Total Pb-210 and Cs-137 activities were measured non-destructively via gamma spectroscopy of the 46.5 and 661.6 keV photopeaks, respectively (Cutshall et al., 1983). Supported Pb-210 was determined by measuring the activity of its parent radioisotope, Bi-214, using the 609.3 keV photopeak. Approximately 25–50 g of dry sediment from each 2-cm core interval was ground to a fine powder, placed in a 60 ml plastic screw-lid jar, and counted for 48 hours on a Canberra Instruments Model 2020 low-energy Germanium detector (LEGe). Detector efficiencies were computed based on measured versus registered activities of NISST Standard Reference Material 4357B (a.k.a. Ocean Sediment). For each subsample the supported activity of Pb-210 was subtracted from the total activity to compute excess activity.

Spot measurements of the natural radioisotope Be-7 ($t_{1/2}$=53 days) were made on HDC samples from two sites in the estuary where fresh deposition was presumed at the time of sampling. Beryllium-7 is produced in the atmosphere by cosmic ray spallation of nitrogen and oxygen and delivered to the earth's surface through precipitation and dry deposition. In turbid estuaries Be-7 is rapidly adsorbed to particles and serves as a tracer of short-term deposition (or mixing) when present in bottom sediments (Olsen et al., 1986). Samples for Be-7 measurements were processed and gamma counted as per Cs-137 and Pb-210, and the activities were quantified from the 477.7 keV photopeak following the method of Larsen and Cutshall (1981).

5. RESULTS AND INTERPRETATION

5.1. Sonar and Bottom Sampling Coverage

Sonar tracklines and sediment sampling stations are presented together in a series of 12 maps scaled at approximately four-by-four nautical miles (Figures 5–16). Plotted are the actual tracks of the survey vessel as recorded by DGPS, numbered 1–122 following the order in which they were completed in the field. Note that each line has a corresponding sidescan, chirp and echosounder record. Due to a problem with the data cable, chirp data were not collected along Tracklines 11–14. Geographic positions of bottom grab and HDC sampling stations shown in Figures 5–16 are tabulated in Appendix D and presented in the accompanying GIS database.

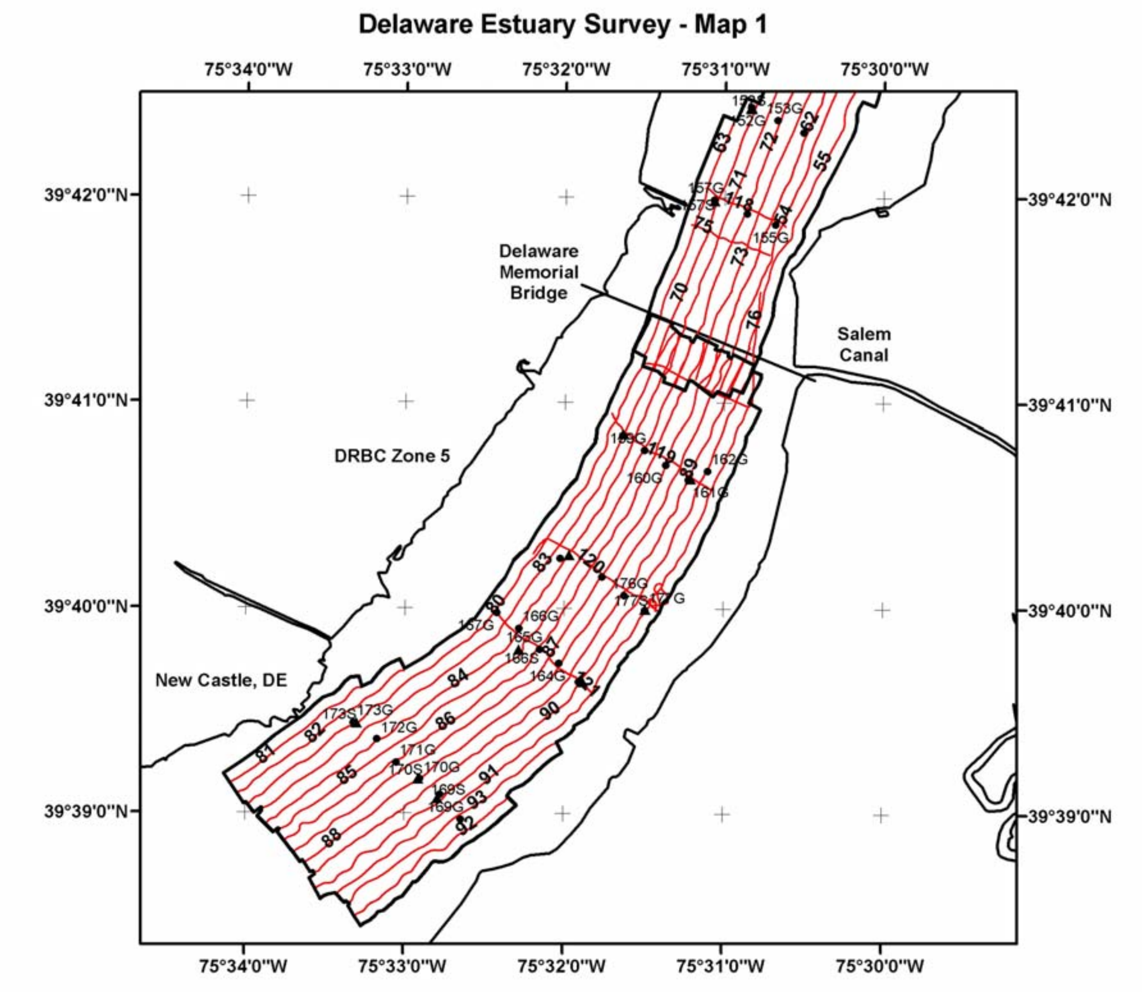

Figure 5. Survey Area Map 1. The entire survey area is presented in Maps 1−12 of Figures 5−16. Bold-numbered lines (red) are vessel tracklines along which sonar data were collected. Circles and triangles denote sediment-grab (G) and HDC stations (S), respectively. The thick black line represents the areal extent of sidescan sonar coverage.

