CRUISE REPORT

W-134B

A Report On The Academic & Scientific Activities Of The

Science at SEA Program

Shore Component
August 7 - August 19, 1994

Sea Component
August 21 - August 27, 1994

Sea Education Association
Woods Hole, Massachusetts

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To All *Science at SEA Westward*-ites,

This compilation of data and information is written by all twenty-two of you. You, who as a group, between August 21st and 27th of 1994, intensely researched, hypothesized, sailed, and navigated along the coast of southern New England, learning the ways of oceanography and of the *Westward*. Each and every one of you contributed to the overwhelming success of this week-long voyage, with your energy and enthusiasm as well as your brain and muscle power.

When all forty-five *Science* at *SEA* participants convened in the Madden Center on the opening day of the shore component, few of you knew the full extent of the sciences *of the* sea. The popularity of marine biology as an answer to Mary's question of "why did you come to SEA?", told us that the class was unsuspecting of the multidisciplinary nature of the studies which lay ahead.

Our plan was to expose you all to those many disciplines contained within the broad science of oceanography. This plan included investigating not only the living inhabitants of the oceans, but the physical processes and chemistry of the water itself, and the dynamic geology of the sea floor. By the end of those two weeks ashore on the SEA campus, all forty-five of you possessed a much more comprehensive understanding of the many scientific pieces which, when fitted together, form the whole of the marine environment.

Cliff and I, along with our five fearless and absolutely indispensable House Leaders/ Teaching Assistants, led the group on a step-by-step exploration through the fields of geological, chemical, physical, and then biological oceanography. In addition to our campus classes and lab activities, we visited Rindy Ostermann at the Core Lab of the Woods Hole Oceanographic Institution (WHOI). Susan Humphris, also from WHOI, came to talk to us about Hydrothermal Vent Systems. We took a trip to Little Sippewissett salt marsh in W. Falmouth at low tide on a beautiful day, and we spent one entire day on Coast Guard Beach, part of the Cape Cod National Seashore. By taking advantage of these local scientists and environments, we, as a group, turned our shore component into an exciting discovery of our coastlines and the seas beyond.

The next step was a big one - onto the decks of the *Westward* and then away from Dyers Dock. On August 21st we set out for a week of the sailor's life, to see if everything Mary had told us in her Maritime Studies classes was actually true (and to learn a few things about oceanography and sailing while we were there).

Much of our focus in preparing for our research cruise was on the oceanographic processes which occur on the continental shelf off of the NE coast. Specifically, we talked quite a bit about Georges Bank, that highly productive and historically important shelf extension southeast of Cape Cod. Although we were never able to sail to Georges Bank (due to a persistent wind and the resulting stomach-churning seas), the bank remained invaluable to us - as a model of a shallow, well mixed, and highly productive marine environment. Our ultimate cruise track destinations shared those same characteristics, but with a twist.

The twist that we added to our studies was the coast of southern New England. Rather than setting a course for an offshore area, we decided, as a famous Captain named John Wigglesworth once said, to "fake left and go right!" We and the *Westward* sailed west to Block Island and Long Island Sounds and proceeded to quickly and successfully adapt to our new scientific and navigational tasks.

Our oceanographic station work occurred in Block Island Sound, where Elke and B Watch ran the show, out in the center of Long Island Sound, with John and C Watch in charge, and at the mouth of the Thames River, where Margaret and A Watch were at the helm (so to speak).

The theme of our work had become the estuary, one of the most immediately relevant and important marine environments to the human race. An estuary is often the place where the ocean and all of us land-dwelling humans meet - or collide. The Long Island Sound estuary is directly affected by the coasts of Connecticut and New York, where both the population density and industrial output are extremely high. Block Island Sound is similarly affected by the coast of Rhode Island. There are two major cities at the mouth of the Thames River estuary, both of which are hubs of maritime and industrial activity.

An estuary is a semi-enclosed basin where fresh, less dense water meets denser, salty, ocean water. The resulting physical and biological processes create an intensely productive region, from which all levels of the food chain can benefit and prosper.

Sea water is carried into and out of coastal estuarine areas by the flow and ebb of the daily tides. Fresh water sources can be rivers flowing out of inland watershed regions, rain run-off from land, ground water seepage, or simply rain falling directly into the relatively shallow and, therefore, easily diluted basin. Nutrients are found in abundance in these bodies of water, introduced from both natural and human-made sources on land. Enough of these are present to support an enormous crop of phytoplankton which, in turn, is food for zooplankton and other invertebrates, which is food for nekton etc...

Block Island Sound is an estuary without any major point sources of fresh water; however, seawater enters to the north and west of Block Island twice daily on a flood tide. In contrast, several large rivers including the Connecticut, the Quinnipiac, and the Thames, bring enormous volumes of fresh water into Long Island Sound. Most of this basin's incoming seawater enters through the Race, at the eastern end of Long Island Sound, only after first flowing through Block Island Sound. The Thames River, bordered at its mouth by the cities of New London, CT to the west and Groton, CT to the east, in itself is a smaller scale and more simplified estuary. Fresh water flows seaward from one source, the Thames River watershed area, and seawater flows landward, coming in with the tides from Long Island Sound.

The cruise track of our voyage enabled us to investigate estuaries in a general sense. We were able to explore the physical, chemical, and biological processes which both affect and are affected by neighboring land-based activities. However, by sailing through three distinct regions, we were also able to make some important comparisons and distinctions among differing estuarine systems.

What better place to begin to experience the ocean than the transition zone between land and sea? After our intensive experience in this zone, my hope is that you all have come to recognize our coastlines from "the other side" and to better appreciate the complexity of our coastal environments.

And on top of all the super science that we did during these six days, we had an all-out, great sailing adventure!!

Many thanks to all of you for your hard work and enthusiasm.

All the Best,

Anne

Table 1. Science At SEA Staff

Shore Staff

Mary Malloy	Maritime Studies
Anne Woomer	Chief Scientist / Oceanography
Cliff Low	Chief Scientist / Oceanography
Wendy Keith-Hardy	Nautical Science / E House Leader
Ken Neal	Nautical Science / B House Leader
Margaret Brumsted	Teaching Assistant / D House Leader
John Cooke	Teaching Assistant / A House Leader
Carolyn Sheild	Teaching Assistant / C House Leader

Westward Staff

A watch:	Ken Neal	Chief Mate
	Margaret Brumsted	Third Assistant Scientist
B watch:	Tim Kenna	Second Mate
	Elke Bergholz	Second Assistant Scientist
C watch:	Marco Liebig	Third Mate
	John Cooke	First Assistant Scientist
Dave Reynolds		Engineer
Eric Jenkins		Steward
Claire Prochaska		Assistant Steward
John Wigglesworth		Captain
Anne Woomer		Chief Scientist

Table 2. Science At SEA Participants

Students

A-Watch:

Joel Abraham	Merrillville, IN
Marisa Porges	Penn Valley, PA
Laura Leicht	Denver, CO
Jay Gardner	Portland, OR
Sarah Morison	Pittsburgh, PA
Matt Ahlers	South Setauket, NY
Colleen Yachimski	North Easton, MA

B-Watch:

Jason Sylvan	Wantagh, NY
Dave Morgan	Rydal, PA
Roy Pollock	Kennett Square, PA
Jennifer Haggerty	Dunstable, MA
Leigh Greenwood	Pound Ridge, NY
Caroline Philbert	Manchester, NH
Chelsea Ruben	Mill Valley, CA

C -Watch:

Kathryn Giles	Succasunna, NJ
Greg Klie	Fairport, NY
Jackie Hui	Palisades, NY
Mike Netto	East Falmouth, MA
Brian Larson	Minnetonka, MN
Nick Nash	Weston, CT
Elizabeth Lieb	Livingston, NJ
Alison Sargent	McLean, VA

