Anatomy of a Depth Survey

Part I
General Considerations

Tom O'Donnell, AP
Miles River Squadron

Why do depth surveys?

NOAA, through its Office of Coast Survey, is mandated to keep our nautical charts accurate and safe to use. Budgetary constraints however limit resurveys to those waterways frequented by commercial shipping. Other areas, those commonly frequented by recreational boaters, are necessarily given lower priority. It is in these areas, of importance to us, that we can make a concrete contribution to water safety by doing Co-operative Charting depth surveys. However, our work must be accurate and reliable. Moreover NOAA must believe that it is accurate and reliable. What follows is a technique we developed that is by no means the only technique, but one that has proven acceptable to NOAA.

Depth Surveys are also fun to do. They get you out on the water, where you can practice boat handling and using your GPS. At the computer you can practice electronic charting and data transfer to and from your GPS.

What kind of Boat?

Any boat with a depth sounder that reads to one decimal place will do, although an out board or stern drive is preferable, should one encounter unexpected shallows. Remember also: the bigger the boat, the bigger the fuel bill.

What kind of equipment?

As stated earlier, a depth sounder that reads to one decimal place is mandatory, as is a GPS. A WAAS or DGPS enabled GPS is recommended for maximum accuracy. Garmin GPS units have a two-fold advantage: both Maptech software (useful in creating survey routes as we will see) and G7ToWin software (useful in transferring GPS data to your PC) both "talk to" Garmin units. G7ToWin is the preferred transfer software since it can produce a file (with a .wiz extension) that is easily read by DepthWiz, the software developed by USPS for creating survey reports acceptable to NOAA.

The GPS serves not only as the optimal method of localizing recorded depth measurements, but its navigational guidance qualities can greatly assist you in performing the survey.

Survey Techniques

There are two basic survey recording techniques, one using GPS waypoints and the other using GPS trackpoints (tracklog):

Using waypoints, an older technique, requires one crew member at the GPS to perform the "Mark Waypoint" while another notes and records the depth from the sounder display. A third member steers the boat. A fourth member can do the actual depth recording , which then makes for a nice two couple activity. We have created a protocol that uses 2 Garmin 76 handhelds, one for navigation, the other for waypoint recording.

Using a 1:40,000 scale chart, we have found a Mark Waypoint interval of 60sec with a survey speed of 6kn by GPS to be optimal

Using trackpoints, a newer technique, requires a GPS connected to a sounder. It can be a single unit (such as the Garmin 178C we use) or separate units connected by cable (as the portable system devised by DepthWiz creator Bill Lazear). The tracklog is set to record intervals by distance or time. We have found a distance interval of 0.1nm to be ideal for the

1:40,000 scale chart we use. At 6 kn survey speed, this is roughly equivalent to a sounding every 60sec. This technique is easily done by a couple, one to steer, the other as lookout.

Pre-survey preparation

Your survey will create soundings as measured from your transducer, and recorded regularly during the survey. It is necessary to convert these measurements to measurements from the water surface at MLLW, in order to be consistent with those readings already displayed on the nautical chart. DepthWiz was created to facilitate this conversion but requires specific and accurate input from you. The trick is to have this all this input ready before opening DepthWiz.

Transducer offset

You must first address the "transducer offset". Your soundings are measured from your transducer which will not be exactly at the waterline, whether thru-hull or transom mount. At survey speed your boat will exhibit some degree of "squat" which places the transducer below the water surface. Your recorded soundings will be less than the actual water depth by this amount. To measure, create a sounding pole (instructions in the DepthWiz manual) or "lead line" . Drop a marker (we use a Tide bottle attached by line to a lead weight), and measure the depth adjacent to it with the pole (or lead line). Then pass by the marker at survey speed and record the sounding. The difference will be the "vertical" transducer offset. You should also use a tape to measure the distance between the GPS antenna and the sounder transducer, the "horizontal" transducer offset. DepthWiz will ask you for both.

