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**DISAGGREGATED INORGANIC GRAIN SIZE ANALYSIS
OF SURFICIAL SEDIMENTS IN THE ANNAPOLIS BASIN,
NOVA SCOTIA**

T.G. Milligan, T.M. Schell, and K.S. Saunders

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Canada

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ABSTRACT

Milligan, T.G., T.M. Schell and K.S. Saunders. 1999. Disaggregated Inorganic Grain Size Analysis of Surficial Sediments in the Annapolis Basin, Nova Scotia. Can. Data Rep. Fish. Aquat. Sci. 1041: vi + 52.

Between 1988 and 1996, surficial sediment samples were collected from the Annapolis Basin, N.S. In 1996, additional sediment samples were collected from the Annapolis River in the region of the head pond for the tidal power generating station at Annapolis Royal. The disaggregated inorganic grain size distributions of the samples were determined by electro-resistance particle sizing techniques using either a Model TAI Coulter Counter or a Coulter Multisizer IIE. This report presents the station locations and the results of the analysis carried out. Data collected during the sampling programs described can be used as a baseline for determining changes in the sedimentological regime of the Annapolis Basin.

RÉSUMÉ

Milligan, T.G., T.M. Schell and K.S. Saunders. 1999. Disaggregated Inorganic Grain Size Analysis of Surficial Sediments in the Annapolis Basin, Nova Scotia. Can. Data Rep. Fish. Aquat. Sci. 1041: vi + 52.

Entre 1988 et 1996, des échantillons de sédiments de surface ont été recueillis dans le bassin de l'Annapolis (N.-É.). En 1996, des sédiments additionnels ont été recueillis dans la rivière Annapolis, dans la zone de l'étang d'amont de la centrale marémotrice d'Annapolis Royal. Les distributions granulométriques des échantillons désagrégés ont été établies par des techniques de granulométrie par électro-résistance au moyen de compteurs Coulter de modèles TAI ou Multisizer IIE. Le présent rapport décrit les coordonnées des stations et les résultats des analyses. Les données recueillies à la faveur des programmes d'échantillonnage décrits peuvent servir de références pour mesurer les changements du régime sédimentologique du bassin de l'Annapolis.

INTRODUCTION

The disaggregated inorganic grain size (DIGS) of bottom sediments can be used to describe the sedimentary conditions within a body of water being studied (Kranck et al., 1996a, b, Milligan and Loring, 1997). Changes to the sediment dynamics in an area can be deduced from changes in the size distribution of the surficial sediment. The size distribution of a sediment reflects the depositional conditions under which it was formed and is sensitive to changes in turbulence, particle concentration, and the cohesivity of the particles in suspension (Milligan, 1995; Milligan and Loring, 1997; Milligan and Hill, 1998). It has been suggested that intense aquaculture activity could increase both particle concentration and particle 'stickiness' and hence result in increased deposition of fine particulate material as a result of increased particle aggregation rate (Milligan and Loring, 1997). As part of a baseline study to determine the effect of salmon aquaculture on the natural environment, surficial sediment samples were collected over a number of years from stations throughout the Annapolis Basin, NS.

The Annapolis Basin is a macro tidal inlet, connected to the Bay of Fundy through a narrow, <1 km, channel. Its total area is 66.5 km² with an axial length of 25.8 km (Gregory et al., 1993). The maximum depth of the basin is 94.2 m with a tidal range from 6.8 - 9.3 m. The mean tidal volume is 553.2x10⁶ m³ with mean tidal currents computed from that volume of approximately 1 m·s⁻¹ and maximum currents in excess of 1.5 m·s⁻¹ (Gregory et al., 1993). The intertidal area, calculated from the difference between chart datum and high-water mark, is approximately 30 km² (Gregory et al., 1993). These extensive intertidal mud flats support a substantial soft shell clam (*Mya arenaria*) harvest. Scallops (*Placopecten magellanicus*), lobsters (*Homous americanus*) and groundfish are also exploited within the basin. In 1960 a causeway was constructed at Annapolis Royal which changed the natural hydrographic conditions in the upper reaches of the Annapolis Basin from unstratified to a two-layered salt wedge type estuary (Daborn et al., 1982). In 1983, a tidal power facility was completed at the causeway, creating a large headpond at the mouth of the Annapolis River.

During the period from 1988 to 1996, several sampling programs were carried out to examine the sedimentary regime in the Annapolis Basin. This report presents the results of the disaggregated inorganic grain size analysis (DIGS) of the samples collected. Inferences about the physical environment can be made and results may be used in the future to assess changes in the sedimentological conditions of the Annapolis Basin.

METHODS

SAMPLE LOCATIONS:

Samples were collected throughout the Annapolis Basin, in four different years (fig. 1). Initially, 19 stations in the outer reaches of the Annapolis Basin were sampled from the CSS Dawson in July 1988, as part of a general study of particle dynamics in the Bay of Fundy (fig. 2). In 1993, a sampling program to provide baseline data prior to the introduction of salmon and scallop aquaculture was initiated. In June of that year, 59 stations along 10 intertidal transects and 47 subtidal stations were sampled (Hargrave et al., 1993) (fig. 3). Two new transects were added at Port Wade (PW) (Hargrave et al., 1993) to the 8 transects of Prouse et al. (1988) at Thorne's Cove (T), Queen Anne Marsh (QA), and Oak Point (OP). Stations on the tidal flat transects are identified by location on the flat, East (E), West (W) or Center (C), sequential number from high water to low water. Subtidal stations were sampled in July 1993 from the CSS J.L. Hart. In May, 1994, samples were obtained at the proposed Rattling Beach Salmon Farm and in June, near the scallop farm located west of Cornwallis (fig. 4). Sampling of the Basin and the head pond above the tidal barrage was completed in November 1996 (fig. 5).

SAMPLE ANALYSIS:

Surficial sediments were collected using a 0.25 m² van Veen (1988) or a 0.1 m² Eckman grab. The top 0.5 cm of the sediment in the grab was subsampled using a cut-off 10 ml plastic syringe. The DIGS was determined for each sample by electro-resistance particle sizing using the techniques described by Milligan and Kranck (1991). Sample analyses were carried out using a

Model TAI Coulter Counter (1988) or Coulter Multisizer IIE over a size range from approximately 0.7 - 400 μm . Subsamples were digested in an excess of 35% H_2O_2 and suspended in 1% NaCl before disaggregation with a sapphire tipped sonic probe. Results were plotted as frequency distributions, or frequency spectra, of \log_{10} equivalent weight percentage of sediment, determined from the volume in logarithmically equal size classes using a specific gravity of $2.65 \text{ kg}\cdot\text{m}^{-3}$ vs. \log_{10} diameter. For the 1988 samples, a $1/3 \phi$ mid-point size class (i.e. diameter doubling every three channels) was used. For all other years, diameters are reported in $1/5 \phi$ intervals. The size distribution data were normalised to the total weight in the size range analysed.

Kranck et al. (1996a, b) and Milligan and Loring (1997) presented a method whereby the DIGS of a bottom sediment can be used to determine its depositional history. Using this method, the inorganic fraction of a sediment can be separated into three components, each of which has a different mode of settling (fig. 6). The components are: 1) material settled in a flocculated form, defined by the straight-line portion of the curve starting at 0.7 μm in the plots and termed the floc tails; 2) material deposited as single grains from suspension which forms the "one-round" modal peak with a slope, m , of 2, occurring at around 10 μm ; 3) material which has undergone further suspension sorting, usually as a result of high-energy events, as defined by the well sorted, "multi-round" peak in the coarsest size range with $m > 2$. In any sediment size distribution, one or more of these components will occur. For a particular geography, the slope of the flat, floc tail is defined by the nature of the source material, and can be used to indicate the origins of the material making up the sediment (Kranck and Milligan, 1985). The modal diameter and degree of sorting, increasing values of m , in the bottom sediment is controlled by the energy to which the sediment is exposed.

RESULTS AND DISCUSSION

Figure 1 shows the location of all samples collected during the 5 different sampling programs. Station location maps for individual years are shown in figures 2-5. Table 1 lists by year the station

number, location and discrete identifier number for each sample analysed. Data for the DIGS of the samples are listed in tables 2-6 with the corresponding plots of the size spectra illustrated in figures 8-20. The individual grain size plots may also be viewed interactively using station location maps on the Internet at <http://www.mar.dfo-mpo.gc.ca/science/mesd/he/particle/>. All data listed are available in electronic format. Tidal flat transect stations are labelled using an abbreviation for each location.

The DIGS distributions of the bottom sediment samples collected in Annapolis Basin reflect the high-energy regime from which they have been deposited. The source slope, the slope of the floc tail, is constant throughout the basin indicating a single source material for the fine sediment. Samples in the outer reaches of the Basin have coarse, well-sorted distributions with very little material in the floc tail portion of the curve. Modal diameter correlates well with current speed, with coarseness increasing as you approach the narrow channel of Digby Neck. Samples collected in the region of Digby Neck, not reported here, consisted of coarse gravel and boulders. The very small amount of floc and one-round deposited sediment in these sediments indicates that there is considerable reworking of the bottom by tidal action. The size distributions of samples collected seaward of Goat Island are all very similar. Upstream of Goat Island, the modal size starts to decrease and the proportion of floc settled material increases slightly. The finest sediment found below the causeway is located in deep water at the sides of the channel opposite Annapolis Royal. Above the tidal barrage the size distribution of the bottom sediments changes dramatically. In these samples, modal size is almost an order of magnitude less than below the barrage and the samples consist of almost 100% floc derived sediment. This change from current dominated, reworked sediments to flocculated sediments is likely the result of trapping the Annapolis River turbidity maximum in a low turbulence region above the tidal barrage.

The lack of floc settled material in the sediments of the tidal flats and subtidal stations, and the evidence of reworking, shown by the multi-round modal peaks, suggests that it is unlikely that fine particulate material introduced by salmon aquaculture will accumulate in the Annapolis Basin

sediments. Even relatively sheltered embayments such as Bear Cove do not appear to be regions of flocc dominated deposition. This is likely due to high bottom shear stresses from tidal currents. The fact that the fine, cohesive sediment appears to be flocculating and depositing above the tidal barrage could have implications for sediment erosion below the causeway by removing this source of cohesive sediment. Further research is required to confirm this hypothesis.

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TABLE 1: Station locations and corresponding sample identification numbers.

1988 Annapolis Basin Sample Locations

Station	Latitude	Longitude	ID Number
52	44 40.61 N	65 39.30 W	881125052
53	44 40.47 N	65 39.30 W	881125053
54	44 40.36 N	65 39.28 W	881125054
55	44 40.29 N	65 39.92 W	881125055
56	44 40.04 N	65 40.46 W	881125056
57	44 39.84 N	65 40.93 W	881125057
58	44 39.85 N	65 41.72 W	881125058
59	44 39.77 N	65 41.71 W	881125059
60	44 39.09 N	65 41.33 W	881125060
61	44 38.96 N	65 41.38 W	881125061
62	44 38.84 N	65 41.69 W	881125062
63	44 38.69 N	65 41.94 W	881125063
64	44 38.99 N	65 42.15 W	881125064
65	44 38.96 N	65 43.04 W	881125065
66	44 38.44 N	65 43.84 W	881125066
70	44 39.53 N	65 43.67 W	881125070
71	44 39.82 N	65 43.71 W	881125071
73	44 39.50 N	65 44.75 W	881125073
75	44 40.41 N	65 45.51 W	881125075

1993 Annapolis Basin Sample Locations

Station	Latitude	Longitude	ID Number
TE1	44 41.90 N	65 40.50 W	930531001
TE2	44 41.88 N	65 40.50 W	930531002
TE4	44 41.82 N	65 40.50 W	930531003
TE6	44 41.77 N	65 40.50 W	930531004
TE8	44 41.73 N	65 40.50 W	930531005
TE10	44 41.65 N	65 40.10 W	930531006
TE12	44 41.55 N	65 40.10 W	930531007
TE14	44 41.45 N	65 40.10 W	930531008
TE16	44 41.35 N	65 40.10 W	930531009
TE18	44 41.28 N	65 40.10 W	930531010
TE20	44 41.20 N	65 40.10 W	930531011
TW1	44 41.60 N	65 40.90 W	930531012
TW2	44 41.52 N	65 40.83 W	930531013
TW4	44 41.37 N	65 40.57 W	930531014
TW6	44 41.25 N	65 40.57 W	930531015
TW8	44 41.15 N	65 40.50 W	930531016
TW10	44 41.05 N	65 40.43 W	930531017
TW12	44 40.95 N	65 40.37 W	930531018
OPE1	44 42.10 N	65 34.80 W	930601001
OPE2	44 42.13 N	65 34.80 W	930601002
OPE4	44 42.20 N	65 34.80 W	930601003
OPE4	44 42.20 N	65 34.80 W	930601004
OPE7	44 42.27 N	65 34.80 W	930601005

TABLE 1(cont.): Station locations and corresponding sample identification numbers.