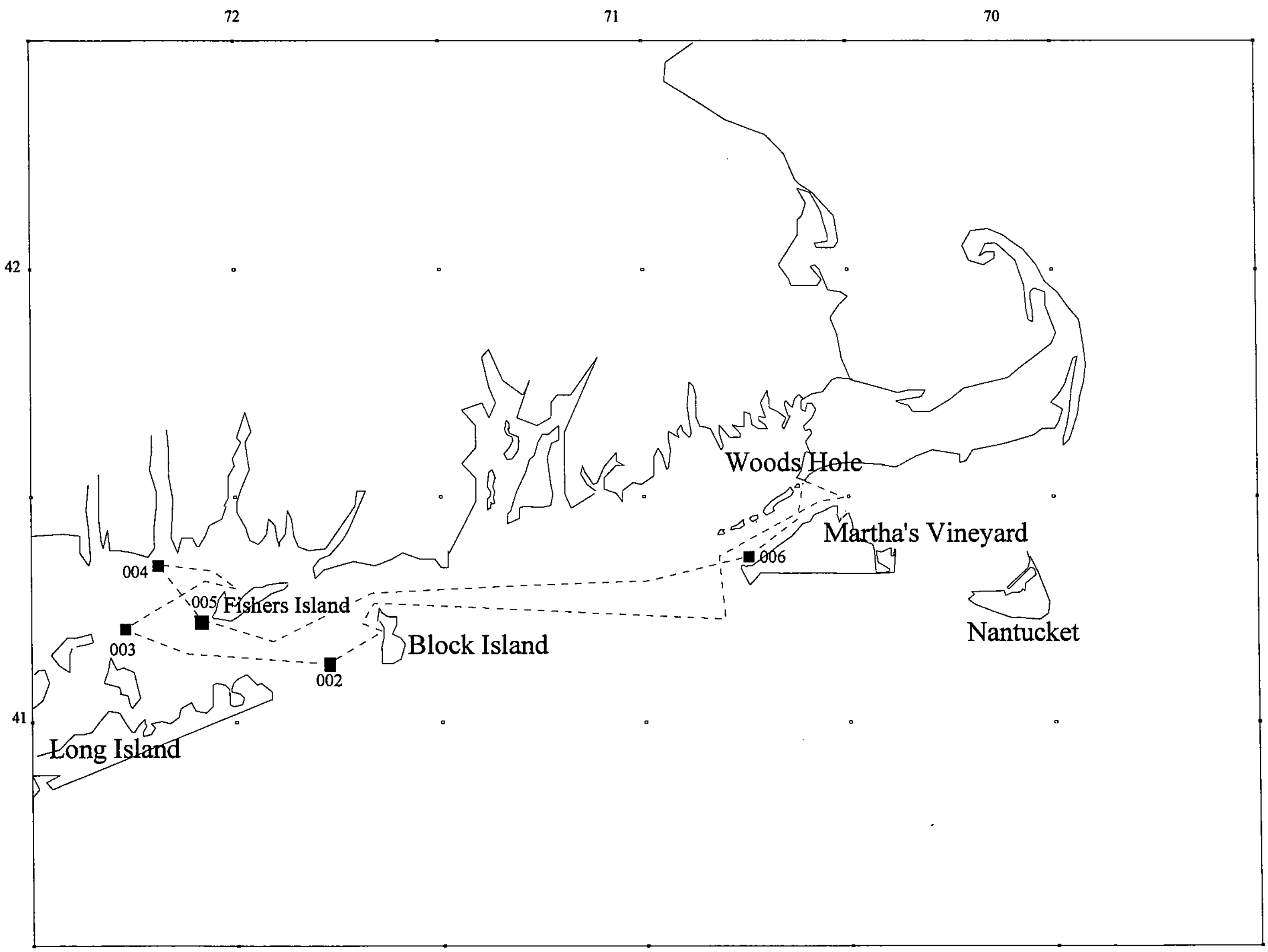


FIGURE 1. W134B Cruise Track; Major Stations Plotted

Table 3. Oceanographic Stations

Station #	Date	Time	Log (nm)	Lat (°N)/Long (°W)	Location	Equipment Deployed
W134B-001	22-Aug	1600	14.9	41°22' / 70°55'	Vineyard Sound	Shipek Grab
W134B-002	23-Aug	1100	46	41°13' / 71°42'	Block Island Sound	Secchi Disk Shipek Grab CTD/Hydrocast Meter Net
W134B-003	23-Aug	1730	65	41°15' / 72°05'	Long Island Sound	CTD/Hydrocast Shipek Grab Phytoplankton Net
W134B-004	24-Aug	0930	69.8	41°17' / 72°06'	Thames River	Secchi Disk Shipek Grab CTD/Hydrocast Meter Net Phytoplankton Net
W134B-005	24-Aug	1200	~	41°15' / 72°04'	E. Long Island Sound	Secchi Disk CTD
W134B-006	25-Aug	1145	110.1	41°22' / 70°47'	Menemsha Bight	Otter Trawl

BLOCK ISLAND SOUND

After spending a quiet and comfortable night at anchor in a calm Block Island harbor, we set sail on the morning of August 23rd for a spot just a few miles west, for our first Super Station of the trip. B Watch, with some help from Elke and Tim, spent the morning gathering as much data as possible from the waters of Block Island Sound. The Secchi disk, Shipek grab, CTD, Niskin bottles, and meter net were deployed (and retrieved!), samples were processed, and then we set our sails and were on our way again!

The following Figures and Tables are the results of station W134B-002 in Block Island Sound:

Table 4. W-134B-002 Hydrocast Data, Block Island Sound

Bottle#	Depth (m)	dO2 (ml/L)	Chl a (ug/L)
6	0	5.02	2.64
5	5	5.74	3.68
4	10	6.08	2.05
3	15	5.93	2.37
2	20	6.02	2.05
1	25	5.98	1.07

Table 5. W134B-002 Meter Net Data, Block Island Sound

Date: 8/23
Log: 47 nm
Time: 1200
Position: 41°12'N / 71°43'W
Tow Depth: 15 m
Zooplankton Density: 0.90 ml/m3
Tow Description: 99% copepods, 1% crab zoea larvae

Table 6. W134B-002 Shipek Grab Data, Block Island Sound

Date: 8/23
Position: 41°13'N / 71°42'W
Time: 1050
Water Depth: 33 m
Log: 46.0 nm
Sediment: 73% of sample=125 um size fraction or smaller, 27%=500-3000 um range
Biota: amphipods, polychaete worms