Confidence Check

It is worthwhile to determine the exact GPS coordinates at your dock/lift (perhaps by the "static test" technique also described in the manual). Before leaving for a survey, check your GPS reading to see if it is consistent with this "known" (It just has to be close, not exact). This constitutes the "Confidence Check" asked for in DepthWiz.

The Survey Route

Creating a survey route to follow offers several advantages: one can comprehensively cover an area without the worry of overrunning previous soundings and it is easy to advance by adding new contiguous survey segments. Likewise large areas can be broken up into smaller survey segments.

We have grown to appreciate Maptech's Chart Navigator software (free with many USPS courses) in conjunction with their digital raster charts. We had purchased Maptech digital charts for the Chesapeake but accurate up to date charts can now be downloaded for free from Maptech or NOAA. This free combination is hard to beat.

For "Area Surveys", we have chosen to plan soundings approximately every 600ft (0.1nm) in what we call the "carpet bombing" technique. We have been using a 1:40,000 scale chart. The idea is to "cram"in as many soundings as possible and still be able to read the values (and compare with those already printed on the chart) We use the Chart Navigator "route tool" to create survey routes of parallel legs roughly 0.1nm apart and preferably no more than 2 – 21/2 nm in length. It is best if the parallel legs can cross perpendicular to the contour lines near shore but this is not always possible. Try to orient the legs diagonally (SE – NW or SW – NE) or vertically (N-S) to make the soundings more legible on the final chart product

Sounding numbers tend to run together if the leg is horizontal (E - W). Four or six parallel legs means 8 – 12 waypoints, which are usually placed at the 6ft contour line (although we go past the waypoint into shallower water usually to a depth of 4ft or so). The route is then downloaded to the GPS.

While Chart Navigator is still open, use the "A to B" tool to measure the distance from the middle of the survey area to the nearest tidal substation and nearest water level station. Huh? What are they?

Tide Predictions
Remember, you need to convert your depth readings to values directly comparable to the charted depths. Converting the transducer measurement to water surface level is only a part of what needs to be done. You need to convert a whole series of readings, taken at different times, to a single theoretical time, MLLW, the datum level used on NOAA charts. If you survey in tidal waters, most of the readings will not be at low tide. You'll need to find the tide prediction substation nearest your survey area and note the times and heights of the Low and High tides that day and plan your survey time accordingly. You'll want to plan your survey to lie on one part of the tide curve (between one high and subsequent low or vice versa) which simplifies DepthWiz's job of doing the math conversion from all these points on the curve to MLLW.

Tide Prediction Corrections
But that won't be enough. The tide predictions are theoretical, based on astronomical influences, but your readings will be taken under real world conditions. The water levels you measure may be higher or lower than predicted due to meteorological influences. You can correct for this in two ways. You can find a Tidal Benchmark, measure the actual water level, and compare with predicted, or find the NOAA web site for the closest Water Level Station where they do the measuring and comparing. Either way, obtain readings for a time roughly midway through the survey.

Weather conditions
Wind speed and direction, barometric pressure and water temp will all be asked for in DWiz. There are a number sources for this information, a convenient one being a weather buoy if near the survey area. Any way, choose a time roughly midway during the survey.

Worksheets
It helps to have worksheets created on which to record your data. We created two, one to use on the boat, one to use later at the computer.

On the boat worksheet, you wish to record the time you leave the dock/lift and the time you return. If you use the waypoint technique, you don't have to record the time of first and last waypoint (that's a part of the waypoint info collected). If you use trackpoints however, you need these times to differentiate the survey period from the trip out and back (you'll be recording trackpoints every 0.1nm the whole trip). You also want to note and record the number of satellites and the satellite accuracy at the start and finish of the survey. If you're using the waypoint technique, just stay on the satellite status screen while you do your Mark Waypoints and periodically note the number and accuracy.