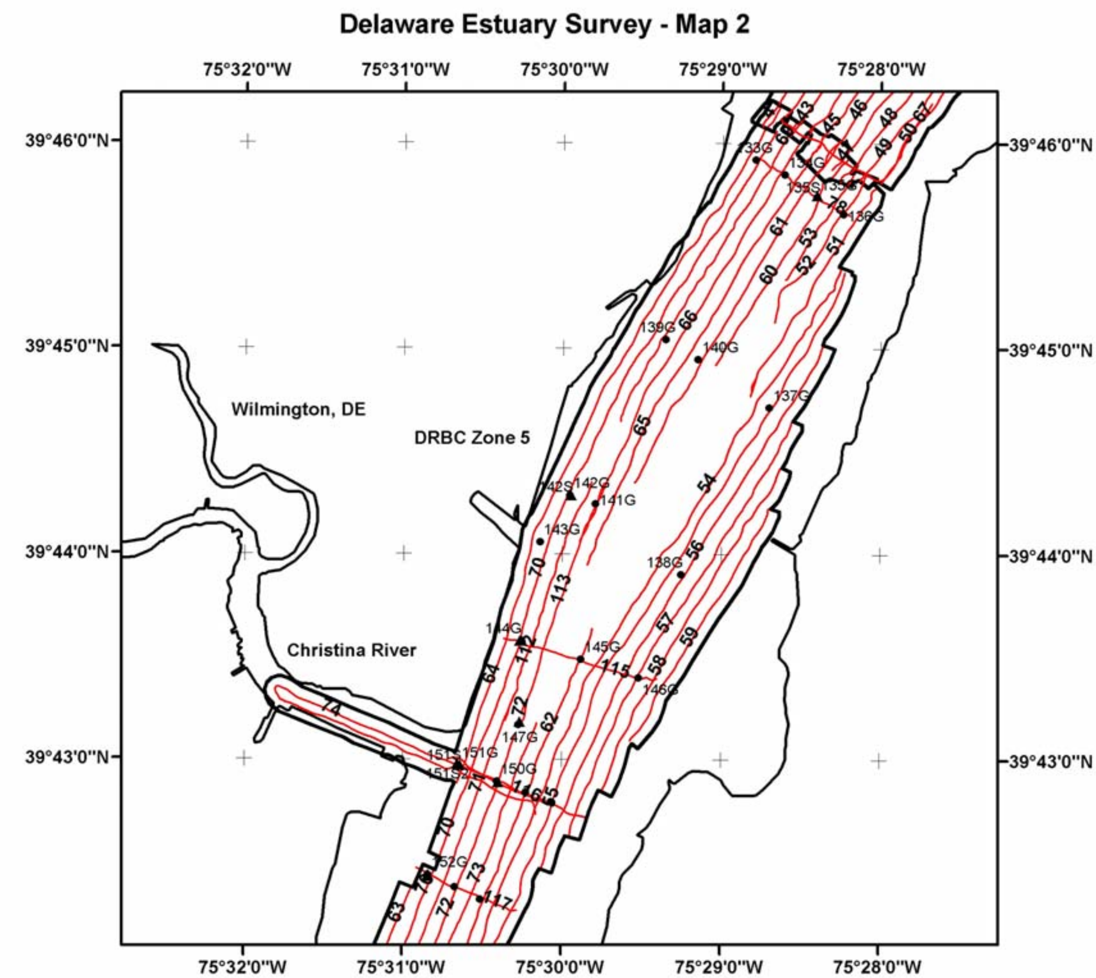

Figure 6. Survey Area Map 2. See Fig. 5 for details.