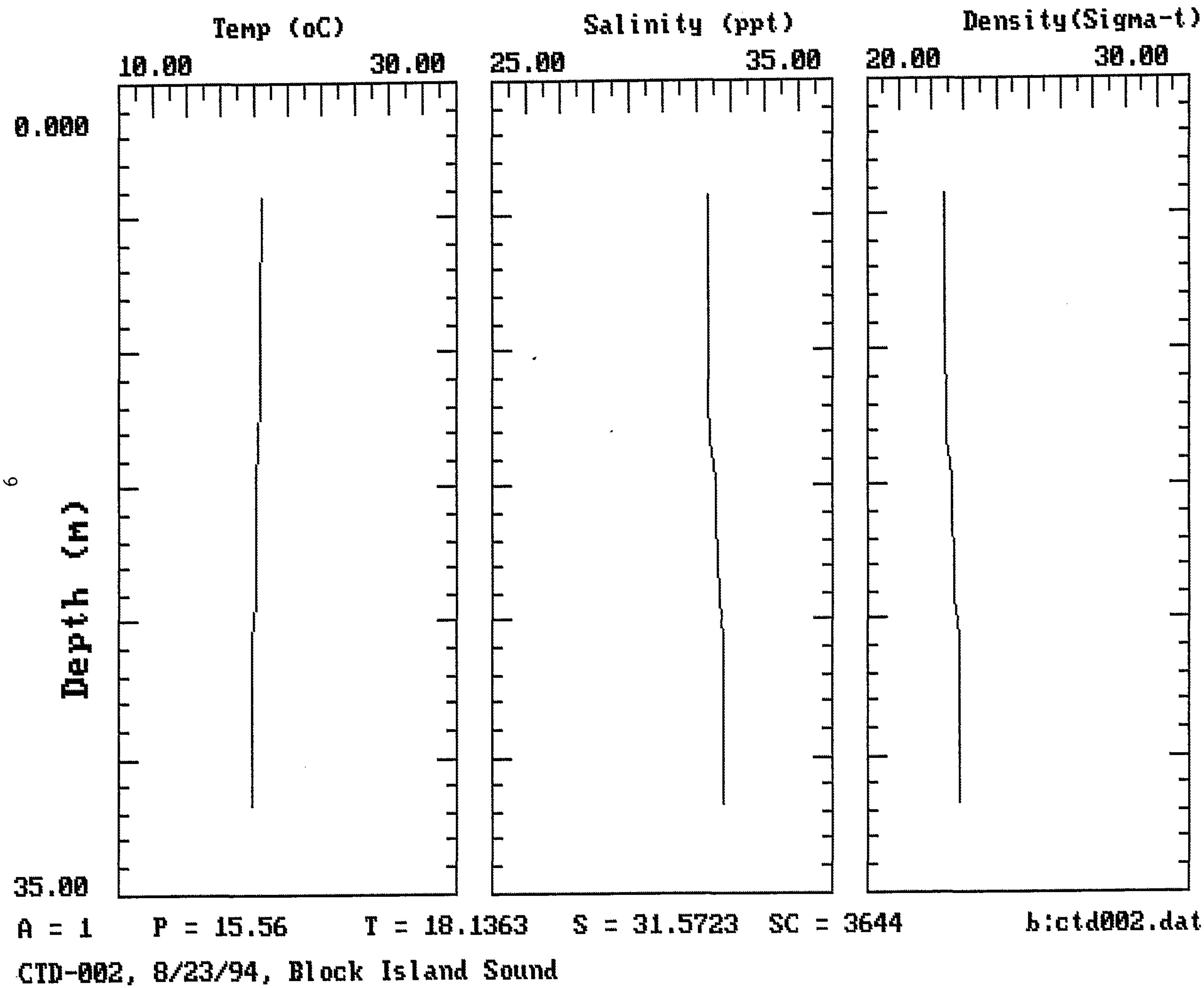

Temp (oC)
10.00
30.00
Salinity (ppt)
25.00
35.00
Density(Sigma-t)
20.00
30.00
0.000
Depth (m)
35.00
A = 1 P = 15.56 T = 18.1363 S = 31.5723 SC = 3644 b:ctd002.dat
CTD-002, 8/23/94, Block Island Sound

Figure 2.

Figure 3.

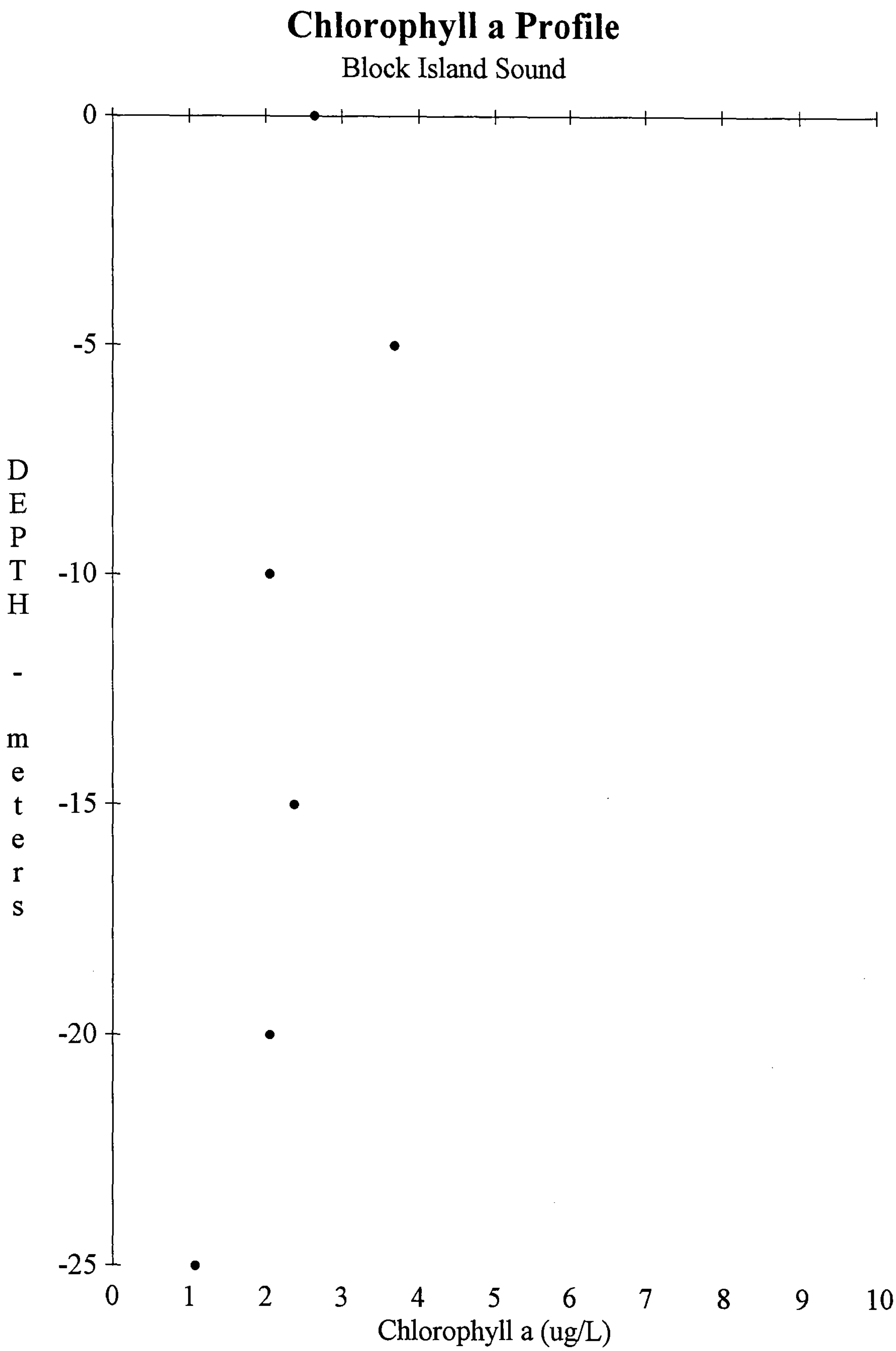
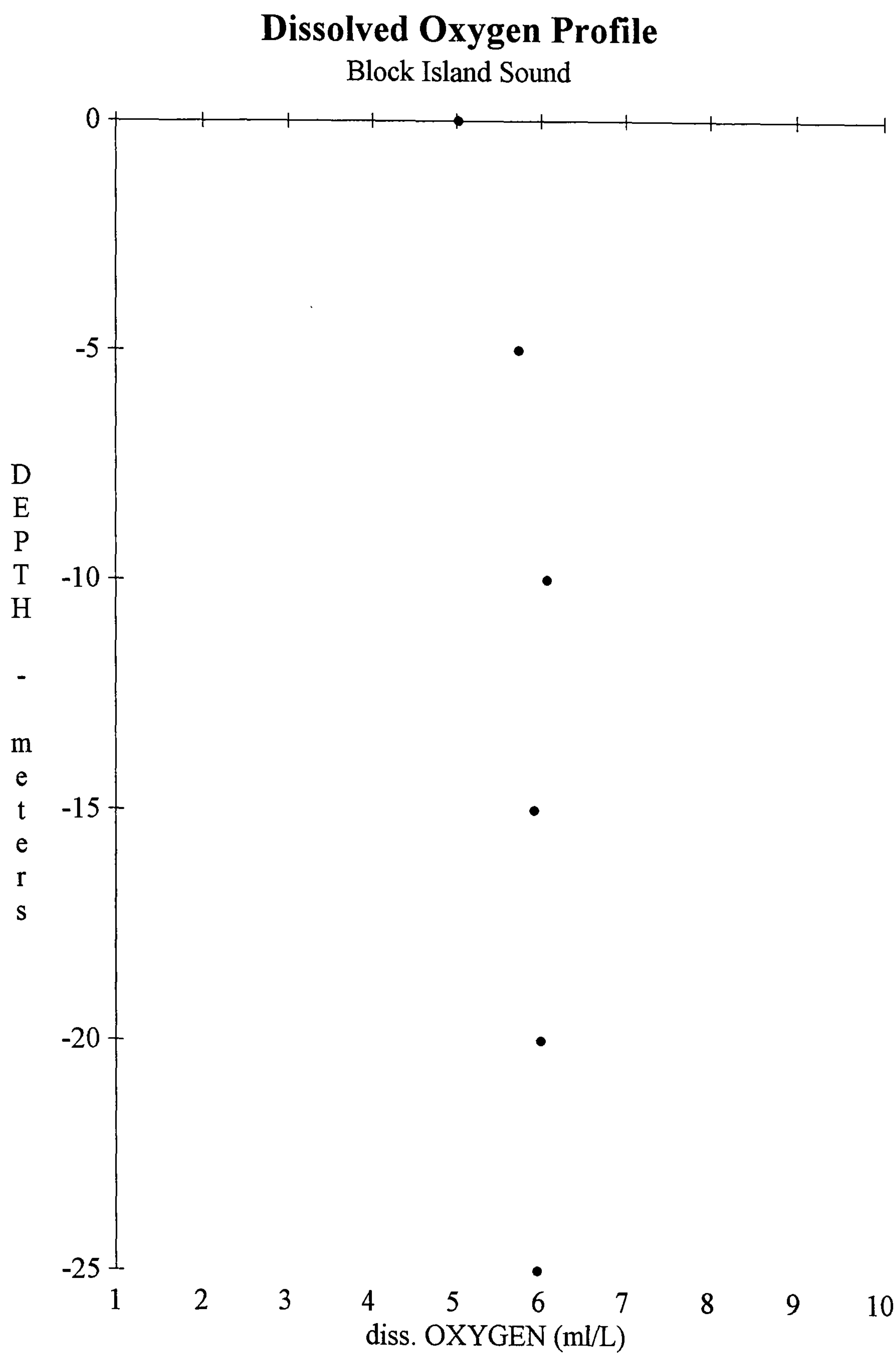