For the computer worksheet, you'll need places to record:
Survey start and finish times, tide prediction times and heights, tide correction time and values, weather conditions such as wind speed, direction, barometric pressure and water temp
You'll also need to record your chart jpg calibration data. What?

Chart JPG
DepthWiz needs a chart substrate upon which to print the converted soundings. NOAA requires that it be based on a genuine NOAA chart, and prefers that it be in a jpg format. Formerly this meant that you had to scan a paper chart. Now you can simply download the latest electronic raster chart for free. You can then use Maptech's free Chart Navigator software to view this. (As we said previously, creating the survey route can easily be done using this combination.) For DepthWiz to accurately place the converted soundings, the chart jpg must be "calibrated", that is you must specify coordinates for 2 (usually diagonally placed) points. This can easily be done using Chart Navigator's Mark" tool. Afterwards, you'll need to "capture" the relevant area of the chart. We use Snagit by TechSmith, but you can simply use the "PrintScreen" key on your keyboard. You'll then need to use an image editing program to crop and resize. We use Macromedia Fireworks but Paint Shop Pro and Photoshop are also excellent. If you have Microsoft Office you can use Photo Editor, and you can even use MS Paint but it's a little more work. Finally save your chart image as a jpg. NOAA requires the chart jpg to fit an 8.5 x 11 printed sheet in portrait view. We usually crop and resize to an 8 x 8 in square – 768 x 768 pixels at 96ppi (576 x 576 pixels if 72ppi).

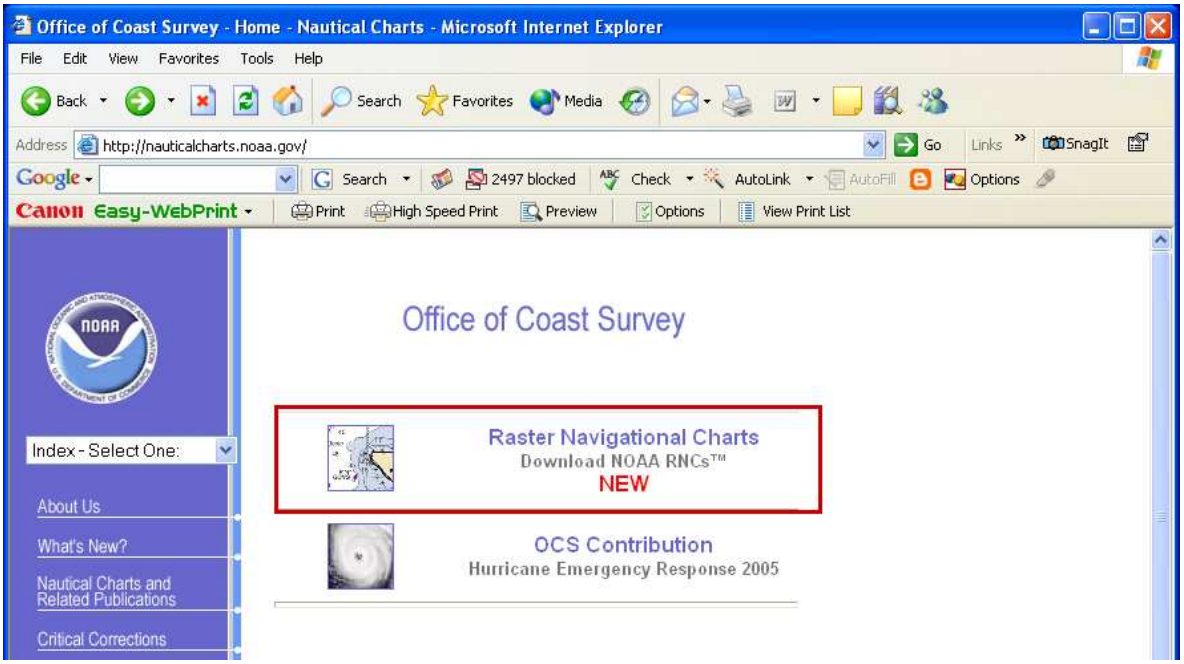
DepthWiz
As mentioned before, DepthWiz is software created to convert your recorded soundings to depths at MLLW, which allows you to compare the depths with those on the chart. It will also print these depths on the chart section. Both the data file (a .dww file extension) and the chart jpg (with soundings overprinted) are required by NOAA. In order to do all this, DepthWiz needs your raw soundings data but also your GPS/sounder info, your transducer offset, tide predictions and corrections and weather data for the survey period, and finally a blank chart jpg for the survey area. The key to making DepthWiz easy is to have all this ready, the reason for the worksheets.