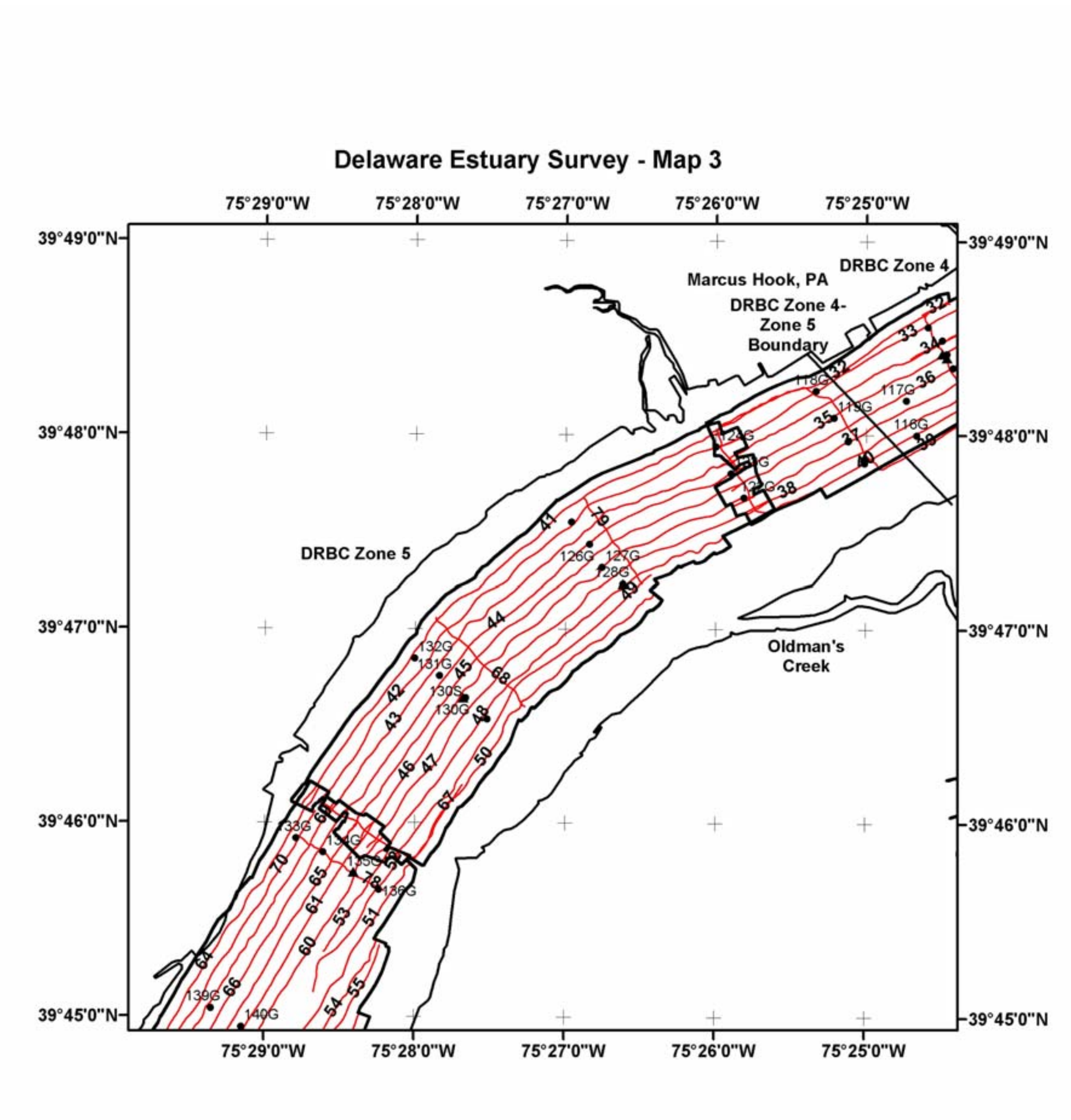

Figure 7. Survey Area Map 3. See Fig. 5 for details.

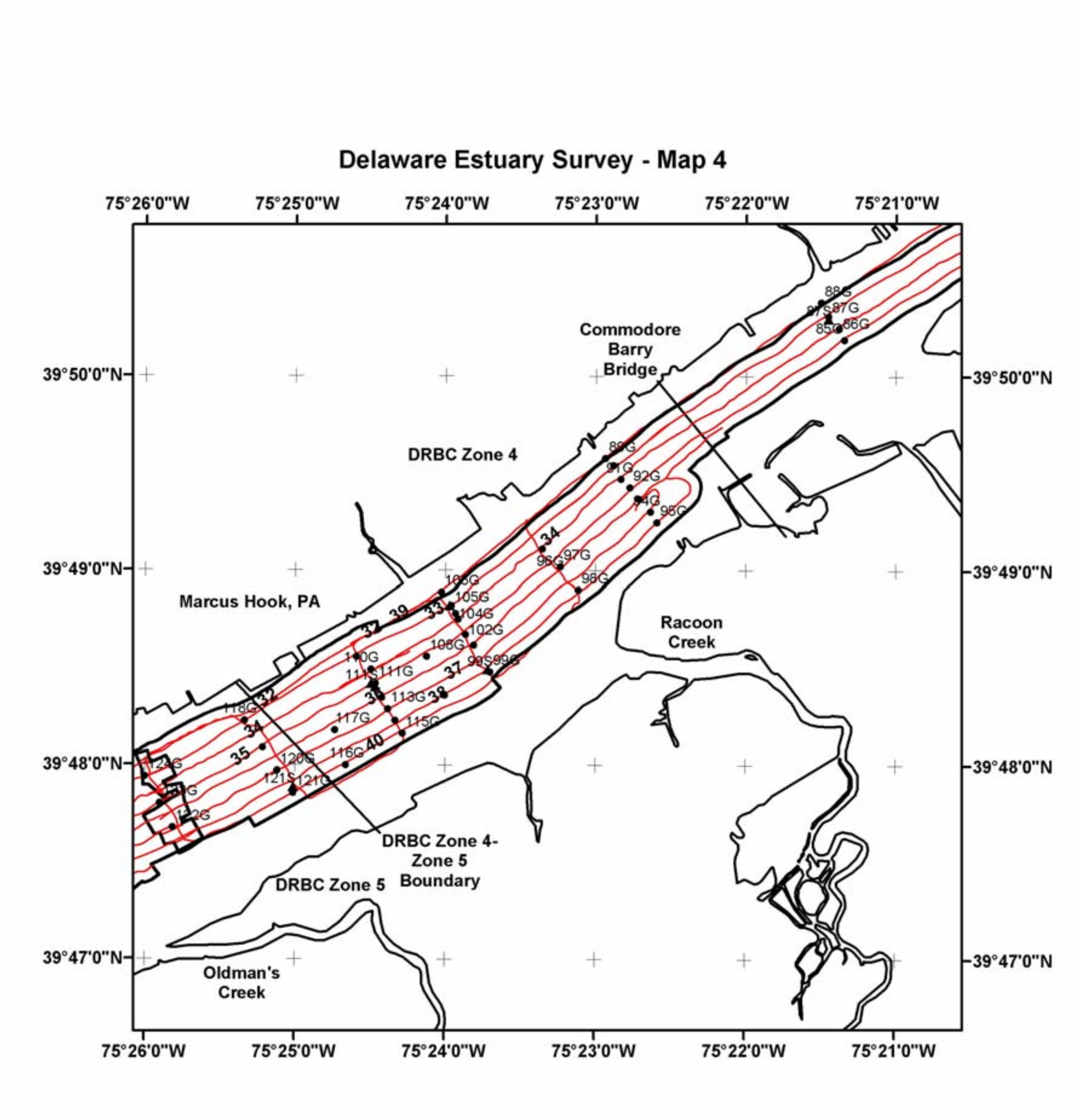

Figure 8. Survey Area Map 4. See Fig. 5 for details.