1993 Annapolis Basin Sample Locations

Station	Latitude	Longitude	ID Number
OPE8	44 42.30 N	65 34.80 W	930601006
OPC 1	44 N	65 W	930601007
OPC 2	44 N	65 W	930601008
OPC 4	44 N	65 W	930601009
OPC 6	44 N	65 W	930601010
OPC 7	44 N	65 W	930601011
OPW1	44 41.80 N	65 35.30 W	930601012
OPW2	44 41.87 N	65 35.30 W	930601013
OPW2	44 41.87 N	65 35.30 W	930601014
OPW4	44 41.90 N	65 35.30 W	930601015
OPW6	44 41.95 N	65 35.30 W	930601016
OPW8	44 42.00 N	65 35.30 W	930601017
QAE1	44 42.70 N	65 35.90 W	930602001
QAE2	44 42.65 N	65 35.90 W	930602002
QAE4	44 42.55 N	65 35.90 W	930602003
QAE6	44 42.45 N	65 35.90 W	930602004
QAE7	44 42.40 N	65 35.90 W	930602005
QAC1	44 42.75 N	65 35.95 W	930602006
QAC2	44 42.70 N	65 36.00 W	930602007
QAC3	44 42.65 N	65 36.05 W	930602008
QAC4	44 42.60 N	65 36.10 W	930602009
QAW1	44 42.73 N	65 36.20 W	930602010
QAW2	44 42.70 N	65 36.20 W	930602011
QAW4	44 42.63 N	65 36.20 W	930602012
QAW6	44 42.50 N	65 36.20 W	930602013
QAW7	44 42.40 N	65 36.20 W	930602014
PWE1	44 41.10 N	65 41.70 W	930603001
PWE2	44 41.03 N	65 41.67 W	930603002
PWE4	44 40.90 N	65 41.60 W	930603003
PWE6	44 40.77 N	65 41.47 W	930603004
PWE8	44 40.63 N	65 41.33 W	930604001
PWW1	44 40.60 N	65 42.40 W	930603005
PWW2	44 40.53 N	65 42.37 W	930603006
PWW4	44 40.40 N	65 42.30 W	930603007
PWW6	44 40.27 N	65 42.17 W	930603008
PWW9	44 40.07 N	65 41.97 W	930603009
1	44 39.90 N	65 38.20 W	930614001
2	44 39.10 N	65 40.20 W	930614002
3	44 38.80 N	65 41.55 W	930614003
4	44 38.90 N	65 41.58 W	930614004
5	44 38.61 N	65 42.34 W	930614005
6	44 38.48 N	65 43.00 W	930615031
7	44 38.51 N	65 43.68 W	930615032
8	44 38.73 N	65 43.65 W	930615033
9	44 38.89 N	65 43.16 W	930615034
10	44 39.16 N	65 43.12 W	930615035
11	44 39.44 N	65 43.67 W	930615036

TABLE 1(cont.): Station locations and corresponding sample identification numbers.

1993 Annapolis Basin Sample Locations

Station	Latitude	Longitude	ID Number
17	44 39.15 N	65 43.77 W	930615037
18	44 39.46 N	65 44.06 W	930615038
20	44 37.74 N	65 44.98 W	930615040
22	44 39.57 N	65 44.46 W	930616007
35	44 39.00 N	65 44.60 W	930616008
35	44 39.00 N	65 44.60 W	930616009
36	44 43.08 N	65 34.00 W	930617001
37	44 42.58 N	65 35.00 W	930617002
38	44 42.50 N	65 36.00 W	930617003
39	44 42.59 N	65 36.28 W	930617004
40	44 42.50 N	65 37.00 W	930617005
41	44 42.00 N	65 38.00 W	930617006
42	44 41.50 N	65 38.00 W	930617007
43	44 41.00 N	65 39.00 W	930617008
44	44 40.58 N	65 39.08 W	930617009
45	44 40.02 N	65 40.07 W	930617010
46	44 40.00 N	65 41.00 W	930617011
47	44 39.50 N	65 41.00 W	930617012

1994 Annapolis Basin Sample Locations (May)

Station	Latitude	Longitude	ID Number
4.00	44 39.46 N	65 45.44 W	940512001
7.00	44 39.39 N	65 45.36 W	940512002
8.10	44 39.36 N	65 45.38 W	940512003
8.20	44 39.36 N	65 45.38 W	940512004
9.00	44 39.31 N	65 45.38 W	940512005
10.00	44 39.27 N	65 45.39 W	940512006
11.00	44 39.24 N	65 45.36 W	940512007
13.00	44 39.23 N	65 45.44 W	940512008
14.00	44 39.19 N	65 45.42 W	940512009
15.00	44 39.14 N	65 45.38 W	940512010
17.00	44 39.04 N	65 45.34 W	940512011
19.00	44 39.28 N	65 45.28 W	940512012
21.00	44 39.25 N	65 45.45 W	940512013

1994 Annapolis Basin Sample Locations (June)

Station	Latitude	Longitude	ID Number
2.00	44 39.70 N	65 39.50 W	940620088
3.00	44 39.70 N	65 39.00 W	940620087
4.00	44 39.70 N	65 38.50 W	940620086
5.00	44 39.20 N	65 40.20 W	940620097
6.00	44 39.20 N	65 39.50 W	940620093

TABLE 1 (cont.): Station locations and corresponding sample identification numbers.

1994 Annapolis Basin Sample Locations (June)

Station	Latitude		Longitude		ID Number
7.00	44	39.20	N 65	39.00	W 940620092
8.00	44	38.90	N 65	40.20	W 940620096
9.00	44	38.90	N 65	39.50	W 940620094
10.00	44	39.50	N 65	39.00	W 940620090
11.00	44	39.50	N 65	39.50	W 940620089
12.00	44	39.50	N 65	40.20	W 940620098
13.00	44	38.60	N 65	40.20	W 940620095
14.00	44	39.20	N 65	38.70	W 940620091
15.00	44	39.10	N 65	40.00	W 940620100

1996 Annapolis Basin Sample Locations

Station	Latitude		Longitude		ID Number
1	44	37.86	N 65	45.50	W 961112001
2	44	37.86	N 65	45.77	W 961112002
3	44	37.83	N 65	45.75	W 961112003
4	44	37.83	N 65	45.17	W 961112004
5	44	36.38	N 65	45.69	W 961112005
6	44	36.21	N 65	45.24	W 961112006
7	44	36.14	N 65	44.76	W 961112007
8	44	35.86	N 65	44.50	W 961112008
9	44	35.77	N 65	44.67	W 961112009
10	44	36.62	N 65	44.71	W 961112010
11	44	36.88	N 65	44.01	W 961112011
12	44	37.46	N 65	43.99	W 961112012
13	44	38.05	N 65	44.00	W 961112013
14	44	38.53	N 65	44.01	W 961112014
15	44	38.52	N 65	43.00	W 961112015
16	44	37.99	N 65	43.00	W 961112016
17	44	38.01	N 65	41.97	W 961112017
18	44	38.55	N 65	42.04	W 961112018
19	44	38.52	N 65	41.01	W 961112019
20	44	38.49	N 65	39.98	W 961113001
21	44	39.01	N 65	40.05	W 961113002
22	44	39.53	N 65	40.00	W 961113003
23	44	40.02	N 65	40.00	W 961113004
24	44	40.52	N 65	40.00	W 961113005
25	44	41.03	N 65	39.97	W 961113006
26	44	41.01	N 65	39.47	W 961113007
27	44	40.49	N 65	39.49	W 961113008
28	44	39.99	N 65	39.51	W 961113009
29	44	39.48	N 65	39.49	W 961113010
30	44	38.98	N 65	39.49	W 961113011
31	44	38.98	N 65	39.01	W 961113012
32	44	40.03	N 65	38.01	W 961113013
33	44	39.69	N 65	37.61	W 961113014
34	44	40.51	N 65	38.05	W 961113015
35	44	41.01	N 65	37.99	W 961113016
36	44	41.53	N 65	37.98	W 961113017
37	44	42.01	N 65	37.99	W 961113018
39	44	42.41	N 65	35.92	W 961113019

TABLE 1 (cont.): Station locations and corresponding sample identification numbers

1996 Annapolis Basin Sample Locations

Station	Latitude	Longitude	ID Number
41	44 42.24 N	65 35.02 W	961113020
42	44 42.51 N	65 34.99 W	961113021
43	44 42.79 N	65 34.99 W	961113022
44	44 43.24 N	65 34.02 W	961113023
45	44 43.00 N	65 34.02 W	961113024
46	44 42.71 N	65 33.99 W	961113025
47	44 43.54 N	65 32.97 W	961113026
48	44 43.72 N	65 33.11 W	961113027
49	44 43.83 N	65 33.24 W	961113028
50	44 44.29 N	65 32.15 W	961113029
51	44 44.15 N	65 32.03 W	961113030
52	44 43.98 N	65 31.93 W	961113031
55	44 44.37 N	65 31.22 W	961113032
56	44 44.51 N	65 31.35 W	961113033
57	44 44.58 N	65 31.46 W	961113034
58	44 44.71 N	65 31.66 W	961113035
59	44 45.04 N	65 31.21 W	961113036
62	44 45.24 N	65 30.89 W	961113037
63	44 39.10 N	65 45.42 W	961113038
64	44 38.62 N	65 45.32 W	961113039
65	44 46.74 N	65 26.06 W	961114001
66	44 46.74 N	65 26.05 W	961114002
67	44 46.74 N	65 26.05 W	961114003
68	44 46.69 N	65 26.06 W	961114004
69	44 46.57 N	65 26.12 W	961114005
70	44 46.47 N	65 26.13 W	961114006
71	44 46.33 N	65 26.14 W	961114007
72	44 46.28 N	65 27.62 W	961114008
73	44 46.21 N	65 27.58 W	961114009
74	44 46.20 N	65 27.50 W	961114010
75	44 45.23 N	65 28.57 W	961114011
76	44 45.40 N	65 28.62 W	961114012
77	44 45.62 N	65 28.75 W	961114013
78	44 44.63 N	65 30.14 W	961114014
79	44 44.88 N	65 29.92 W	961114015
80	44 45.17 N	65 30.25 W	961114016

Table 2 (cont.): Annapolis Basin 1988

STATION#	62	63	64	65	66	70	71	73	75
DIAMETER (μm)									
0.63	0.67	0.38	0.33	0.48	0.46	0.33	0.65	0.30	0.66
0.79	0.63	0.36	0.28	0.43	0.43	0.31	0.57	0.27	0.60
1.00	0.62	0.36	0.26	0.42	0.42	0.29	0.52	0.25	0.58
1.26	0.62	0.35	0.25	0.41	0.41	0.31	0.49	0.25	0.59
1.59	0.65	0.33	0.25	0.42	0.41	0.32	0.50	0.26	0.58
2.00	0.65	0.33	0.25	0.44	0.43	0.35	0.52	0.27	0.60
2.52	0.69	0.33	0.24	0.43	0.43	0.35	0.52	0.25	0.59
3.17	0.76	0.33	0.27	0.49	0.47	0.41	0.62	0.29	0.70
4.00	0.83	0.36	0.24	0.47	0.47	0.39	0.60	0.29	0.72
5.04	0.94	0.40	0.26	0.53	0.53	0.35	0.66	0.31	0.76
6.35	1.03	0.46	0.28	0.58	0.56	0.37	0.74	0.34	0.80
8.00	1.04	0.48	0.28	0.59	0.55	0.35	0.82	0.34	0.82
10.08	1.18	0.53	0.30	0.69	0.60	0.36	0.91	0.38	0.93
12.70	1.33	0.62	0.35	0.77	0.70	0.39	1.13	0.43	1.04
16.00	1.61	0.67	0.42	0.89	0.78	0.45	1.38	0.50	1.21
20.16	1.89	0.76	0.47	1.06	0.97	0.52	1.65	0.58	1.47
25.40	2.65	0.87	0.67	1.09	1.35	0.66	2.13	0.67	1.92
32.00	4.14	1.22	0.95	1.79	2.11	0.98	3.15	0.98	2.09
40.32	4.27	1.20	1.23	2.24	2.47	1.17	2.96	1.03	2.58
50.80	2.58	1.49	1.80	1.45	3.47	1.45	3.02	1.30	3.81
64.00	3.93	2.33	2.91	1.84	5.47	2.17	4.04	1.66	5.71
80.63	6.79	4.01	5.22	2.39	8.59	3.34	4.76	2.50	9.01
101.59	11.46	8.15	9.14	3.56	14.15	6.05	5.65	3.73	13.44
128.00	21.27	19.74	20.41	6.75	22.93	11.26	6.50	7.17	19.81
161.27	21.11	29.10	31.27	15.39	22.27	23.25	5.68	14.73	19.22
203.19	5.29	15.25	15.90	24.40	7.00	27.34	4.06	25.45	6.85
256.00	1.08	4.77	4.50	15.26	1.16	11.30	4.72	17.18	1.62
322.54	0.29	2.00	1.31	4.68	0.42	2.81	12.51	10.26	1.30
406.37	..	1.88	..	5.20	..	1.68	5.71	5.02	..
512.00	..	0.94	..	4.85	..	0.67	12.29	3.01	..
645.08	..	..	..	..	..	..	10.54	..	..

