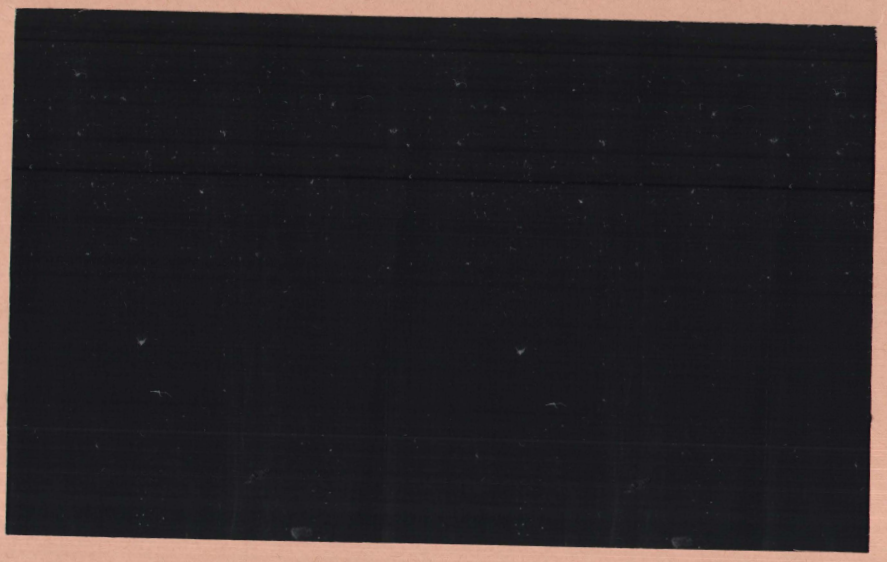
MARINE SCIENCES RESEARCH CENTER
STATE UNIVERSITY of NEW YORK
STONY BROOK, N.Y.



# Dissolved oxygen data in western Long Island Sound 1988-89

J. Salerno, H. Bokuniewicz and R. Muller
Marine Sciences Research Center
State University of New York
Stony Brook, New York 11794-5000



MARINE SCIENCES RESEARCH CENTER

STATE UNIVERSITY OF NEW YORK

STONY BROOK, NEW YORK 11794-5000

# Dissolved oxygen data in western Long Island Sound 1988-89

J. Salerno, H. Bokuniewicz and R. Muller
Marine Sciences Research Center
State University of New York
Stony Brook, New York 11794-5000

This work was supported by the U.S. Environmental Protection Agency as part of their National Estuary Program's Long Island Sound Study.

Approved for Distribution

J. R. Schubel, Director
September 1989

Working Paper #36
Reference #89-8

## INTRODUCTION

From April 1988 through September 1989, dissolved oxygen concentrations were measured for the purpose of defining areas of hypoxia and determining the length of time that these areas were hypoxic. These data are presented in this report. The description of the oxygen distribution was used as part of the basis of a water quality model for the Sound.

## METHODS

The Long Island Sound sampling cruises were conducted from the SUNY, Stony Brook, R/V ONRUST. Cruises from April 1988 through October 1988 covered a sampling area that extended about 80 km from the Whitestone Bridge to the waters between New Haven, CT. and Shoreham, NY (Figure 1; Table 1). The cruises from November 1988 through September 1989 included 9 stations positioned along the axis of the Sound. These stations extended from the Throgs Neck Bridge east to the waters between New Haven and Shoreham (Figure 2; Table 2).

The water sampling depths were designated as surface and bottom. Surface water was sampled at a depth of 2 m. Bottom water was considered to be at a depth of 20 m unless the station total depth was less than 20 m. At these stations, bottom water was sampled from 5 m above the actual bottom depth.

Water samples were collected with a Niskin bottle. Ten milliliter subsamples were extracted from the Niskin bottle and analyzed immediately on board using the modified winkler titration method described in Appendix I.

A similar sampling program was conducted in the eastern Sound by the University of Connecticut Marine Science Institute.

## RESULTS

The measurements of dissolved oxygen are tabulated in Appendix II. The dissolved oxygen concentrations in the surface and bottom water along the axis of the Sound for each cruise are shown in Figures 3 through 30. Hypoxia is defined as D.O. concentrations of 3 mg/l or less. As expected, hypoxia occurred in the bottom waters during August when the water column was typically thermally well-stratified as, for example, at one station in July 1988 (Figure 10), on 2-4 August 1988 (Figure 11), 15-16 August 1988 (Figure 12) and at one station on 24 July 1989 (Figure 28) and on 7 August 1989 (Figure 29) and 21 August 1989 (Figure 30). Dissolved oxygen in the surface water only fell below 3 mg/l at one station on 15-16 August 1988 (Figure 12) and again on 21 August 1989 (Figure 30). Levels of dissolved oxygen never went below about 1.4 mg/l which was measured in the bottom water at one station in the western Sound on 15-16 August 1988. The distribution of dissolved oxygen levels in both the surface and bottom water for surveys that included transects across the Sound are mapped in Figures 32 to 57.

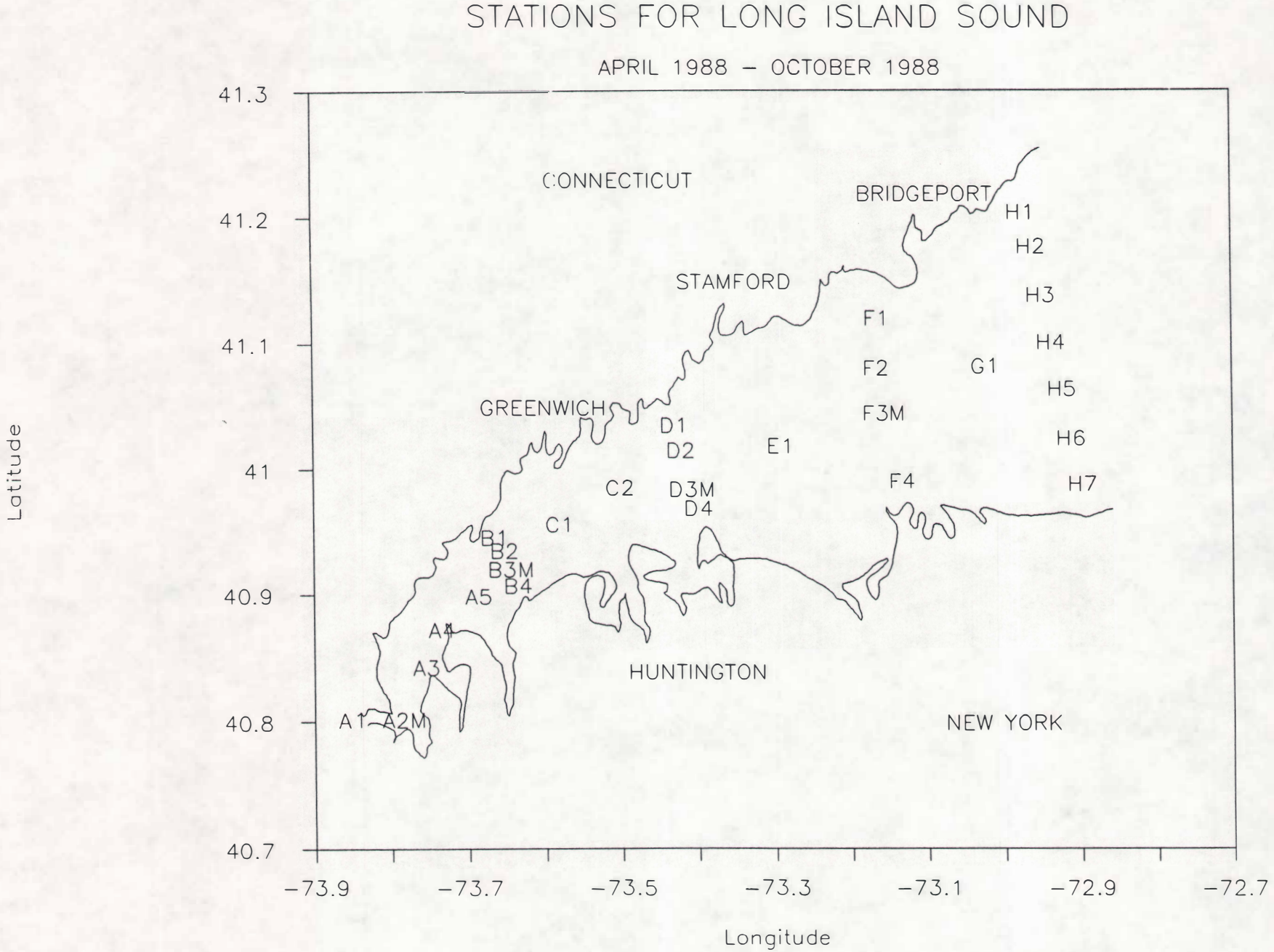

STATIONS FOR LONG ISLAND SOUND
APRIL 1988 – OCTOBER 1988
CONNECTICUT
BRIDGEPORT
STAMFORD
GREENWICH
HUNTINGTON
NEW YORK
H1
H2
H3
H4
H5
H6
H7
F1
F2
F3M
F4
G1
E1
D1
D2
D3M
D4
C1
C2
B1
B2
B3M
B4
A5
A4
A3
A1
A2M
41.3
41.2
41.1
41
40.9
40.8
40.7
-73.9
-73.7
-73.5
-73.3
-73.1
-72.9
-72.7
Latitude
Longitude

Figure 1

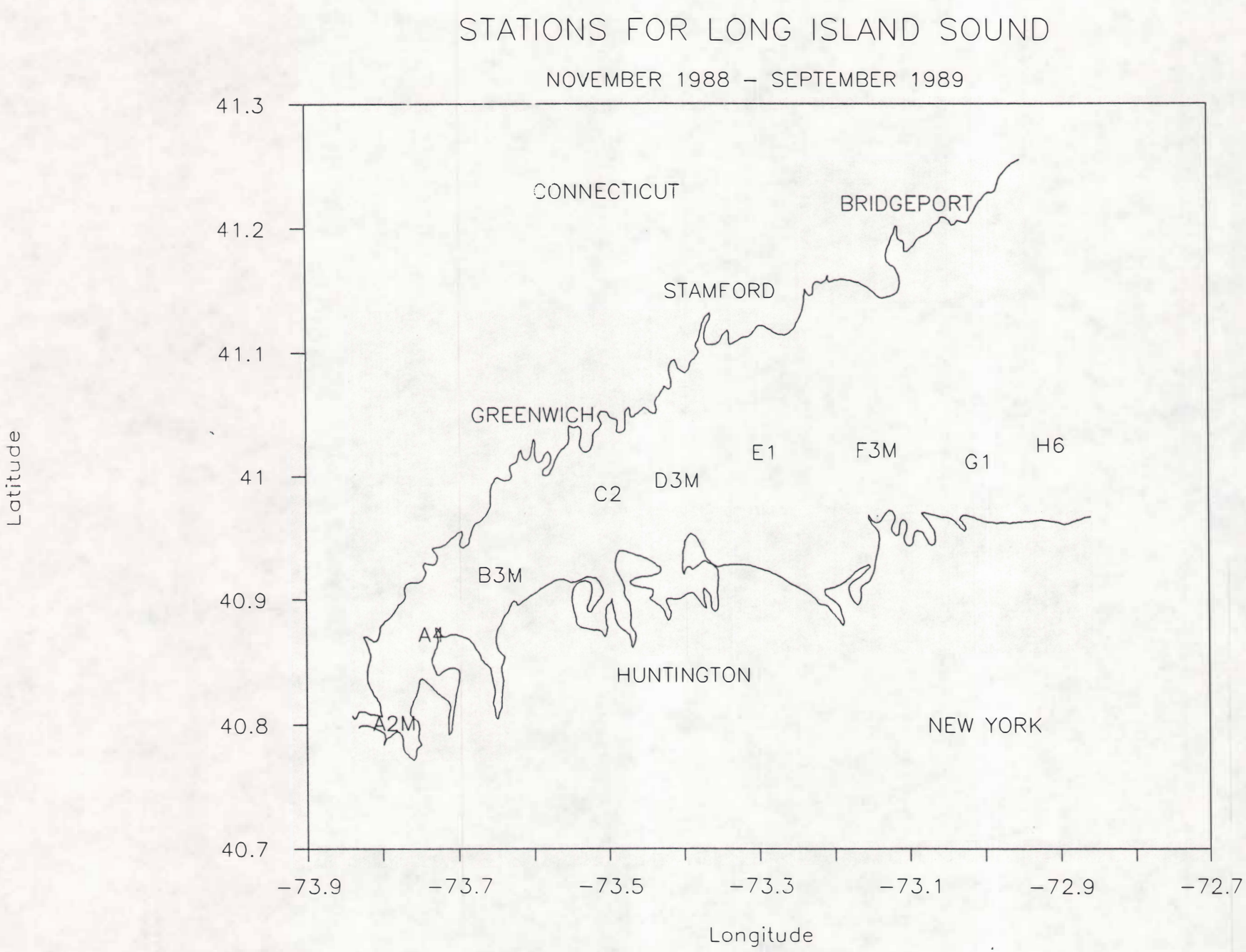

STATIONS FOR LONG ISLAND SOUND
NOVEMBER 1988 – SEPTEMBER 1989
CONNECTICUT
BRIDGEPORT
STAMFORD
GREENWICH
E1
F3M
G1
H6
C2
D3M
B3M
A4
HUNTINGTON
A2M
NEW YORK
41.3
41.2
41.1
41
40.9
40.8
40.7
−73.9
−73.7
−73.5
−73.3
−73.1
−72.9
−72.7
Latitude
Longitude

Figure 2

TABLE I

STATION LOCATIONS
APRIL 1988 - OCTOBER 1988

| STATION | DEPTH m | LATITUDE DEG | LATITUDE MIN | LONGITUDE DEG | LONGITUDE MIN |
|---|---|---|---|---|---|
| A1 | 26 | 40 | 48.2 | 73 | 49.6 |
| A2M | 35 | 40 | 48.1 | 73 | 47.0 |
| A3 | 25 | 40 | 50.5 | 73 | 45.3 |
| A4 | 35 | 40 | 52.3 | 73 | 44.1 |
| A5 | 13 | 40 | 53.9 | 73 | 41.2 |
| B1S | 15 | 40 | 56.7 | 73 | 40.0 |
| B2 | 20 | 40 | 56.1 | 73 | 39.2 |
| B4 | 15 | 40 | 54.4 | 73 | 38.1 |
| B3M | 19 | 40 | 55.2 | 73 | 38.7 |
| C1 | 19 | 40 | 57.3 | 73 | 34.8 |
| C2 | 35 | 40 | 59.1 | 73 | 30.0 |
| D1 | 21 | 41 | 2.1 | 73 | 25.9 |
| D2 | 28 | 41 | 0.9 | 73 | 25.3 |
| D4 | 13 | 40 | 58.1 | 73 | 23.9 |
| D3M | 29 | 40 | 59.0 | 73 | 24.4 |
| E1 | 36 | 41 | 1.2 | 73 | 17.5 |
| F1 | 10 | 41 | 7.2 | 73 | 9.8 |
| F2 | 20 | 41 | 4.8 | 73 | 9.9 |
| F3M | 27 | 41 | 2.7 | 73 | 9.2 |
| F4 | 25 | 40 | 59.5 | 73 | 7.8 |
| G1 | 28 | 41 | 5.0 | 73 | 1.3 |
| H1 | 12 | 41 | 12.3 | 72 | 58.4 |
| H2S | 15 | 41 | 10.7 | 72 | 57.6 |
| H3 | 20 | 41 | 8.4 | 72 | 56.9 |
| H4S | 25 | 41 | 6.1 | 72 | 56.1 |
| H5 | 35 | 41 | 3.9 | 72 | 55.3 |
| H6MS | 40 | 41 | 1.5 | 72 | 54.5 |
| H7 | 23 | 40 | 59.4 | 72 | 53.7 |

TABLE II

STATION LOCATIONS
NOVEMBER 1988 - SEPTEMBER 1989

| STATION | DEPTH m | LATITUDE DEG | LATITUDE MIN | LONGITUDE DEG | LONGITUDE MIN |
|---|---|---|---|---|---|
| A2M | 35 | 40 | 48.1 | 73 | 47.0 |
| A4 | 35 | 40 | 52.4 | 73 | 44.1 |
| B3M | 19 | 40 | 55.1 | 73 | 38.7 |
| C2 | 35 | 40 | 59.1 | 73 | 30.1 |
| D3M | 44 | 40 | 59.8 | 73 | 24.5 |
| F3M | 42 | 41 | 1.3 | 73 | 8.5 |
| H6M | 40 | 41 | 1.5 | 72 | 54.6 |

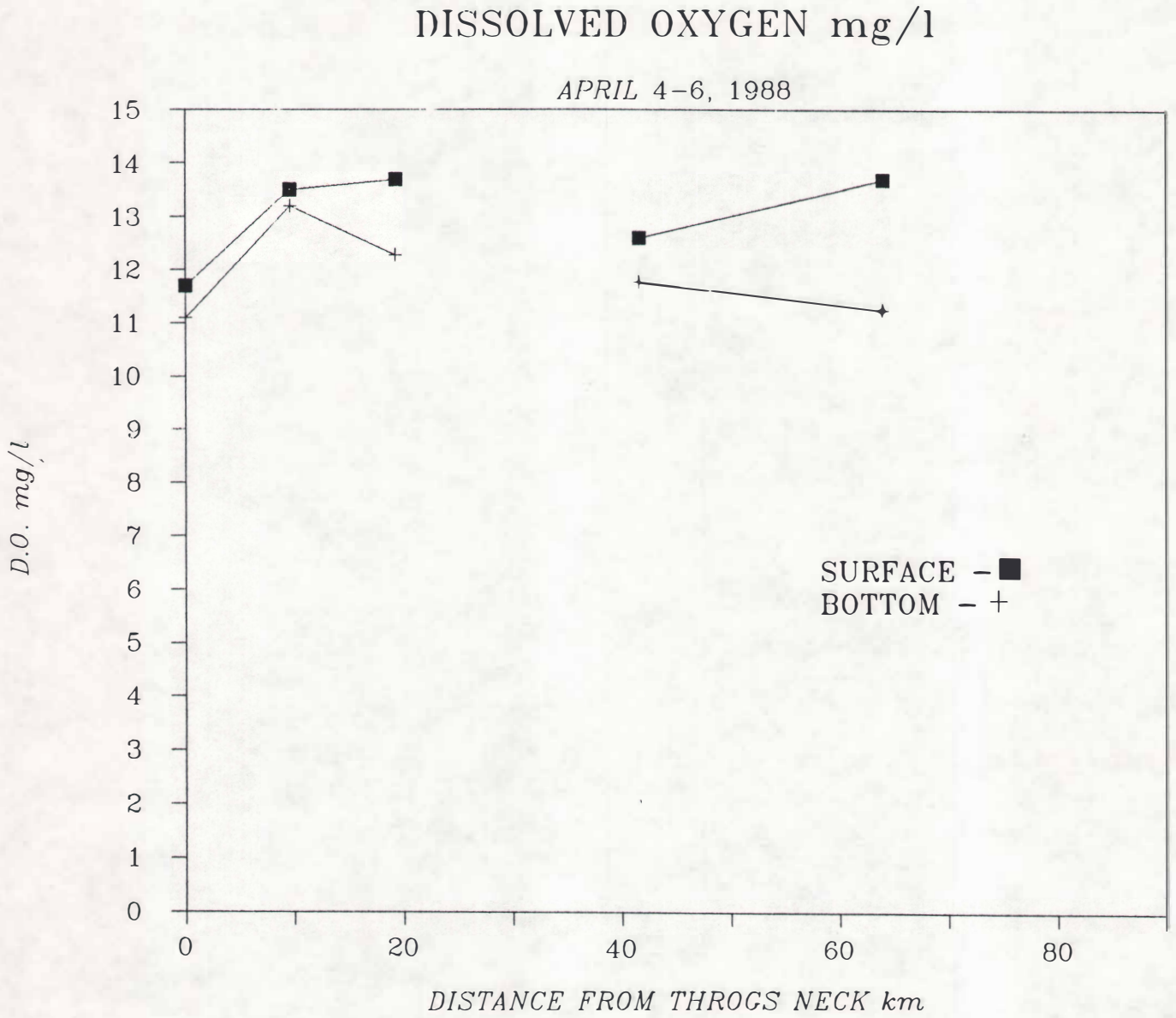

DISSOLVED OXYGEN mg/l
APRIL 4-6, 1988
D.O. mg/l
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
0
20
40
60
80
DISTANCE FROM THROGS NECK km
SURFACE - ■
BOTTOM - +

Figure 3

# DISSOLVED OXYGEN mg/l

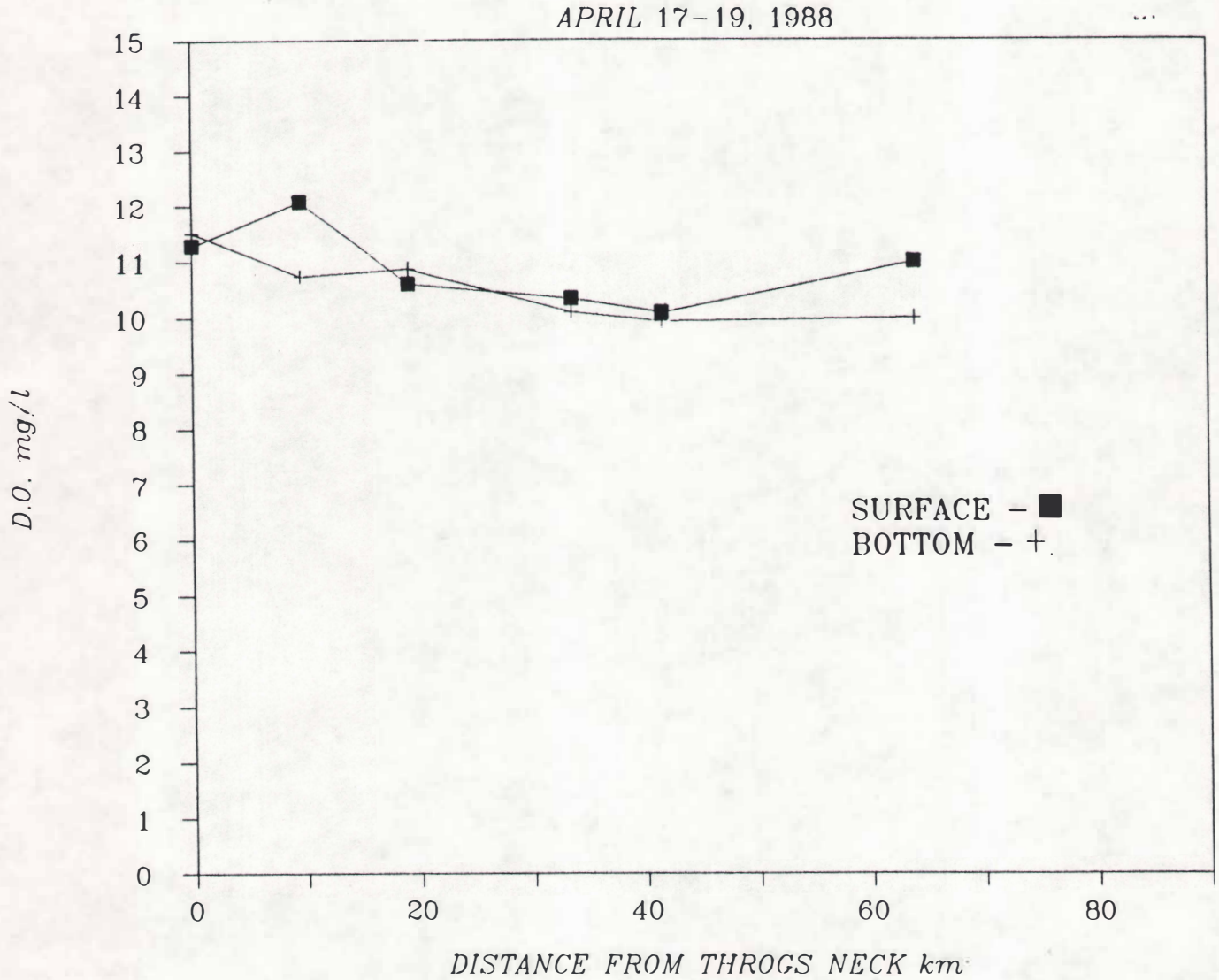



Figure 4

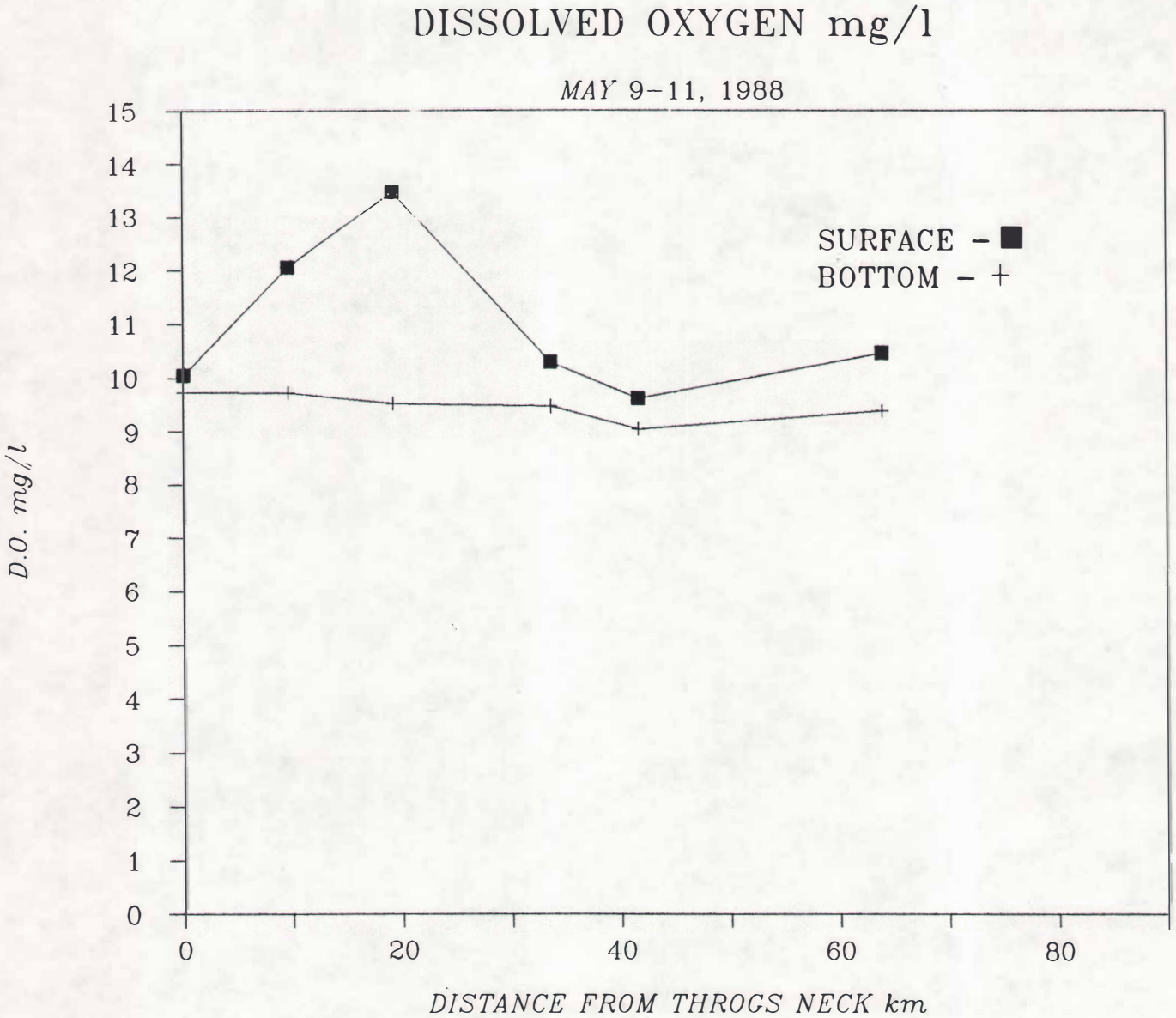

DISSOLVED OXYGEN mg/l
MAY 9-11, 1988
SURFACE - ■
BOTTOM - +
D.O. mg/l
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
0
20
40
60
80
DISTANCE FROM THROGS NECK km