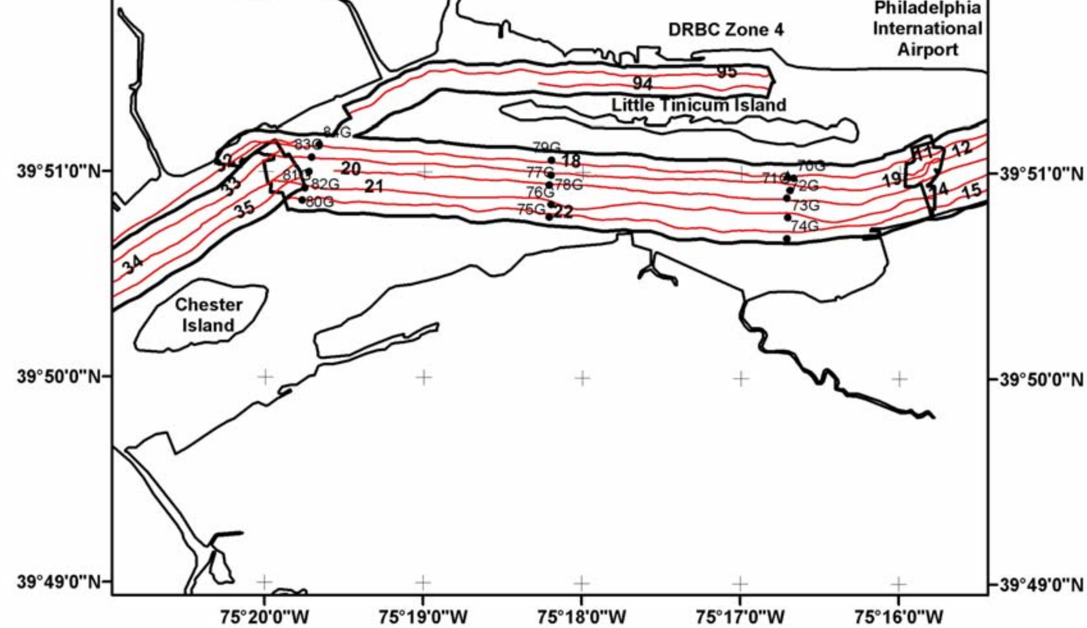

Figure 9. Survey Area Map 5. See Fig. 5 for details.

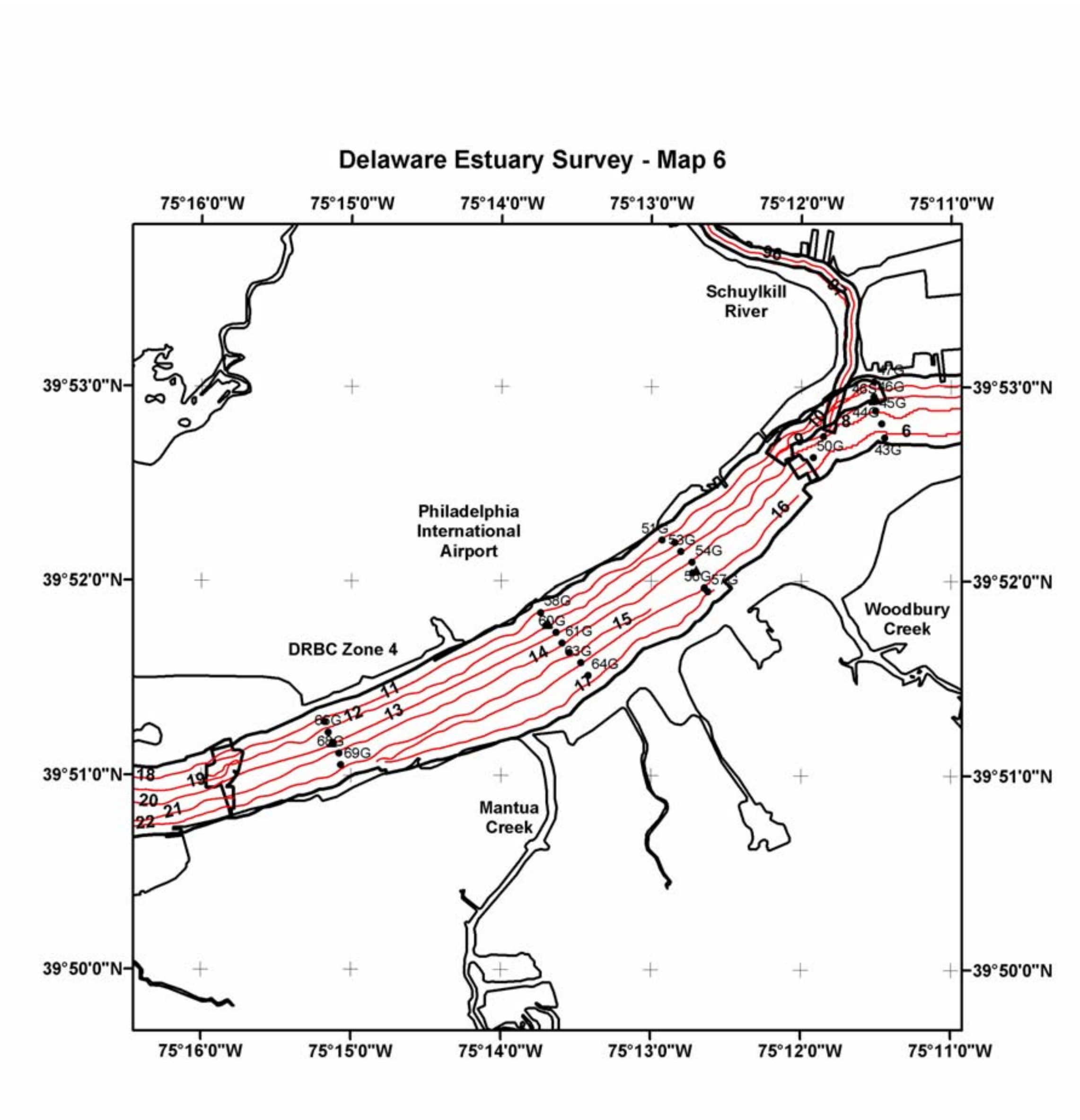

Figure 10. Survey Area Map 6. See Fig. 5 for details.