Table 4 (cont.): Annapolis Basin 1994(May)

Station #	17	19	21
DIAMETER (μm)			
0.66	0.24	0.12	0.13
0.76	0.23	0.11	0.12
0.87	0.23	0.11	0.13
1.00	0.24	0.12	0.14
1.15	0.24	0.13	0.15
1.32	0.26	0.14	0.16
1.52	0.28	0.15	0.18
1.74	0.29	0.16	0.18
2.00	0.32	0.17	0.20
2.30	0.32	0.19	0.22
2.64	0.36	0.20	0.23
3.03	0.39	0.20	0.25
3.48	0.43	0.22	0.27
4.00	0.43	0.25	0.27
4.59	0.47	0.26	0.31
5.28	0.51	0.30	0.33
6.06	0.54	0.32	0.37
6.96	0.59	0.36	0.41
8.00	0.62	0.39	0.43
9.19	0.65	0.43	0.47
10.56	0.68	0.48	0.53
12.13	0.73	0.52	0.55
13.93	0.81	0.64	0.60
16.00	0.83	0.66	0.68
18.38	0.89	0.75	0.75
21.11	1.00	0.78	0.86
24.25	1.07	0.97	0.97
27.86	1.07	1.20	1.00
32.00	1.19	1.27	1.24
36.76	1.40	1.53	1.36
42.22	1.72	2.15	2.02
48.50	2.36	2.98	2.74
55.72	3.30	4.07	3.91
64.00	4.43	5.53	5.37
73.52	5.98	7.85	7.05
84.45	7.28	9.73	8.98
97.01	7.41	11.63	9.40
111.43	6.76	12.39	8.89
128.00	6.19	12.09	7.80
147.03	4.15	10.05	7.22
168.90	2.66	5.44	6.39
194.01	1.86	2.22	5.26
222.86	2.36	0.49	3.78
256.00	3.44	0.26	4.29
294.07	3.19	..	2.09
337.79	3.61	..	1.33
388.02	4.75	..	..
445.72	3.68	..	..
512.00	4.79	..	..
588.13	2.80	..	..
675.59	..	..	..
776.05	..	..	..

Table 5 (cont.): Annapolis Basin 1994(June)

Station #	12	13	14	15	16
DIAMETER (μm)					
0.57	..	..	..	..	..
0.66	..	..	..	..	..
0.76	0.08	0.13	0.09	0.15	0.20
0.87	0.08	0.13	0.10	0.15	0.19
1.00	0.09	0.14	0.11	0.17	0.21
1.15	0.10	0.15	0.13	0.20	0.23
1.32	0.11	0.16	0.15	0.22	0.24
1.52	0.12	0.17	0.16	0.24	0.26
1.74	0.13	0.18	0.17	0.26	0.27
2.00	0.14	0.19	0.18	0.27	0.28
2.30	0.16	0.21	0.20	0.31	0.30
2.64	0.16	0.22	0.21	0.32	0.32
3.03	0.18	0.22	0.23	0.36	0.33
3.48	0.19	0.24	0.26	0.38	0.35
4.00	0.19	0.25	0.26	0.40	0.37
4.59	0.20	0.28	0.27	0.45	0.39
5.28	0.23	0.28	0.30	0.51	0.37
6.06	0.26	0.33	0.31	0.53	0.46
6.96	0.29	0.35	0.37	0.58	0.43
8.00	0.32	0.39	0.42	0.65	0.46
9.19	0.34	0.42	0.44	0.73	0.52
10.56	0.37	0.45	0.50	0.79	0.55
12.13	0.41	0.48	0.55	0.83	0.58
13.93	0.41	0.52	0.58	0.89	0.61
16.00	0.46	0.54	0.65	0.96	0.62
18.38	0.47	0.59	0.67	1.00	0.64
21.11	0.44	0.62	0.65	1.09	0.63
24.25	0.51	0.66	0.80	1.10	0.72
27.86	0.53	0.75	0.96	1.14	0.74
32.00	0.57	1.02	1.55	1.17	0.77
36.76	0.95	1.45	2.03	1.77	1.39
42.22	1.33	2.10	2.90	2.46	1.92
48.50	1.81	2.74	3.87	3.42	2.57
55.72	2.58	3.75	5.20	4.77	3.54
64.00	3.57	5.56	7.26	6.57	4.73
73.52	5.01	7.90	9.99	8.50	6.65
84.45	7.11	10.50	12.73	10.29	8.34
97.01	9.22	12.79	16.00	12.24	10.04
111.43	11.26	15.13	15.57	11.46	11.24
128.00	14.98	15.33	9.51	10.60	11.59
147.03	15.85	9.13	2.85	7.10	11.69
168.90	10.91	2.72	0.81	2.94	7.18
194.01	5.91	0.72	..	1.19	4.82
222.86	0.90	0.11	..	0.63	1.35
256.00	0.61	..	..	0.21	0.91
294.07	0.42	..	..	..	..
337.79	..	..	..	..	..
388.02	..	..	..	..	..
445.72	..	..	..	..	..
512.00	..	..	..	..	..
588.13	..	..	..	..	..
675.59	..	..	..	..	..
776.05	..	..	..	..	..

Table 6 (cont.): Annapolis Basin 1996

Station #	77	78	79	80
DIAMETER (μm)				
0.76	1.56	1.04	1.62	1.35
0.87	1.58	1.07	1.66	1.35
1.00	1.69	1.16	1.77	1.44
1.15	1.80	1.26	1.89	1.56
1.32	1.91	1.34	1.97	1.70
1.52	2.07	1.41	2.08	1.75
1.74	2.19	1.57	2.12	1.93
2.00	2.35	1.65	2.25	2.04
2.30	2.45	1.69	2.27	2.21
2.64	2.78	1.71	2.46	2.42
3.03	2.88	1.92	2.46	2.47
3.48	2.89	1.97	2.36	2.46
4.00	3.46	1.84	2.97	2.87
4.59	3.60	2.11	3.09	2.94
5.28	3.72	2.45	3.26	3.30
6.06	3.87	2.53	3.44	3.77
6.96	4.10	2.71	3.71	3.88
8.00	4.25	2.91	3.83	4.21
9.19	4.41	3.19	4.13	4.42
10.56	4.34	3.38	4.36	4.58
12.13	4.27	3.67	4.52	4.86
13.93	4.57	4.09	4.55	5.09
16.00	4.24	4.53	4.66	5.30
18.38	4.31	5.11	4.93	5.30
21.11	4.15	5.63	4.32	5.55
24.25	4.05	6.20	4.43	4.49
27.86	3.81	6.55	4.23	4.14
32.00	3.47	6.43	3.75	3.34
36.76	3.12	5.50	2.91	2.70
42.22	2.46	4.73	2.26	2.13
48.50	1.77	3.49	1.66	1.48
55.72	1.15	2.30	1.45	1.11
64.00	0.50	1.40	1.22	0.83
73.52	0.21	0.94	0.79	0.54
84.45	..	0.52	0.63	0.36
97.01	..	..	..	0.12
111.43	..	..	..	..
128.00	..	..	..	..
147.03	..	..	..	..
168.90	..	..	..	..
194.01	..	..	..	..
222.86	..	..	..	..
256.00	..	..	..	..
294.07	..	..	..	..
337.79	..	..	..	..
388.02	..	..	..	..
445.72	..	..	..	..
512.00	..	..	..	..
588.13	..	..	..	..
675.59	..	..	..	..
776.05	..	..	..	..

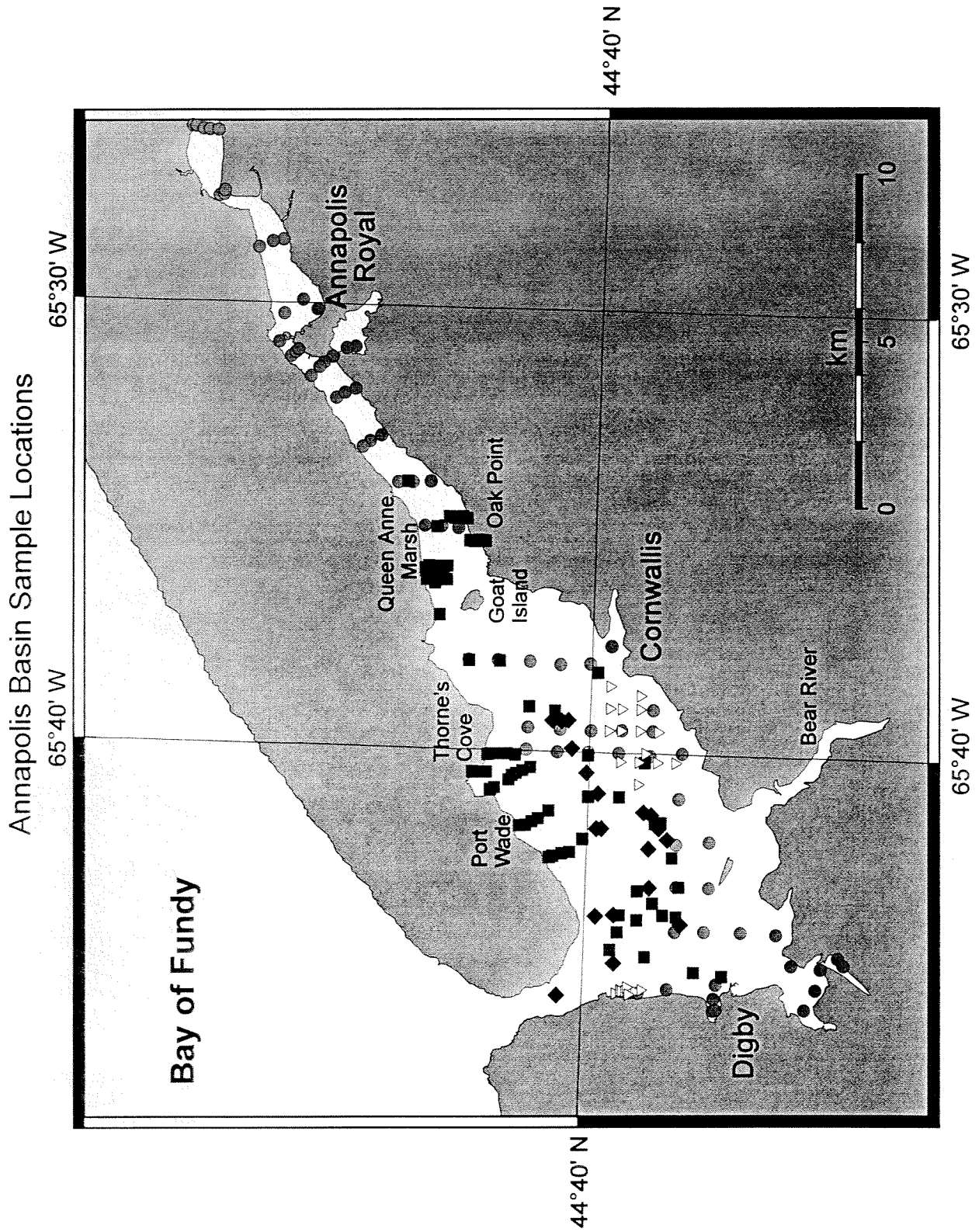


Figure 1. Map of sample locations for all years. Stations for 1988 are represented by dark gray diamonds, 1993 by medium gray squares, 1994 by white inverted triangles and 1996 by light gray circles.