The Resurvey
The primary reason for all this effort is to find areas where your soundings are less than those currently printed on the chart, or "uncharted shoaling". (To do this you must be able to read each sounding and compare with those already printed.) If such soundings are recorded, NOAA wants you to resurvey to verify their presence and extent. Sometimes the abnormal soundings are valid but sometimes spurious (perhaps due to a school of fish).

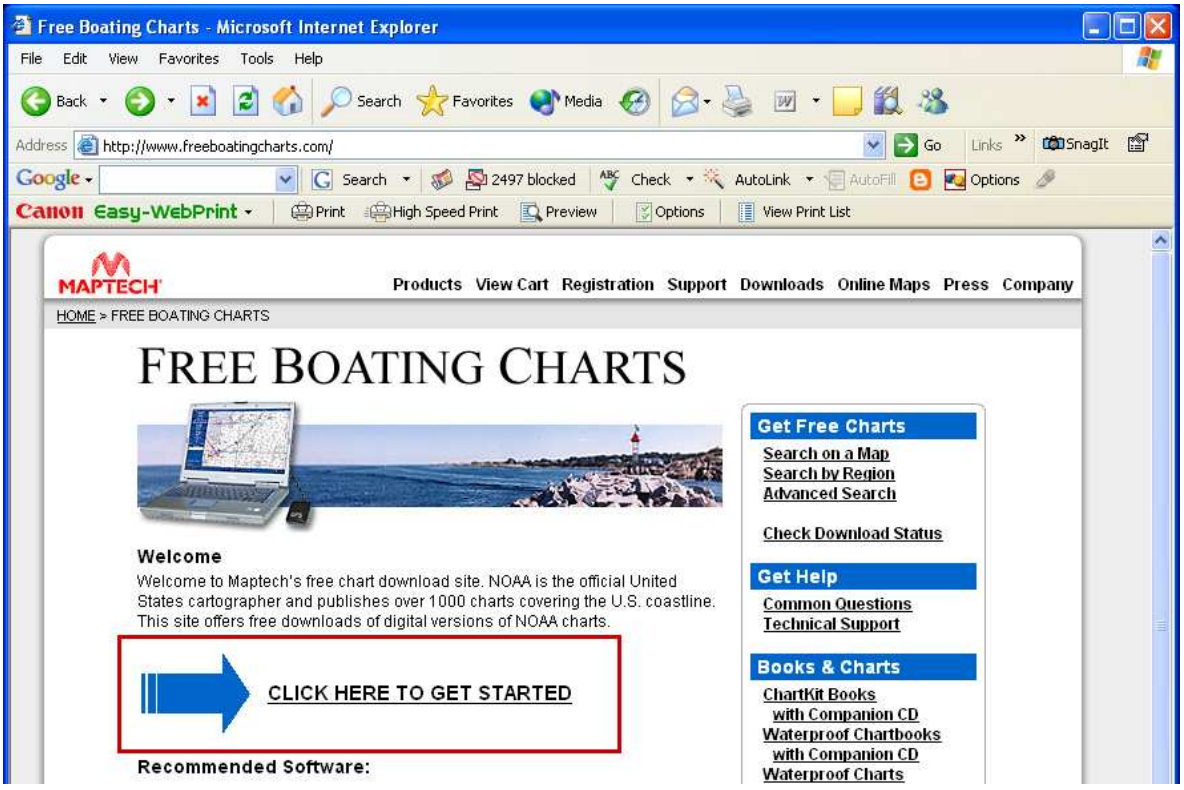
There appear to be two basic scenarios: a single sounding less than surrounding printed depths, and multiple nearby soundings that are less than the printed depths. The first suggests an isolated hazard like a sunken wreck, the latter an area of shoaling or an extension of a known shoal. Each scenario is resurveyed differently. For the isolated reading, NOAA wants a "Star" pattern resurvey, centered on the abnormal reading. For the multiple reading, they prefer a series of short legs perpendicular to the printed contour lines. For both, they want a record interval of 2 seconds, easily accomplished using the trackpoint technique.