Figure 5

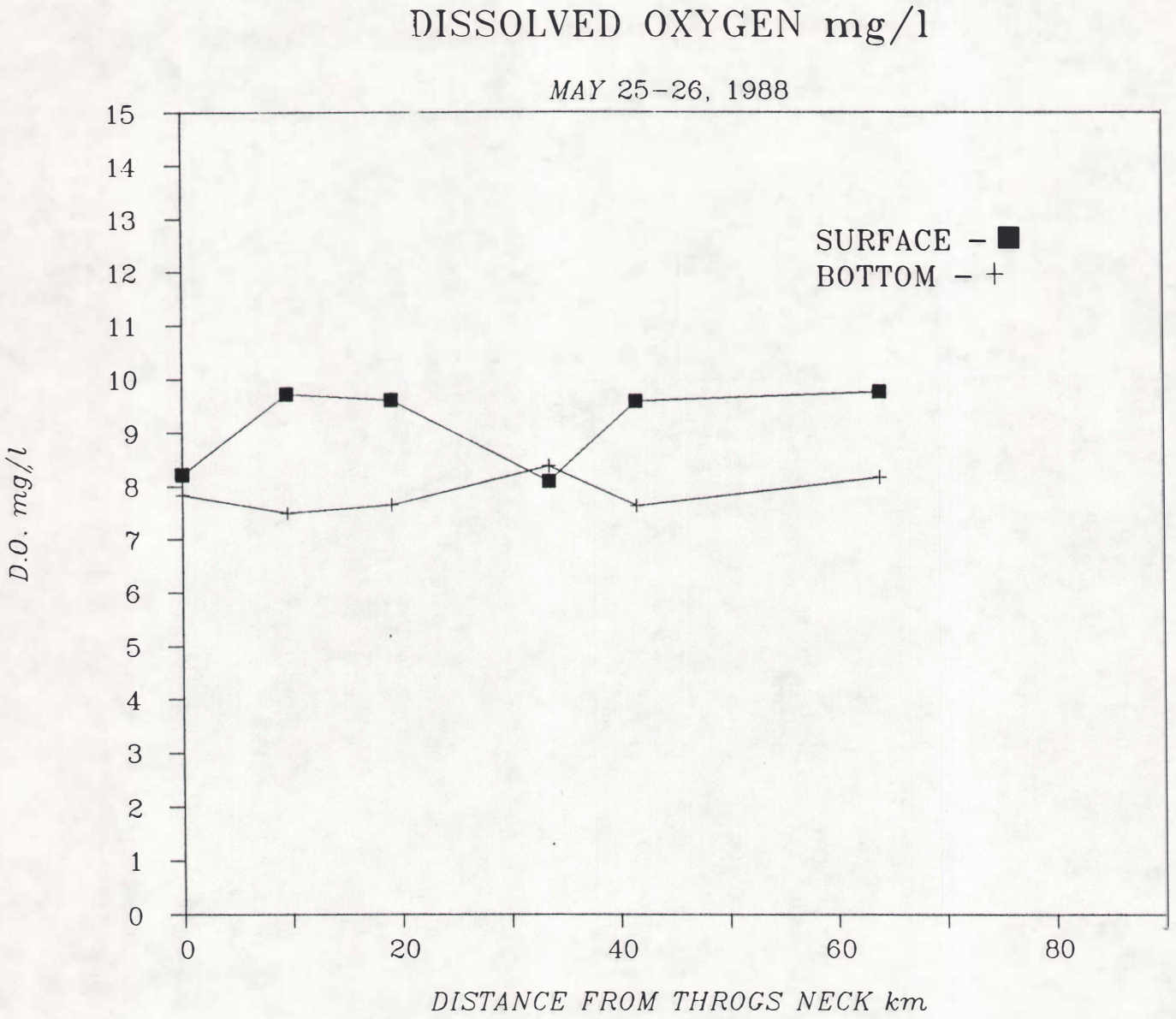

DISSOLVED OXYGEN mg/l
MAY 25-26, 1988
SURFACE - ■
BOTTOM - +
D.O. mg/l
DISTANCE FROM THROGS NECK km
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
0
20
40
60
80

Figure 6

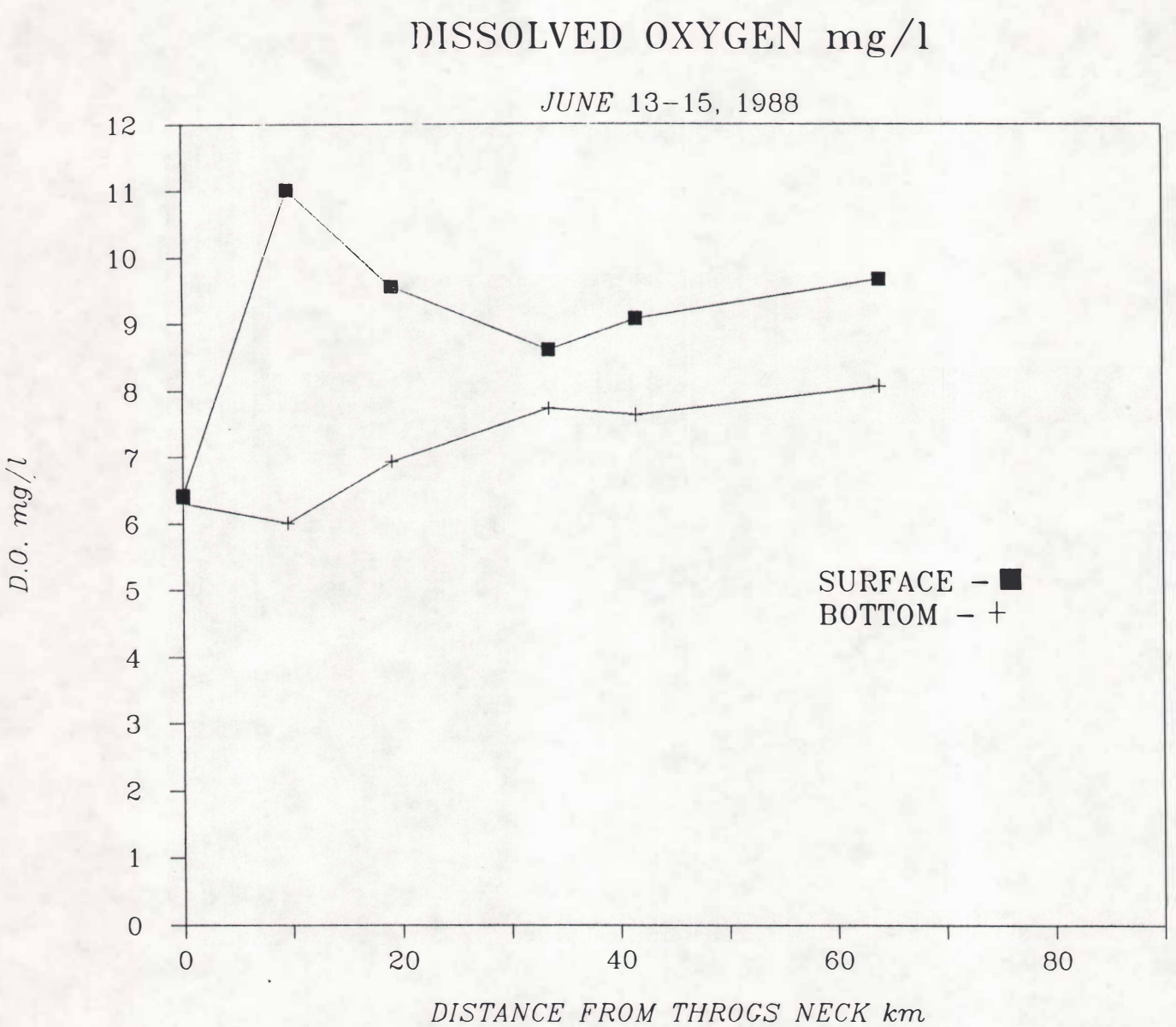

DISSOLVED OXYGEN mg/l
JUNE 13-15, 1988
D.O. mg/l
12
11
10
9
8
7
6
5
4
3
2
1
0
0
20
40
60
80
DISTANCE FROM THROGS NECK km
SURFACE - ■
BOTTOM - +

Figure 7

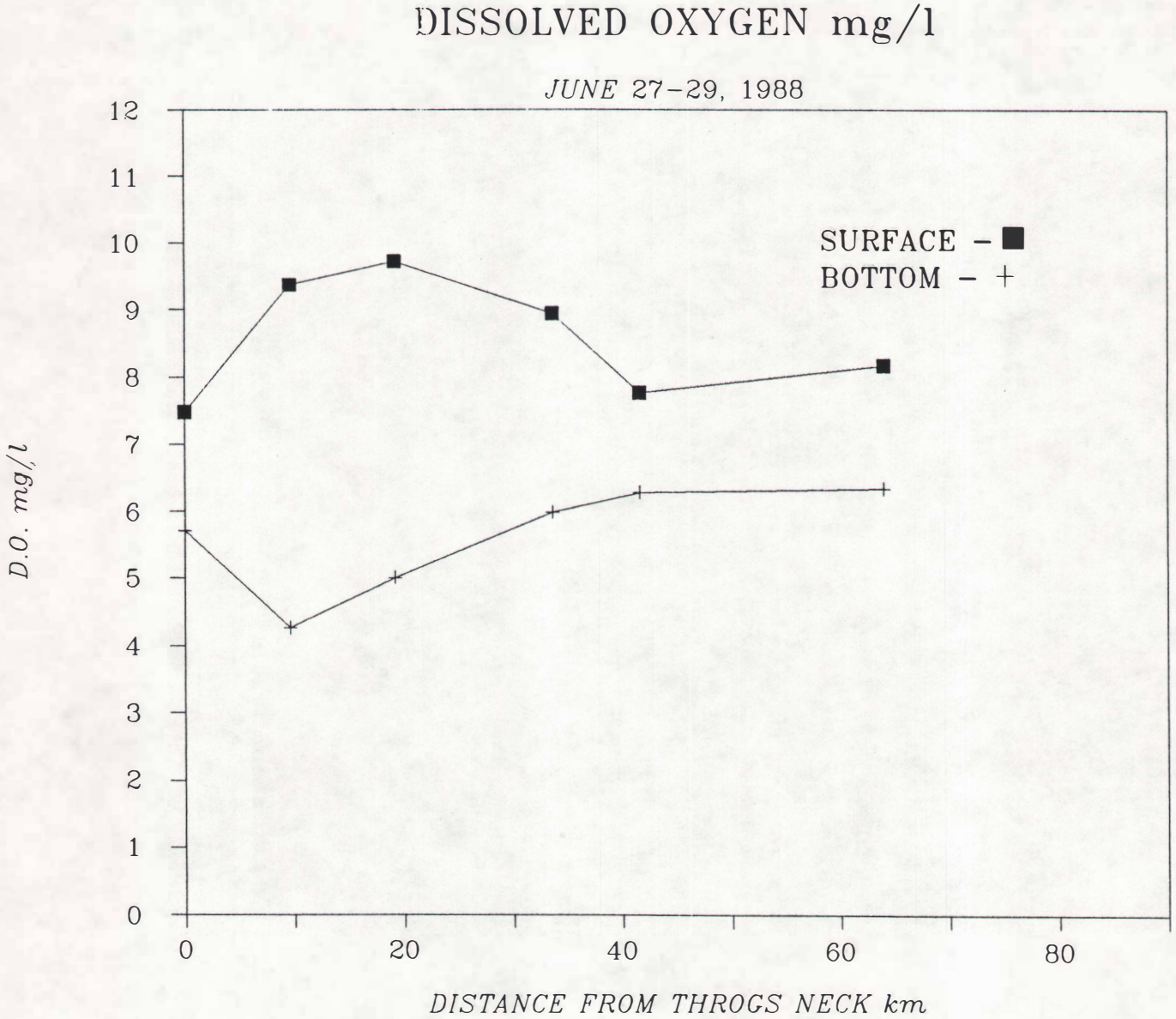

DISSOLVED OXYGEN mg/l
JUNE 27-29, 1988
SURFACE - ■
BOTTOM - +
D.O. mg/l
12
11
10
9
8
7
6
5
4
3
2
1
0
0
20
40
60
80
DISTANCE FROM THROGS NECK km

Figure 8

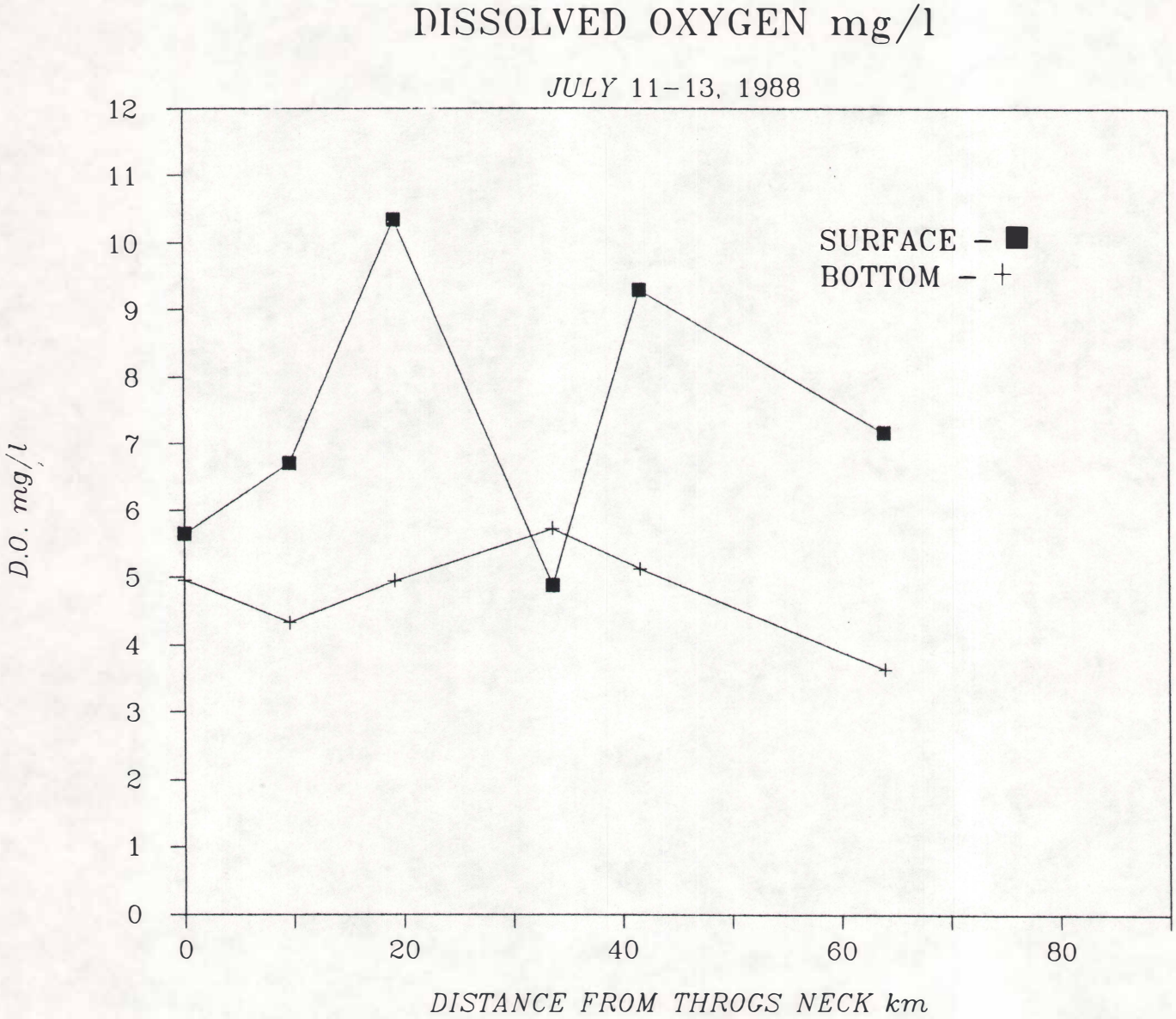

DISSOLVED OXYGEN mg/l
JULY 11-13, 1988
SURFACE - ■
BOTTOM - +
D.O. mg/l
DISTANCE FROM THROGS NECK km
0
1
2
3
4
5
6
7
8
9
10
11
12
0
20
40
60
80

Figure 9

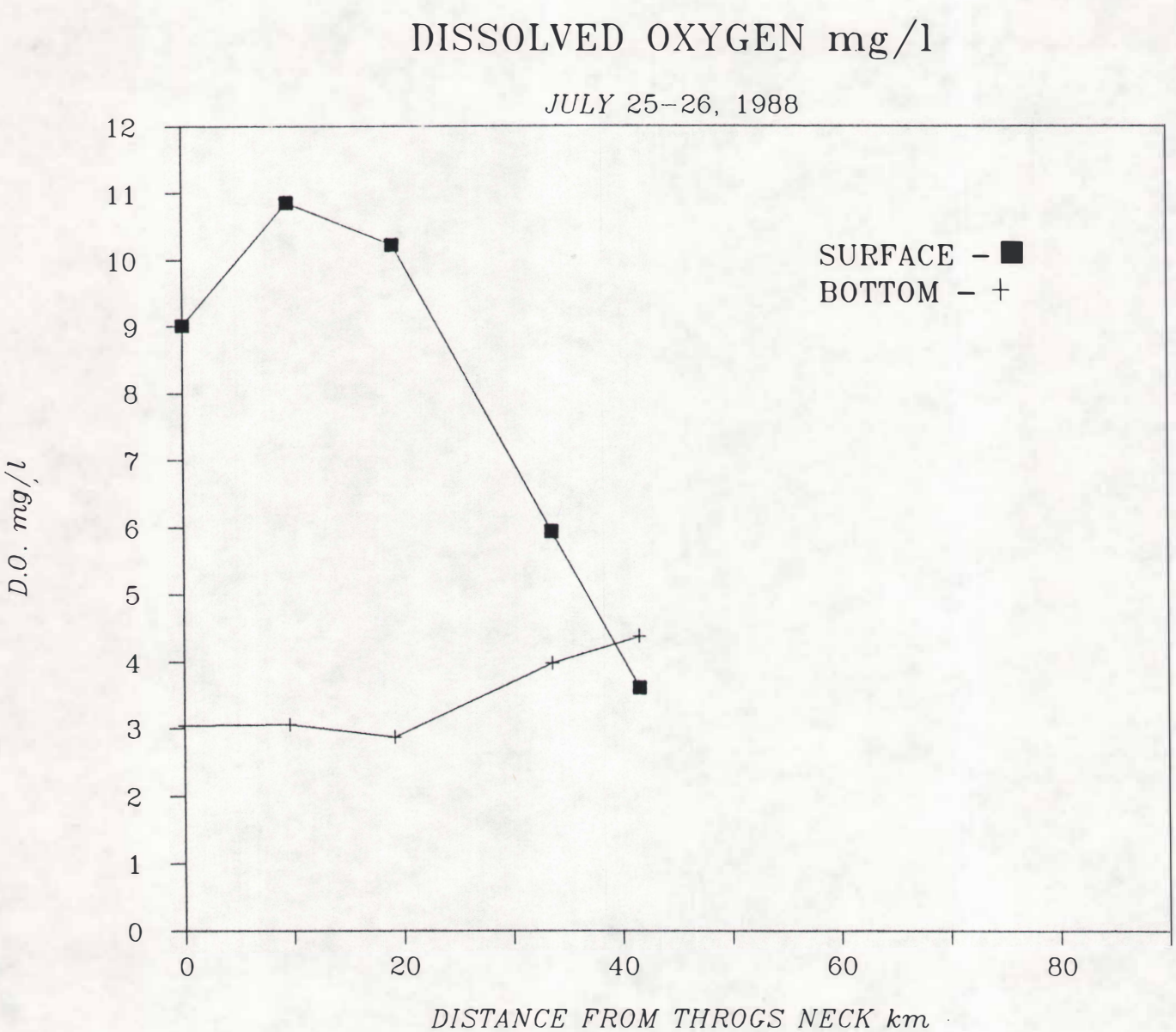

DISSOLVED OXYGEN mg/l
JULY 25–26, 1988
SURFACE – ■
BOTTOM – +
D.O. mg/l
DISTANCE FROM THROGS NECK km
0
1
2
3
4
5
6
7
8
9
10
11
12
0
20
40
60
80

Figure 10

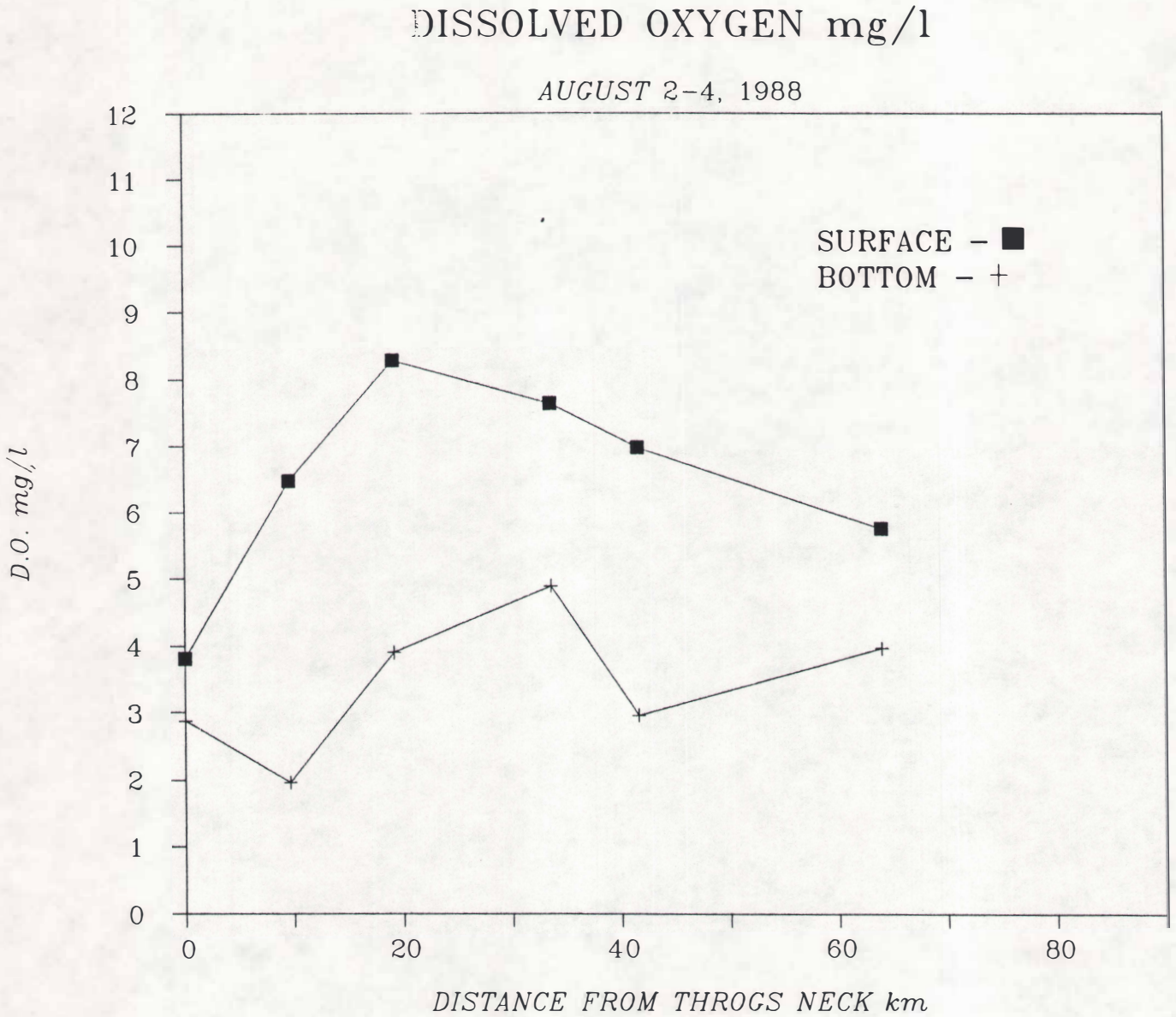

DISSOLVED OXYGEN mg/l
AUGUST 2-4, 1988
SURFACE - ■
BOTTOM - +
D.O. mg/l
DISTANCE FROM THROGS NECK km
0
1
2
3
4
5
6
7
8
9
10
11
12
0
20
40
60
80