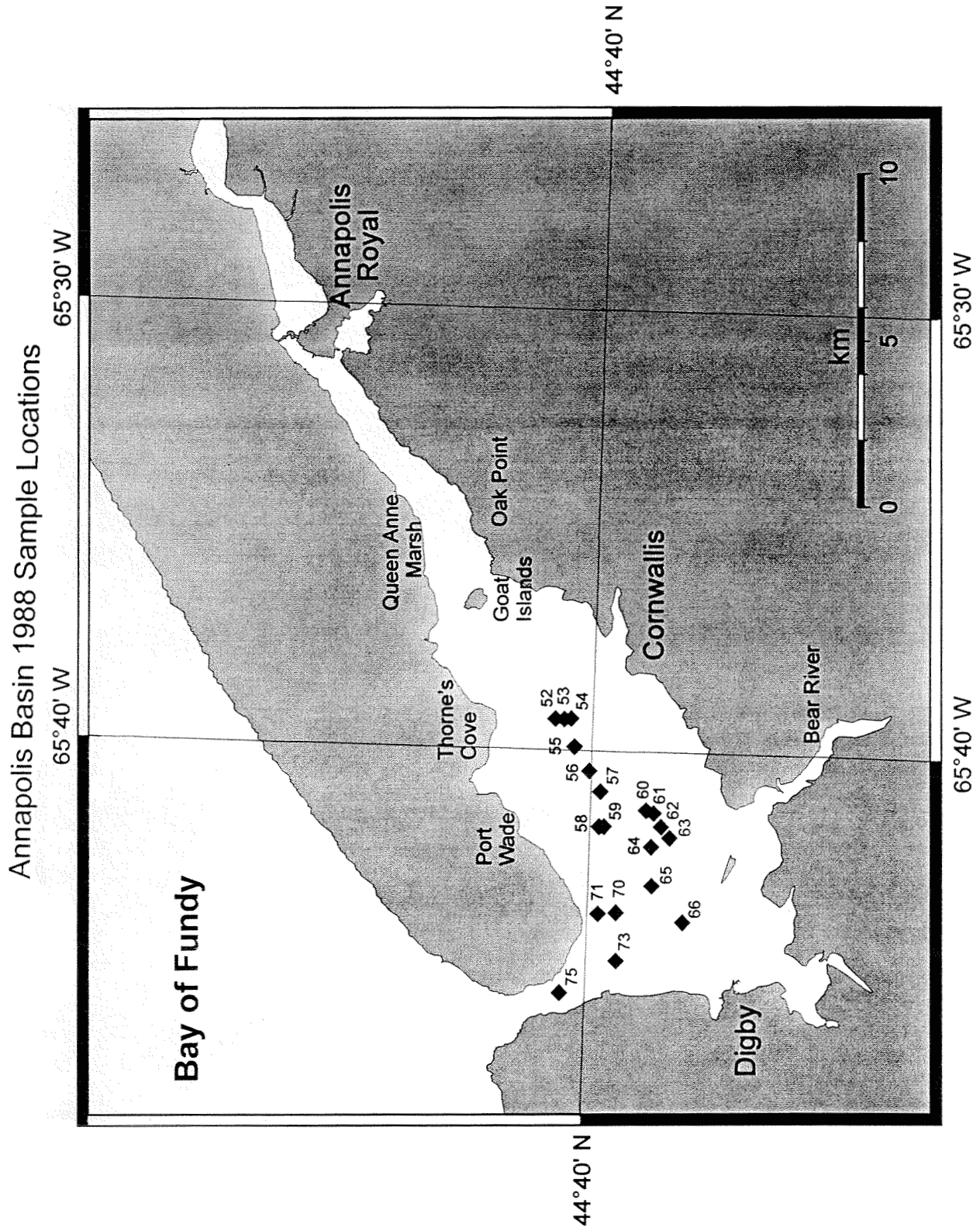


Figure 2. Map of sample locations for Annapolis Basin, July 1988.

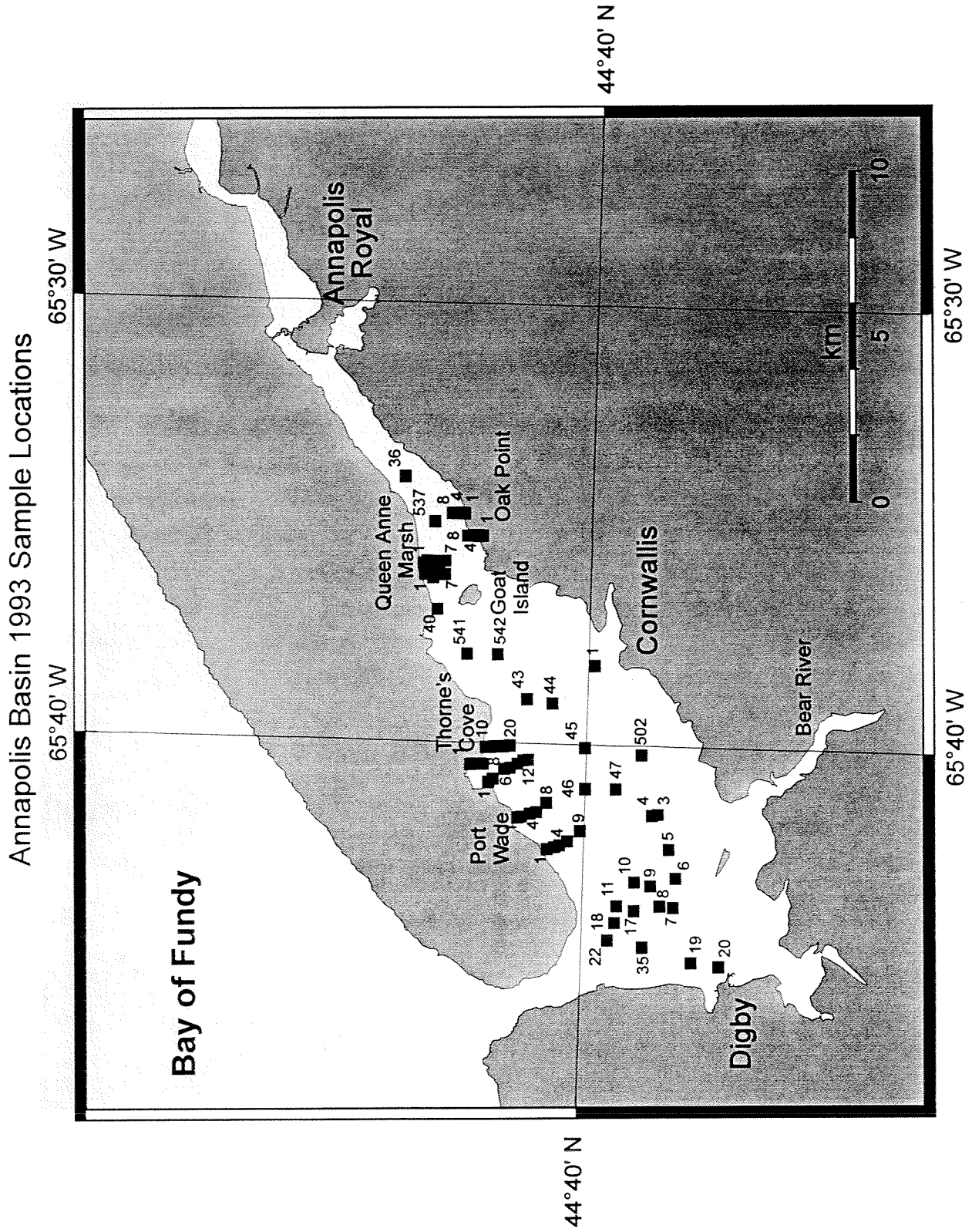


Figure 3. Map of sample locations for Annapolis Basin, June 1993.

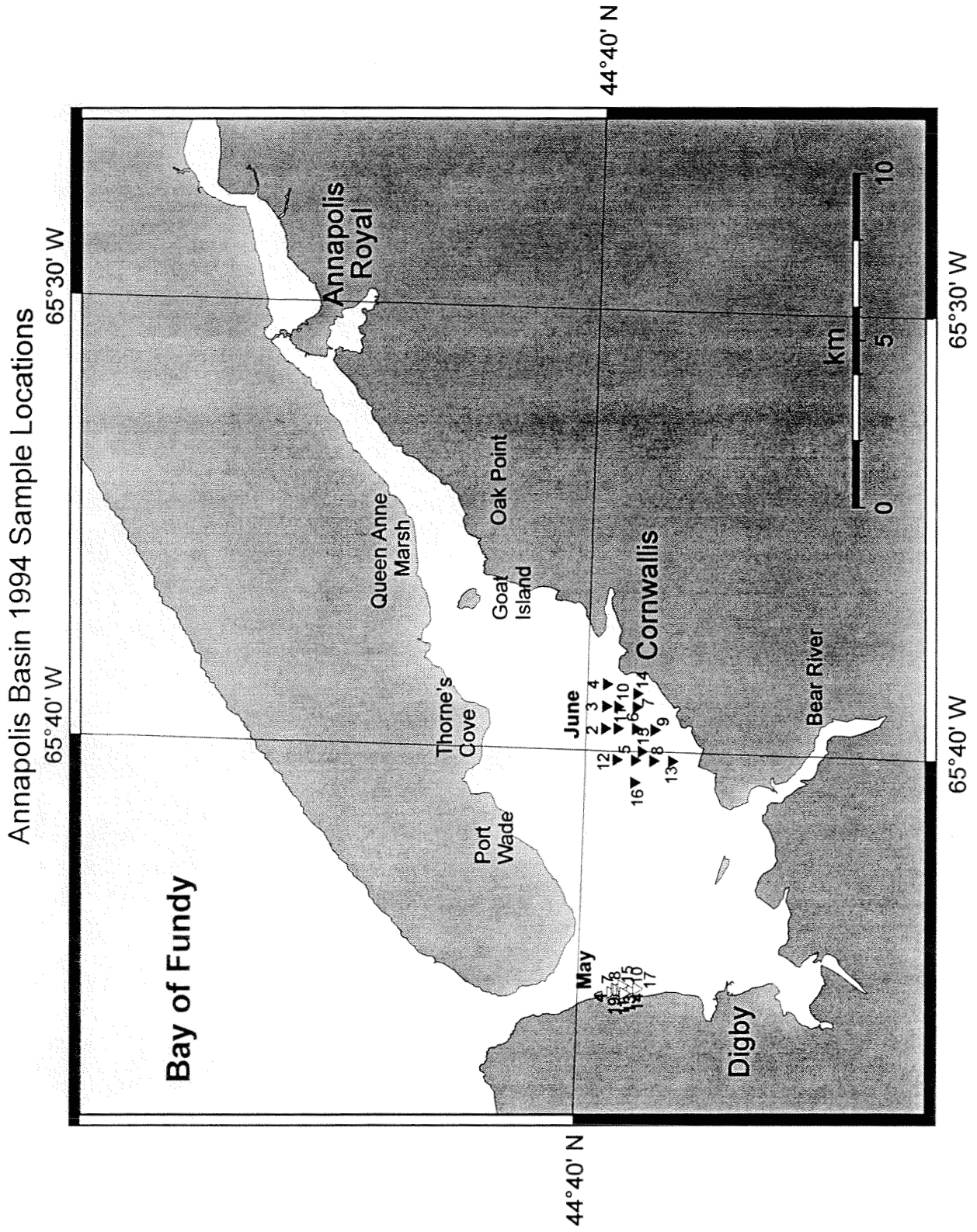


Figure 4. Map of sample locations for Annapolis Basin 1994.

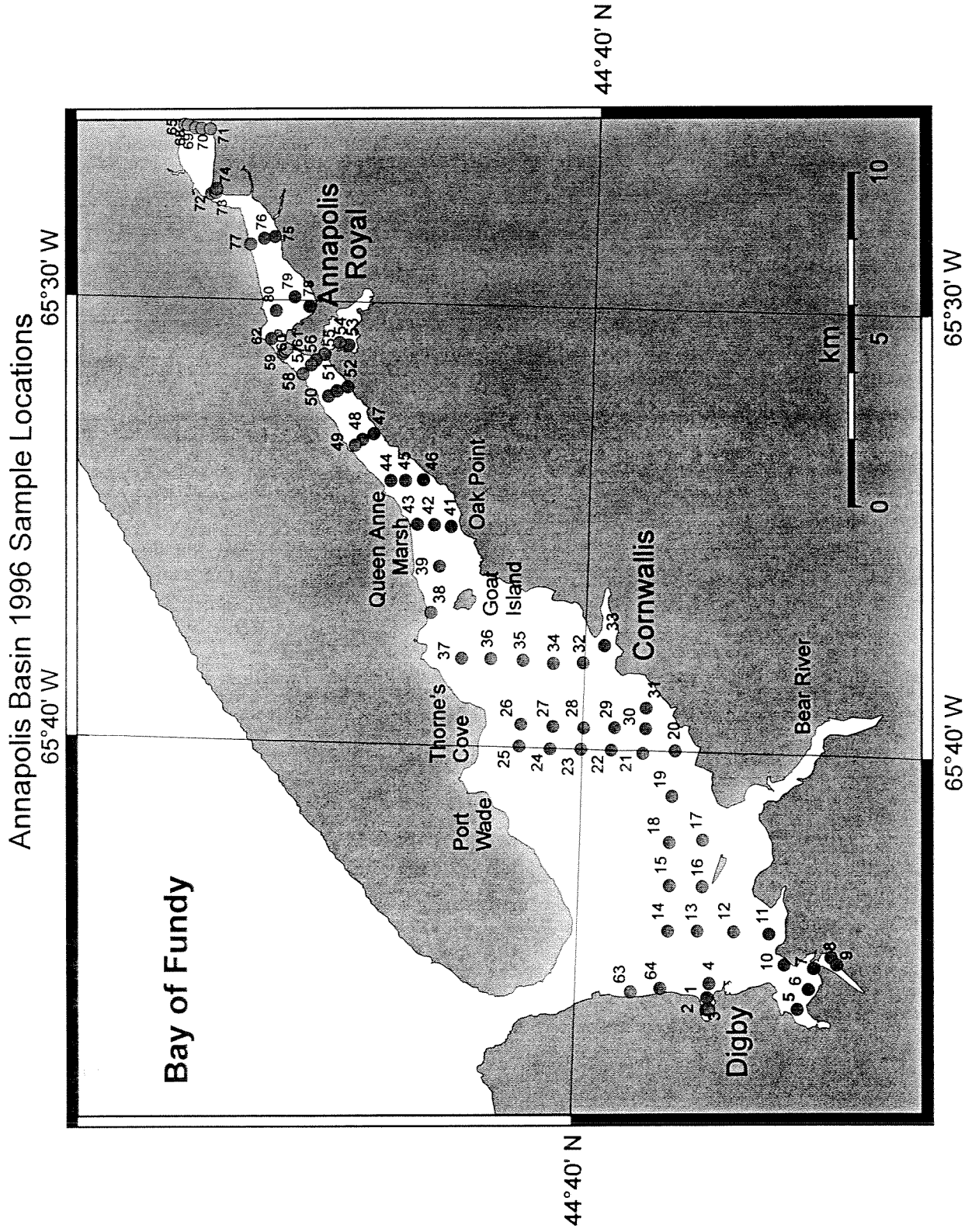


Figure 5. Map of sample locations for Annapolis Basin, November 1996.