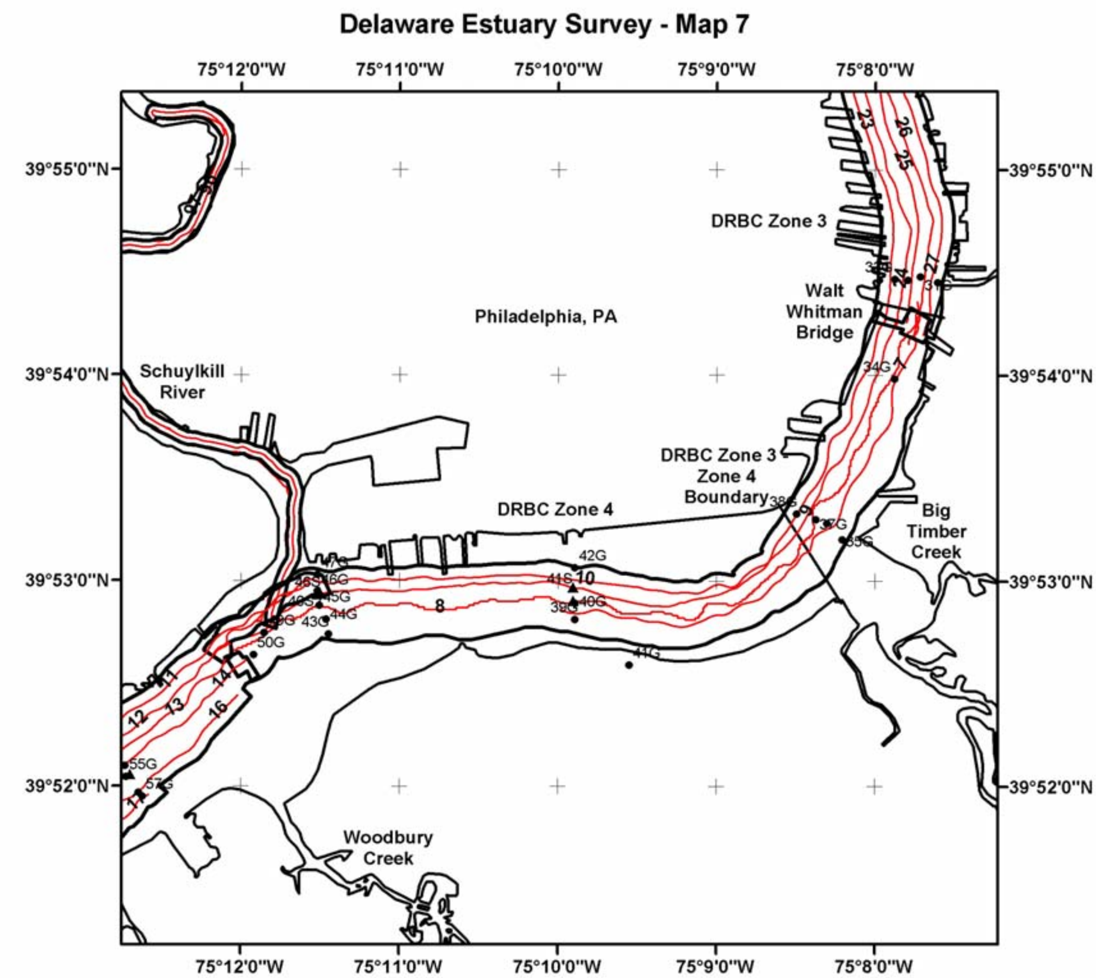

Figure 11. Survey Area Map 7. See Fig. 5 for details.