Figure 11

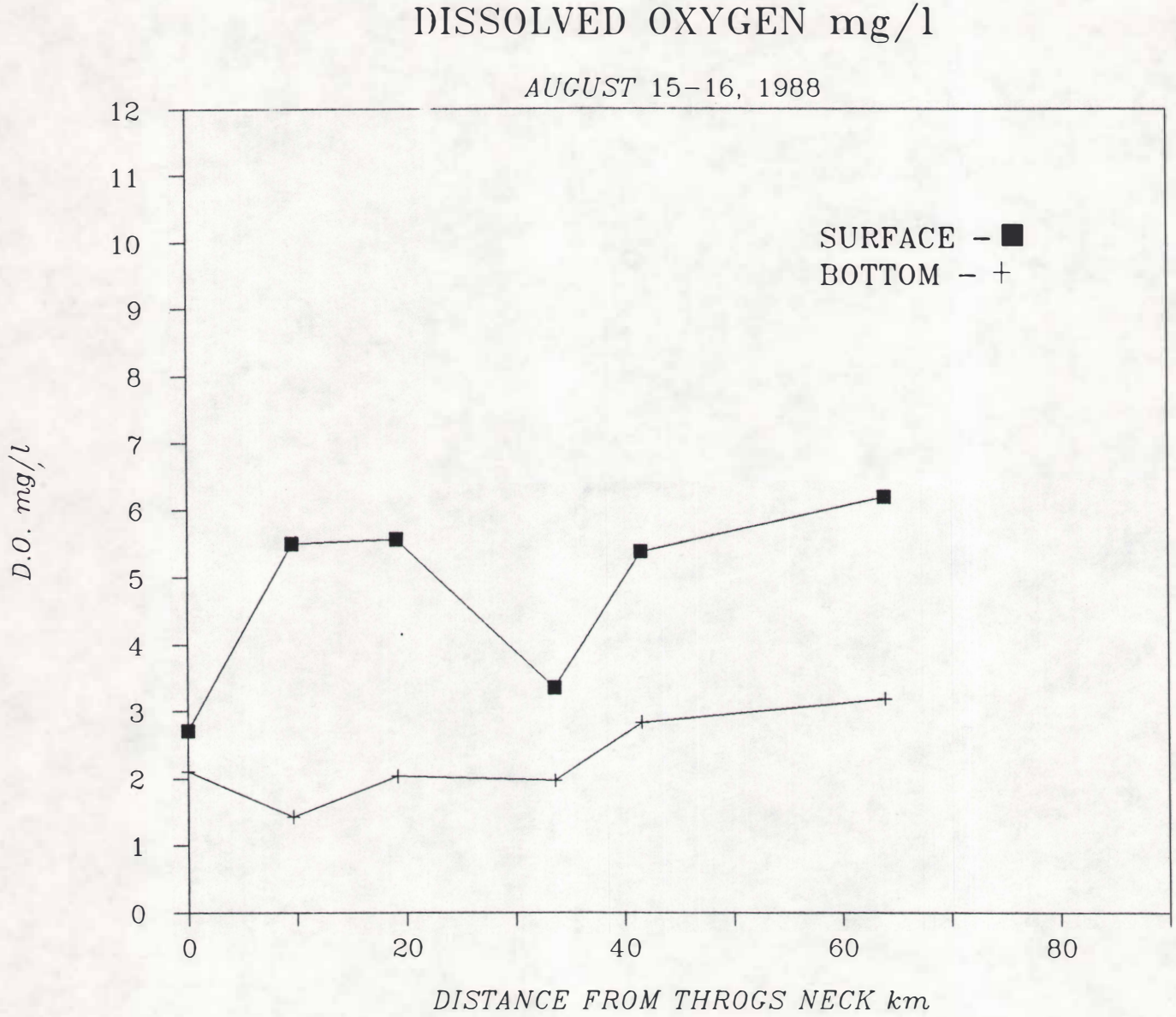

DISSOLVED OXYGEN mg/l
AUGUST 15-16, 1988
SURFACE - ■
BOTTOM - +
D.O. mg/l
DISTANCE FROM THROGS NECK km
0
1
2
3
4
5
6
7
8
9
10
11
12
0
20
40
60
80

Figure 12

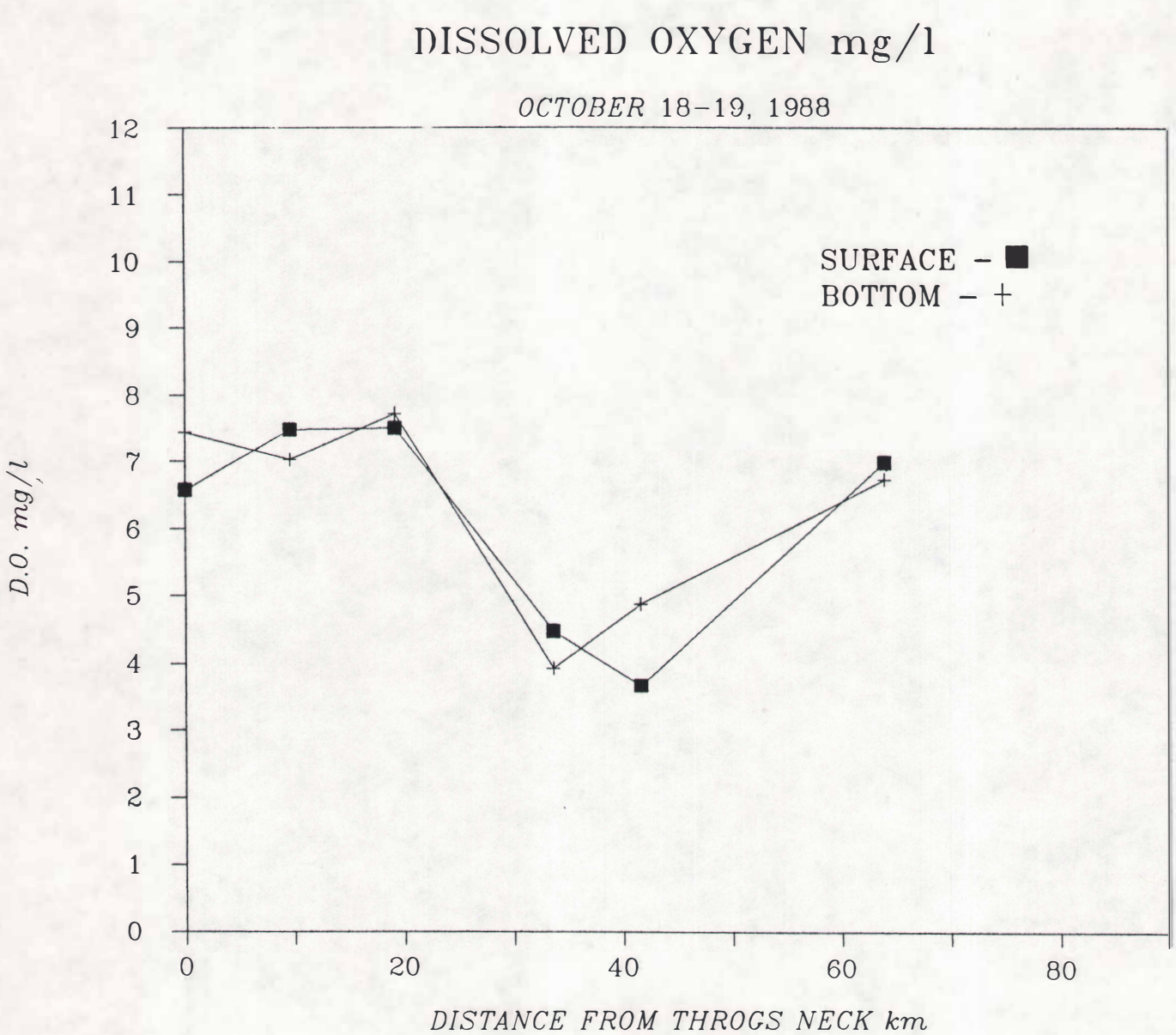

DISSOLVED OXYGEN mg/l
OCTOBER 18-19, 1988
SURFACE - ■
BOTTOM - +
D.O. mg/l
DISTANCE FROM THROGS NECK km
0
1
2
3
4
5
6
7
8
9
10
11
12
0
20
40
60
80

Figure 15

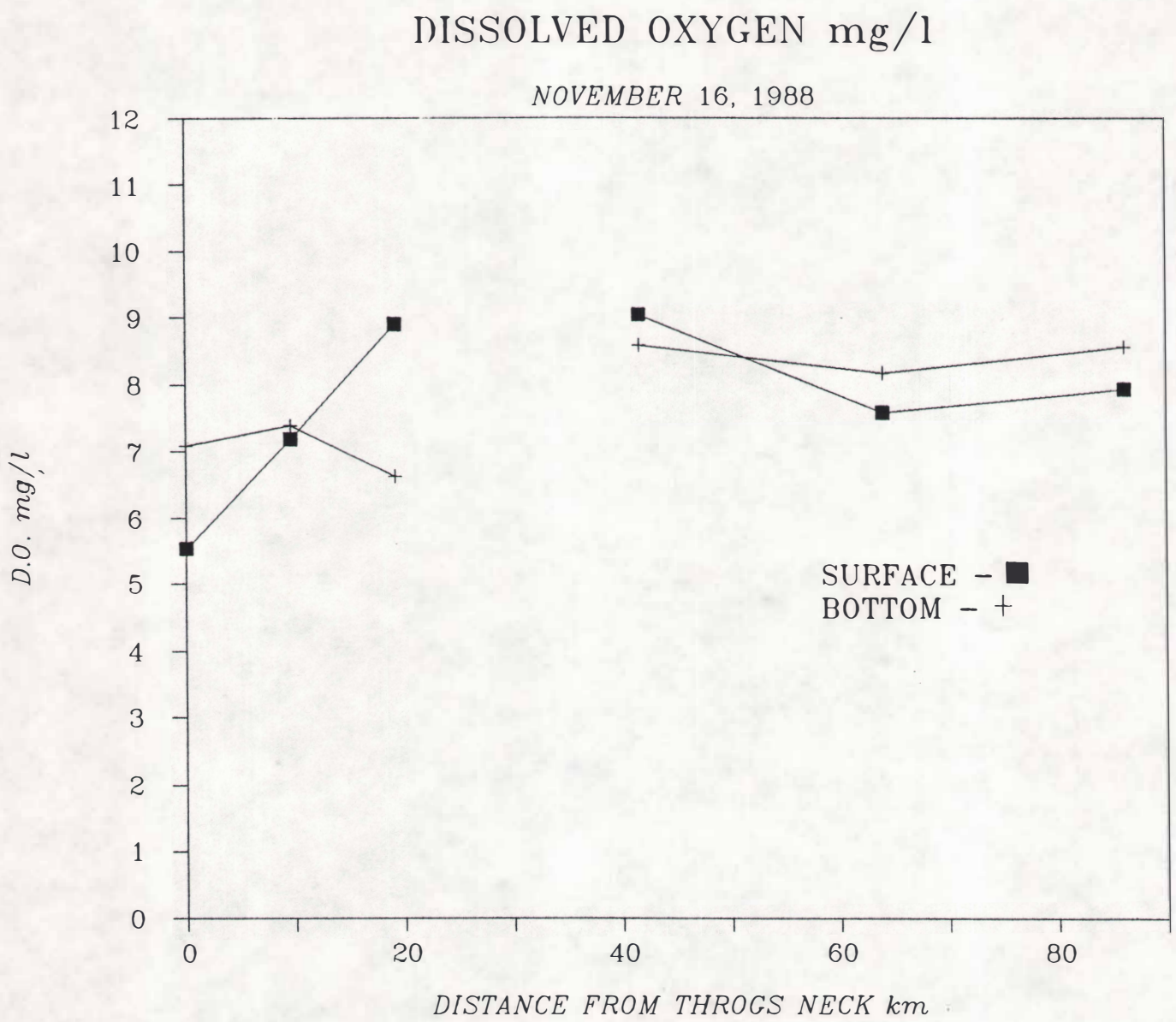

DISSOLVED OXYGEN mg/l
NOVEMBER 16, 1988
D.O. mg/l
12
11
10
9
8
7
6
5
4
3
2
1
0
0
20
40
60
80
DISTANCE FROM THROGS NECK km
SURFACE - ■
BOTTOM - +

Figure 16

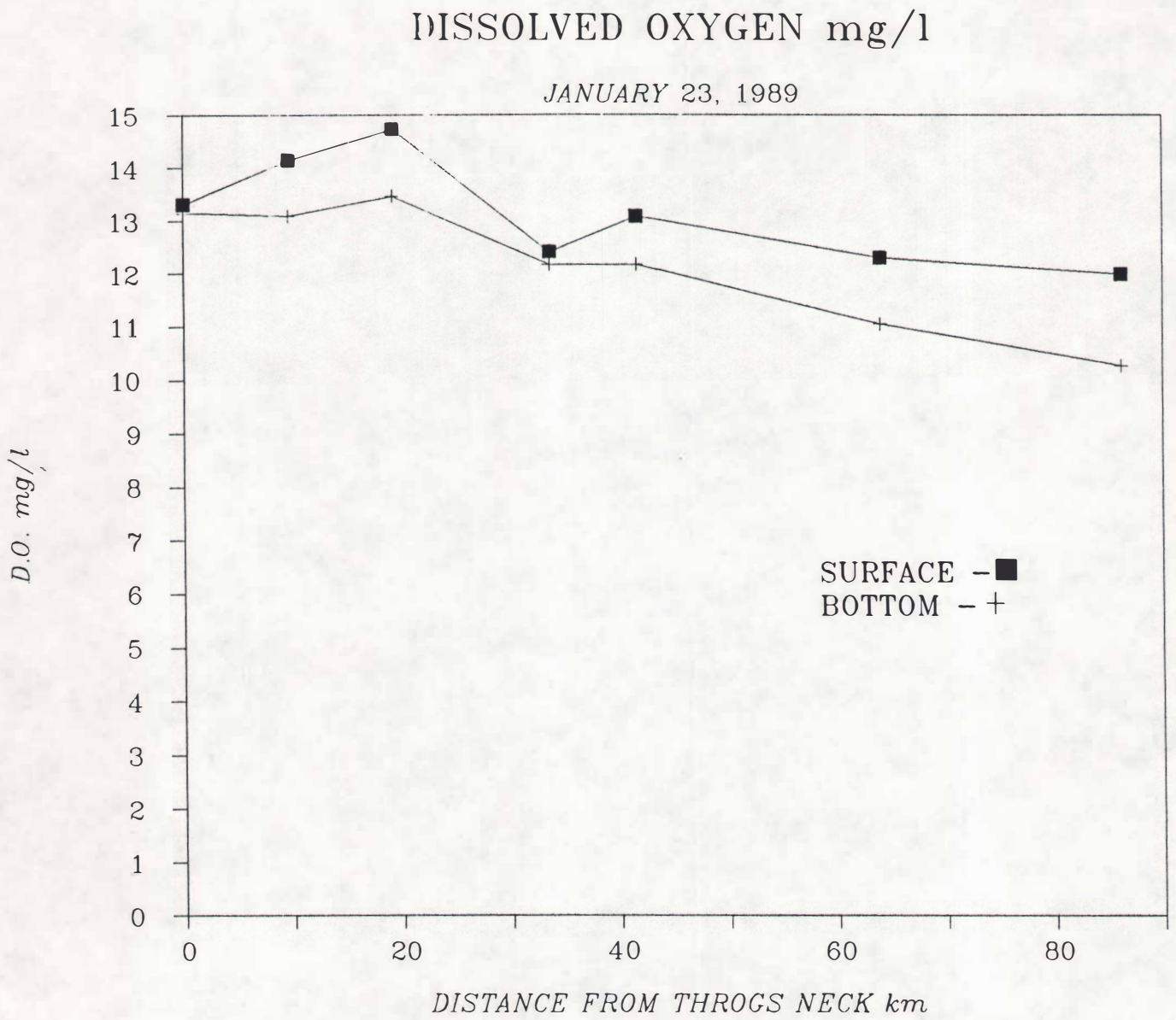

DISSOLVED OXYGEN mg/l
JANUARY 23, 1989
D.O. mg/l
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
0
20
40
60
80
DISTANCE FROM THROGS NECK km
SURFACE -■
BOTTOM -+

Figure 17

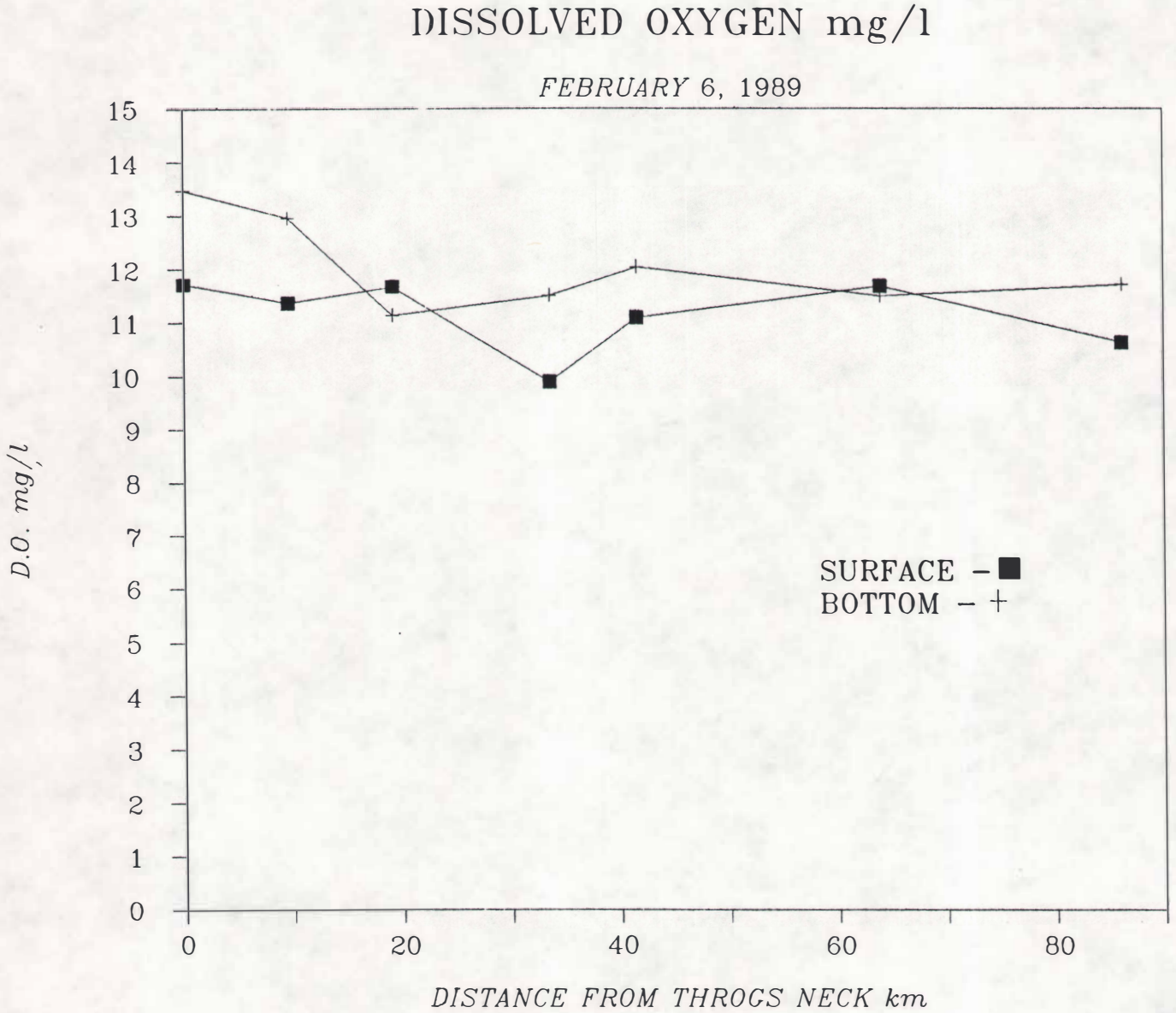

DISSOLVED OXYGEN mg/l
FEBRUARY 6, 1989
D.O. mg/l
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
0
20
40
60
80
DISTANCE FROM THROGS NECK km
SURFACE - ■
BOTTOM - +

Figure 18

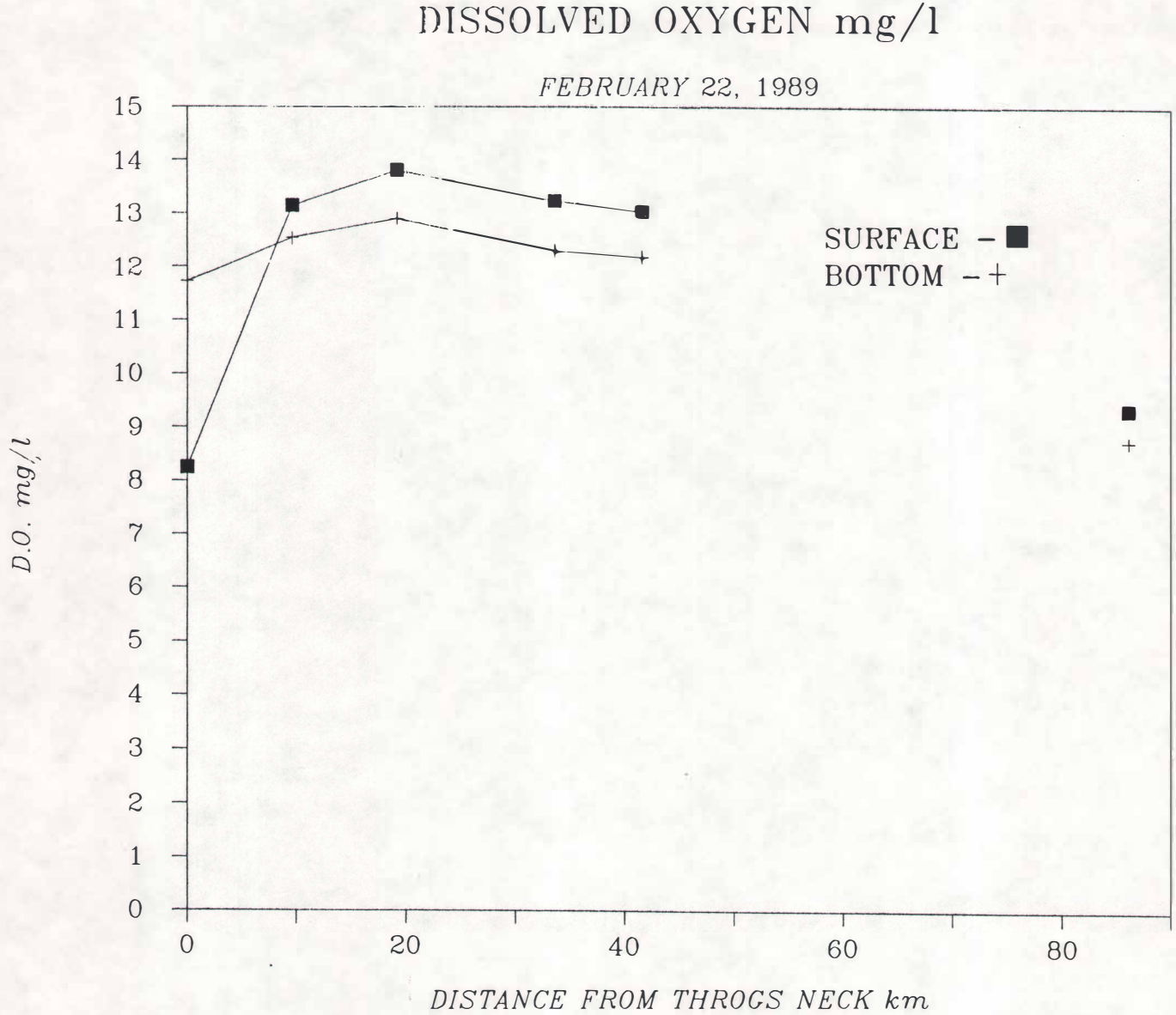

DISSOLVED OXYGEN mg/l
FEBRUARY 22, 1989
SURFACE -
BOTTOM -+
D.O. mg/l
DISTANCE FROM THROGS NECK km
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
0
20
40
60
80

Figure 19

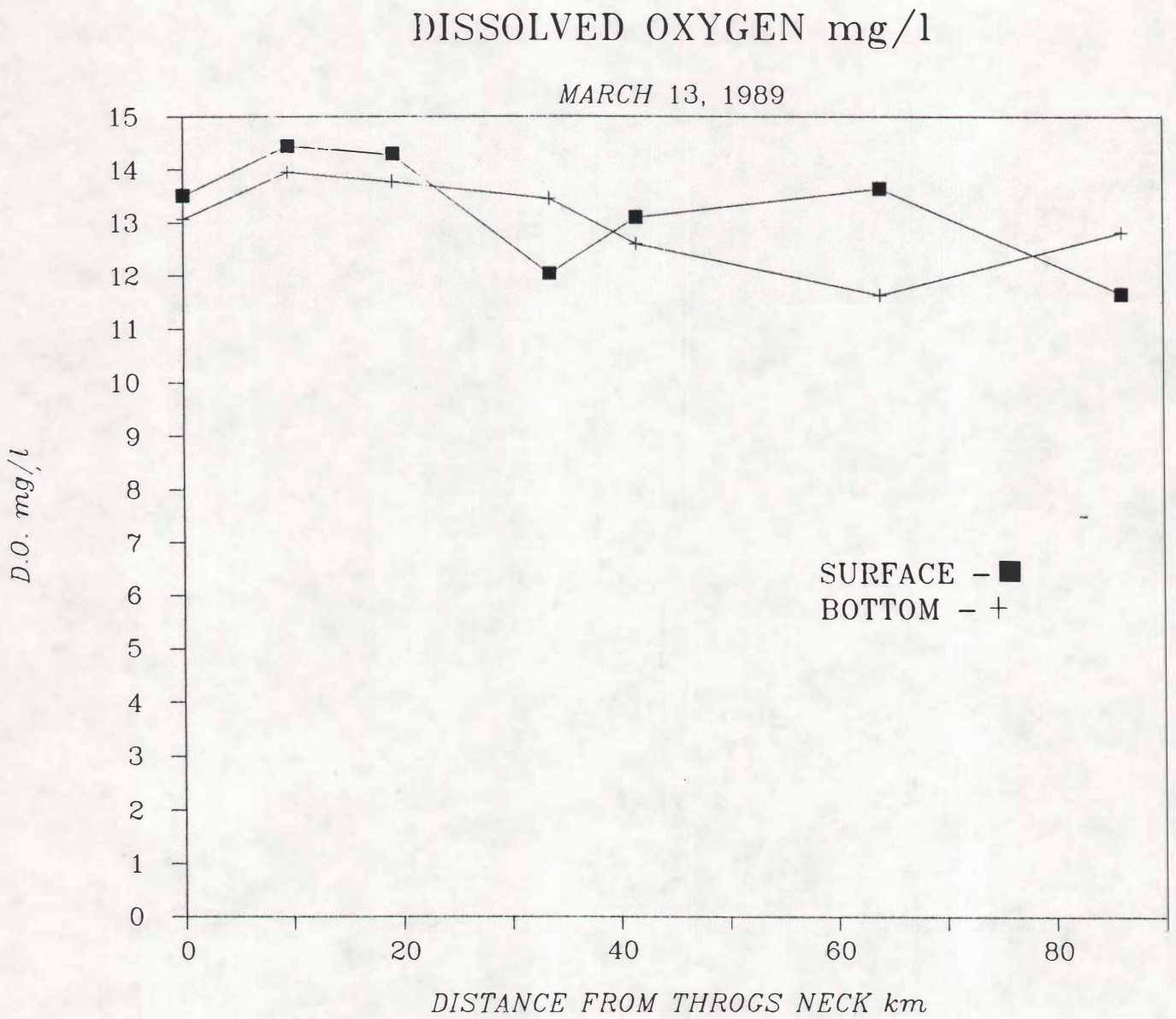

DISSOLVED OXYGEN mg/l
MARCH 13, 1989
D.O. mg/l
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
0
20
40
60
80
DISTANCE FROM THROGS NECK km
SURFACE - ■
BOTTOM - +