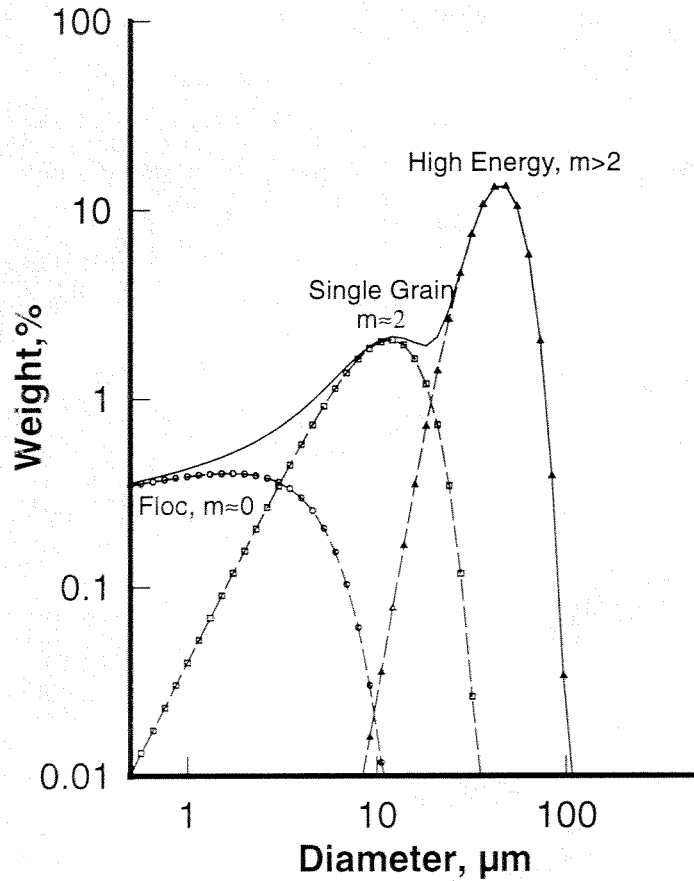


Figure 6: Graph illustrating three components that make up the size distribution of a bottom sediment. The components are: 1) material settled in a flocculated form, defined by the straight-line portion of the curve starting at 0.7 μm termed the floc tail (circles); 2) material deposited as single grains from suspension which forms the "one-round" modal peak with a slope, $m = 2$, (squares); 3) material which has undergone further suspension sorting, usually as a result of high-energy events, defined by the well sorted, "multi-round" peak in the coarsest size range (triangles).

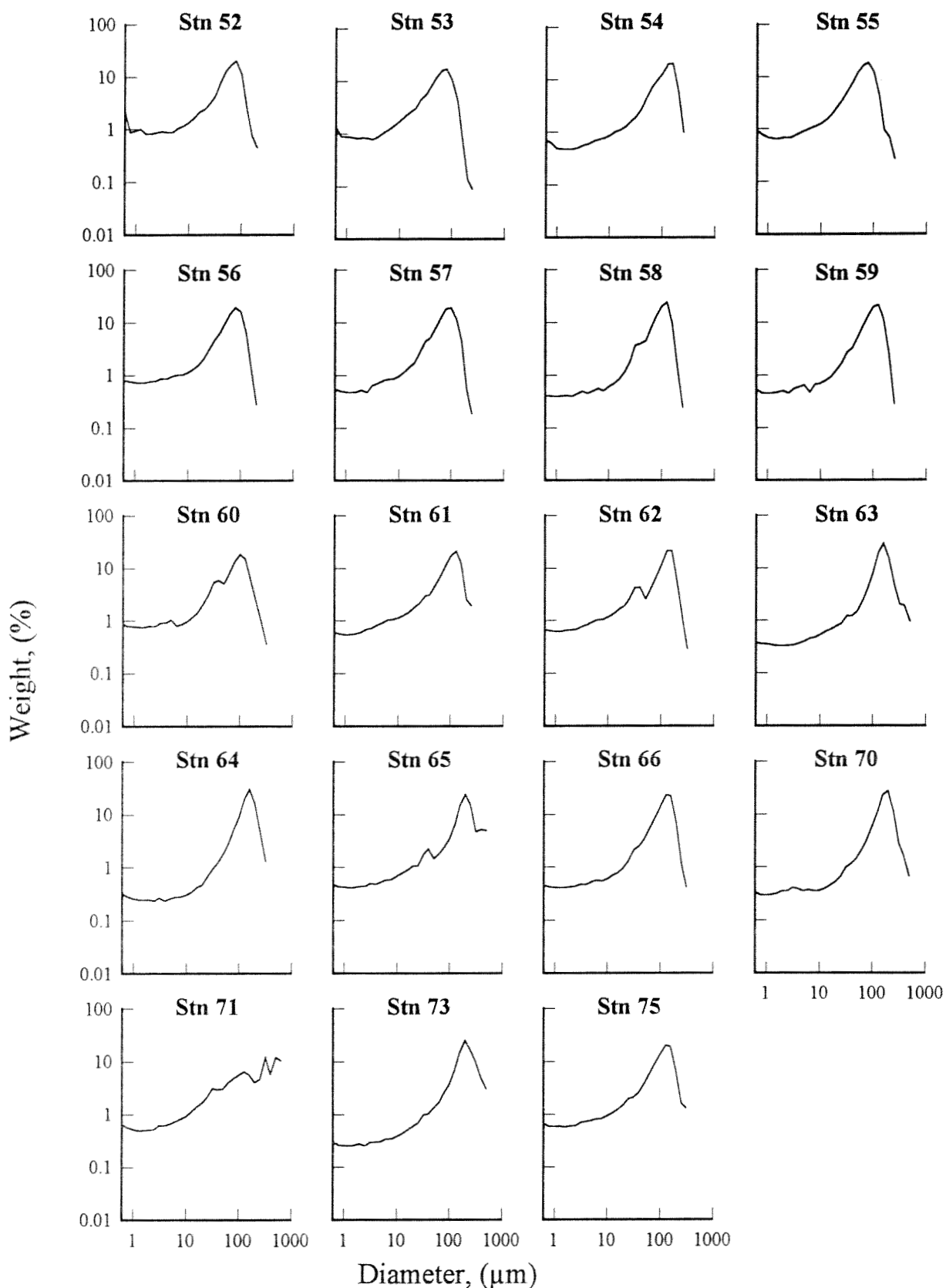


Figure 7. Disaggregated grain size spectra of bottom sediments sampled in 1988 from the Annapolis Basin.

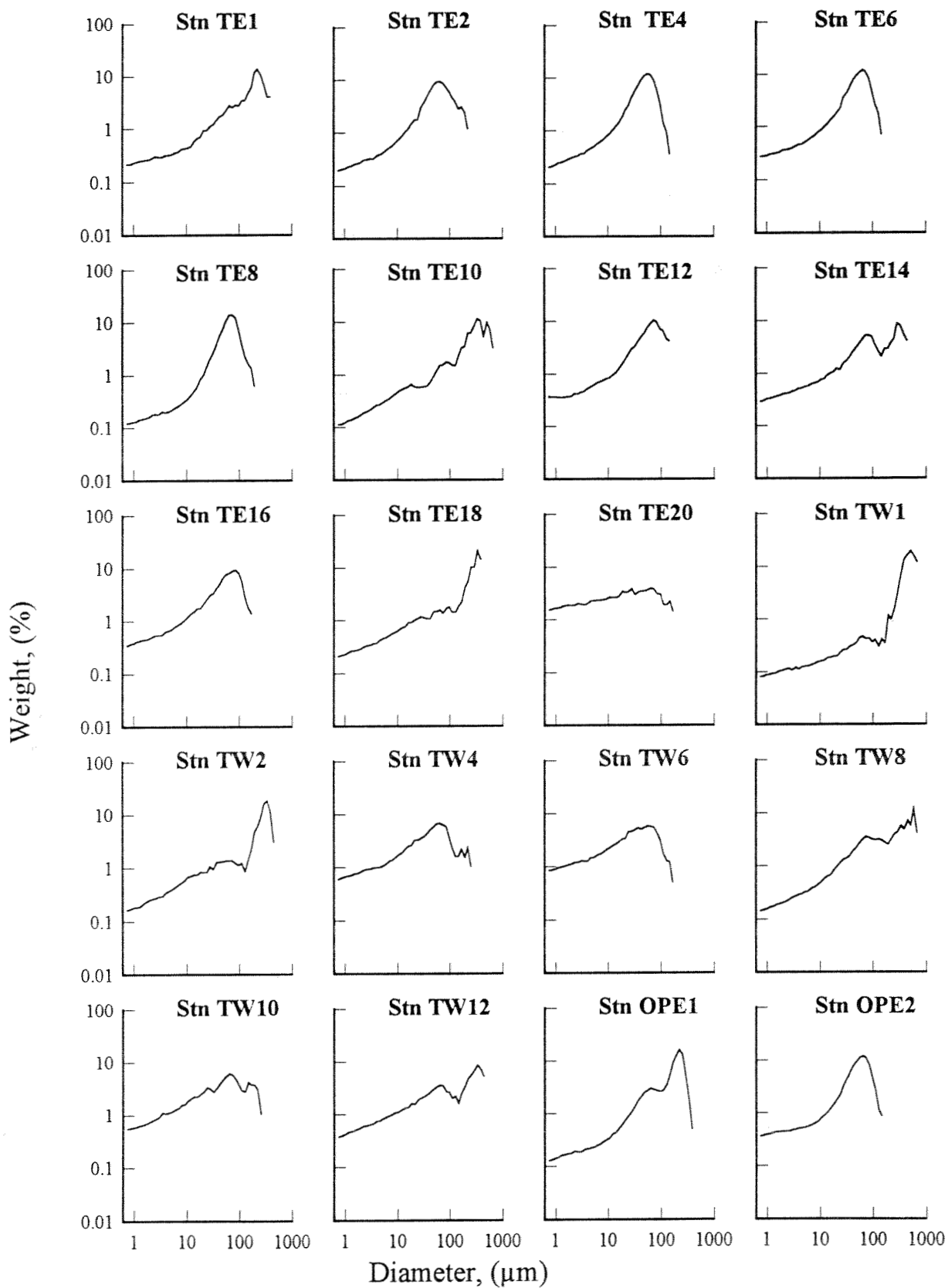


Figure 8a. Disaggregated grain size spectra of bottom sediments sampled in 1993 from the tidal flat stations in Annapolis Basin.