Chlorophyll a Profile
Block Island Sound
0
-5
-10
-15
-20
-25
DEPTH - meters
0
1
2
3
4
5
6
7
8
9
10
Chlorophyll a (ug/L)

Figure 4.


Dissolved Oxygen Profile
Block Island Sound
0
-5
-10
-15
-20
-25
DEPTH - meters
1
2
3
4
5
6
7
8
9
10
diss. OXYGEN (ml/L)

LONG ISLAND SOUND

When we and the *Westward* set sail from Block Island Sound, we sailed east, toward our next estuary Super Station, in Long Island Sound. We motored against the Race's incredible currents and into the eastern end of the Sound in the late afternoon, leaving just enough time for C Watch, John and Marco to complete station W134B-003. Into 70 meters of water, we deployed the CTD, Niskin bottles, and Shipek grab, and before the sun began to set we were on our way to our Fishers Island anchorage for the night.

Our results from Long Island Sound:

Table 7. W134B-003 Hydrocast Data, Long Island Sound

Bottle#	Depth (m)	dO2 (ml/L)	Chl a (ug/L)
6	0	5.66	2.02
5	20	5.54	2.37
4	30	5.5	2.97
3	40	5.66	2.34
2	50	5.62	1.82
1	60	5.44	1.82

Table 8. W134B-003 Shipek Grab Data, Long Island Sound

Date: 8/23 | Position: 41°15'N / 72°05'W

Time: 1850 | Water Depth: 70 m

Log: 65.5 nm

Sediment: Fine grained, gravel, loose rocks

Biota: sea anemones, sea spider, gastropod molluscs, bivalve molluscs, encrusting sponge, amphipods

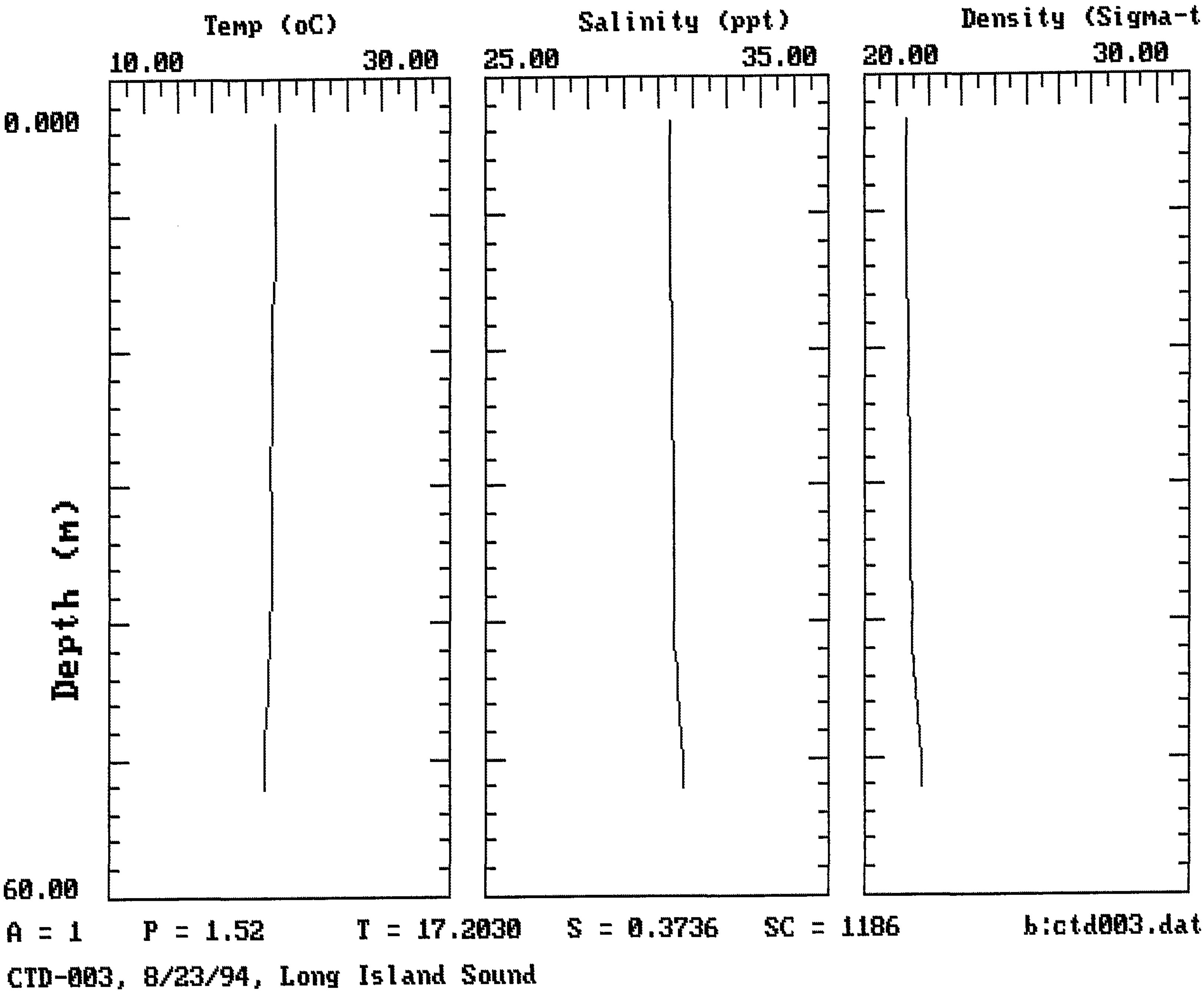

Temp (oC)
10.00
30.00
Salinity (ppt)
25.00
35.00
Density (Sigma-t
20.00
30.00
0.000
Depth (m)
60.00
A = 1
P = 1.52
T = 17.2030
S = 0.3736
SC = 1186
b:ctd003.dat
CTD-003, 8/23/94, Long Island Sound

Figure 5.

Figure 6.