Next Page - **Helpful Web Sites**

For Electronic Raster Navigation Charts :
NOAA - http://nauticalcharts.noaa.gov/

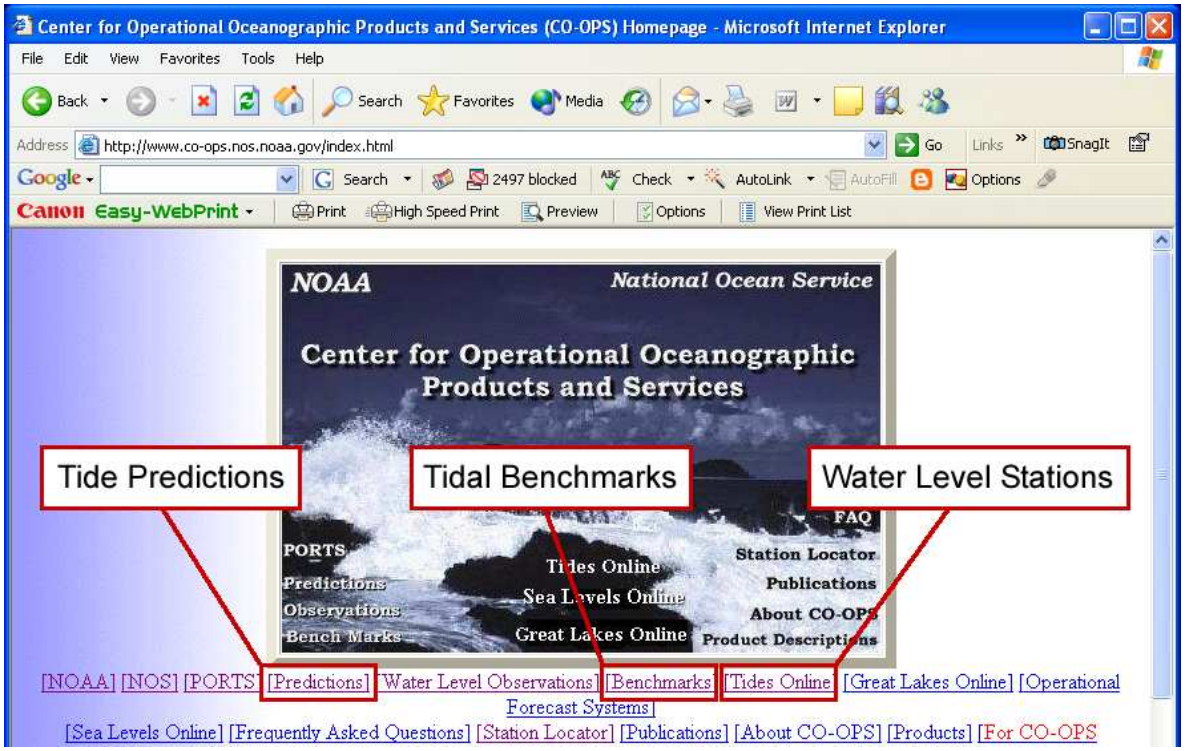


MapTech – http://www.freeboatingcharts.com



Tide Predictions, Water Level Stations, Tidal Benchmarks :