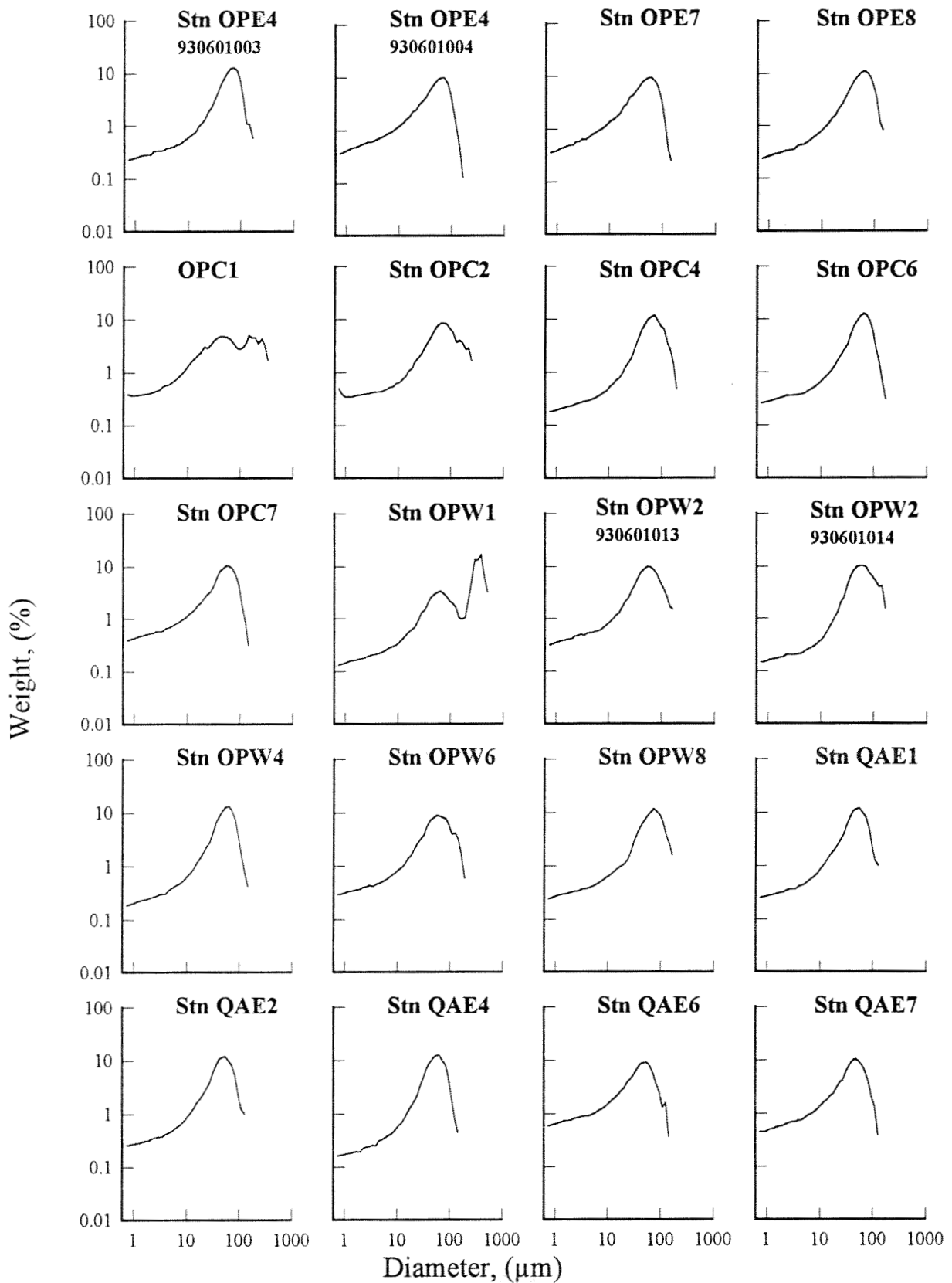


Figure 8b. Disaggregated grain size spectra of bottom sediment samples taken in 1993 from tidal flats in the Annapolis Basin.

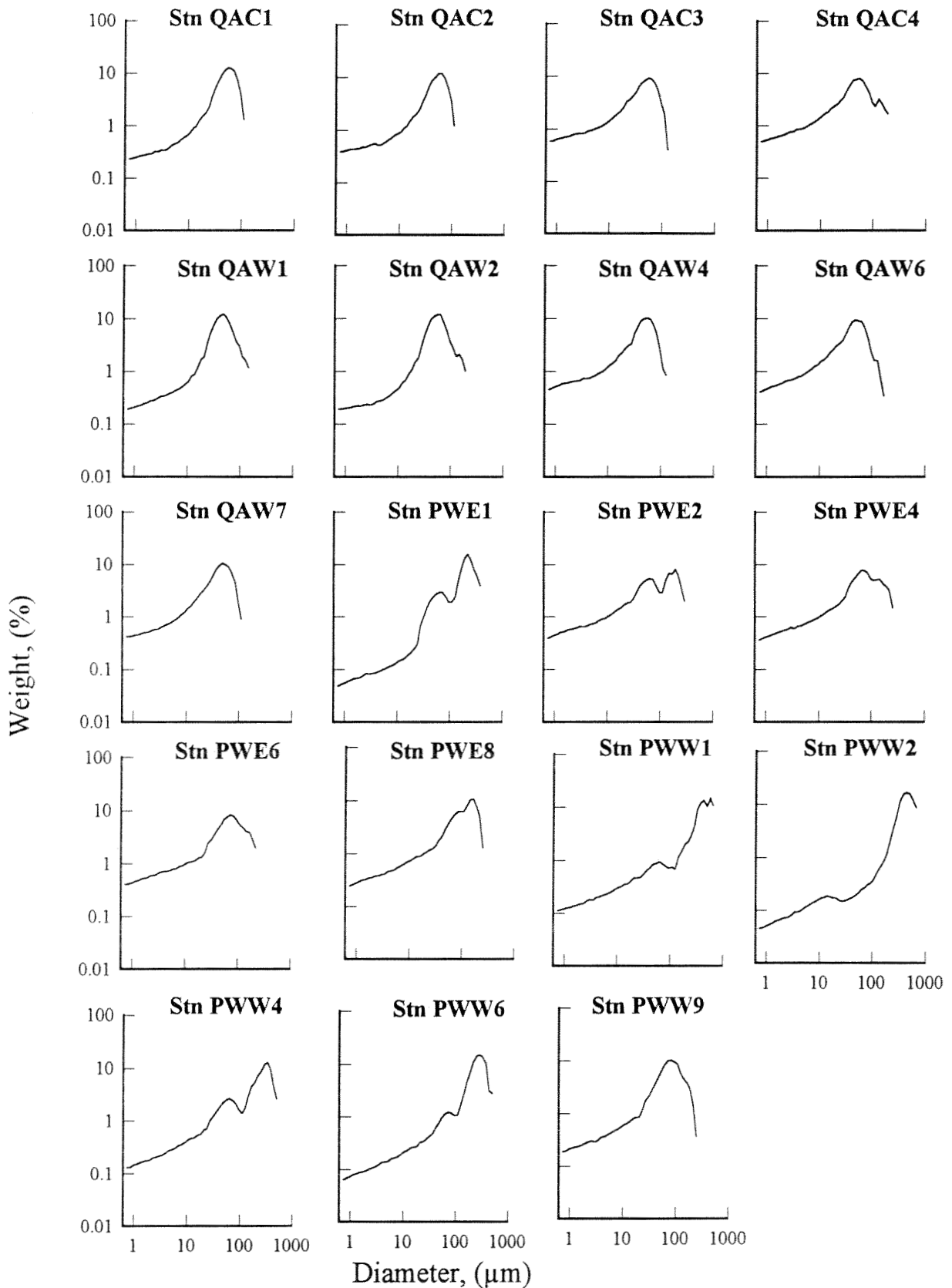


Figure 8c. Disaggregated grain size spectra of bottom sediment samples taken in 1993 from tidal flats in the Annapolis Basin.

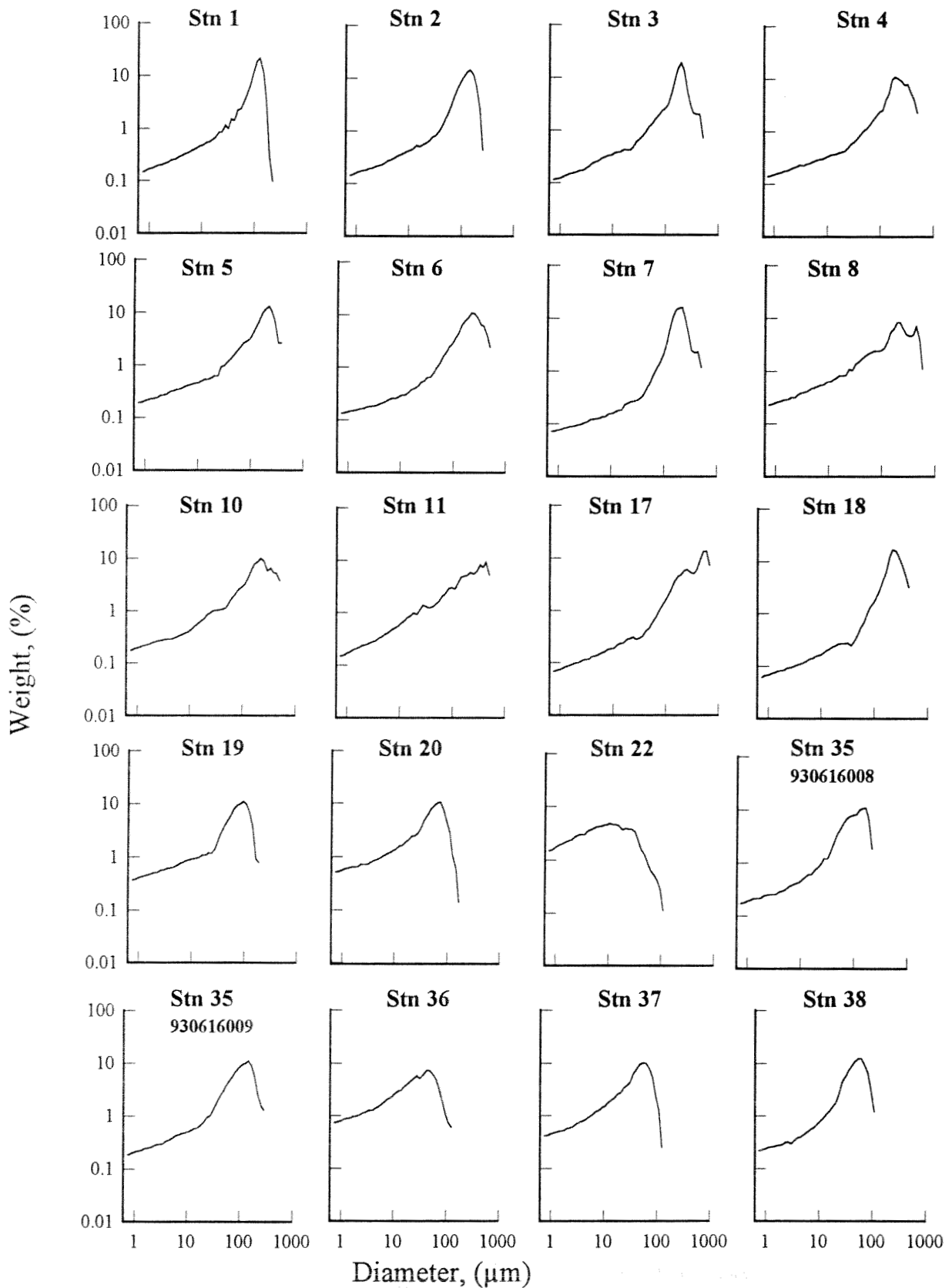


Figure 9a. Disaggregated grain size spectra of bottom sediment samples taken in 1993 from the sublittoral stations in the Annapolis Basin.