Figure 20

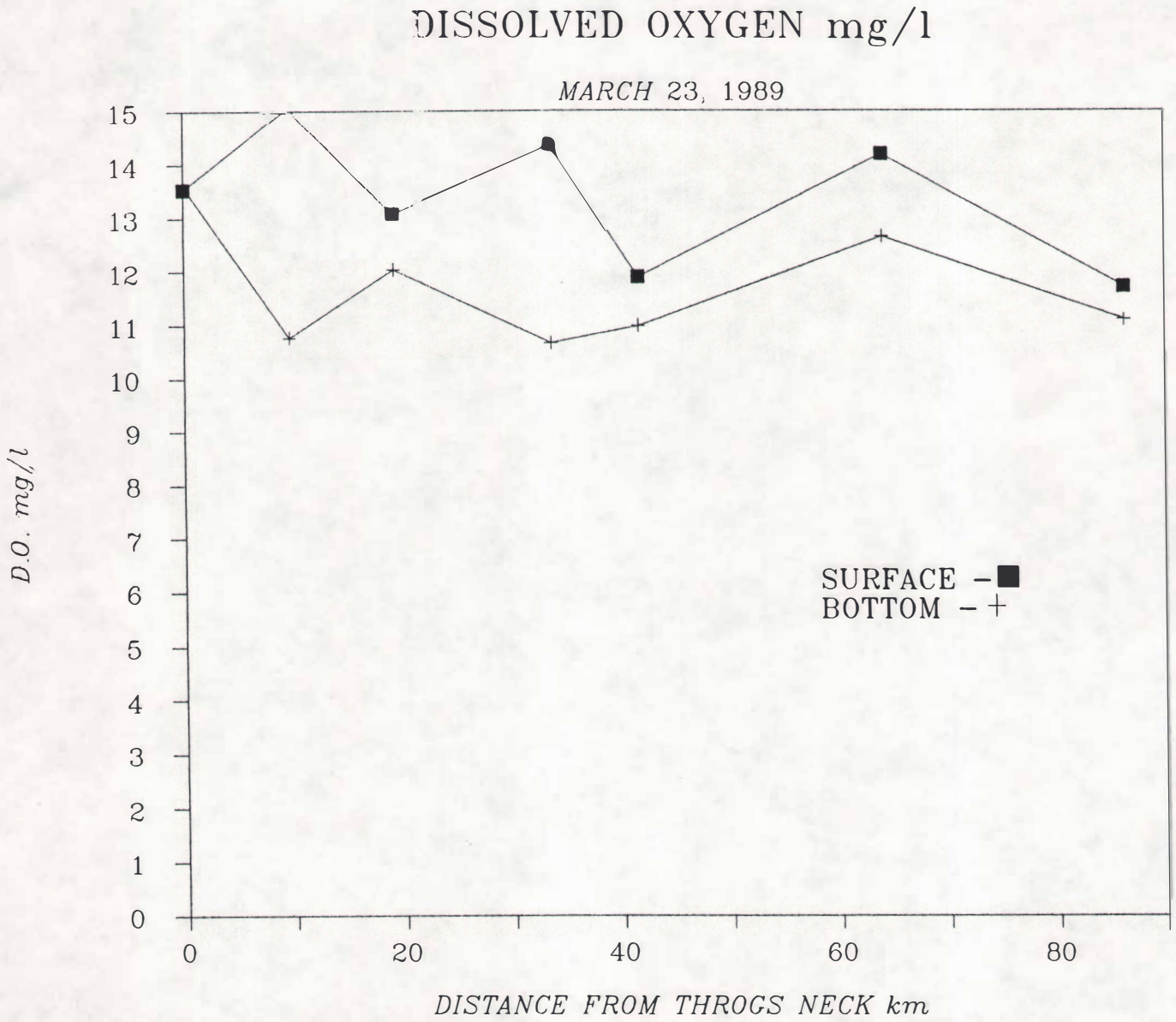

DISSOLVED OXYGEN mg/l
MARCH 23, 1989
D.O. mg/l
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
0
20
40
60
80
DISTANCE FROM THROGS NECK km
SURFACE -■
BOTTOM -+

Figure 21

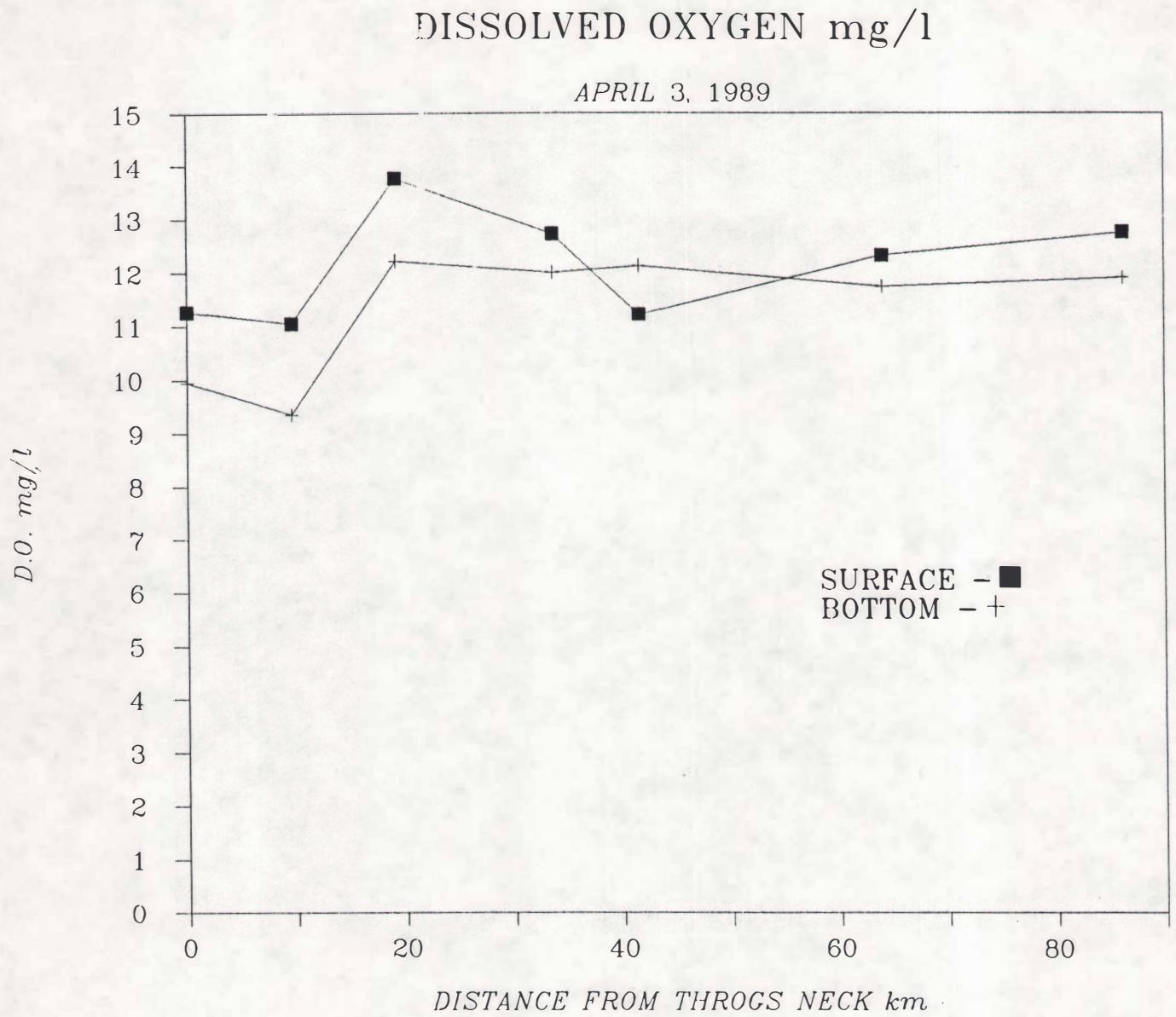

DISSOLVED OXYGEN mg/l
APRIL 3, 1989
D.O. mg/l
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
0
20
40
60
80
DISTANCE FROM THROGS NECK km
SURFACE - ■
BOTTOM - +

Figure 22

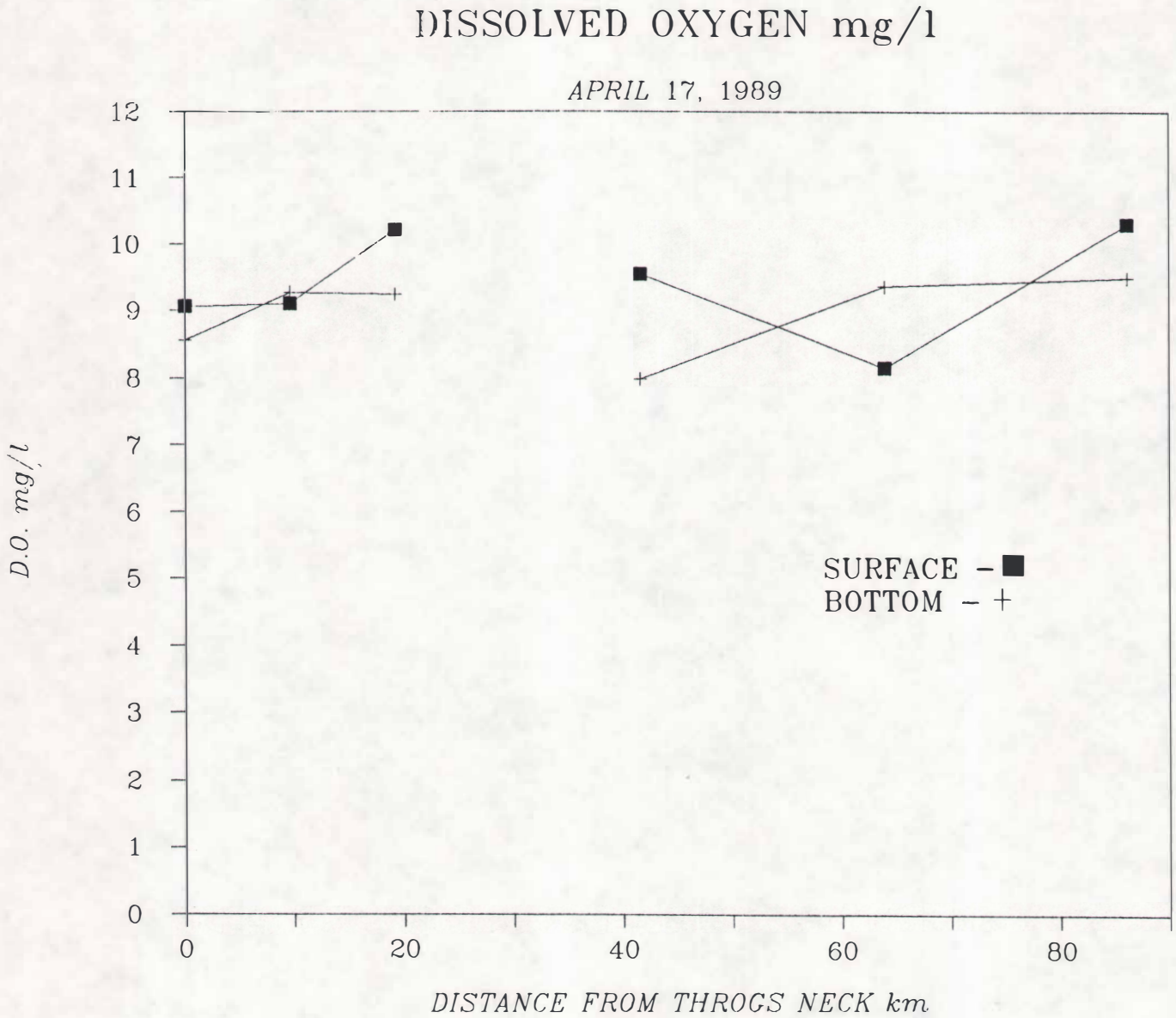

DISSOLVED OXYGEN mg/l
APRIL 17, 1989
12
11
10
9
8
7
6
5
4
3
2
1
0
D.O. mg/l
0
20
40
60
80
DISTANCE FROM THROGS NECK km
SURFACE - ■
BOTTOM - +

Figure 23

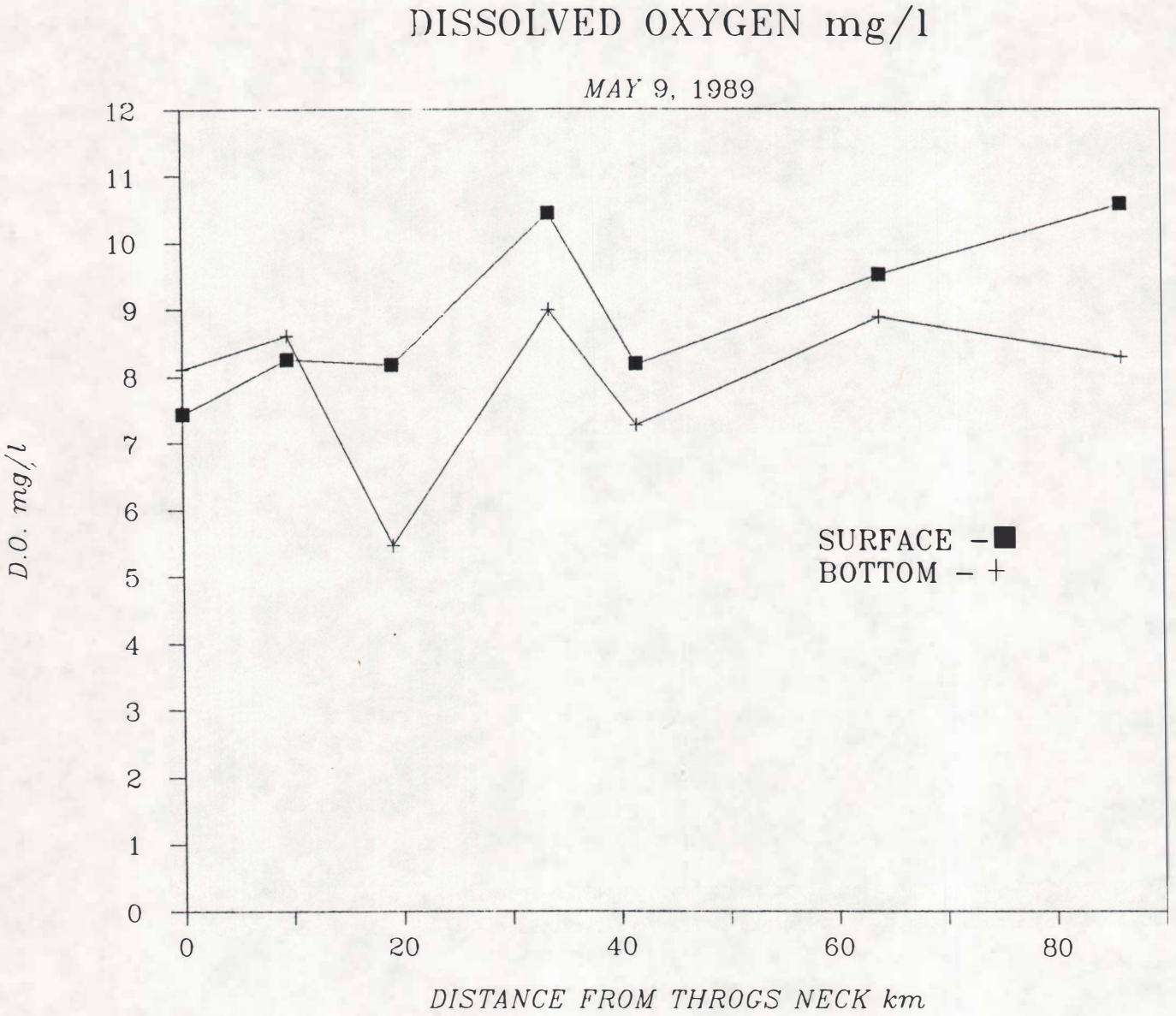

DISSOLVED OXYGEN mg/l
MAY 9, 1989
D.O. mg/l
12
11
10
9
8
7
6
5
4
3
2
1
0
0
20
40
60
80
DISTANCE FROM THROGS NECK km
SURFACE –■
BOTTOM – +

Figure 24

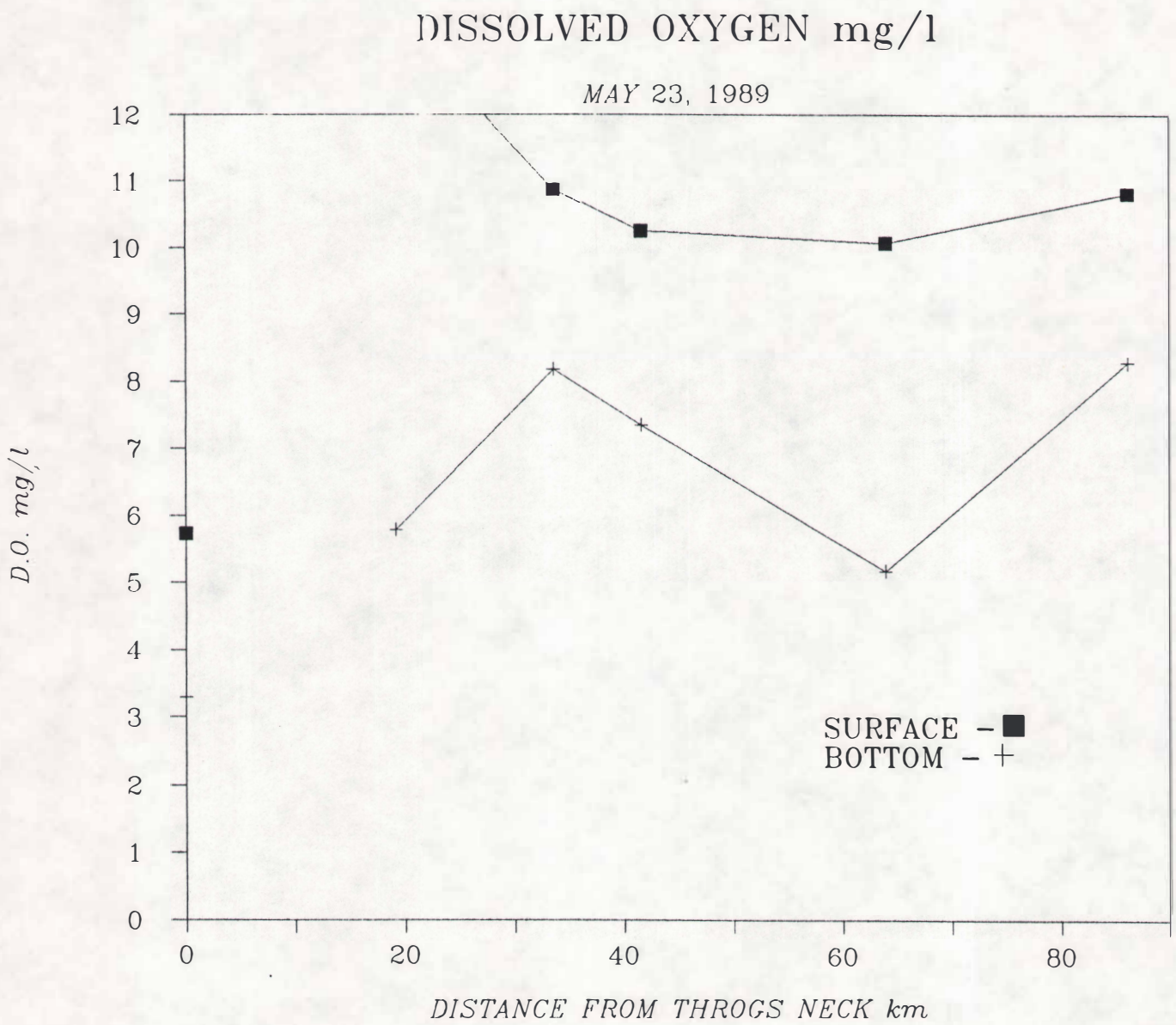

DISSOLVED OXYGEN mg/l
MAY 23, 1989
D.O. mg/l
12
11
10
9
8
7
6
5
4
3
2
1
0
0
20
40
60
80
DISTANCE FROM THROGS NECK km
SURFACE - ■
BOTTOM - +

Figure 25

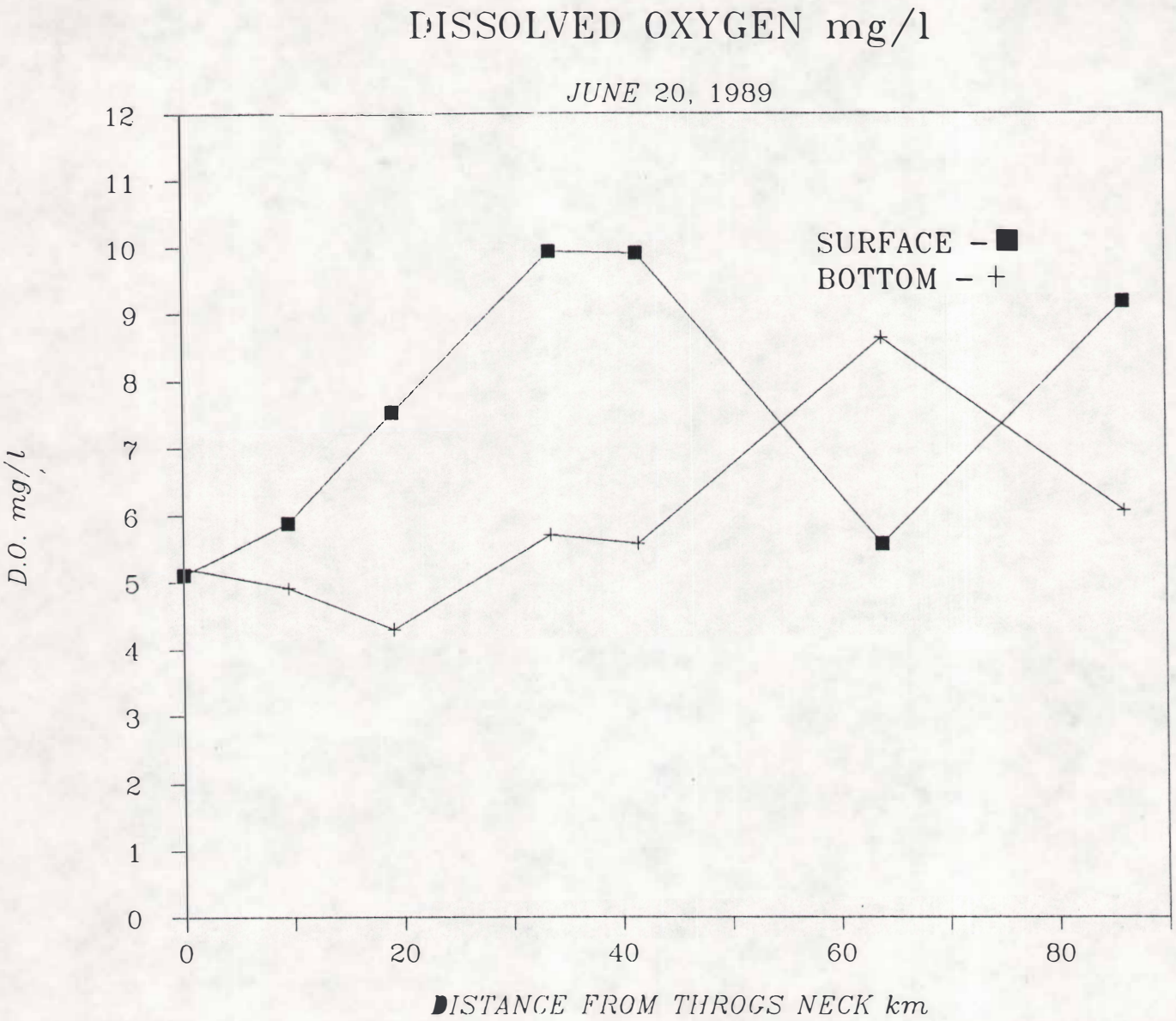

DISSOLVED OXYGEN mg/l
JUNE 20, 1989
SURFACE - ■
BOTTOM - +
D.O. mg/l
12
11
10
9
8
7
6
5
4
3
2
1
0
0
20
40
60
80
DISTANCE FROM THROGS NECK km

Figure 26

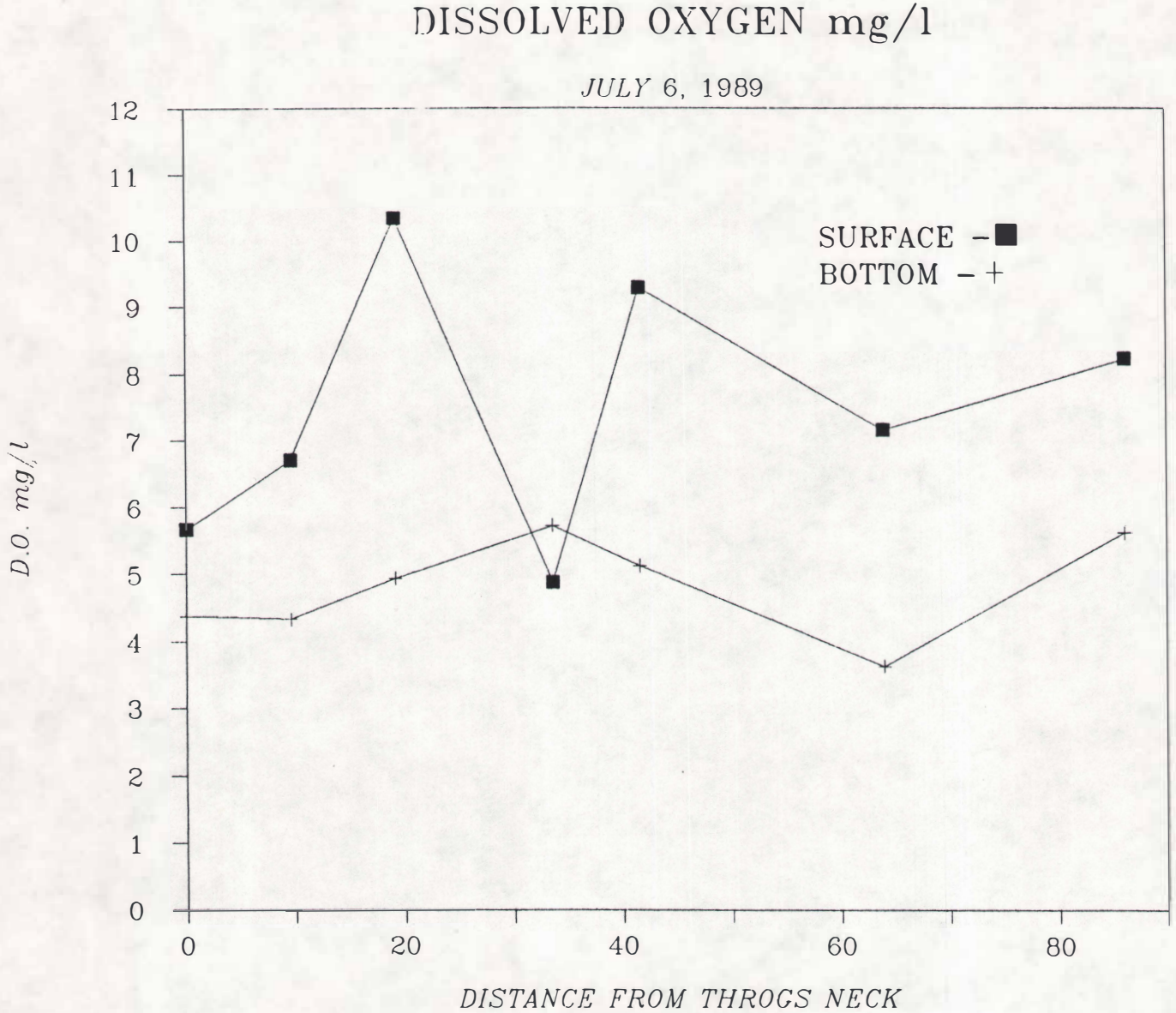

DISSOLVED OXYGEN mg/l
JULY 6, 1989
SURFACE -■
BOTTOM -+
D.O. mg/l
DISTANCE FROM THROGS NECK
0
1
2
3
4
5
6
7
8
9
10
11
12
0
20
40
60
80

