SETTLEMENT AND SQUAT PROCEDURES USING THE MULTIBEAM ECHOSOUNDER METHOD

I. Data Acquisition

Data should be acquired in an area with a flat seafloor and relatively shallow water (but at least 7 times the vessel draft) to reduce attitude bias. (Gridded datasets, such as GEODAS grids or BASE surfaces from prior surveys, are useful for finding appropriate locations.) Choose a location as close as possible to a water level station, and obtain tide zoning files for the area from NOAA's Center for Operational Oceanographic Products and Services (CO-OPS). If the survey time is planned to minimize currents, adequate data can typically be acquired by running in one common direction for all vessel speeds. If currents are significant, it will be necessary to acquire data in opposing directions for each speed and average the two values. As with previous methods, vessel attitude and speed must be stable while acquiring data.

- **Line Acquisition -** Plan a survey line approximately 1000 meters in length. Establish a center reference point for three approximately 20m^2 reference areas located at distances of ¼, ½, and ¾ along the line as shown in Figure 1. Acquire data along the line at

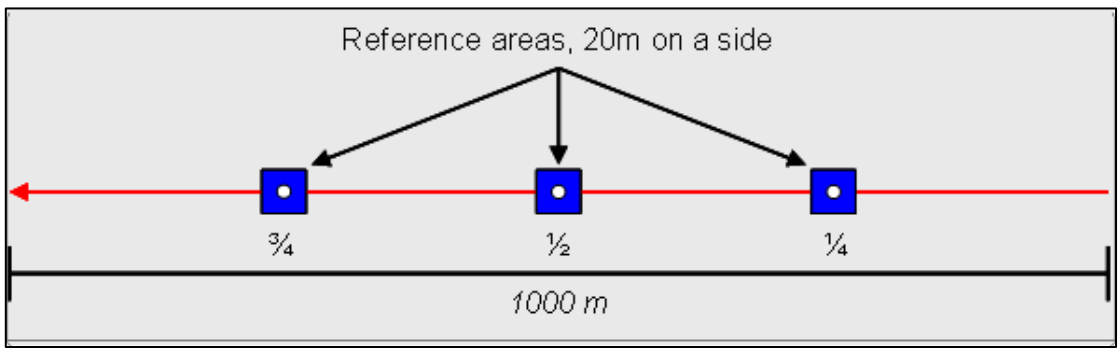

Figure 1. Pictorial representation of line plan for determining settlement and squat using a vessel's echosounder.

various speed intervals, ranging from the minimum to the maximum speed anticipated for survey operations. Minimize across-track error during line navigation and establish a constant speed and heading prior to logging data. Monitor and minimize induced heave during data acquisition.

- **Reference Area Acquisition -** At each reference area, acquire data along the line at the lowest speed possible while maintaining heading and stable attitude. Compare these 0-settlement and squat measurements with each of the at-speed measurements to determined offsets caused by speed variation. If the sea floor is not flat, several passes may be required at each reference area to create an accurate reference surface. Acquire reference surface data before and after line acquisition to bracket and evaluate water level variation. Conduct a sound velocity cast near the center reference point.

II. Data Processing

- **Soundings** - If the echosounder system used for data acquisition performs real-time heave filtering, convert the data without applying heave. Long-period heave will bias dynamic draft calculations. Random, short-period heave should cancel out during statistical averaging of reference surface depths. Filter soundings to reject all but those with the highest data quality flag.

- Sample all line and reference surface soundings using an approximately 3 m x 20 m subset area at each of the 3 reference areas. Minimally clean subsets for gross flyers and noise. Select and query all soundings from each subset dataset and save each CARIS query window as a text file. Import these text files to MS Excel as tab-delimited records. Sort these Excel data by line ID and calculate the median surface depth (use =MEDIAN (c#:c#)) for each speed level at each reference area. Typical sample populations should be between 3,000 – 5,000 soundings (use =COUNTA (c#:c#) to check).