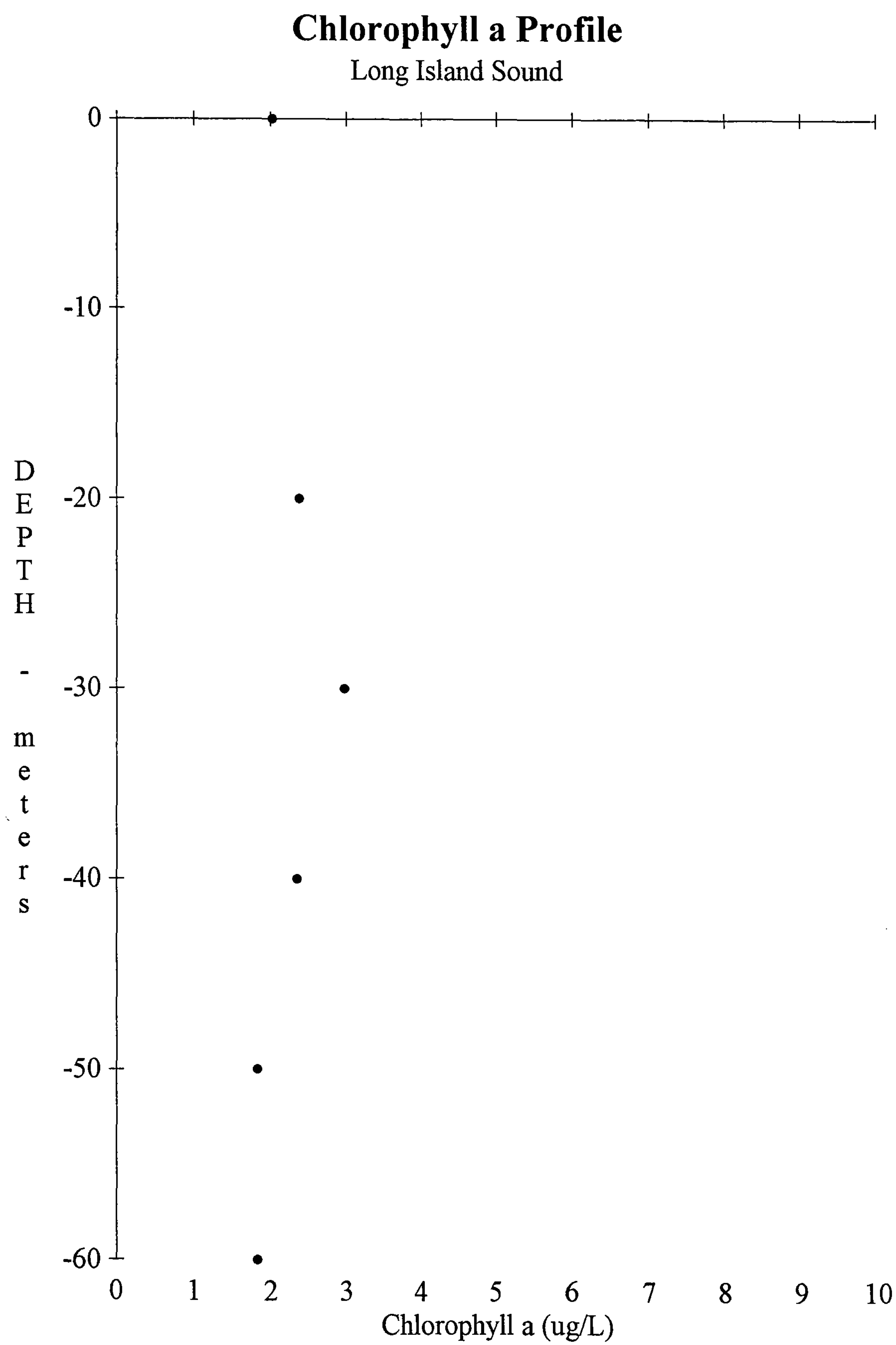
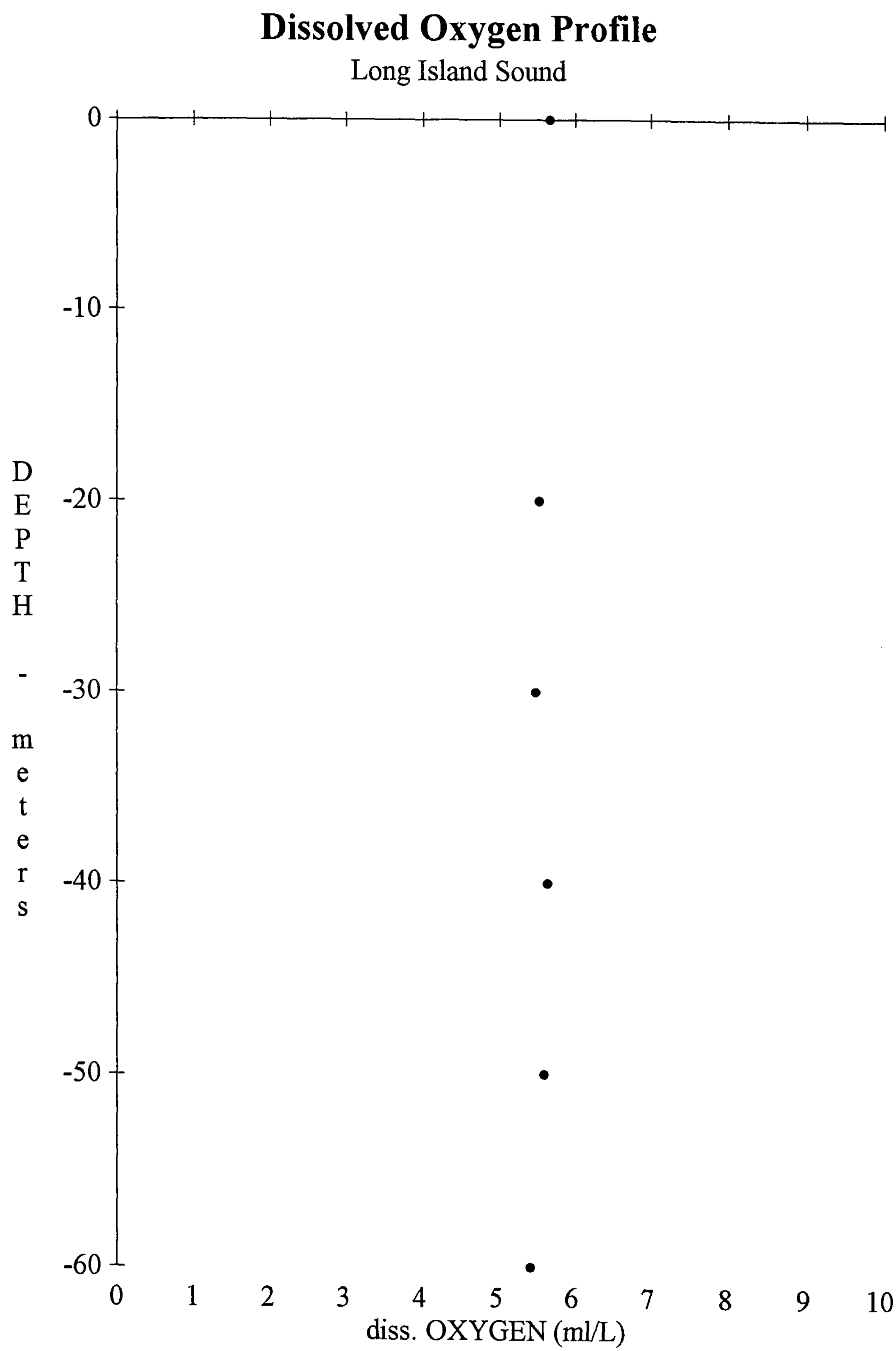

Chlorophyll a Profile
Long Island Sound
DEPTH - meters
0
-10
-20
-30
-40
-50
-60
0
1
2
3
4
5
6
7
8
9
10
Chlorophyll a (ug/L)

Figure 7.