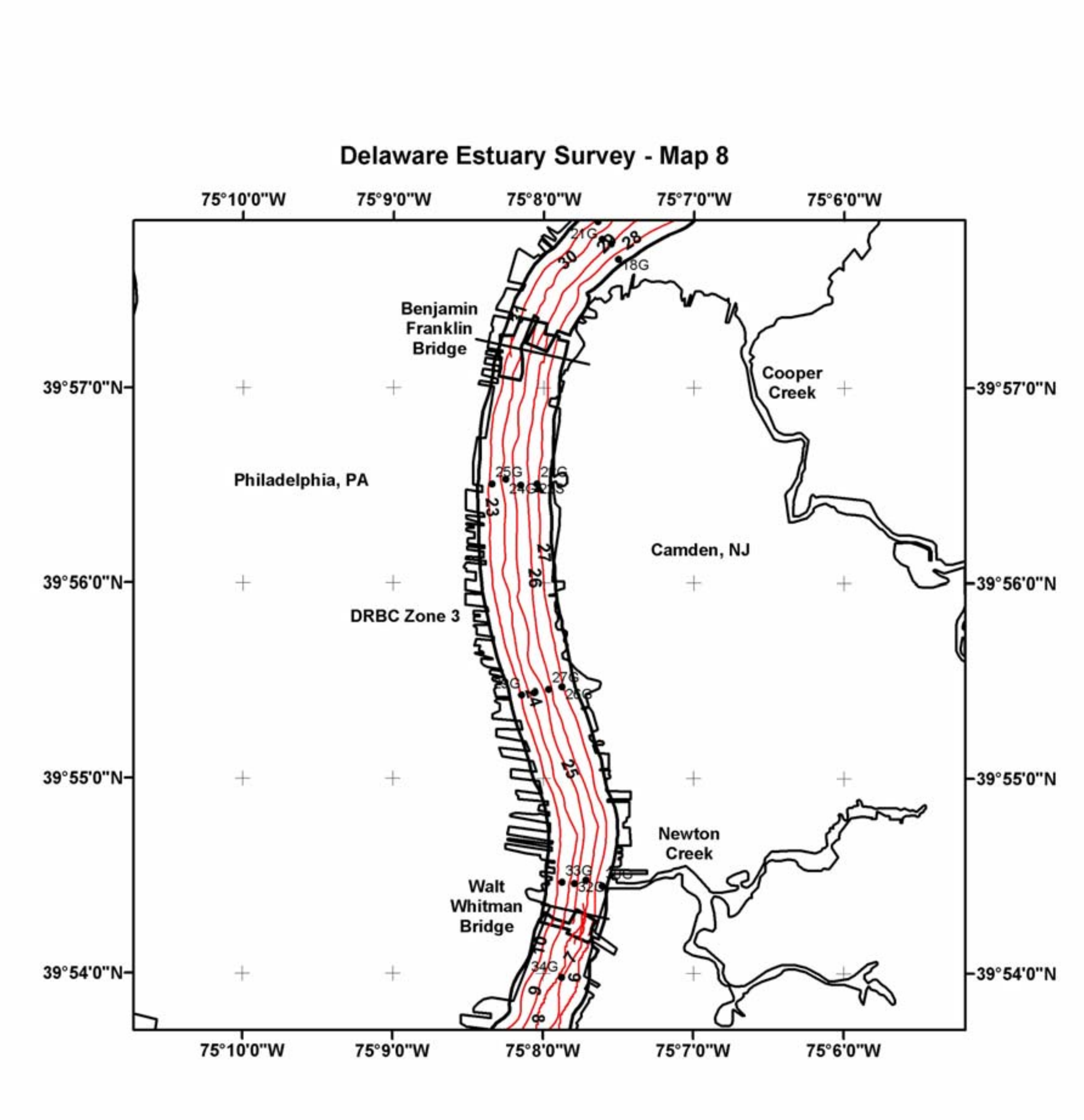

Figure 12. Survey Area Map 8. See Fig. 5 for details.

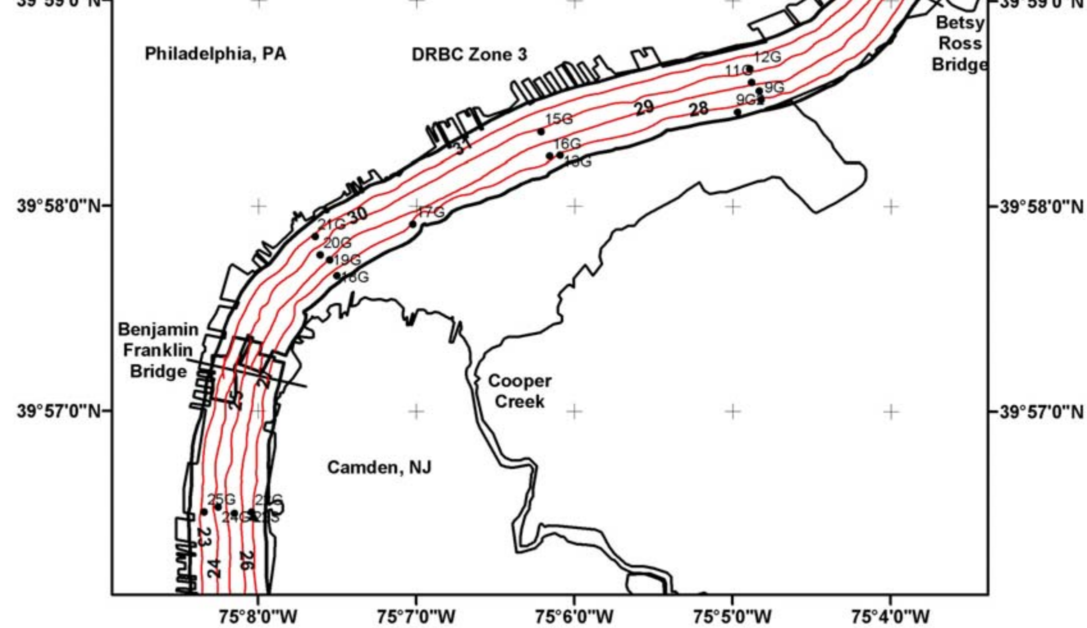

Figure 13. Survey Area Map 9. See Fig. 5 for details.