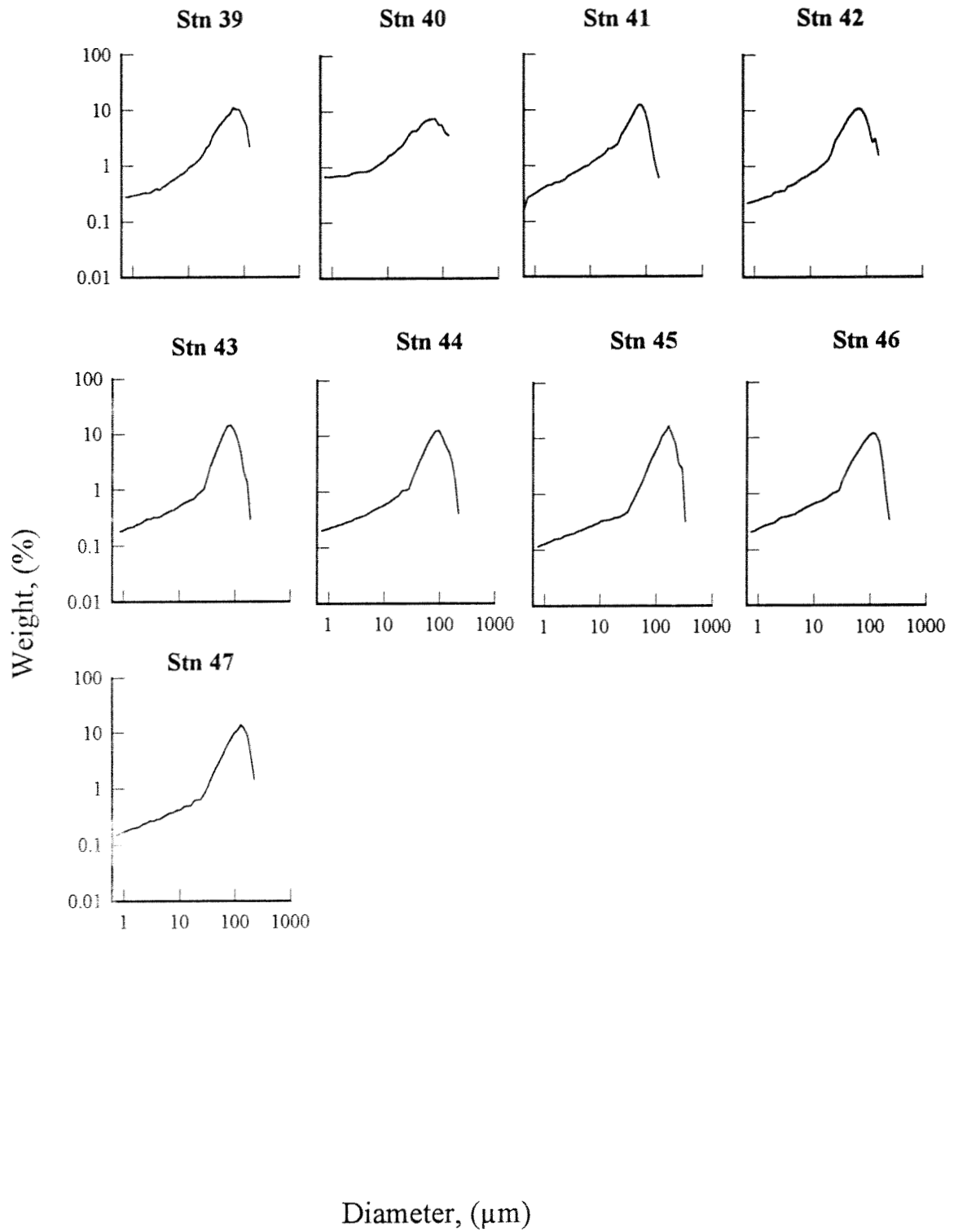


Figure 9b. Disaggregated grain size spectra of bottom sediment samples taken in 1993 from the sublittoral stations in the Annapolis Basin.

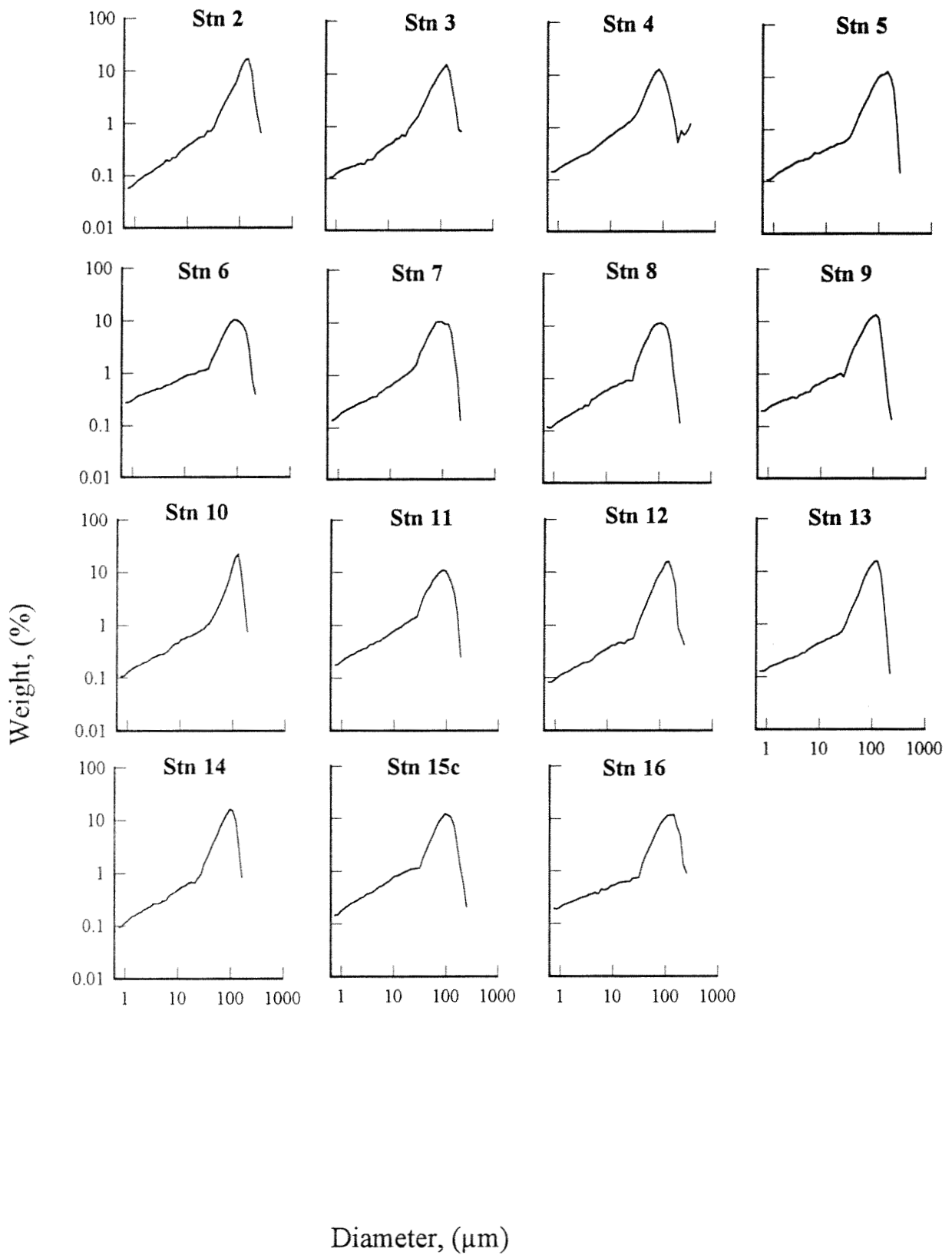


Figure 10. Disaggregated grain size spectra of bottom sediment samples taken in May 1994 from the sublittoral stations in the Annapolis Basin.

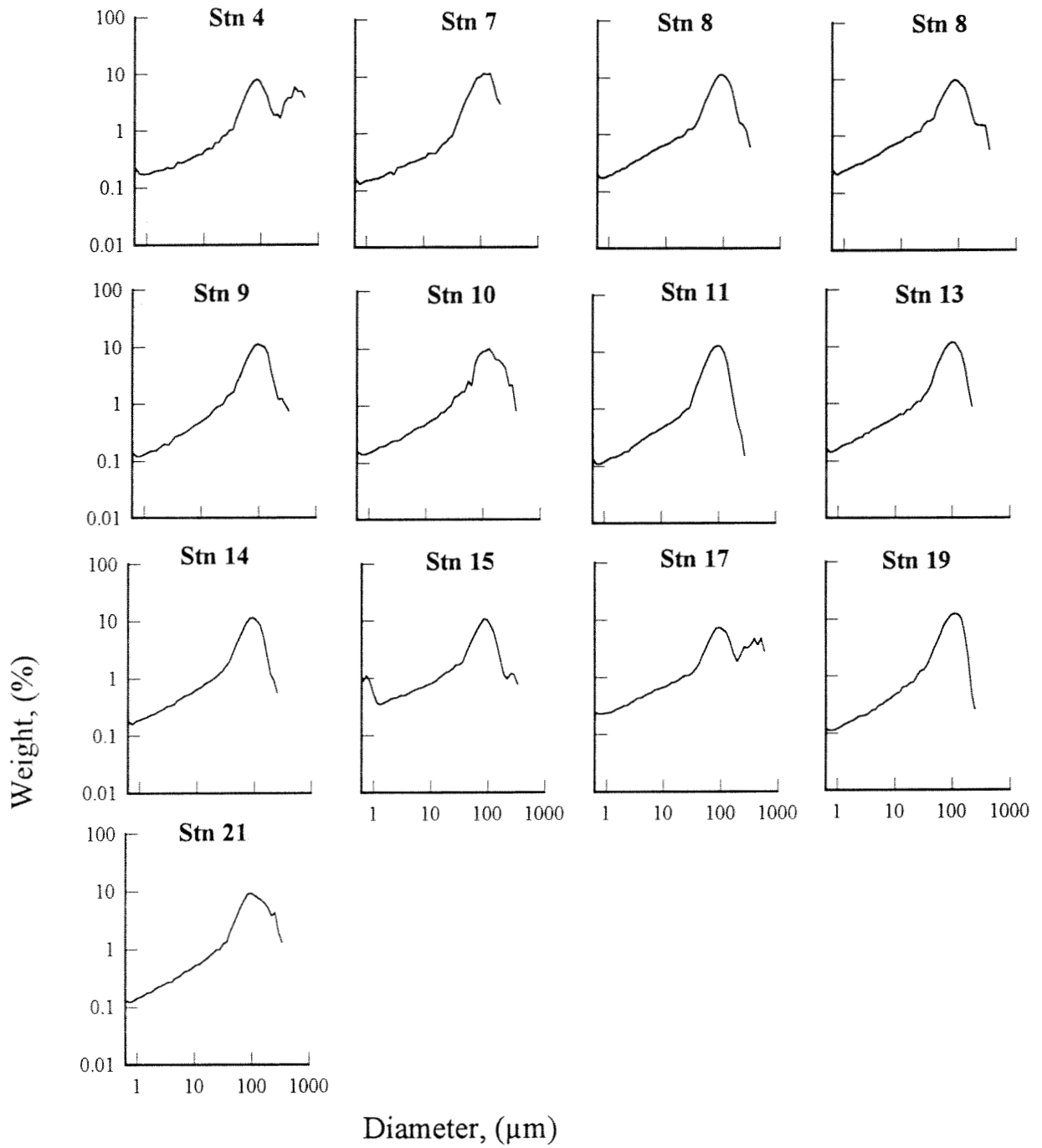


Figure 11. Disaggregated grain size spectra of bottom sediment samples taken in June 1994 from the sublittoral stations in the Annapolis Basin.

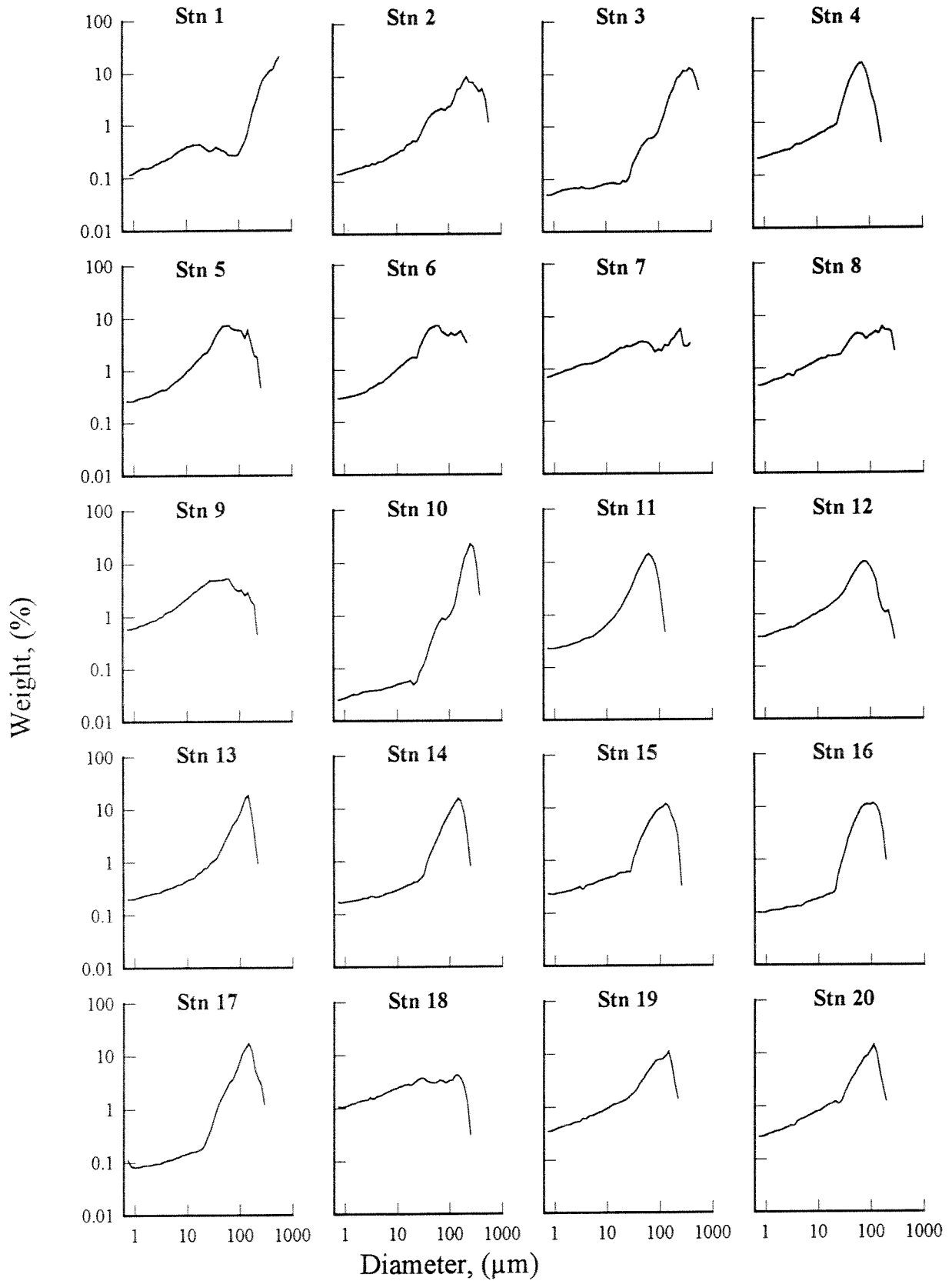


Figure 12a. Disaggregated grain size spectra of bottom sediment samples taken in 1996 from the sublittoral stations in the Annapolis Basin.