Figure 27

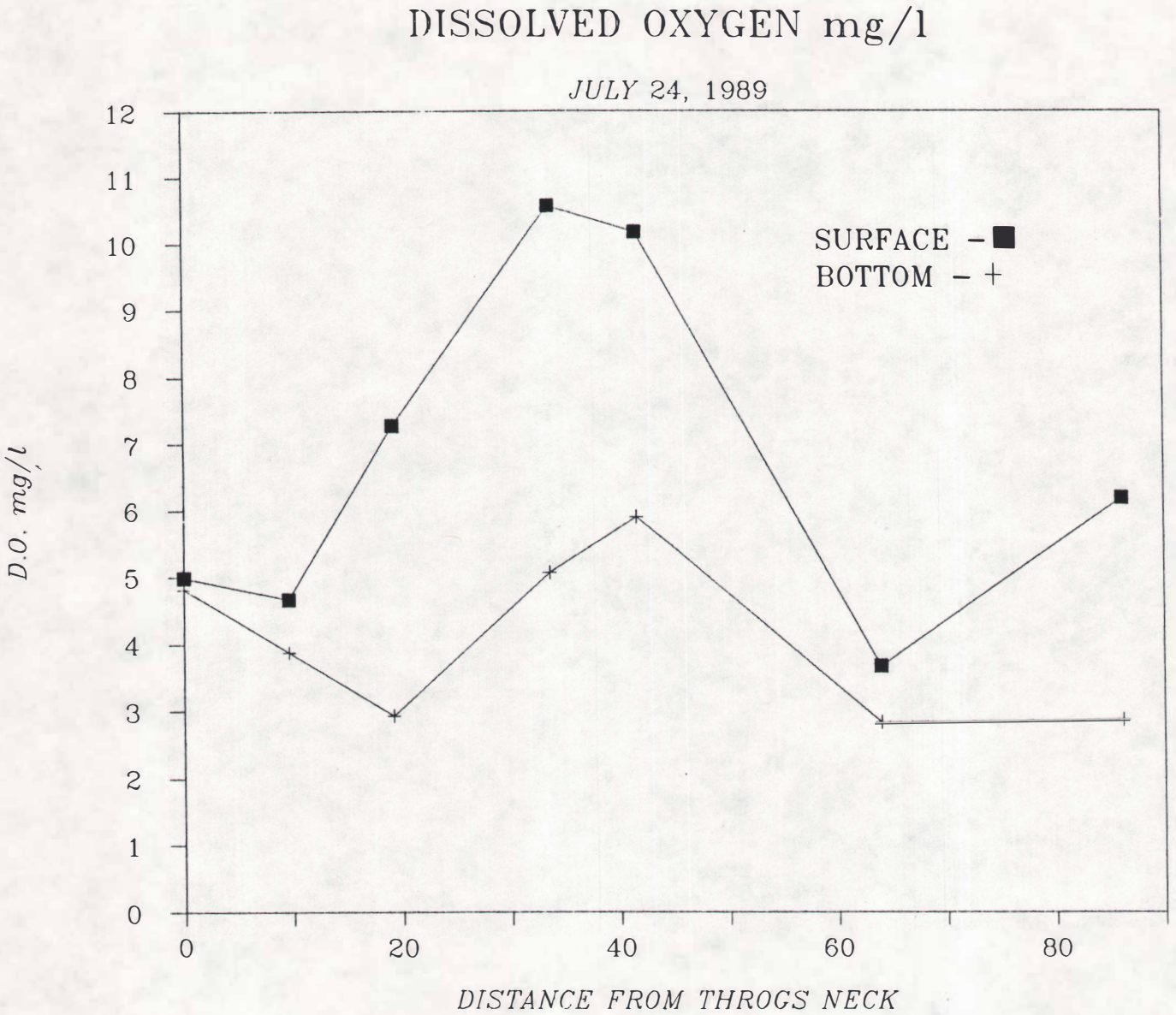

DISSOLVED OXYGEN mg/l
JULY 24, 1989
SURFACE - ■
BOTTOM - +
D.O. mg/l
12
11
10
9
8
7
6
5
4
3
2
1
0
0
20
40
60
80
DISTANCE FROM THROGS NECK

Figure 28

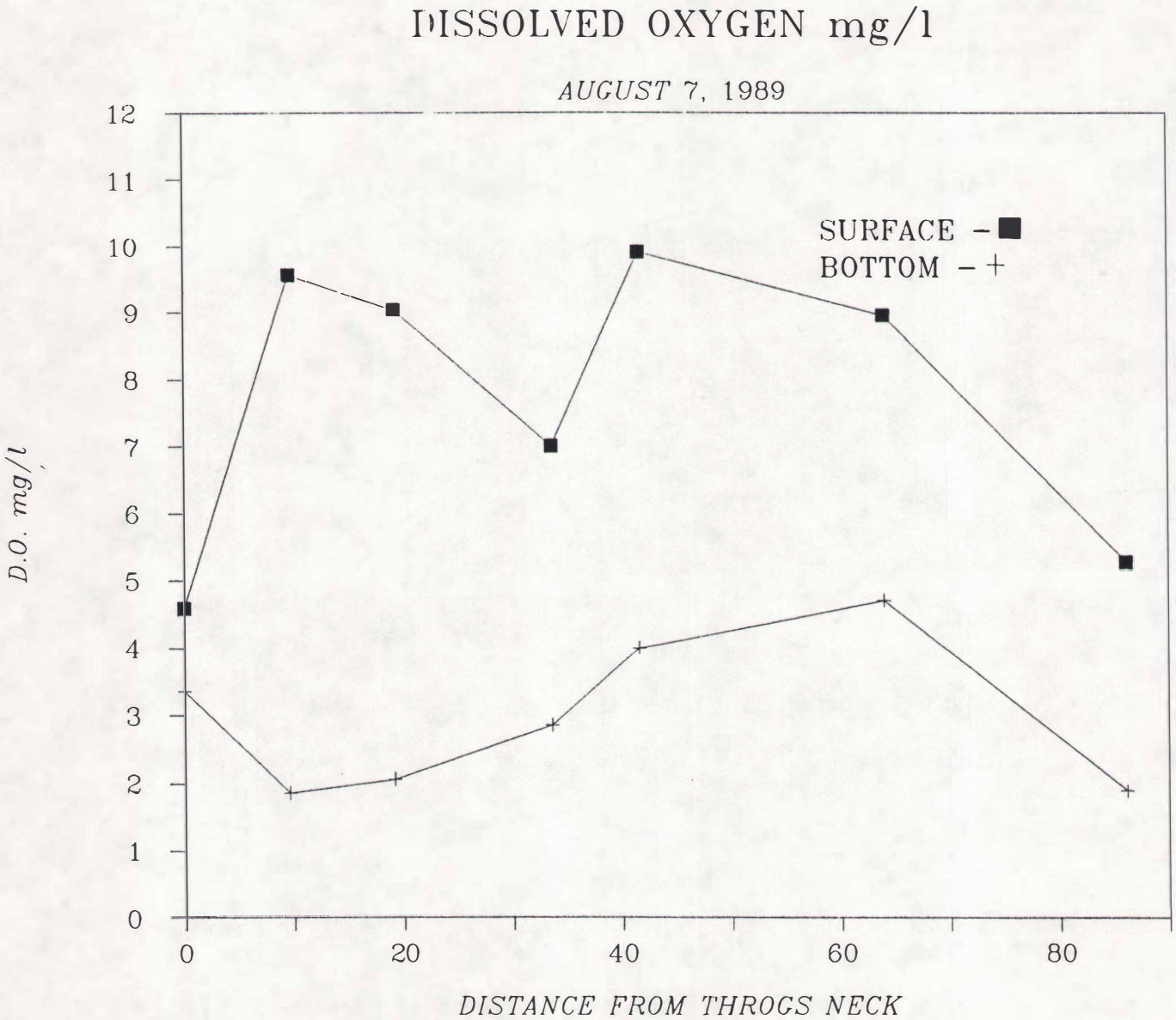

DISSOLVED OXYGEN mg/l
AUGUST 7, 1989
SURFACE - ■
BOTTOM - +
D.O. mg/l
DISTANCE FROM THROGS NECK
0
1
2
3
4
5
6
7
8
9
10
11
12
0
20
40
60
80

Figure 29

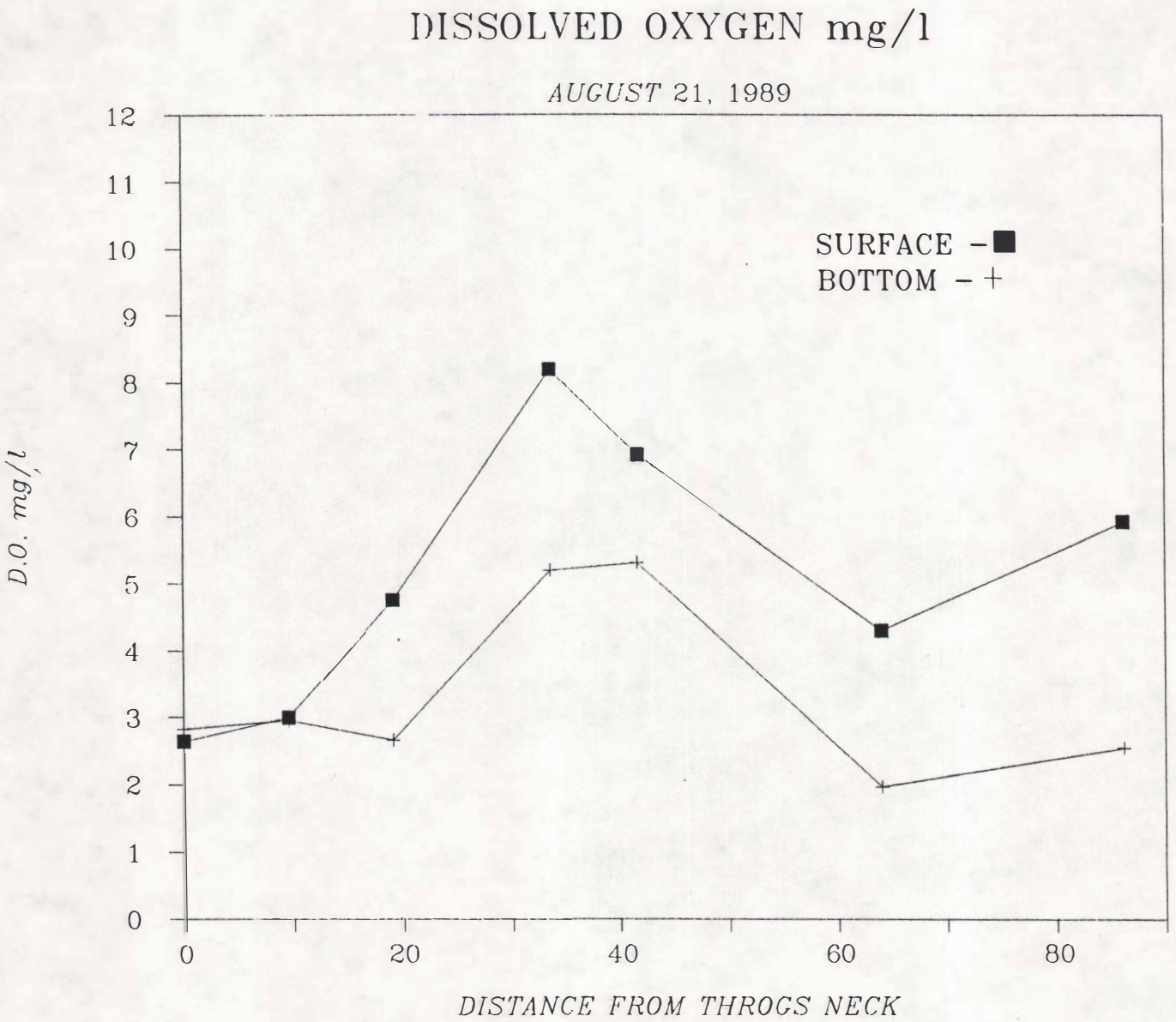

DISSOLVED OXYGEN mg/l
AUGUST 21, 1989
SURFACE - ■
BOTTOM - +
D.O. mg/l
12
11
10
9
8
7
6
5
4
3
2
1
0
0
20
40
60
80
DISTANCE FROM THROGS NECK

Figure 30

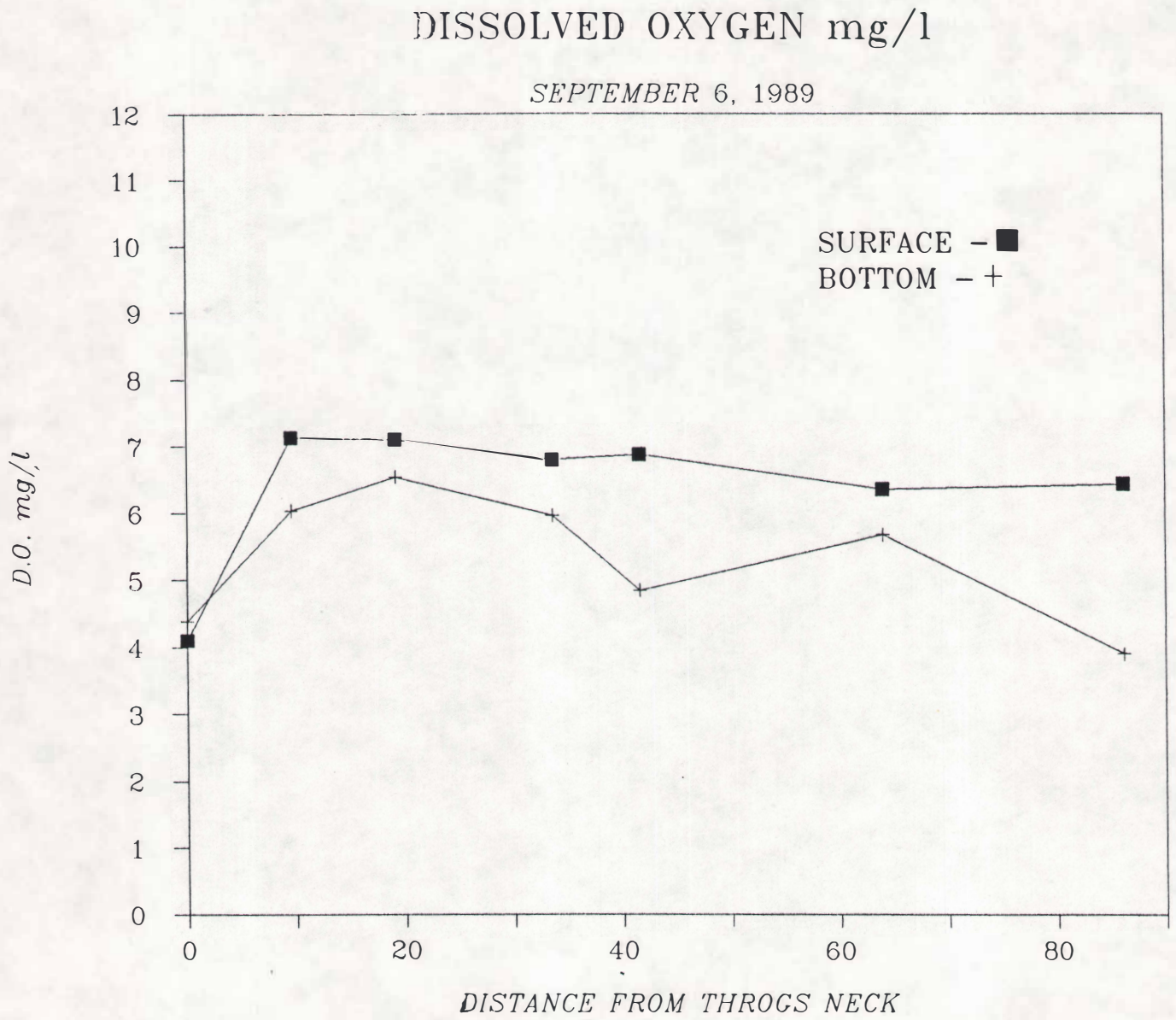

DISSOLVED OXYGEN mg/l
SEPTEMBER 6, 1989
SURFACE - ■
BOTTOM - +
D.O. mg/l
12
11
10
9
8
7
6
5
4
3
2
1
0
0
20
40
60
80
DISTANCE FROM THROGS NECK

Figure 31

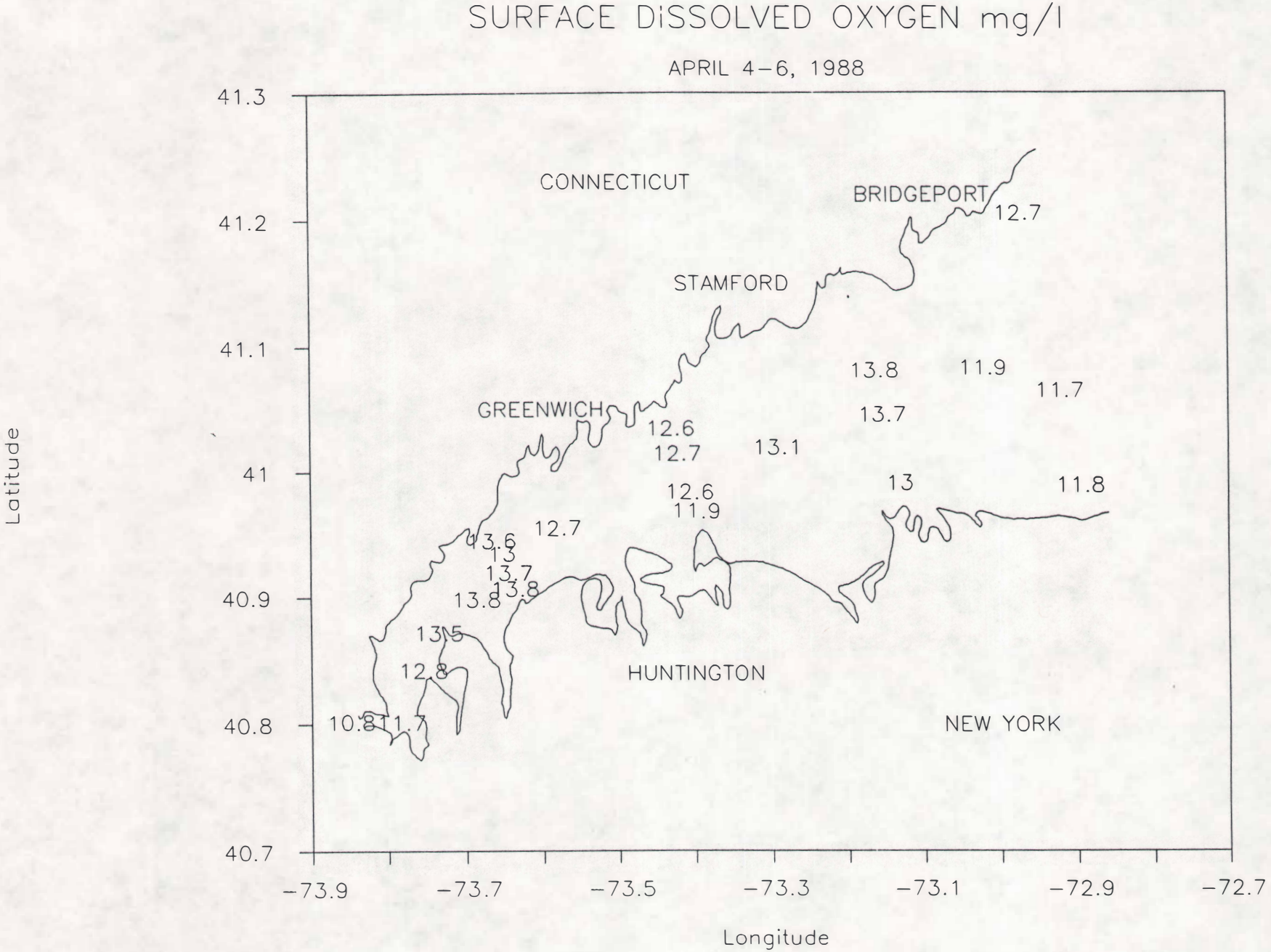

SURFACE DISSOLVED OXYGEN mg/l
APRIL 4-6, 1988
CONNECTICUT
BRIDGEPORT
12.7
STAMFORD
13.8
11.9
11.7
13.7
GREENWICH
12.6
12.7
13.1
13
11.8
12.6
11.9
12.7
13.6
13
13.7
13.8
13.8
13.5
12.8
HUNTINGTON
10.8
11.7
NEW YORK
41.3
41.2
41.1
41
40.9
40.8
40.7
-73.9
-73.7
-73.5
-73.3
-73.1
-72.9
-72.7
Latitude
Longitude

Figure 32

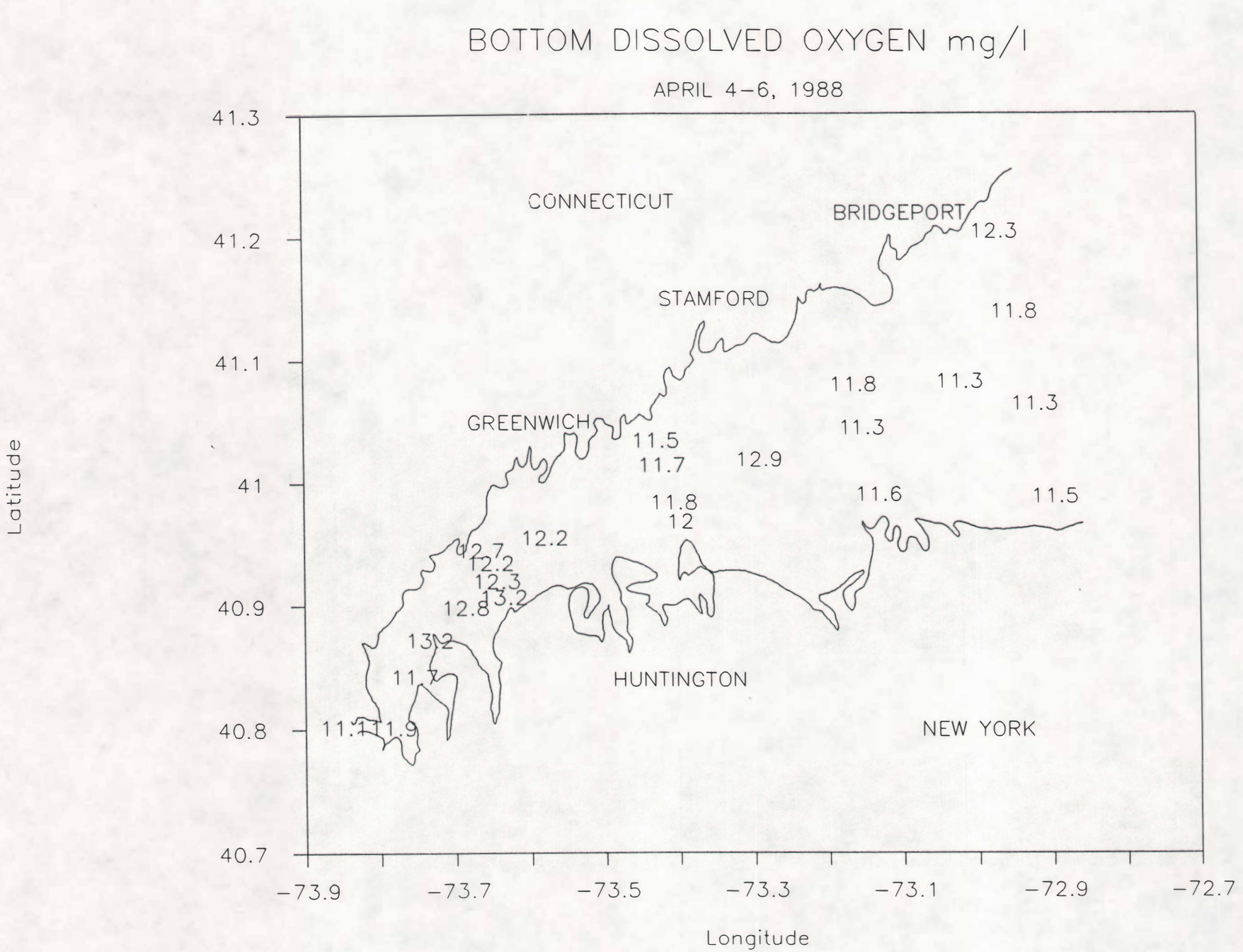

BOTTOM DISSOLVED OXYGEN mg/l
APRIL 4–6, 1988
CONNECTICUT
BRIDGEPORT
STAMFORD
GREENWICH
HUNTINGTON
NEW YORK
12.3
11.8
11.8
11.3
11.3
11.3
11.5
11.7
12.9
11.8
12
11.6
11.5
12.2
12.7
12.2
12.3
13.2
12.8
13.2
11.7
11.1
11.9
41.3
41.2
41.1
41
40.9
40.8
40.7
−73.9
−73.7
−73.5
−73.3
−73.1
−72.9
−72.7
Latitude
Longitude