Dissolved Oxygen Profile
Long Island Sound
DEPTH - meters
0
-10
-20
-30
-40
-50
-60
0 1 2 3 4 5 6 7 8 9 10
diss. OXYGEN (ml/L)

THE THAMES RIVER

Our study of the Thames River estuary consisted of two stations and the surface transect between them, in an attempt to detect a change in salinity as we moved farther away from the mouth of the river. The major station occurred closer to the river's mouth, where A Watch, Margaret and Ken deployed the Secchi disk, CTD and Niskin bottles, the Shipek grab, and the meter net. When we set sail again, surface salinity samples and surface temperatures were taken every 5 minutes along our course away from the river, toward the east end of Long Island Sound, near the Race. Here we hove to again, in order to deploy the CTD, before sailing east through the Race and out of Long Island Sound.

The Figures and Tables that follow constitute the data collected in our study of the Thames River. Surface transect information can be found in Table 13, stations 007-018.

Table 9. W134B-004 Hydrocast Data, Thames River

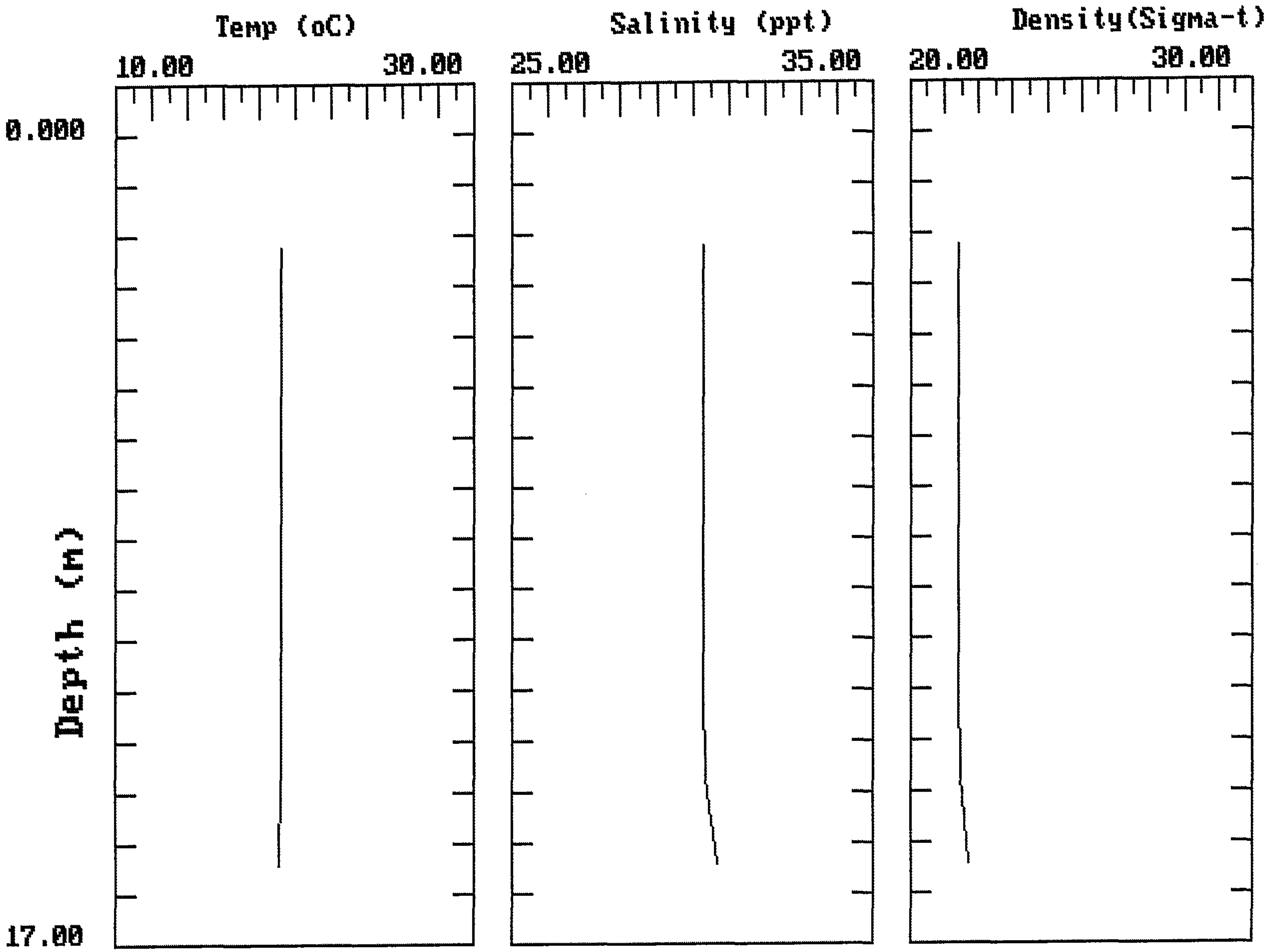
Bottle#	Depth (m)	dO2 (ml/L)	Chl a (ug/L)
3	0	5.6	2.41
2	5	5.54	1.5
1	10	5.61	1.44

Table 10. W134B-004 Meter Net Data, Thames River

Date: 8/24
Log: 69.8 nm
Time: 1020
Position: 41°17'N / 72°06'W
Tow Depth: 7 m
Zooplankton Density: 0.20 ml/m3
Tow Description: 100% copepods

Table 11. W134B-004 Shipek Grab Data, Thames River

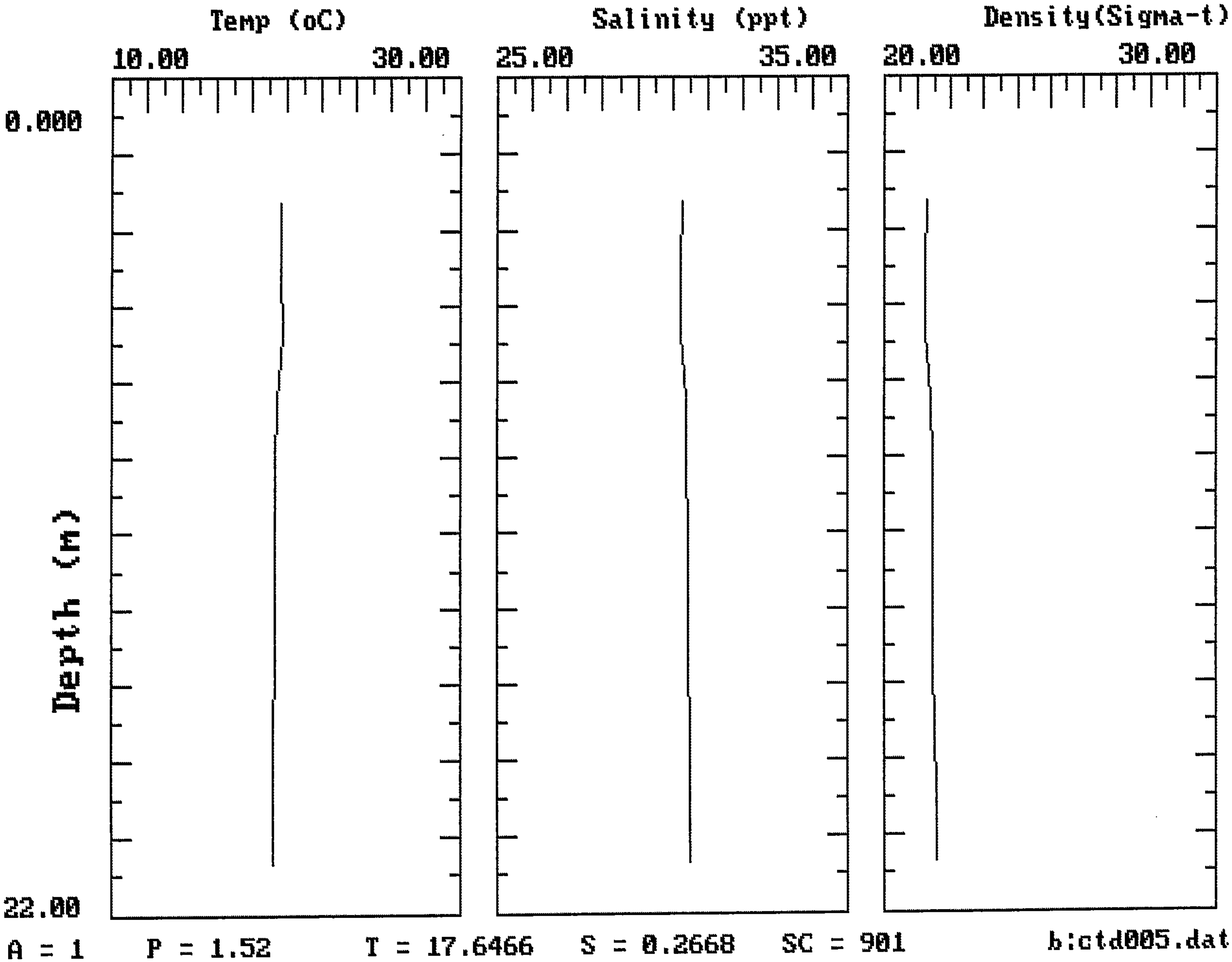
Date: 8/24
Position: 41°17'N / 72°06'W
Time: 0930
Water Depth: 25 m
Log: 69.8 nm
Sediment: 45% of sample=125 um size fraction or smaller, 28%=3000 um size fraction, 27%=500-2000um
Biota: skate egg case, sponges, crabs, polychaete worms and worm tube, bryozoa, barnacles, bivalve mollusc shells



