel like a tilt-a-whirl, depending on if the ship is going straight through a wave or at an angle. Either way, if you don't get seasick it makes for a fun ride!



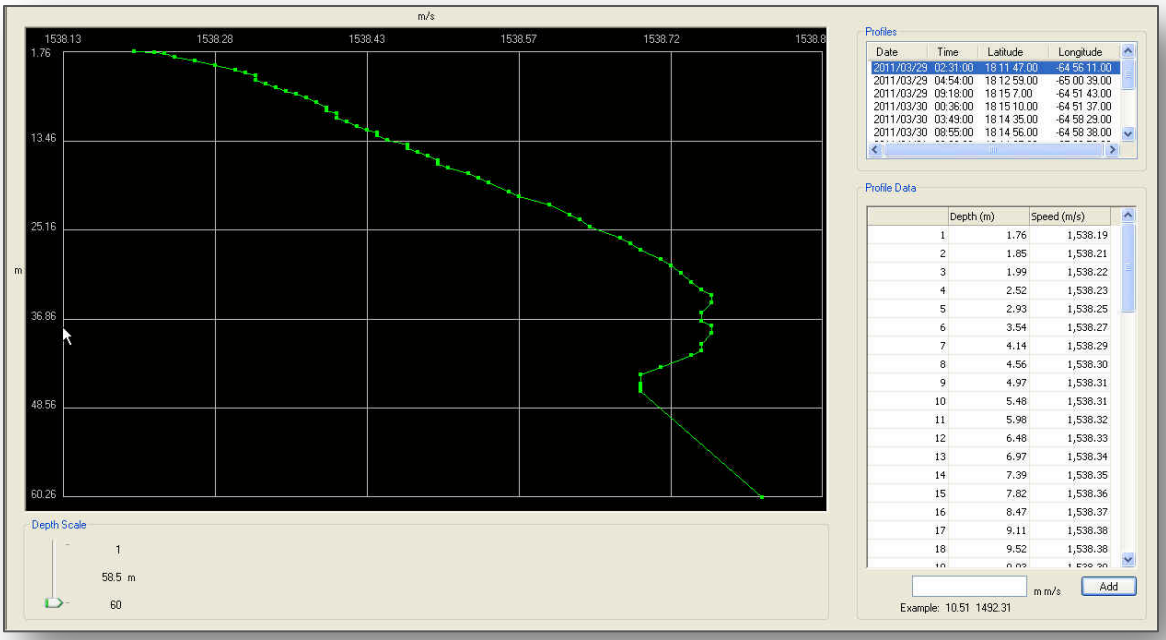
Paul Turner working away on sonar data in the dry lab.



The multibeam data is overlapped on this nautical chart. The numbers are old soundings taken by sailors who dropped lead lines to the sea floor. The bars on the colored multibeam data indicate the ship tracks.

Other factors that affect the data quality are the settings for the sonar. The biggest variables are the transducer frequency, which is the number of pings per second. The higher the frequency the higher the resolution of the bottom, but the range of the sonar is lower. Lower frequencies have deeper range. But if the range is too low, more noise will appear in the sonar. The sea is full of sounds: from waves crashing above, to bubbles coming from below. The ship is very noisy and even other sonars can interfere with the multibeam. All of the ships sonars have to be time calibrated so they don't pick up each other's pings. This is important for us because we are running two sonars with multibeam and one single beam for fish acoustics. All of these sonars behave the same way, and must account for each other. Another very important factor is how the speed of sound will change as it gets deeper in the water column. This is caused by differences of the water from conductivity, temperature, and density (CTD). We make up for these differences by stopping and dropping a CTD caster over board every four hours during multibeam operations, and then uploading the information into our software.

An evening CTD cast.



Above is a sound velocity profile from the CTD . The y-axis shows depth and the x-axis shows the speed of sound. The sound velocity changes depending on the ocean chemistry where we are. We take frequent measurements to calibrate the sonars.

Sonars are becoming more and more accurate to be used for mapping the sea floor and fisheries acoustics and the Navy, but the basic technology is no different than the average fish finder you can buy at a sporting goods store. We can now create high resolution 3D models of the sea floor or identify sunken ships hundreds or even thousands of feet below the surface, but we are only copying what nature has been doing for millions of years. Whales and dolphins are the kings of sonar, and use their senses of echo location just like we use our eyes and ears. But we still have a lot to learn from them as technology is trying to catch up.

For more information about NOAA's Center for Coastal Monitoring and Assessment Biogeography Branch visit, http://ccma.nos.noaa.gov/about/biogeography/welcome.html