Figure 33

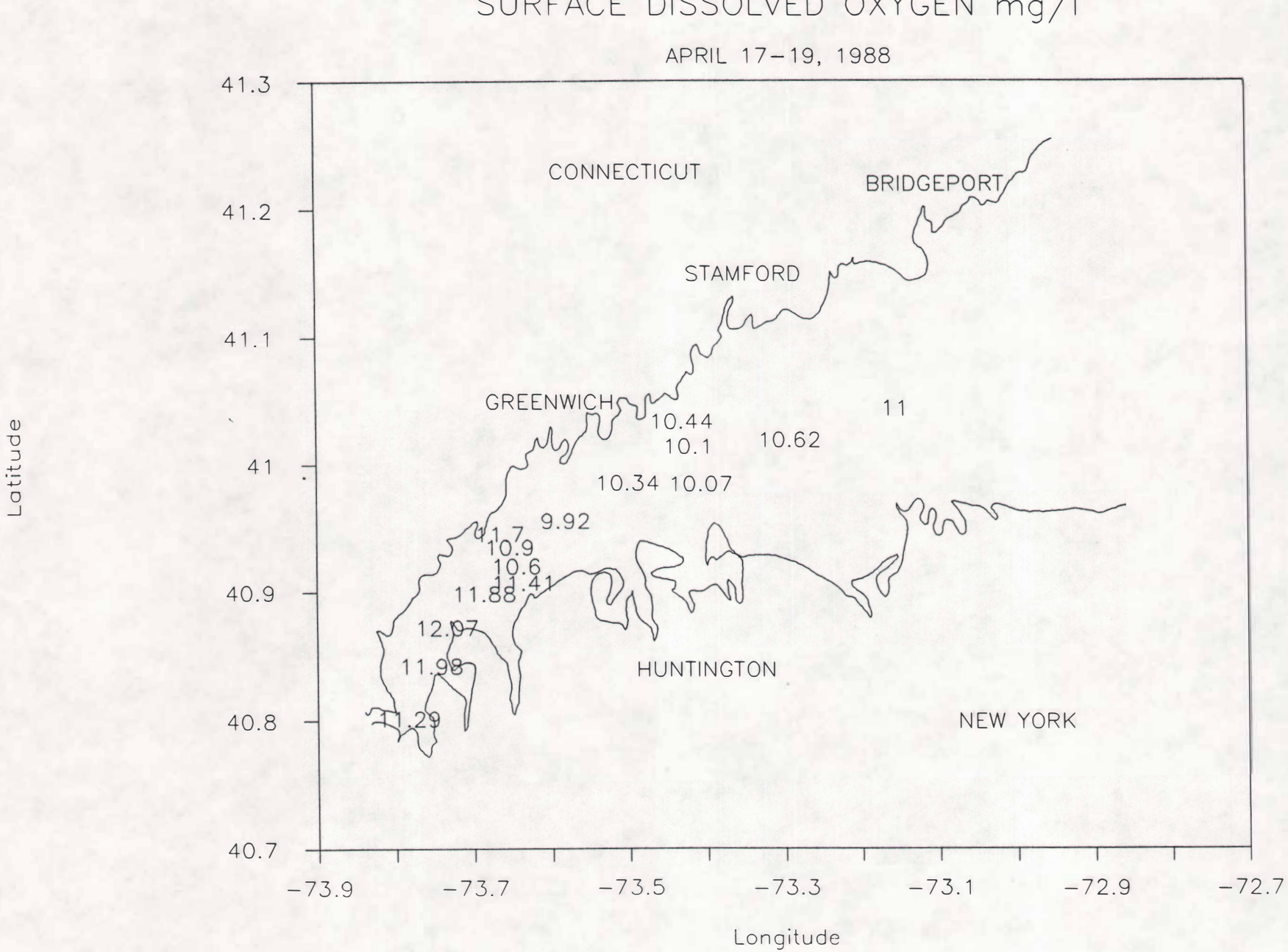

SURFACE DISSOLVED OXYGEN mg/l
APRIL 17-19, 1988
41.3
41.2
41.1
41
40.9
40.8
40.7
Latitude
CONNECTICUT
BRIDGEPORT
STAMFORD
GREENWICH
10.44
10.1
10.62
11
10.34 10.07
9.92
10.9
10.6
11.88
11.41
12.07
11.98
11.29
HUNTINGTON
NEW YORK
-73.9
-73.7
-73.5
-73.3
-73.1
-72.9
-72.7
Longitude

Figure 34

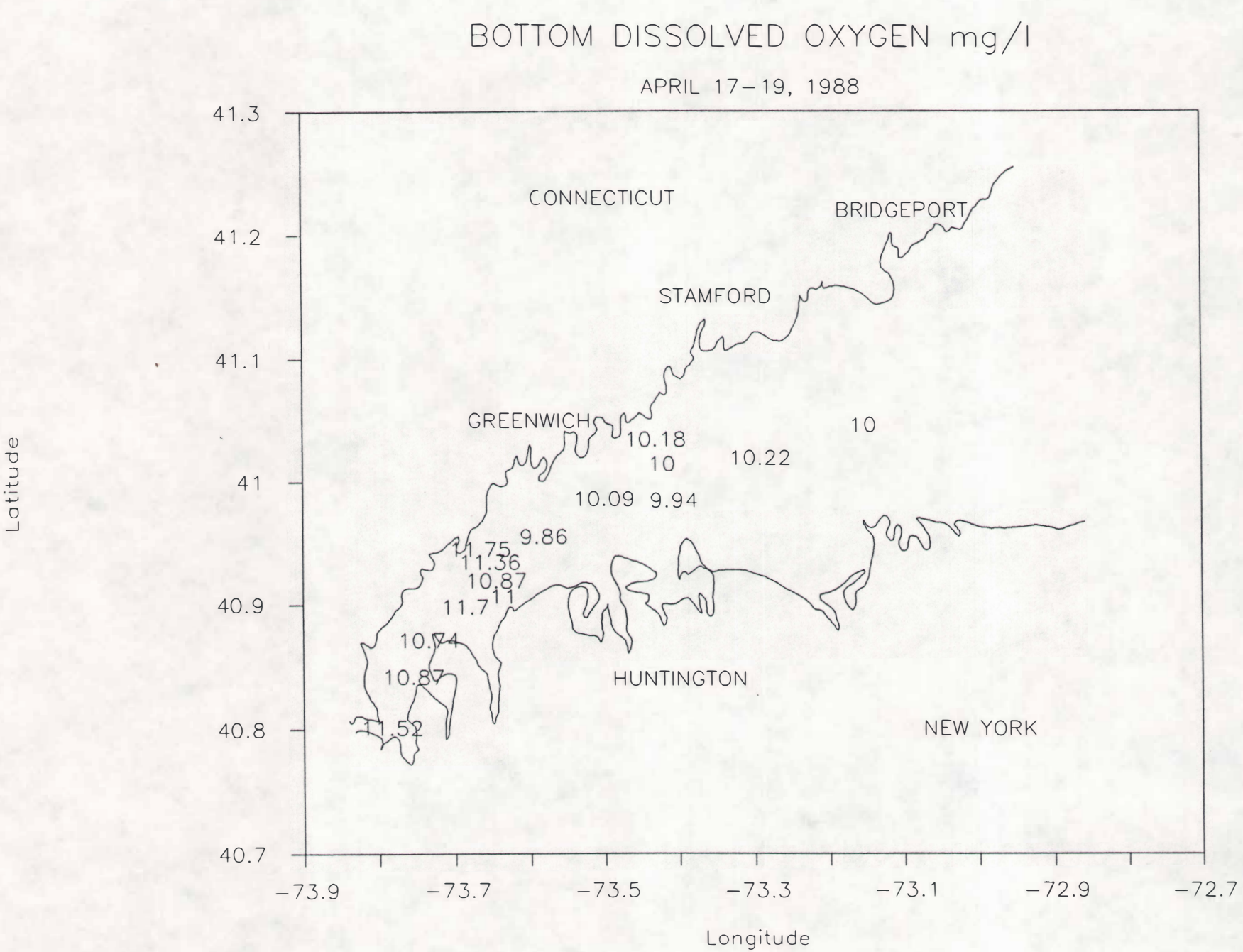

BOTTOM DISSOLVED OXYGEN mg/l
APRIL 17–19, 1988
CONNECTICUT
BRIDGEPORT
STAMFORD
GREENWICH
HUNTINGTON
NEW YORK
10.18
10
10.22
10
10.09
9.94
9.86
11.75
11.36
10.87
11.7
11
10.87
11.52
41.3
41.2
41.1
41
40.9
40.8
40.7
−73.9
−73.7
−73.5
−73.3
−73.1
−72.9
−72.7
Latitude
Longitude

Figure 35

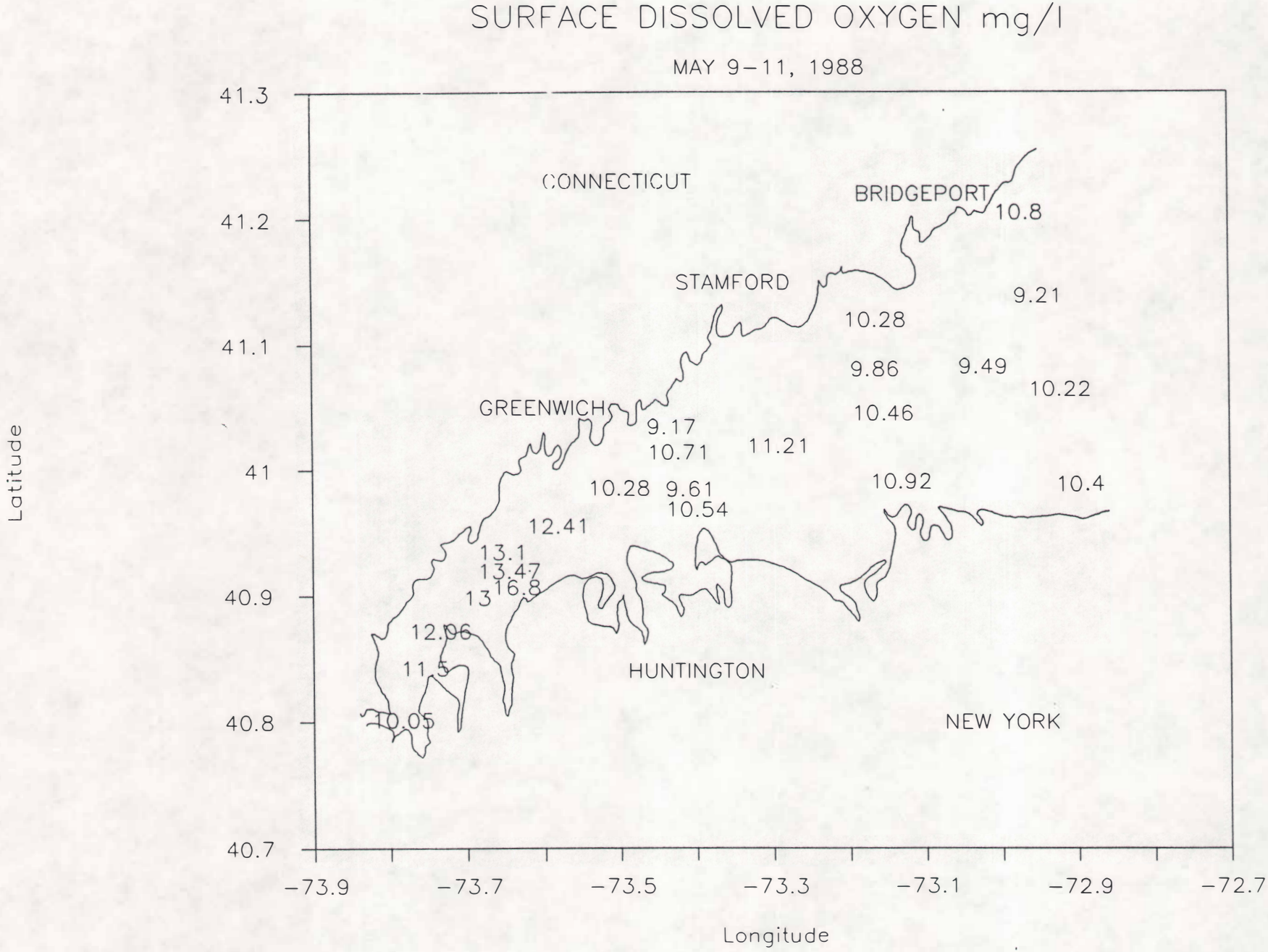

SURFACE DISSOLVED OXYGEN mg/l
MAY 9–11, 1988
CONNECTICUT
BRIDGEPORT
10.8
STAMFORD
9.21
10.28
9.86
9.49
10.22
10.46
GREENWICH
9.17
10.71
11.21
10.28
9.61
10.54
10.92
10.4
12.41
13.1
13.47
13
16.8
12.06
11.5
10.05
HUNTINGTON
NEW YORK
41.3
41.2
41.1
41
40.9
40.8
40.7
−73.9
−73.7
−73.5
−73.3
−73.1
−72.9
−72.7
Latitude
Longitude

Figure 36

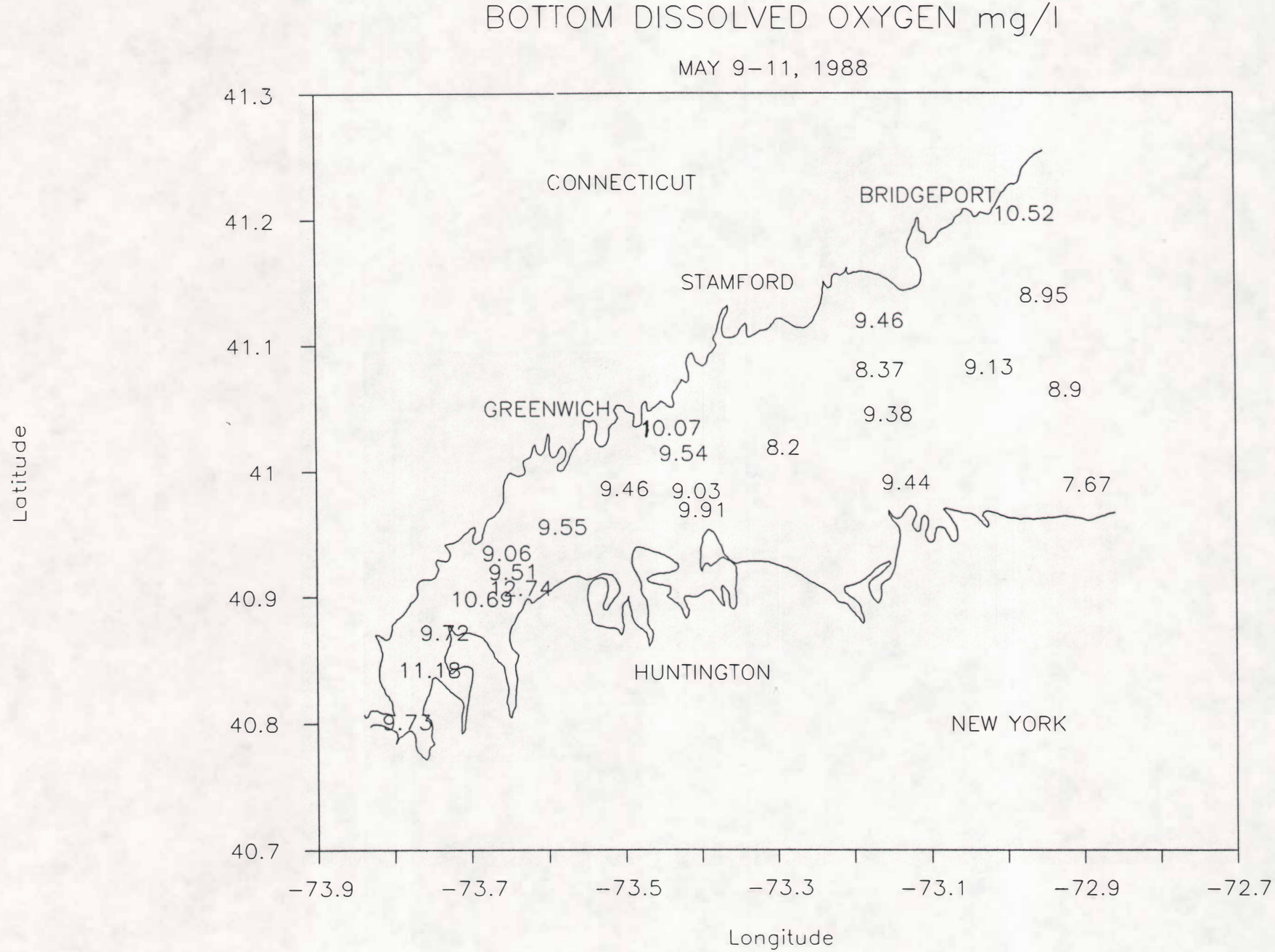

BOTTOM DISSOLVED OXYGEN mg/l
MAY 9–11, 1988
CONNECTICUT
BRIDGEPORT
10.52
STAMFORD
8.95
9.46
8.37
9.13
8.9
9.38
GREENWICH
10.07
9.54
8.2
9.46
9.03
9.91
9.44
7.67
9.55
9.06
9.51
10.69
9.72
11.18
9.73
HUNTINGTON
NEW YORK
41.3
41.2
41.1
41
40.9
40.8
40.7
−73.9
−73.7
−73.5
−73.3
−73.1
−72.9
−72.7
Latitude
Longitude

Figure 37

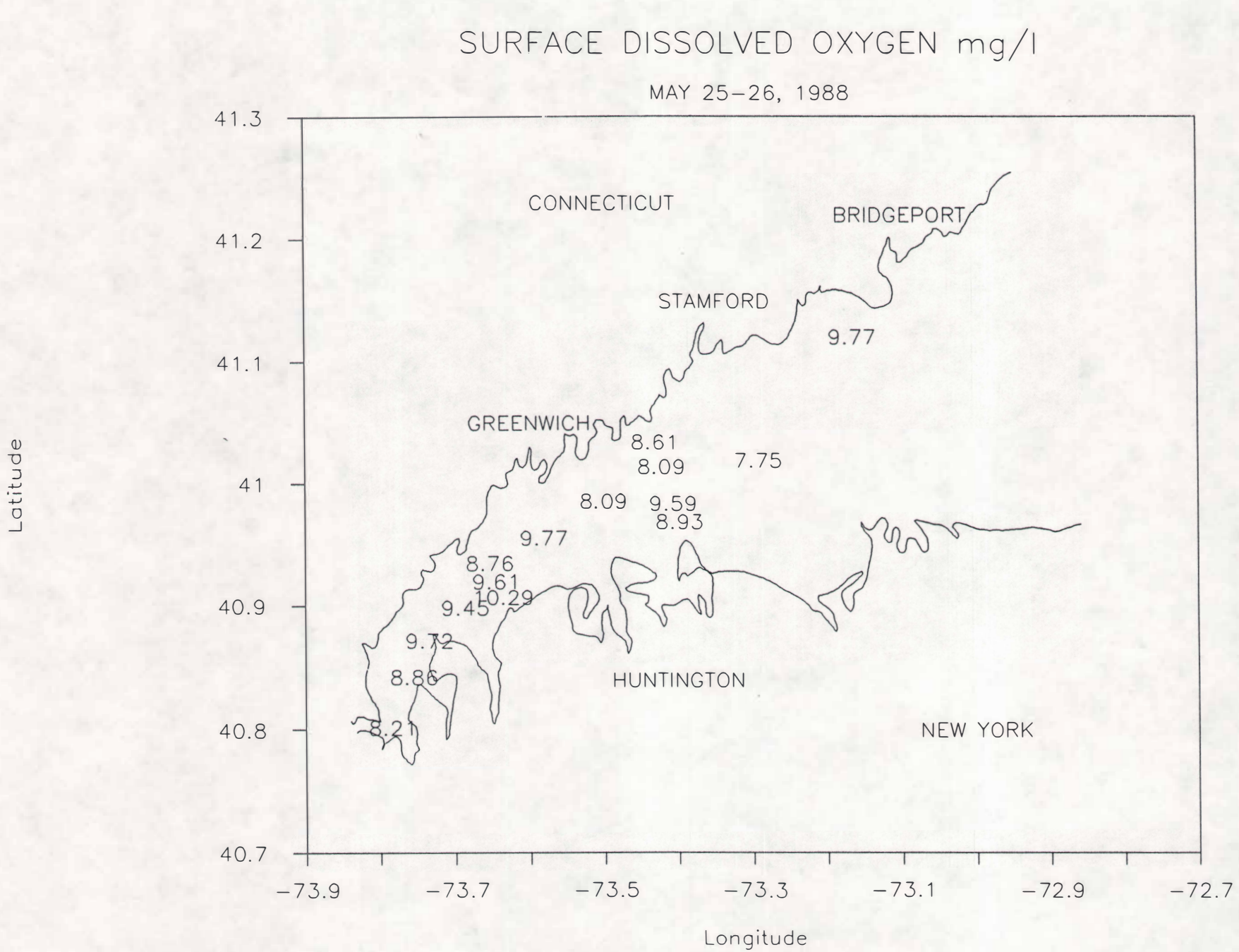

SURFACE DISSOLVED OXYGEN mg/l
MAY 25–26, 1988
CONNECTICUT
BRIDGEPORT
STAMFORD
9.77
GREENWICH
8.61
8.09
7.75
8.09
9.59
8.93
9.77
8.76
9.61
10.29
9.45
9.72
8.86
8.21
HUNTINGTON
NEW YORK
41.3
41.2
41.1
41
40.9
40.8
40.7
Latitude
−73.9
−73.7
−73.5
−73.3
−73.1
−72.9
−72.7
Longitude

Figure 38

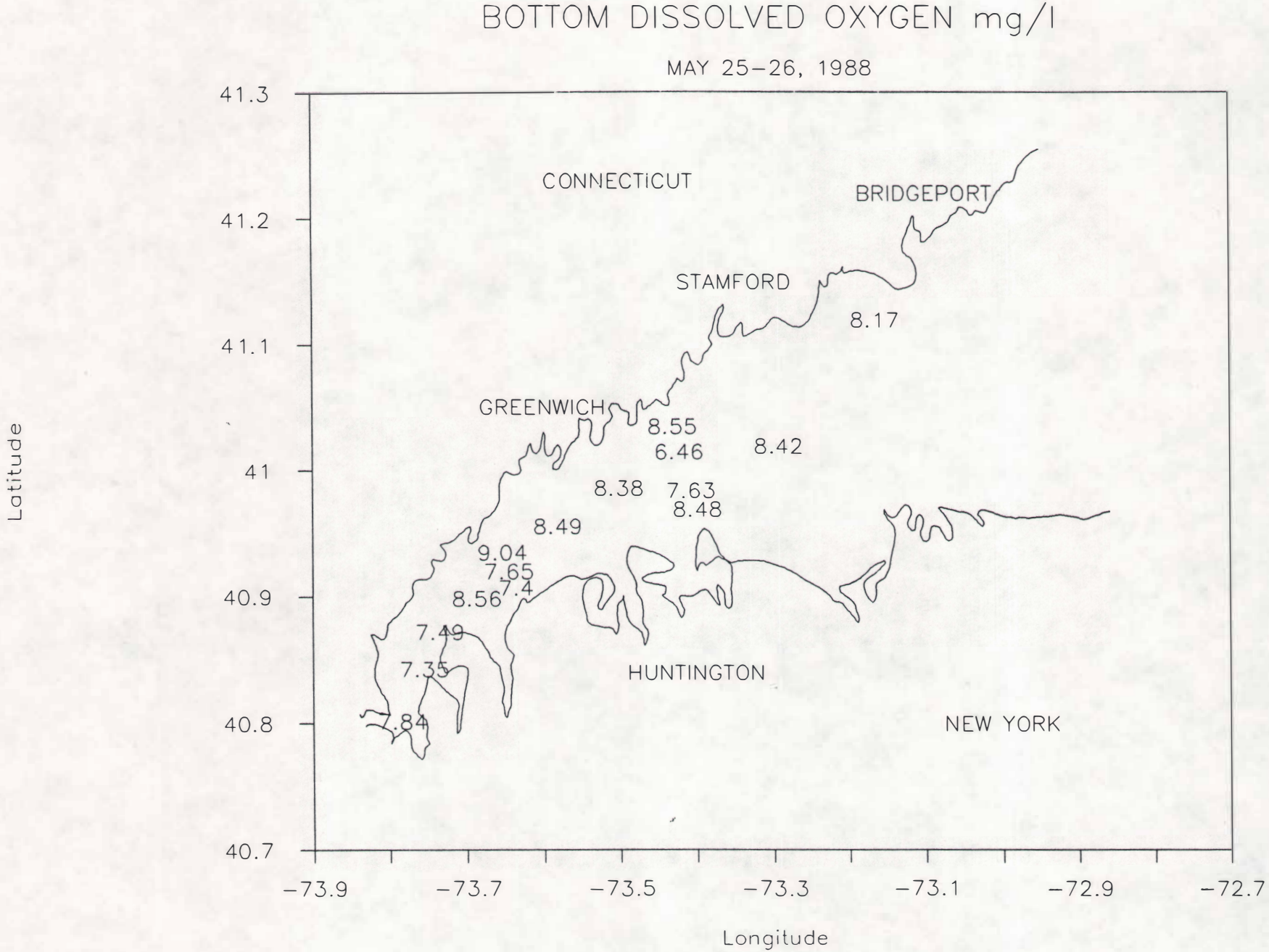

BOTTOM DISSOLVED OXYGEN mg/l
MAY 25–26, 1988
CONNECTICUT
BRIDGEPORT
STAMFORD
8.17
GREENWICH
8.55
6.46
8.42
8.38
7.63
8.48
8.49
9.04
7.65
7.4
8.56
7.49
7.35
7.84
HUNTINGTON
NEW YORK
41.3
41.2
41.1
41
40.9
40.8
40.7
Latitude
−73.9
−73.7
−73.5
−73.3
−73.1
−72.9
−72.7
Longitude