A = 1 P = 3.27 T = 19.2294 S = 30.3264 SC = 3082 b:ctd004.dat

CTD-004, 8/24/94, Mouth of the Thames River

Figure 8.



CTD-005, 8/24/94, East End of Long Island Sound

Figure 9.

Figure 10.

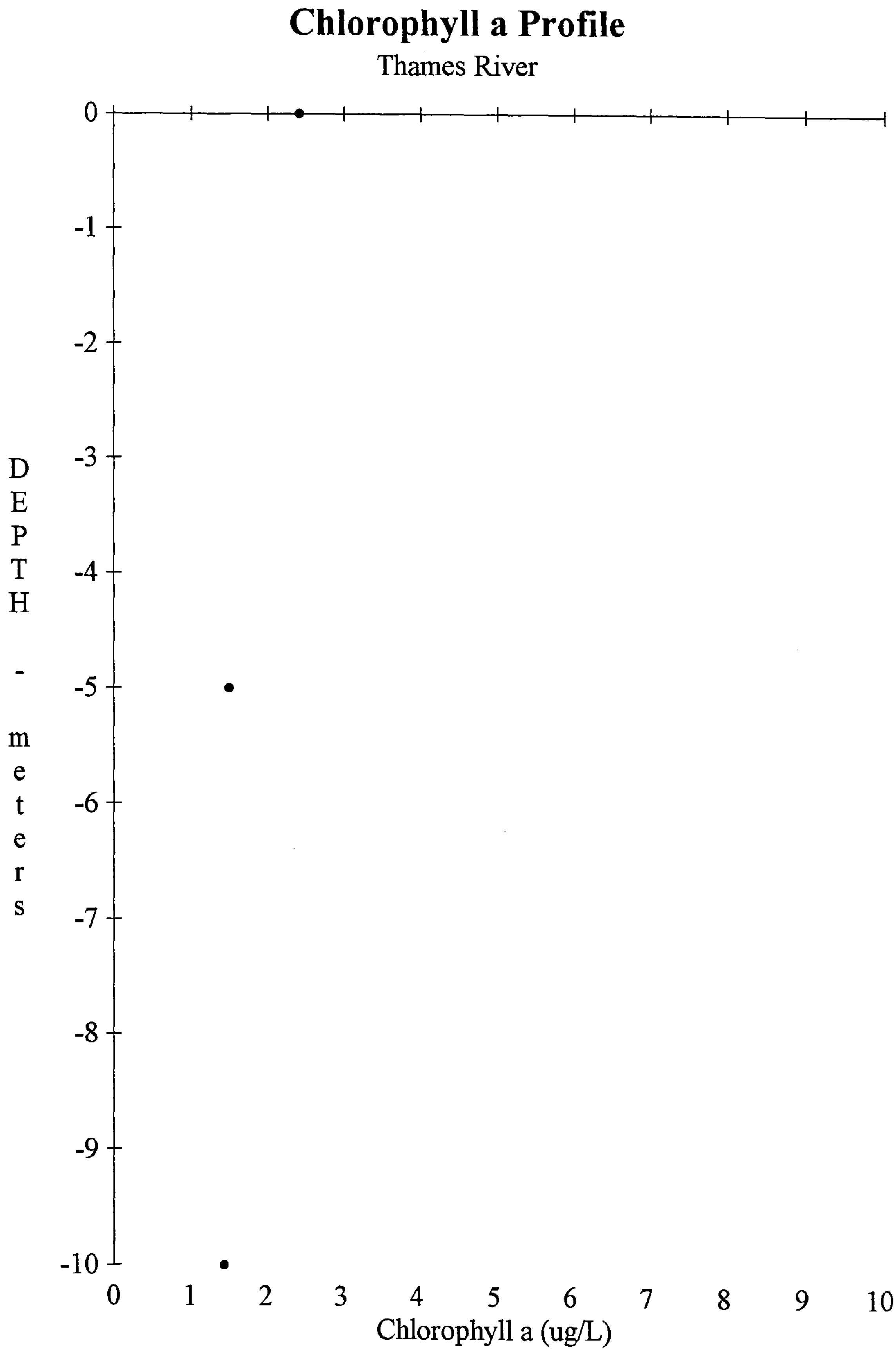

Chlorophyll a Profile
Thames River
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
DEPTH - meters
0
1
2
3
4
5
6
7
8
9
10
Chlorophyll a (ug/L)

Figure 11.

