NOAA Teacher at Sea
Ginger Redlinger
Onboard NOAA Ship RAINIER
July 15 – August 1, 2007

NOAA Teacher at Sea: Ginger Redlinger
NOAA ship RAINIER
Mission: Hydrographic Survey –Baranof Island Project
Date: July 22, 2007
Dorothy Cove & Toy Harbor: Tide Gauge Measurements and Removal of Tide Gauge Instruments

Weather Data from the Bridge 1900 hours
Visibility: 4 Nautical Miles
Wind directions: 190°
Wind Speed: 6 Knots
Sea Wave Height: 0 - 1
Seawater Temperature: 12.8° C
Sea-level Pressure: 1010.0 millibars (mb)
Cloud cover: Cloudy & Rain
Temperature: 13.9° C

Mariner Words of the Day: Port & Starboard
Port and starboard are directional words indicating the sides of the ship. As you are facing the bow (front) of the ship, port is on the left side, and starboard on the right side. How to remember? Port and left both have four letters.

Science and Technology Log
Today was the day that we wrapped things up in this area by re-surveying a few sections to improve the quality of the initial set of readings, took horizontal measurements of the water-level (by hand) in order to improve the accuracy of area mean tide (high and low) data, and prepared the ship to move south.

I have written earlier about the attention to detail, safety, and teamwork in the day-to-day operations, the gathering and processing of data, and daily production of results. Today I am adding the noticeable value of the work done by NOAA vessels as noted by a gentleman and his family who came to watch our tide gauge survey crew work this morning. He said, "You people with NOAA do a great job, and the folks in Sitka use your information all the time. We are thankful that you have provided us with the information we need so we can enjoy navigating the waters around here."

That was a good way to start the day. I highly recommend that you read TAS Beth Carter's description of mechanics and tools involved in Tide Gauge Surveys. While it sounds easy, it is actually very challenging to collect accurate measurements to the

specifications required for this work, which are to the millimeter. Everything has to be level and measured at precise locations using benchmark geodetic locaters installed.

One of five Geodetic Survey Benchmarks at Dorothy Cove

Using the same locations (the geodetic benchmarks) each time you take measurements ensures consistent use and interpretation of horizontal measurements. The horizontal measurements between the benchmarks tell us whether or not the land height has changed. This is important information to give context to any changes the tide gauge measures. If the mean tide level has changed, you need to know if the land level has changed too! Much of the data we gathered today is also connected to the GPS (Global Positioning System.) I have an old farmhouse and level is not a word I can use to describe most of it. Making a precise measure by establishing a level place on a slippery, rocky beach makes taking measurements in my house seem like a piece of cake!

On the right (below) is a picture of the survey scope at one of the benchmarks. They are looking across about 50 feet of water to their left at the picture on the left (below) – which is the rod at another benchmark. The next picture is the rod at the third position, which would be on the beach about 90 degrees, and 50 feet to the left of the survey scope (and the same, but the right, of the rod on the other side. When the lines connect, we have a triangle!

Position B

Position A

Position C

If you would like to see how challenging this can be, here is a simulation that reverses the location of the surveying scope eyepiece (with the crosshairs) and the rod (with the height indicators), but it will definitely give you an appreciation for the challenge of accurate measurement over distance:

Here is another view of the survey scope lining up with the rod. If you look at the bottom of the rod you can see Geodetic Benchmark.

Imagine yourself with a standard size metric ruler and a piece of paper with a crosshair pen line about 10 cm long each direction. About one centimeter from the top and the bottom of the vertical line draw another crossing horizontal line 2 cm long, about 1cm on each side. Tape the paper to the wall across the room and walk to the other side facing the paper you just taped to the wall. Now hold up your ruler an arm's length away, vertically, with the 0 on the bottom so you are reading the measure up from the bottom of the lines. Close one eye. Try to identify exactly the millimeter at each horizontal line, for each of the horizontal lines. Could you line it up exactly? Was your ruler and paper both "level" so you could? Hard to see? Hard to measure? Now you see how challenging this can be! Imagine making an accurate measurement over a distance of 50 to 75 feet!

It is also important to note that multiple measures must be taken that have to agree on the same result, with allowance for a tiny margin of error (again, a two millimeter margin of error is allowed – that is one millimeter error for the upper half of the cross hair and one for the lower half). In the case of Dorothy Harbor, there are five Geodetic benchmark markers. When the line of site is either obstructed, or too great to make an accurate reading, then a "turn point" is established. The turn point is set on a turtle (not a real turtle) which is a heavy disk that serves as set location upon which to balance the rod so measurements can be taken. Measurements must be taken from, and at, each location that needs the turn point to ensure that the data is correct. Since this data is used to ensure the accuracy of tidal data in this area, and to supply information to the GPS – it must be done correctly. In the natural environment, this is quite challenging. The measurements are recorded on a PDA and returned to the ship for processing. Right triangle geometry, simple algebra, or trigonometry can be used to determine the accuracy of the measurements at each point. If you have the markers at two line-of-site points (say to your right and your left) and are measuring the distance from where you are to each of the two points, you can figure out from your findings what the distance is between the two line-of-site points. By moving the rods to each of the five markers, you can verify that the measurements made from each location are accurate. Taking and using multiple measures is common sense to those who do it all the time like the NOAA crew. For many people, learning why is important. Some people learn it through building things- like the common sense rule to measure more than once before you decide to cut lumber, or to measure from two directions before you square a corner – you have to be sure you are right before you move to the next step!

Once we were done with our measurements we ate lunch, then began to disassemble the Tide Gauge measurement assembly. The divers came in later to remove the equipment anchored underwater, and everyone returned to the ship to prepare for the evening's departure. The crew was exhausted as we had to climb, wade, carry, move, hold, disassemble, dive, and concentrate intently on our tasks. Tonight we head south at 2100 towards Ketchikan and begin surveying a different area tomorrow.

After helping the crew complete today's work, I realized how difficult it is to gather precise measures by hand in dynamic, ever changing conditions. (The wind picking up in the middle of a read -moving the 15' high rods just enough to throw off the desired accuracy – so you have to start all over, the trees interfering with the line-of-site between the benchmarks and rods – people pushing back tree branches, trying to triangulate points on an unstable rocky beach, you get the idea…) Despite all these challenges, the crew gets the job done. This is what the navigating public (and commercial navigators), appreciate about NOAA's work. As I heard, straight from the pilot and family of the Sitka-based pleasure craft anchored in Toy Harbor.

I also appreciated the seafloor mapping tools provided by the technology on the ship. What if we had to take seafloor readings by hand! (And *hope* that we had found all the submerged rocks!) I think technology for surveying has made mapping the seafloor easier, at least at the measurement stage :)

Question of the Day

Topic 1: How are navigational charts, topographical maps, and road maps alike? How are they different? (The answer to this question will be explored in the next journal).

Topic 2: Where can you find a geodetic benchmarks in your area? Outside of your area: What is special about the markers that are used in Disneyland (not created by the USGS)?

Topic 3: What are the tools and techniques of surveying?