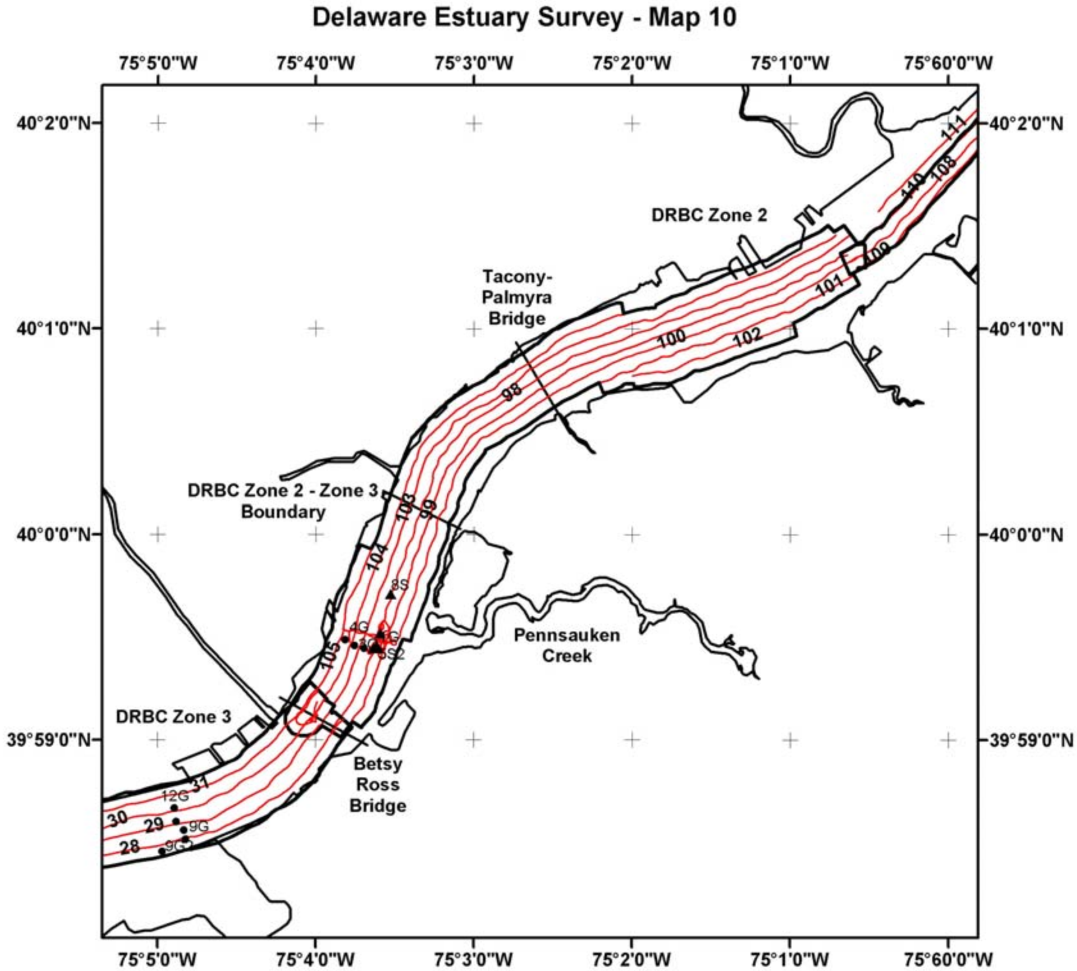

Figure 14. Survey Area Map 10. See Fig. 5 for details.

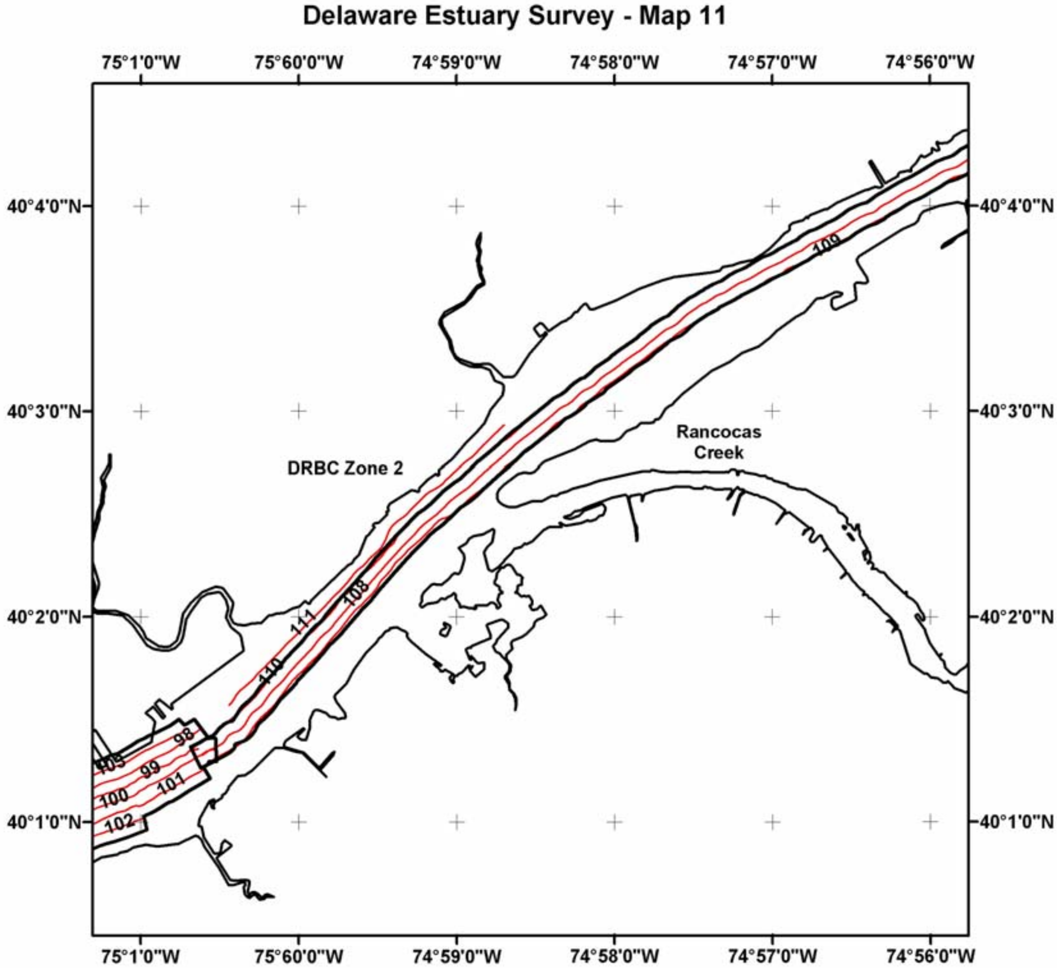

Figure 15. Survey Area Map 11. See Fig. 5 for details.