http://www.co-ops.nos.noaa.gov/index.html

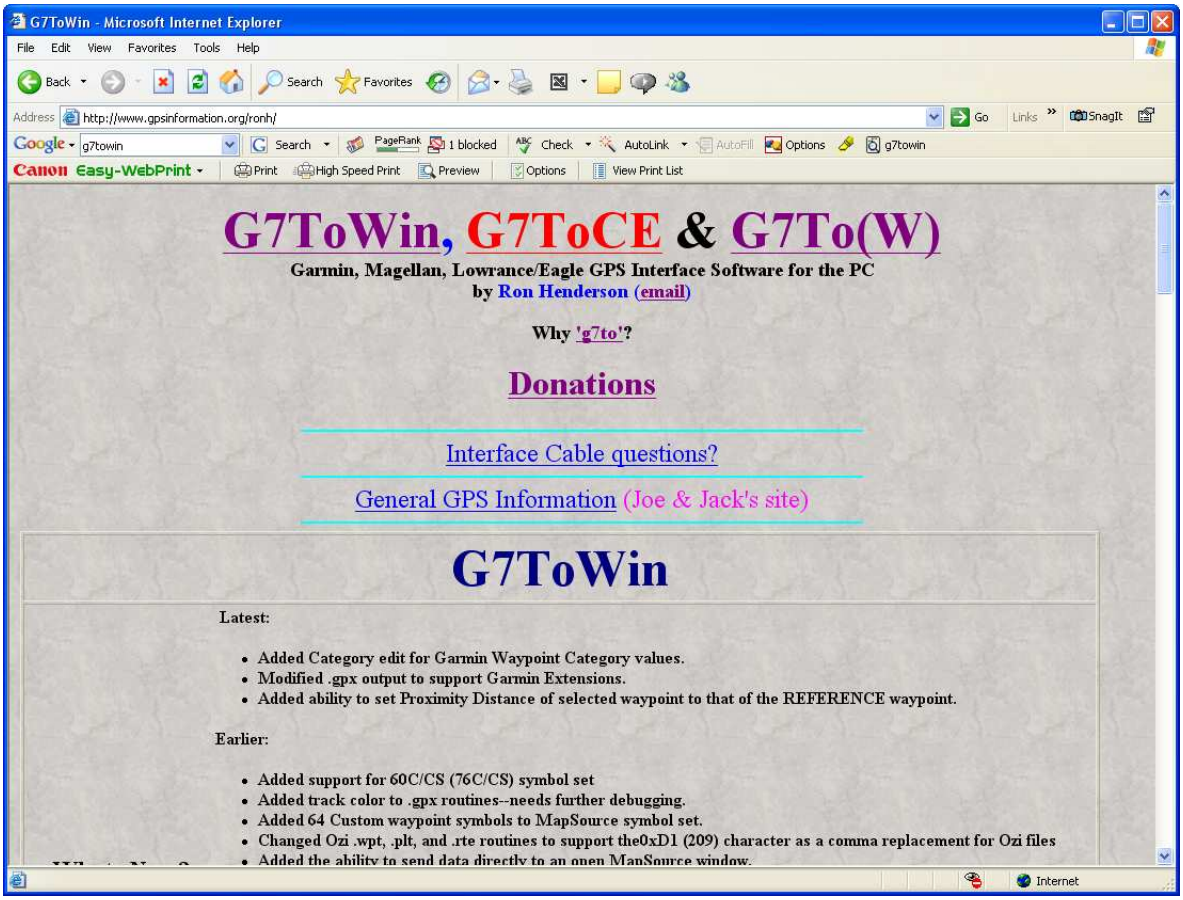


Weather Buoys :

http://www.ndbc.noaa.gov/index.shtml

GPS – Computer Transfer Software:

http://www.gpsinformation.org/ronh/



Next Section - **Part II – An Example Survey**