- **Navigation/Speed** - Using the CARIS Navigation Editor, query position fixes for individual lines within each reference area subset. Save each query as a text file and import these data into Excel as tab-delimited records. Calculate the average speed for each RPM in each of the reference areas (use =average (c#:c#)).

- **Offset Tables -** For each reference area, subtract the median reference surface depth from median depths for each RPM/speed interval to calculate relative dynamic draft offsets. Plot Speed vs. Offset for each of the 3 reference areas to evaluate data consistency. Using data from the ½ and ¾ point reference areas, calculate averages for final offsets. A sample plot is shown in Figure 2 below, with corresponding tabular data displayed in Table 1.

- **Error Analysis -** The standard deviation of each speed correction can be calculated by comparing the values derived from each surface area. The larges standard deviation value should be entered into the vessel's HVF for dynamic draft error.

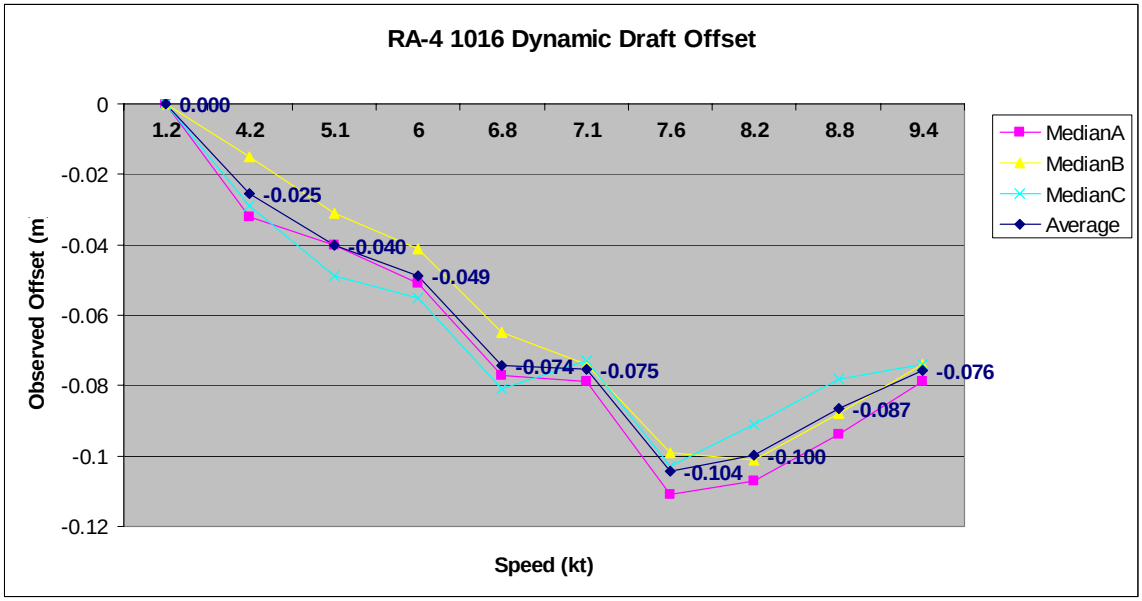

Figure 2. Sample Dynamic Draft Offset Plot

Table 1. Sample Dynamic Draft Offset Table

RPM	Speed	MedianA	MedianB	MedianC	Std. Dev.	Average
0	1.2	0	0	0	0	**0.000**
700	4.2	-0.032	-0.015	-0.029	0.0091	**-0.025**
900	5.1	-0.04	-0.031	-0.049	0.0090	**-0.040**
1000	6	-0.051	-0.041	-0.055	0.0072	**-0.049**
1200	6.8	-0.077	-0.065	-0.081	0.0083	**-0.074**
1400	7.1	-0.079	-0.074	-0.073	0.0032	**-0.075**
1600	7.6	-0.111	-0.099	-0.103	0.0061	**-0.104**
1800	8.2	-0.107	-0.101	-0.091	0.0081	**-0.100**
2000	8.8	-0.094	-0.088	-0.078	0.0081	**-0.087**
2200	9.4	-0.079	-0.074	-0.074	0.0029	**-0.076**