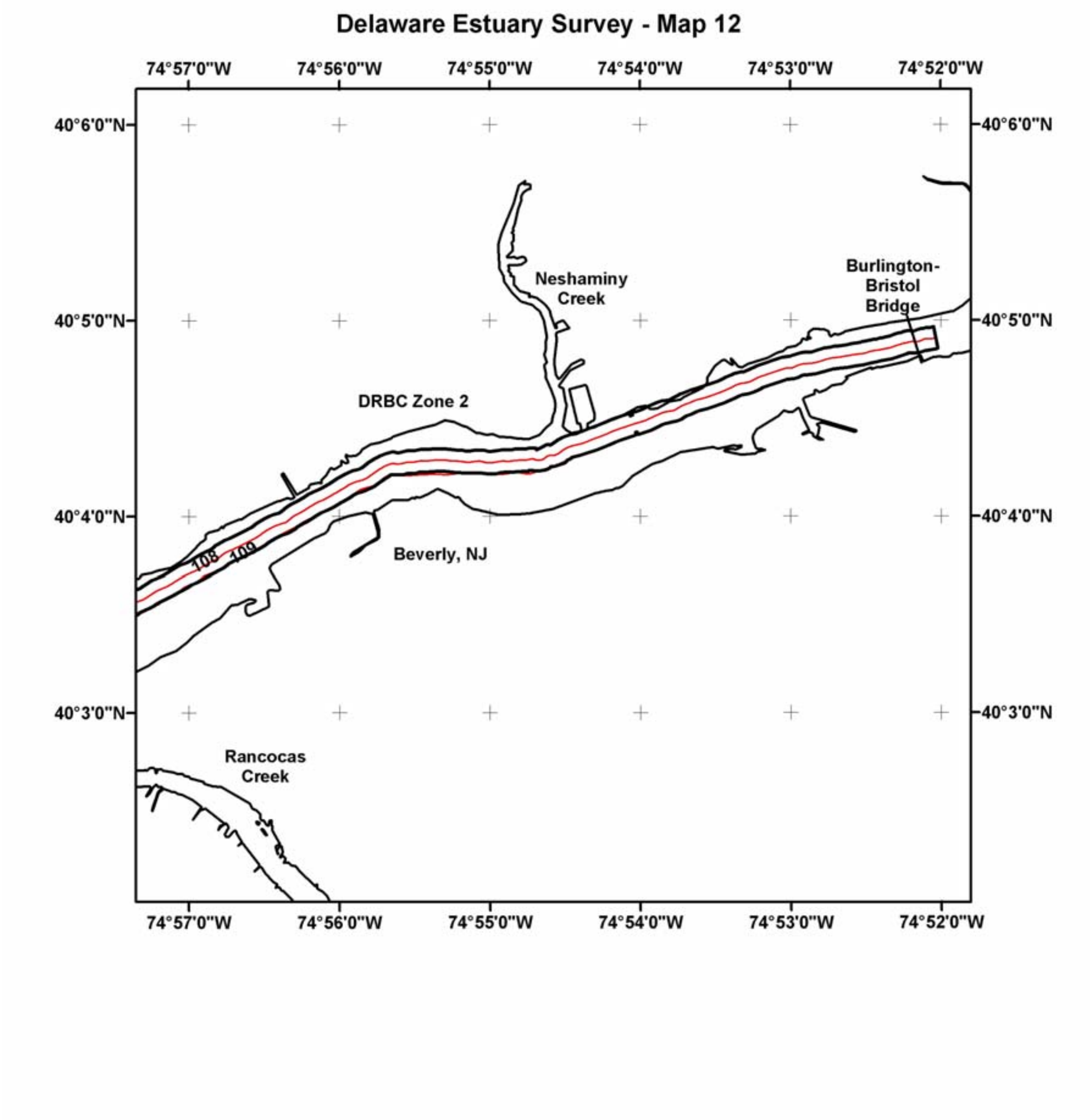

Figure 16. Survey Area Map 12. See Fig. 5 for details.

The total area of the bottom imaged by sidescan was 68.6 km^2, roughly 65 % of the total subaqueous area of the estuary between Burlington and New Castle, 80 % of the area below the 6-m isobath. Most of the remaining area (31.4 km^2) consists of shoals that were too shallow to be mapped without risking damage to the towed instrumentation. Though both sidescan sonar frequencies (100 and 500 kHz) were use to characterize the bottom, the backscatter mosaic was constructed from 100 kHz data because it provided more horizontal range.

5.2. Sidescan Backscatter

Because a detailed analysis of sidescan backscatter at the bedform scale was beyond the scope of this study, only the regional patterns are elaborated herein. The 12 backscatter mosaics are presented together in a large-scale map to illustrate the cumulative coverage (Figure 17; see Table 2 for details), and the individual 1-m resolution mosaics on which the sedimentary environments maps were based are presented as a composite GIS layer.

Table 2. Backcatter mosaic names and locations

DRBC Zone	Mosaic Name	Report Figure
5	New Castle	22
5	Christina	22, 23
5	Marcus Hook Bar	24
4–5	Marcus Hook	25, 26
4	Tinicum	26
4	Airport	27
4	Schuylkill	27, 28
3–4	Navy Yard	28
3	Camden	29
3	Petty Island	30
2–3	Palmyra	31
2	Burlington	32, 33

The spatial distribution of acoustic backscatter intensity exhibits a general along-estuary pattern that mirrors the predominant bed morphology and sediment type (Figure 17). For purposes of interpretation, backscatter intensity was divided into three categories: (1) *strong* (black to dark gray grayscale tones); (2) *moderate* (dark gray to light gray tones); and (3) *weak* (light grey to white tones). Backscatter intensity was