Figure 39

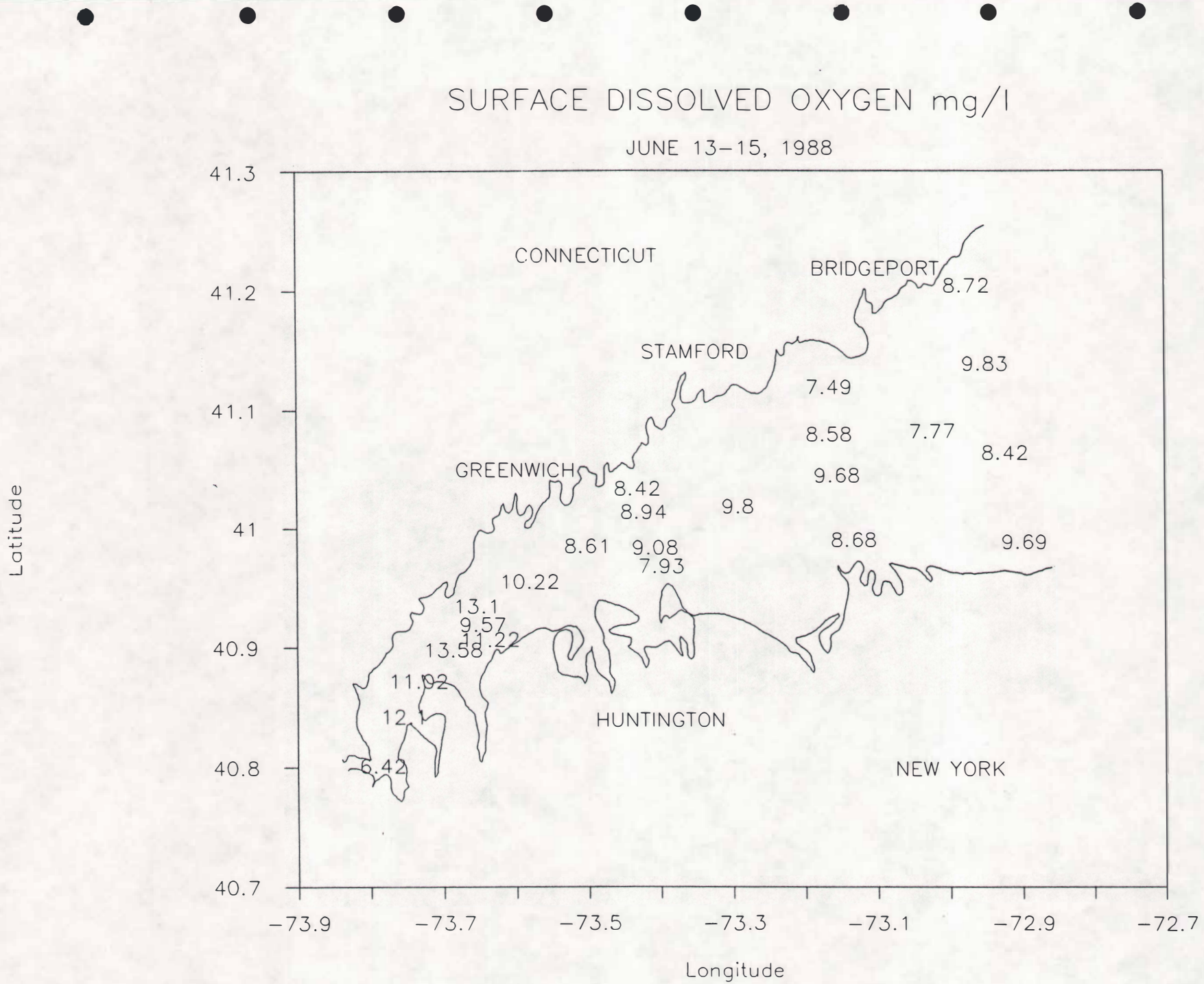

SURFACE DISSOLVED OXYGEN mg/l
JUNE 13–15, 1988
CONNECTICUT
BRIDGEPORT
STAMFORD
GREENWICH
HUNTINGTON
NEW YORK
8.72
9.83
7.49
8.58
7.77
8.42
9.68
8.42
8.94
9.8
8.61
9.08
7.93
8.68
9.69
10.22
13.1
9.57
13.58
11.02
12.1
6.42
41.3
41.2
41.1
41
40.9
40.8
40.7
−73.9
−73.7
−73.5
−73.3
−73.1
−72.9
−72.7
Latitude
Longitude

Figure 40

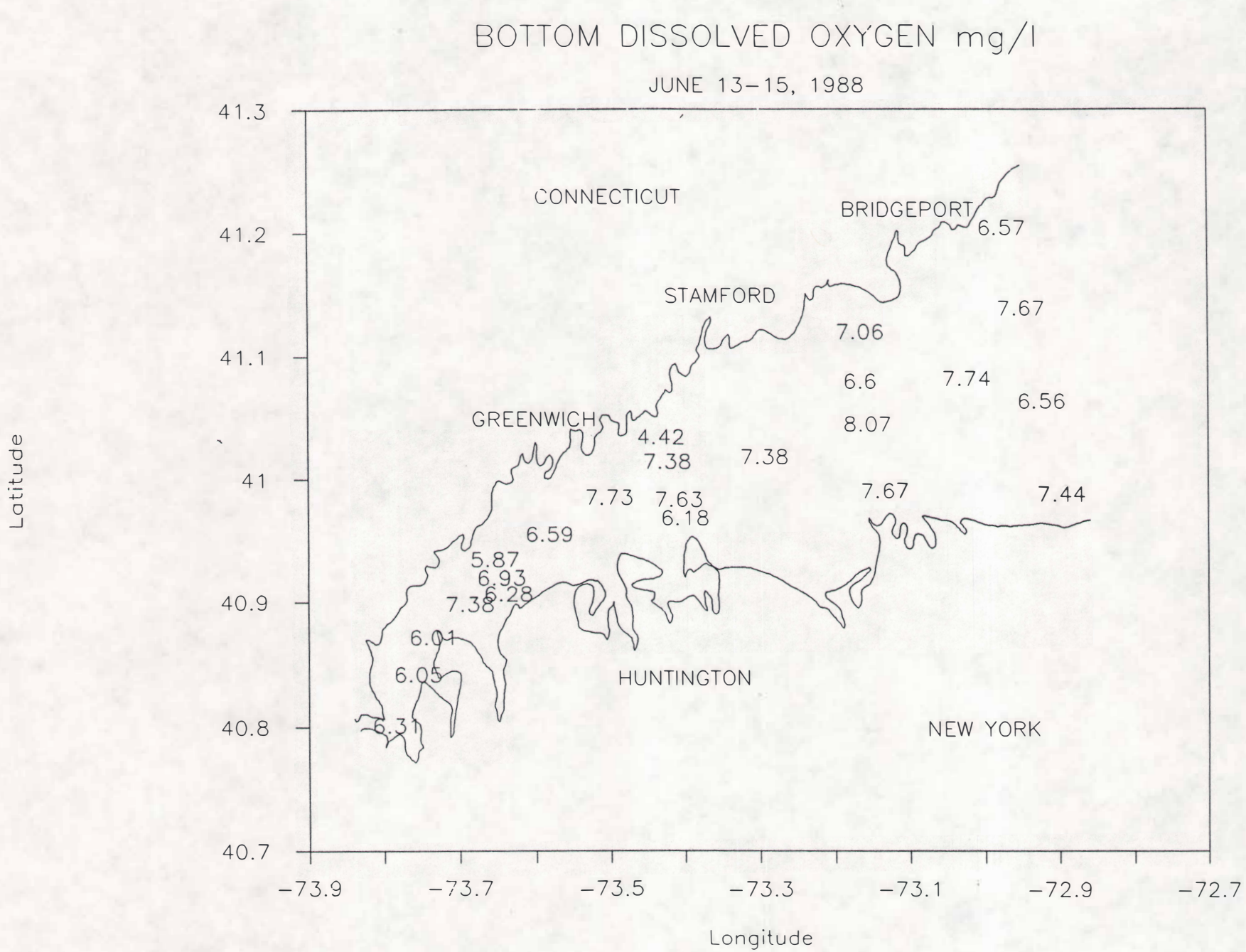

BOTTOM DISSOLVED OXYGEN mg/l
JUNE 13–15, 1988
CONNECTICUT
BRIDGEPORT
STAMFORD
GREENWICH
HUNTINGTON
NEW YORK
6.57
7.67
7.06
6.6
7.74
6.56
8.07
4.42
7.38
7.38
7.73
7.63
6.18
7.67
7.44
6.59
5.87
6.93
6.28
7.38
6.01
6.05
6.31
41.3
41.2
41.1
41
40.9
40.8
40.7
−73.9
−73.7
−73.5
−73.3
−73.1
−72.9
−72.7
Latitude
Longitude

Figure 41

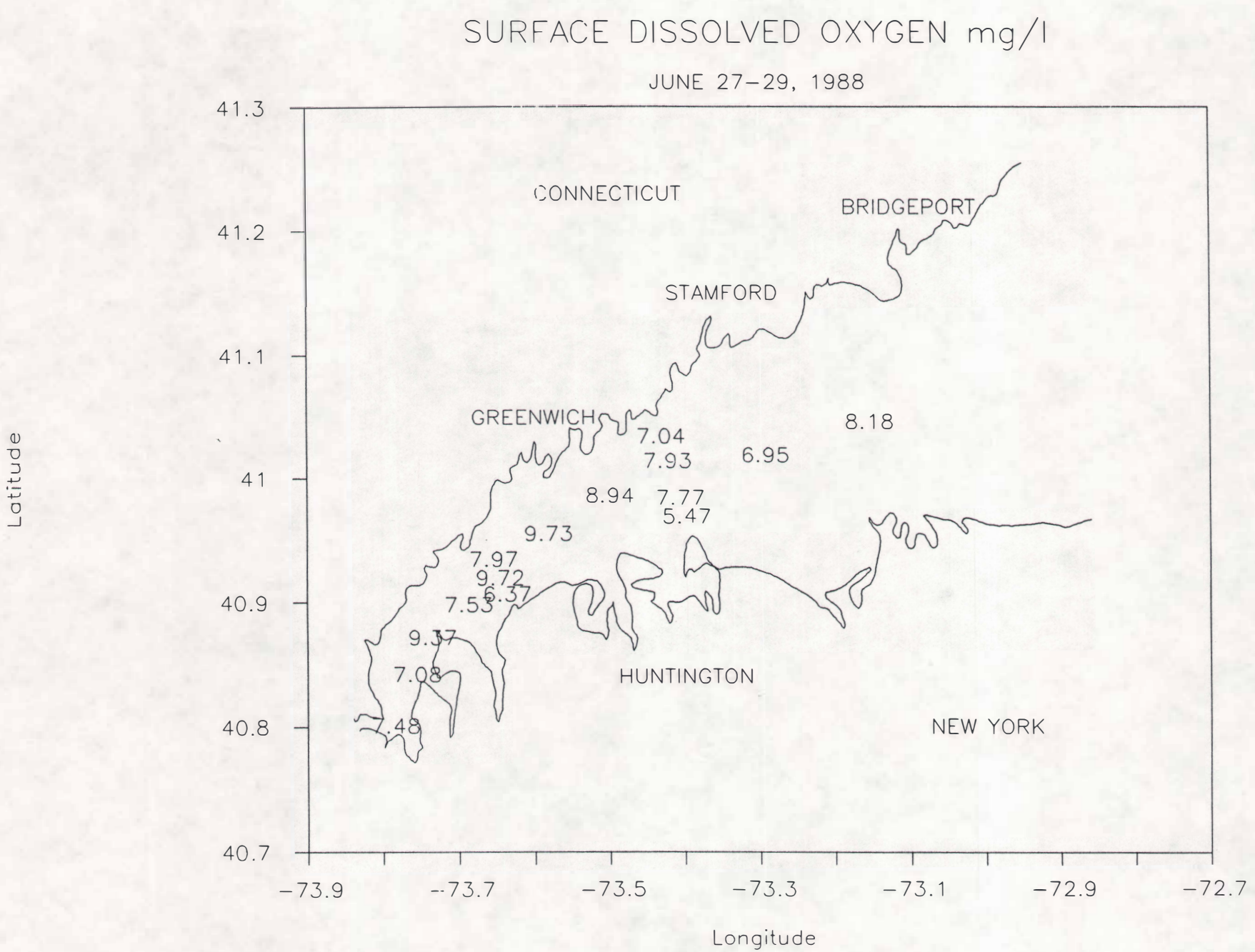

SURFACE DISSOLVED OXYGEN mg/l
JUNE 27–29, 1988
CONNECTICUT
BRIDGEPORT
STAMFORD
GREENWICH
HUNTINGTON
NEW YORK
8.18
7.04
7.93
6.95
8.94
7.77
5.47
9.73
7.97
9.72
6.37
7.53
9.37
7.08
7.48
41.3
41.2
41.1
41
40.9
40.8
40.7
−73.9
−73.7
−73.5
−73.3
−73.1
−72.9
−72.7
Latitude
Longitude

Figure 42

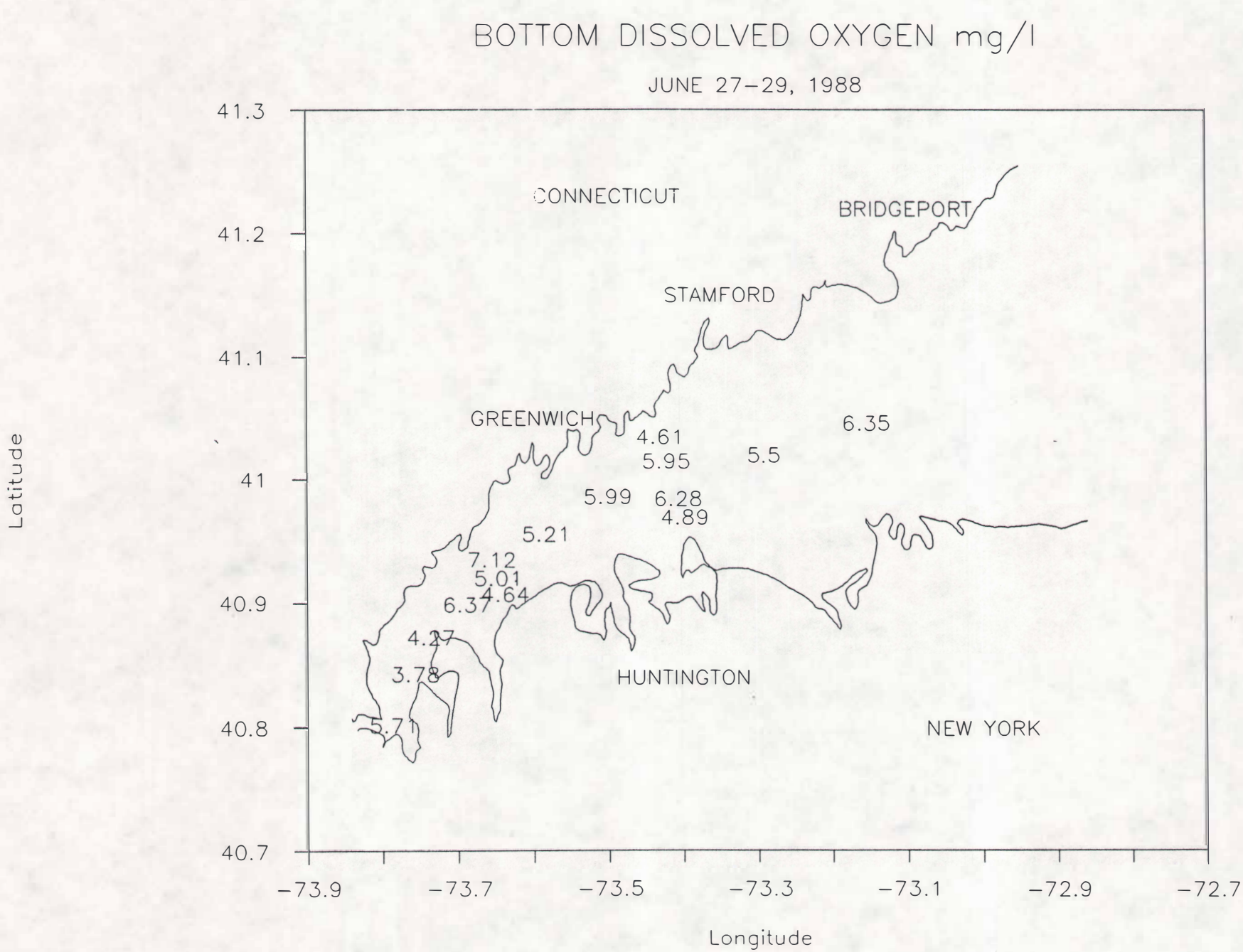

BOTTOM DISSOLVED OXYGEN mg/l
JUNE 27–29, 1988
CONNECTICUT
BRIDGEPORT
STAMFORD
GREENWICH
HUNTINGTON
NEW YORK
6.35
4.61
5.95
5.5
5.99
6.28
4.89
5.21
7.12
5.01
4.64
6.37
4.27
3.78
5.71
41.3
41.2
41.1
41
40.9
40.8
40.7
−73.9
−73.7
−73.5
−73.3
−73.1
−72.9
−72.7
Latitude
Longitude

Figure 43

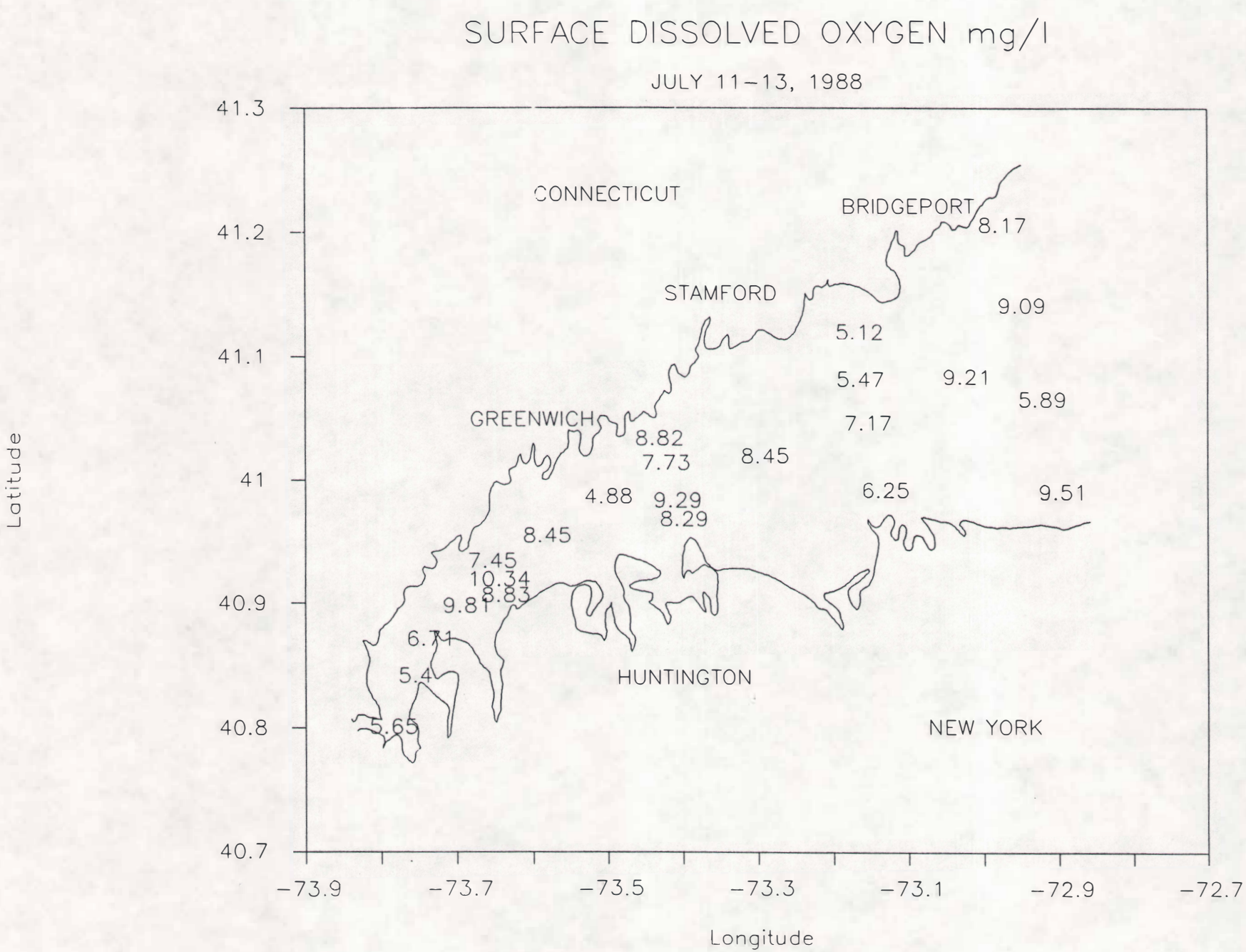

SURFACE DISSOLVED OXYGEN mg/l
JULY 11–13, 1988
CONNECTICUT
BRIDGEPORT
8.17
STAMFORD
9.09
5.12
5.47
9.21
5.89
7.17
GREENWICH
8.82
7.73
8.45
4.88
9.29
8.29
6.25
9.51
8.45
7.45
10.34
8.83
9.81
6.71
5.4
HUNTINGTON
5.65
NEW YORK
41.3
41.2
41.1
41
40.9
40.8
40.7
Latitude
−73.9
−73.7
−73.5
−73.3
−73.1
−72.9
−72.7
Longitude

Figure 44

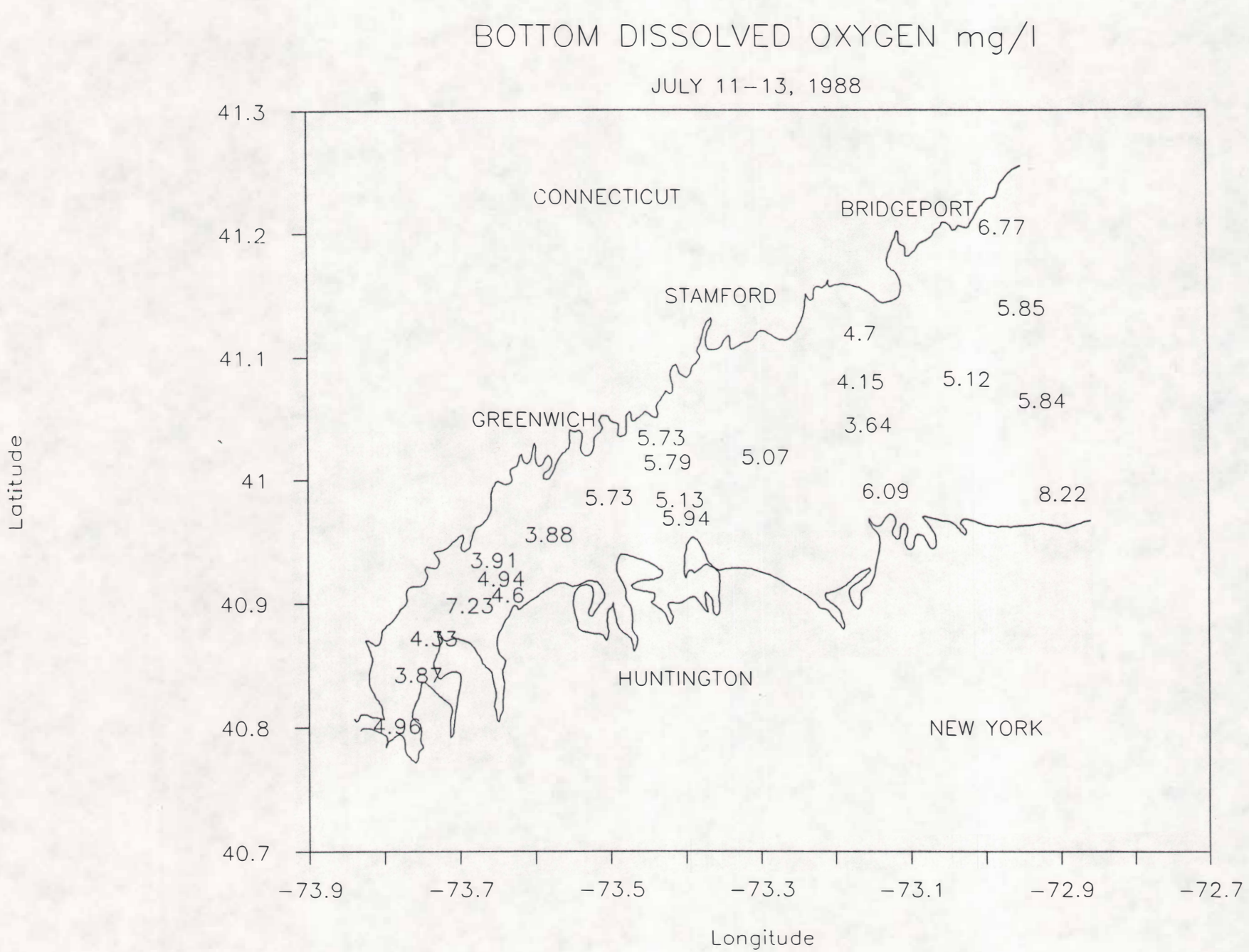

BOTTOM DISSOLVED OXYGEN mg/l
JULY 11–13, 1988
CONNECTICUT
BRIDGEPORT
STAMFORD
GREENWICH
HUNTINGTON
NEW YORK
6.77
5.85
4.7
4.15
5.12
5.84
3.64
5.73
5.79
5.07
5.73
5.13
5.94
6.09
8.22
3.88
3.91
4.94
4.6
7.23
4.33
3.87
4.96
41.3
41.2
41.1
41
40.9
40.8
40.7
−73.9
−73.7
−73.5
−73.3
−73.1
−72.9
−72.7
Latitude
Longitude

Figure 45

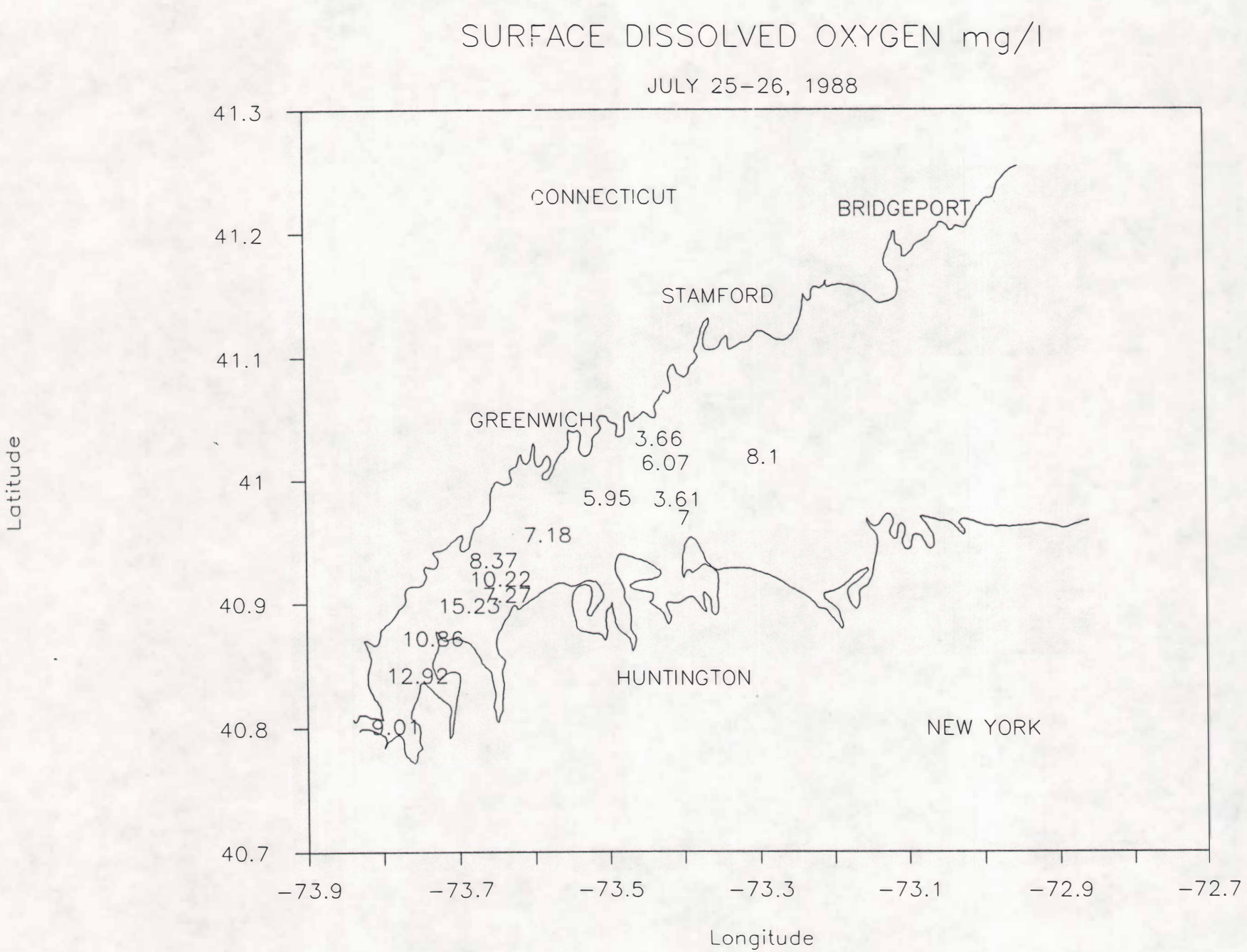

SURFACE DISSOLVED OXYGEN mg/l
JULY 25–26, 1988
CONNECTICUT
BRIDGEPORT
STAMFORD
GREENWICH
HUNTINGTON
NEW YORK
3.66
6.07
8.1
5.95
3.61
7
7.18
8.37
10.22
7.27
15.23
10.86
12.92
9.01
41.3
41.2
41.1
41
40.9
40.8
40.7
−73.9
−73.7
−73.5
−73.3
−73.1
−72.9
−72.7
Latitude
Longitude