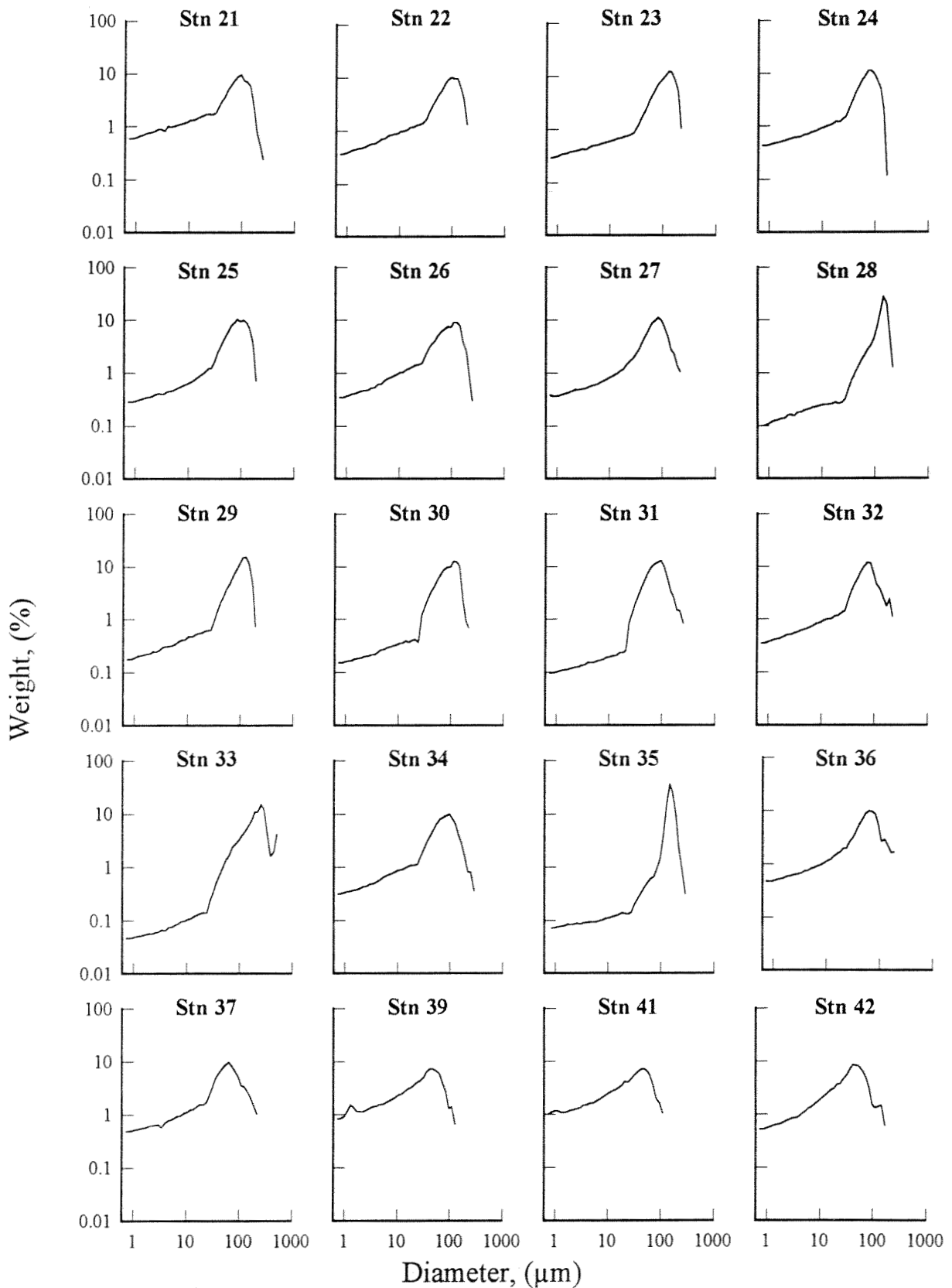


Figure 12b. Disaggregated grain size spectra of bottom sediment samples taken in 1996 from the sublittoral stations in the Annapolis Basin.

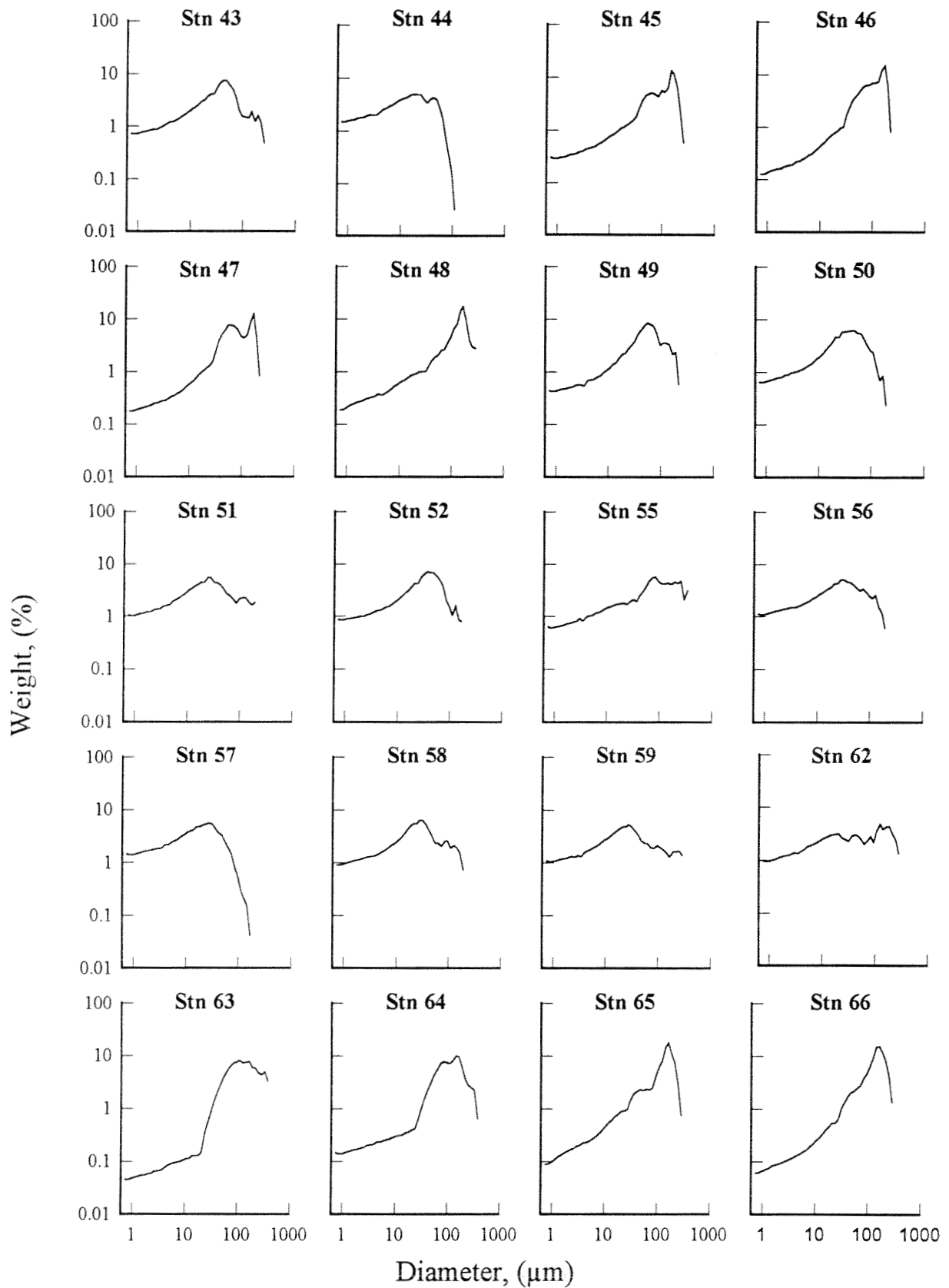


Figure 12c. Disaggregated grain size spectra of bottom sediment samples taken in 1996 from the sublittoral stations in the Annapolis Basin.

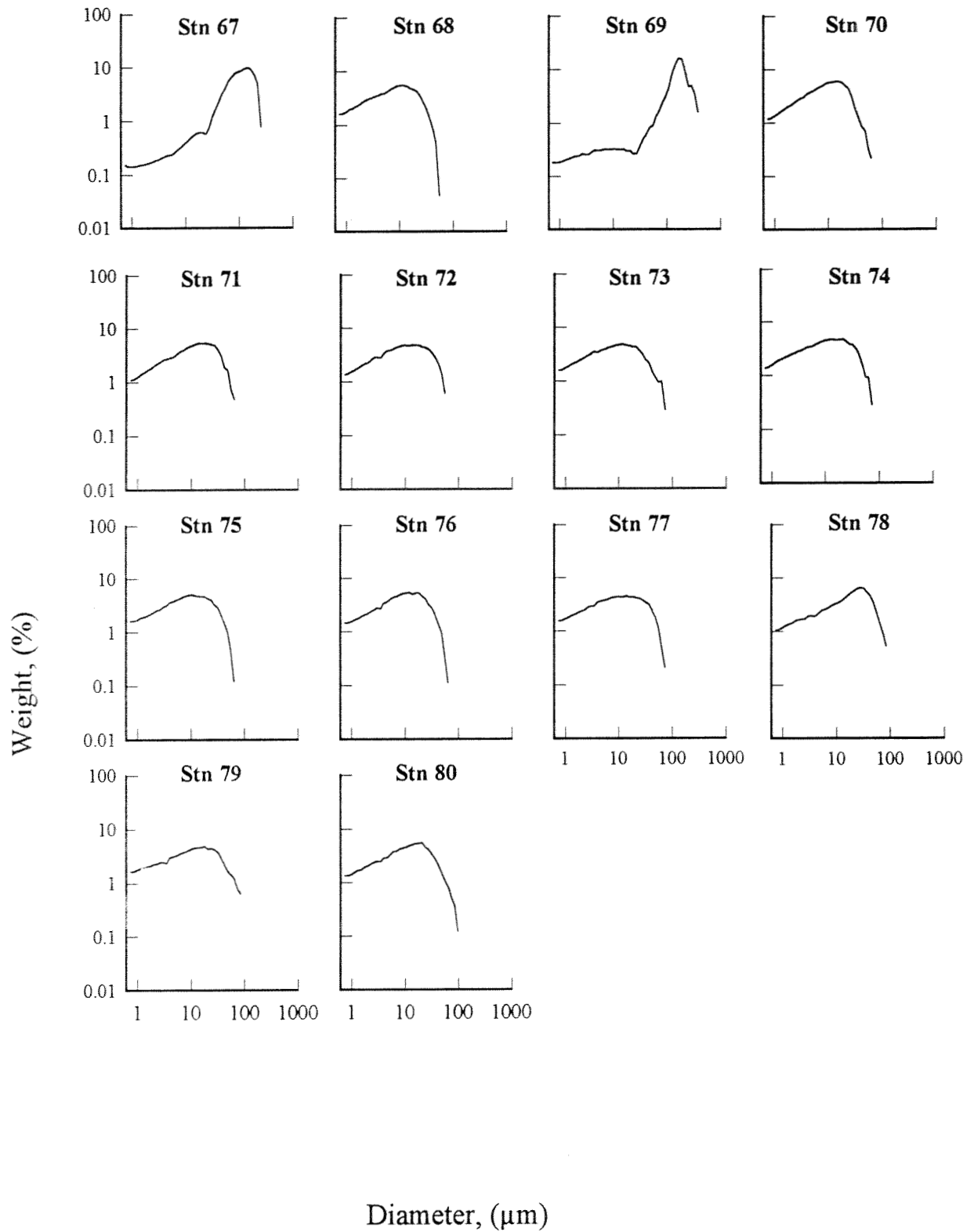


Figure 12d. Disaggregated grain size spectra of bottom sediment samples taken in 1996 from the sublittoral stations in the Annapolis Basin.