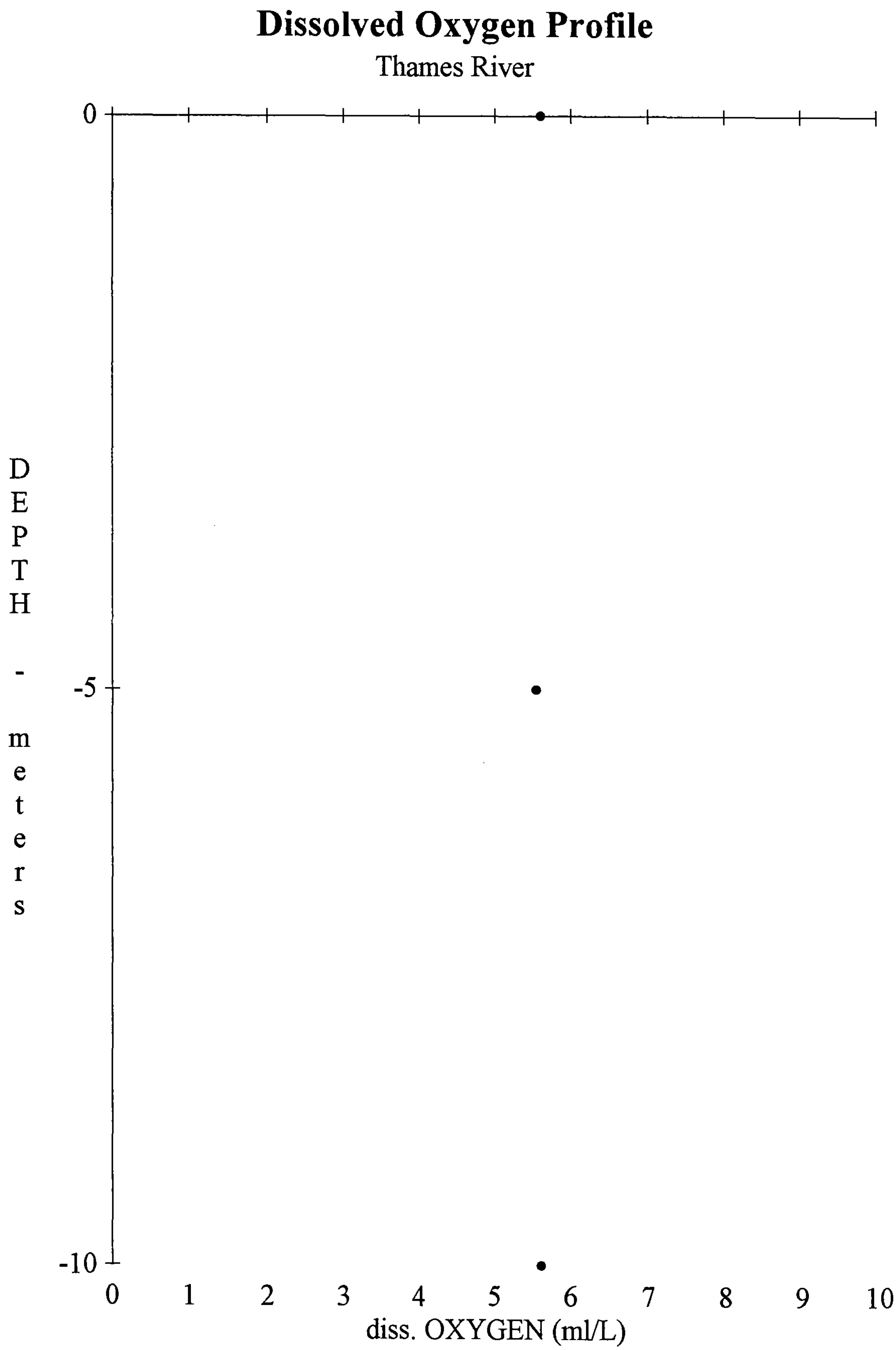

Dissolved Oxygen Profile
Thames River
0
-5
-10
D E P T H - m e t e r s
0
1
2
3
4
5
6
7
8
9
10
diss. OXYGEN (ml/L)

Table 12. W134B-006 Otter Trawl Data, Menemsha Bight

Date: 8/25
Time: 1145
Water Depth: 18.8 m
Log: 110.1 nm
Position: 41°22'N / 70°47'W
Net Contents:

217	sea stars	4	flounder
27	spider crabs	2	rock crabs
16	skate egg cases	3	Northern sea robins
12	lady crabs	3	skates
11	sand dollars		squid egg masses
			seaweed

Table 13. Surface Station Data

Station #	Date	Time	Log (nm)	Lat(°N)/Long(°W)	Ts(°C)	Chl a (ug/L)	Sal.* (ppt)
1	22-Aug	1630	14.9	41°20' / 70°56'	19.2	~	36.39
2	22-Aug	2000	29.4	41°17' / 71°13'	19.2	1.67	36.31
3	22-Aug	2030	32.5	41°17' / 71°19'	~	~	~
4	23-Aug	830	44.0	41°12' / 71°35'	18.8	1.75	35.89
5	23-Aug	1630	61.6	41°14' / 72°02'	19.0	1.43	35.33
6	24-Aug	710	68.5	41°17' / 72°01'	18.1	2.33	34.13
7	24-Aug	1045	~	41°16' / 72°07'	~	1.95	34.77
8	24-Aug	1050	~	41°16' / 72°07'	~	1.98	34.74
9	24-Aug	1055	~	41°16' / 72°07'	19.1	1.52	34.57
10	24-Aug	1100	~	41°16' / 72°07'	19.1	1.26	34.71
11	24-Aug	1105	~	41°16' / 72°07'	19.4	0.22	34.54
12	24-Aug	1110	~	41°16 / 72°07'	19.8	1.06	34.05
13	24-Aug	1115	~	41°16' / 72°06'	20.0	2.33	33.83
14	24-Aug	1120	~	41°16' / 72°06'	19.8	1.30	34.50
15	24-Aug	1130	~	41°16' / 72°05'	19.5	1.73	34.49
16	24-Aug	1140	~	41°16' / 72°05'	19.9	1.28	34.51
17	24-Aug	1150	~	41°16' / 72°04'	19.9	1.63	34.14
18	24-Aug	1215	~	41°15' / 72°04'	20.1	1.43	34.47
19	24-Aug	1600	~	41°14' / 71°47'	19.9	1.75	35.68

* All Salinity values are consistently high and can be used as relative values only.

Table 14. W134B-001 Shipek Grab Data, Martha's Vineyard Sound

Date: 8/22
Time: 1600
Log: 14.9 nm
Position: 40°20'N / 70°56'W
Water Depth: 26 m
Sediment: Fine grained
Biota: isopods, amphipods, shrimp, polychaete worms, cup and saucer limpet

SUMMARY OF STATION WORK

Our Shore Component studies of shallow, well-mixed, and highly productive environments prepared everyone well for the results of our coastal research. The near coastal regions of southern New England presented us with few surprises and not much variation. We looked hard for drastic changes and exciting discoveries, but what we found was simply the story of an estuary. While the straight lines and consistencies in our data did not seem to say much at all, they actually told us quite a bit.

We found no thermoclines, haloclines or pycnoclines in any of the three areas that we studied (Figs. 2, 5, 8, 9). Even in the relatively deep (70 m) station in Long Island Sound, the water showed negligible differences in temperature, salinity and density from top to bottom. None of these three bodies of water are stable enough to maintain stratification. They are all extremely dynamic systems affected by massive and regular water movements, and as a result, are well-mixed. Block Island Sound is continuously flushed by tidal currents moving through. Long Island Sound is also subject to strong tidal currents (such as the one we saw going through the Race), and also flows of fresh river water. The Thames River is a turbulent meeting place for tidal saltwater currents flowing up-river and river water running down toward the Sound.

At each station, salinity profiles showed virtually no change with depth (Figs. 2, 5, 8, 9). However, when comparing the three regions, slight differences exist in the data which make sense in light of local geography. The salinity at the Block Island Sound station was approximately 1.0 ppt higher than those of the Long Island Sound and Thames stations. Both of these less saline bodies are affected by major point sources of fresh, river water, while Block Island Sound is not. In August the differences are not drastic; however during the Spring, when river flow is at its maximum due to thawing, variations in salinity would be more extreme.

The relative surface salinity values from our Thames River transect (Table 13, stations 007-018) do not show variation with distance. Our transect took us more across than away from the river's mouth, so our results were not surprising.

The Chlorophyll a profiles of the three stations (see Figs. 3, 6, 10), show high productivity all the way down through the water column. Block and Long Island Sounds show slight variations with depth; however there is no doubt that the necessary ingredients for photosynthesis, primarily light and nutrients, are available in sufficient amounts from top to bottom.

The dissolved oxygen profiles of the three stations (Figs. 4, 7, 11) are the most straightforward of all of our data - equal and constant.

The conditions of high nutrient and phytoplankton concentrations as well as plenty of oxygen create an ideal habitat for organisms, such as zooplankton, that live higher up on the food chain. We were able tow the *Westward*'s meter net in Block Island Sound and at the mouth of the Thames River, and in both of these places we found high zooplankton densities (Tables 5, 10). The most interesting attribute of our tow samples was the fact that they consisted almost entirely of one type of animal, the copepod. Due to the abundance of food in these coastal regions, hearty copepods thrive, and as a result, out-compete other less hearty types of plankton. The character of the zooplankton populations in these areas is one of high overall abundance but low diversity.

Our Shipek grab samples showed the most variation among the three stations (Tables 6, 8, 11). As we moved from Block to Long Island Sound and then to the Thames, the diversity of the benthic fauna collected increased. The sizes of the sediments in the three regions also varied. The smallest grain size was found in Block Island Sound. The samples from Long Island Sound and the Thames contained larger grain sizes which corresponded to the relatively higher-energy water movements found in these areas. Our Long Island Sound station was located close enough to the Race to be affected by its powerful, constricted currents. At the mouth of the Thames, river flow would be strong enough to similarly affect bottom sediments.

Our last bit of data collection during W134B, using the otter trawl, was in many ways the most exciting. Aside from the instant gratification involved in bringing a pile of sea-dwelling creatures onboard, we were also experiencing the same process (on a smaller scale, of course) that commercial fishermen have been using for a long time. Table 12 lists our impressive, if not edible, catch from Menemsha Bight off of Martha's Vineyard. This tow showed more evidence of the abundance of life that can be supported in productive, near-coastal waters.