Figure 46

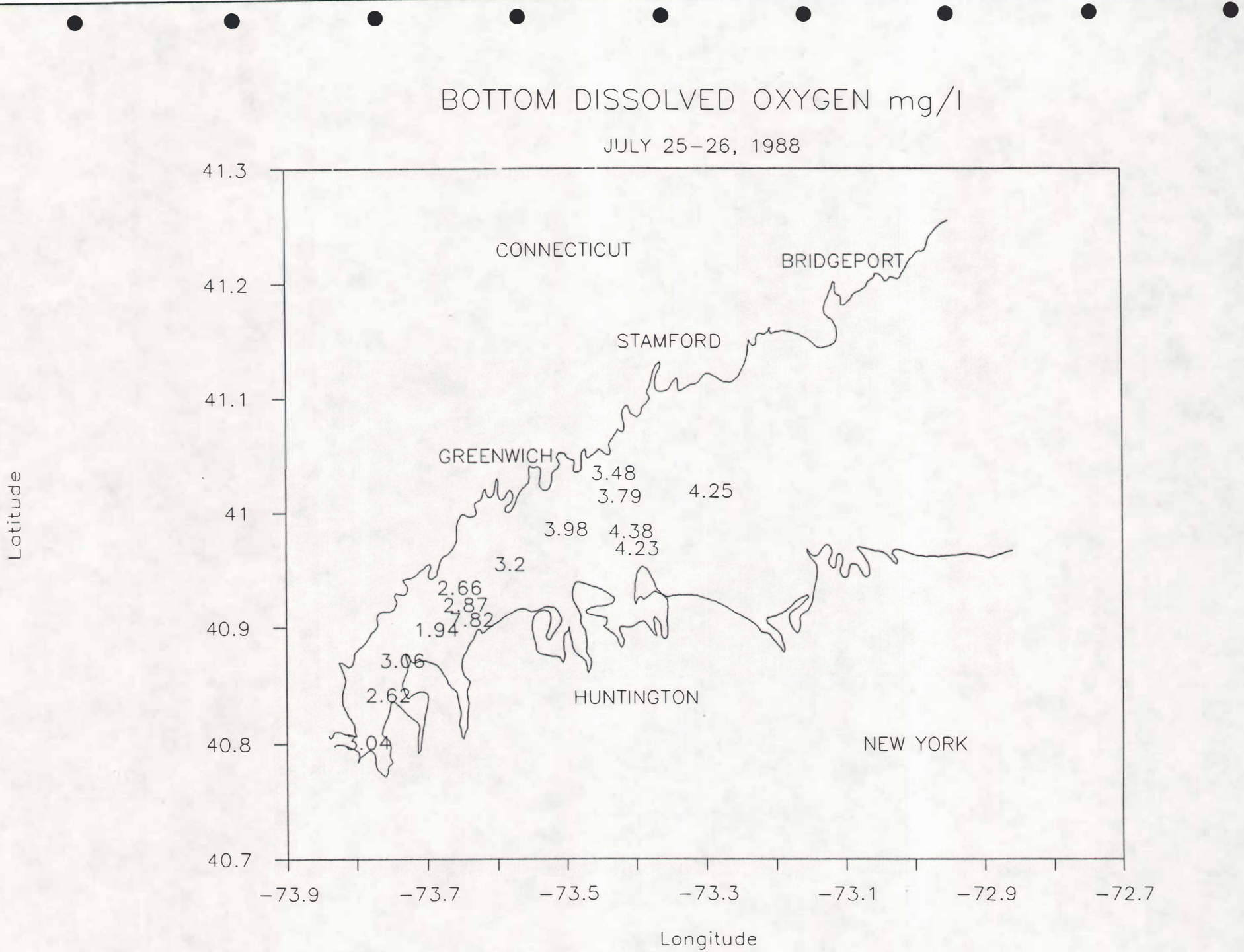

BOTTOM DISSOLVED OXYGEN mg/l
JULY 25–26, 1988
CONNECTICUT
BRIDGEPORT
STAMFORD
GREENWICH
NEW YORK
HUNTINGTON
3.48
3.79
4.25
3.98
4.38
4.23
3.2
2.66
2.87
2.82
1.94
3.06
2.62
3.04
41.3
41.2
41.1
41
40.9
40.8
40.7
Latitude
−73.9
−73.7
−73.5
−73.3
−73.1
−72.9
−72.7
Longitude

Figure 47

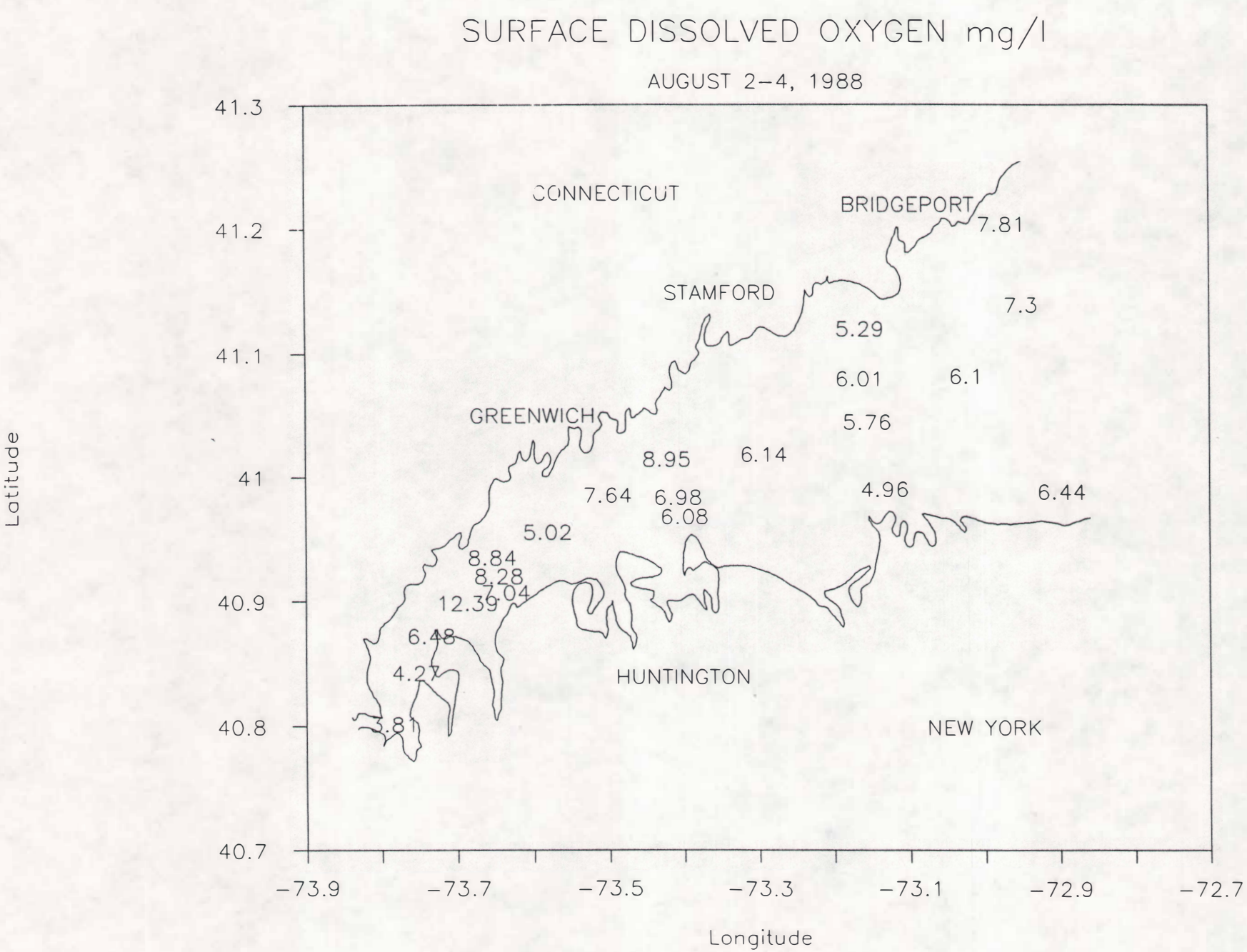

SURFACE DISSOLVED OXYGEN mg/l
AUGUST 2-4, 1988
CONNECTICUT
BRIDGEPORT
STAMFORD
GREENWICH
HUNTINGTON
NEW YORK
7.81
7.3
5.29
6.01
6.1
5.76
8.95
6.14
7.64
6.98
6.08
4.96
6.44
5.02
8.84
8.28
7.04
12.39
6.48
4.27
3.81
41.3
41.2
41.1
41
40.9
40.8
40.7
-73.9
-73.7
-73.5
-73.3
-73.1
-72.9
-72.7
Latitude
Longitude

Figure 48

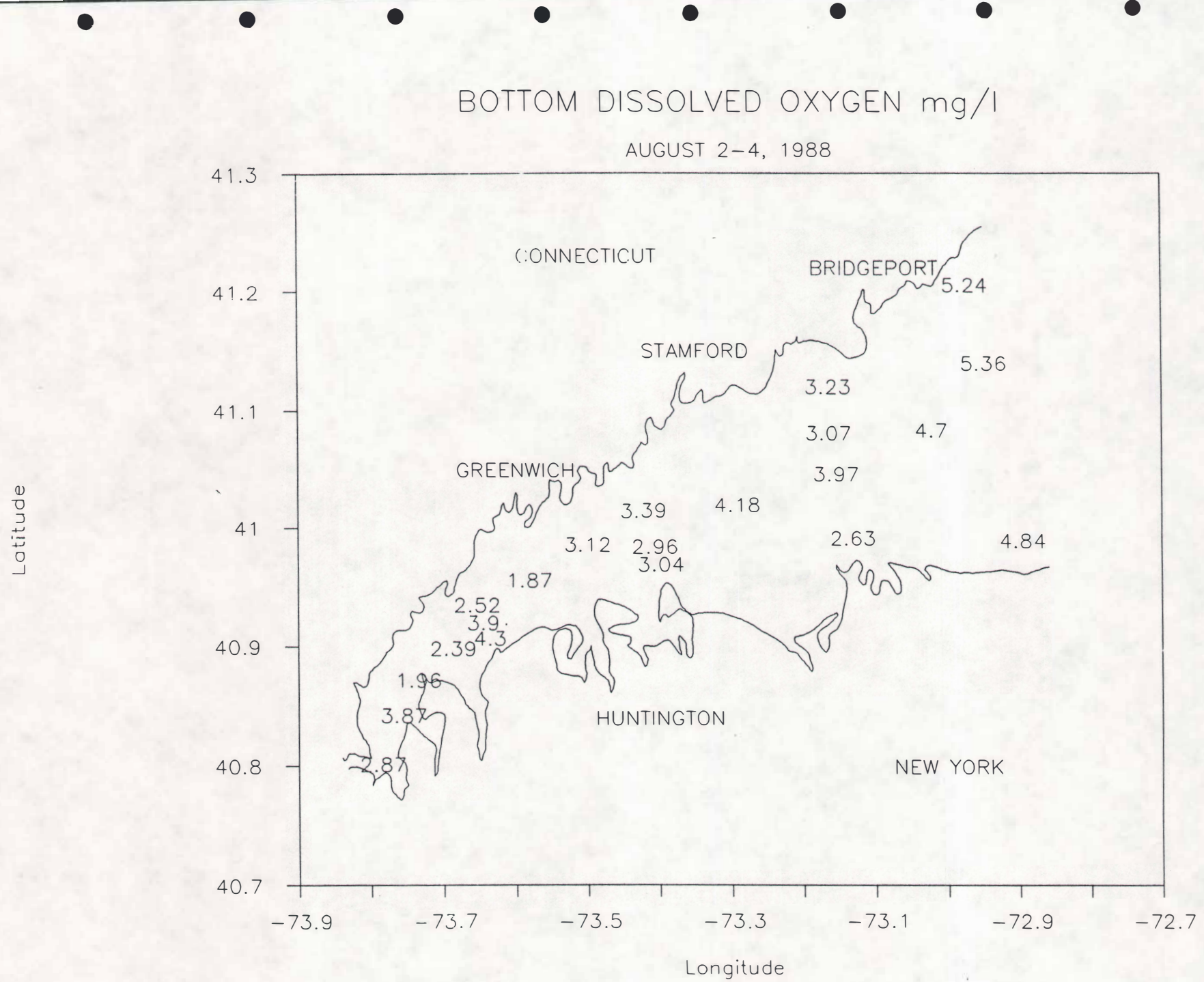

BOTTOM DISSOLVED OXYGEN mg/l
AUGUST 2–4, 1988
CONNECTICUT
BRIDGEPORT
5.24
STAMFORD
5.36
3.23
3.07
4.7
3.97
GREENWICH
3.39
4.18
3.12
2.96
3.04
2.63
4.84
1.87
2.52
3.9
4.3
2.39
1.96
3.87
2.87
HUNTINGTON
NEW YORK
41.3
41.2
41.1
41
40.9
40.8
40.7
Latitude
−73.9
−73.7
−73.5
−73.3
−73.1
−72.9
−72.7
Longitude

Figure 49

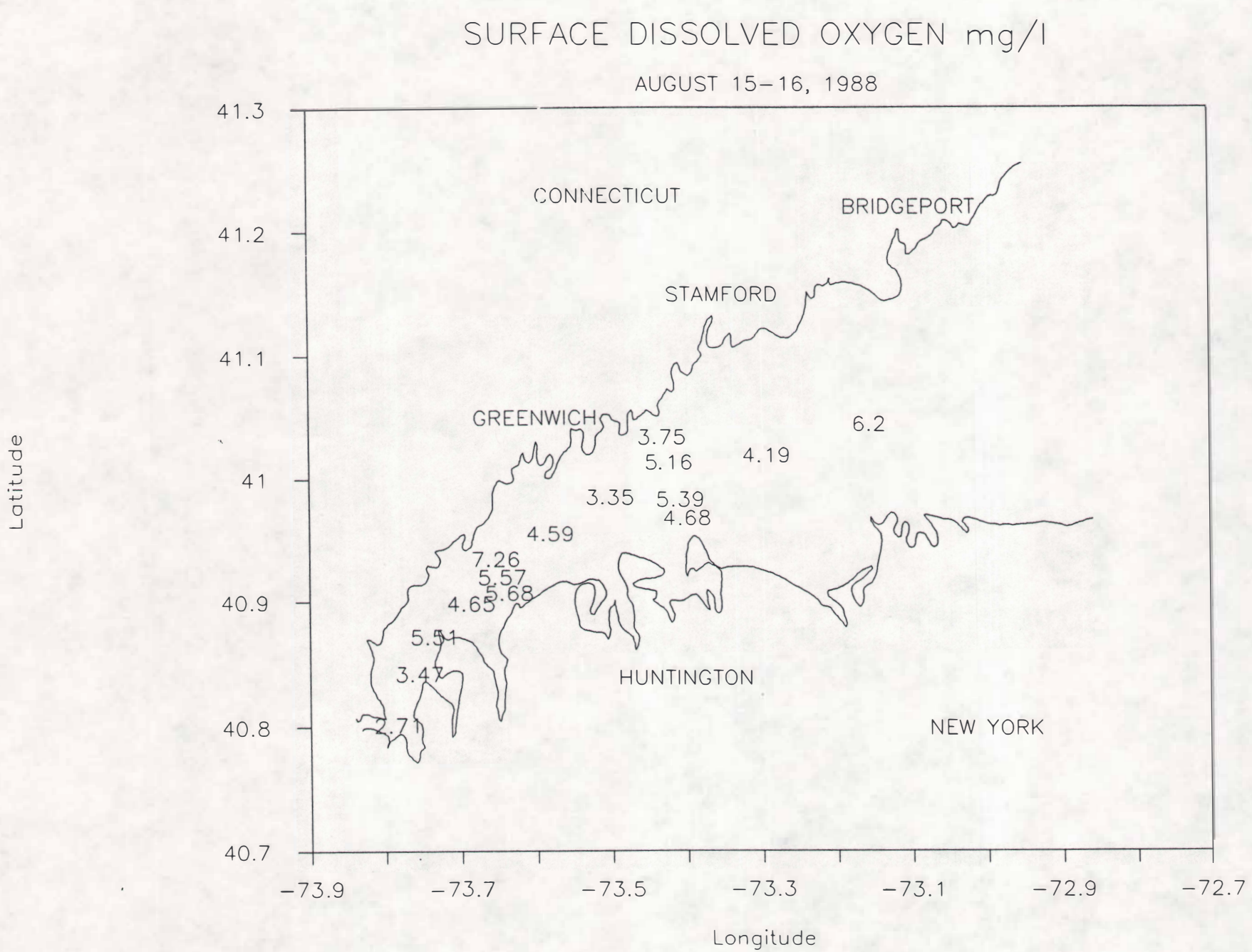

SURFACE DISSOLVED OXYGEN mg/l
AUGUST 15–16, 1988
CONNECTICUT
BRIDGEPORT
STAMFORD
GREENWICH
HUNTINGTON
NEW YORK
6.2
4.19
3.75
5.16
3.35
5.39
4.68
4.59
7.26
5.57
5.68
4.65
5.51
3.47
2.71
41.3
41.2
41.1
41
40.9
40.8
40.7
−73.9
−73.7
−73.5
−73.3
−73.1
−72.9
−72.7
Latitude
Longitude

Figure 50

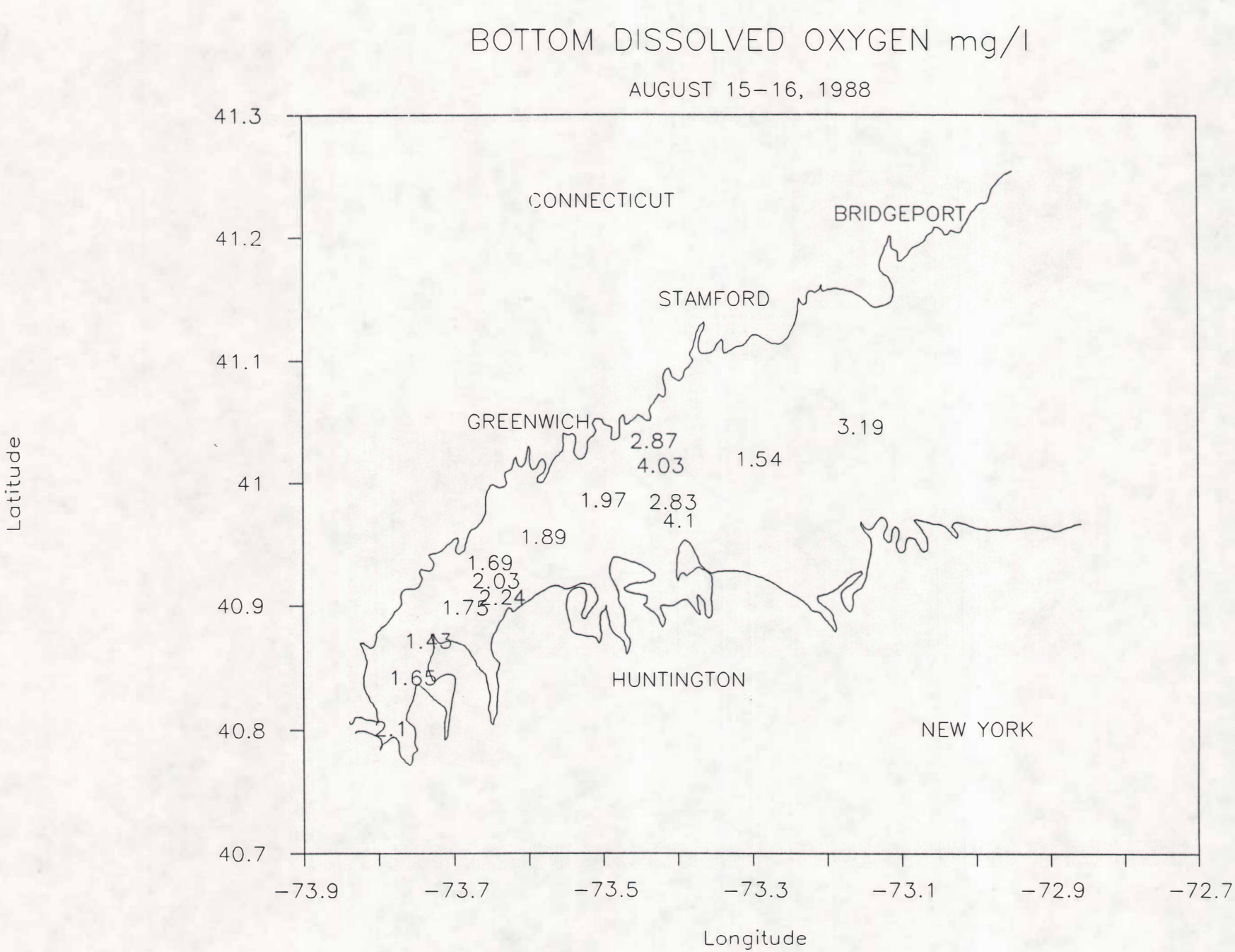

BOTTOM DISSOLVED OXYGEN mg/l
AUGUST 15–16, 1988
CONNECTICUT
BRIDGEPORT
STAMFORD
GREENWICH
HUNTINGTON
NEW YORK
3.19
2.87
4.03
1.54
1.97
2.83
4.1
1.89
1.69
2.03
2.24
1.75
1.43
1.65
2.1
41.3
41.2
41.1
41
40.9
40.8
40.7
−73.9
−73.7
−73.5
−73.3
−73.1
−72.9
−72.7
Latitude
Longitude

Figure 51

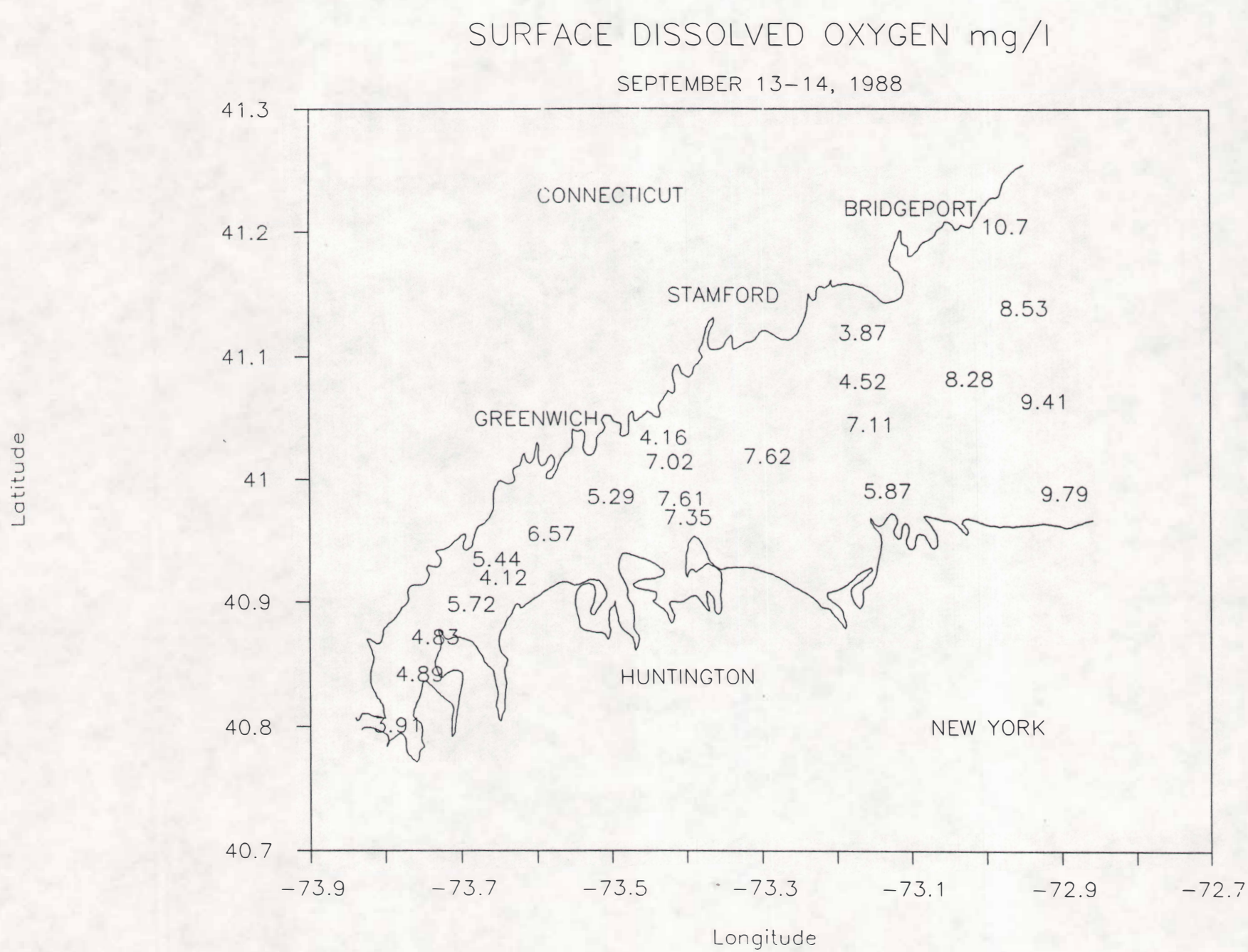

SURFACE DISSOLVED OXYGEN mg/l
SEPTEMBER 13–14, 1988
CONNECTICUT
BRIDGEPORT
10.7
STAMFORD
8.53
3.87
4.52
8.28
9.41
GREENWICH
7.11
4.16
7.02
7.62
5.29
7.61
7.35
5.87
9.79
6.57
5.44
4.12
5.72
4.83
4.89
3.91
HUNTINGTON
NEW YORK
41.3
41.2
41.1
41
40.9
40.8
40.7
−73.9
−73.7
−73.5
−73.3
−73.1
−72.9
−72.7
Latitude
Longitude

Figure 52

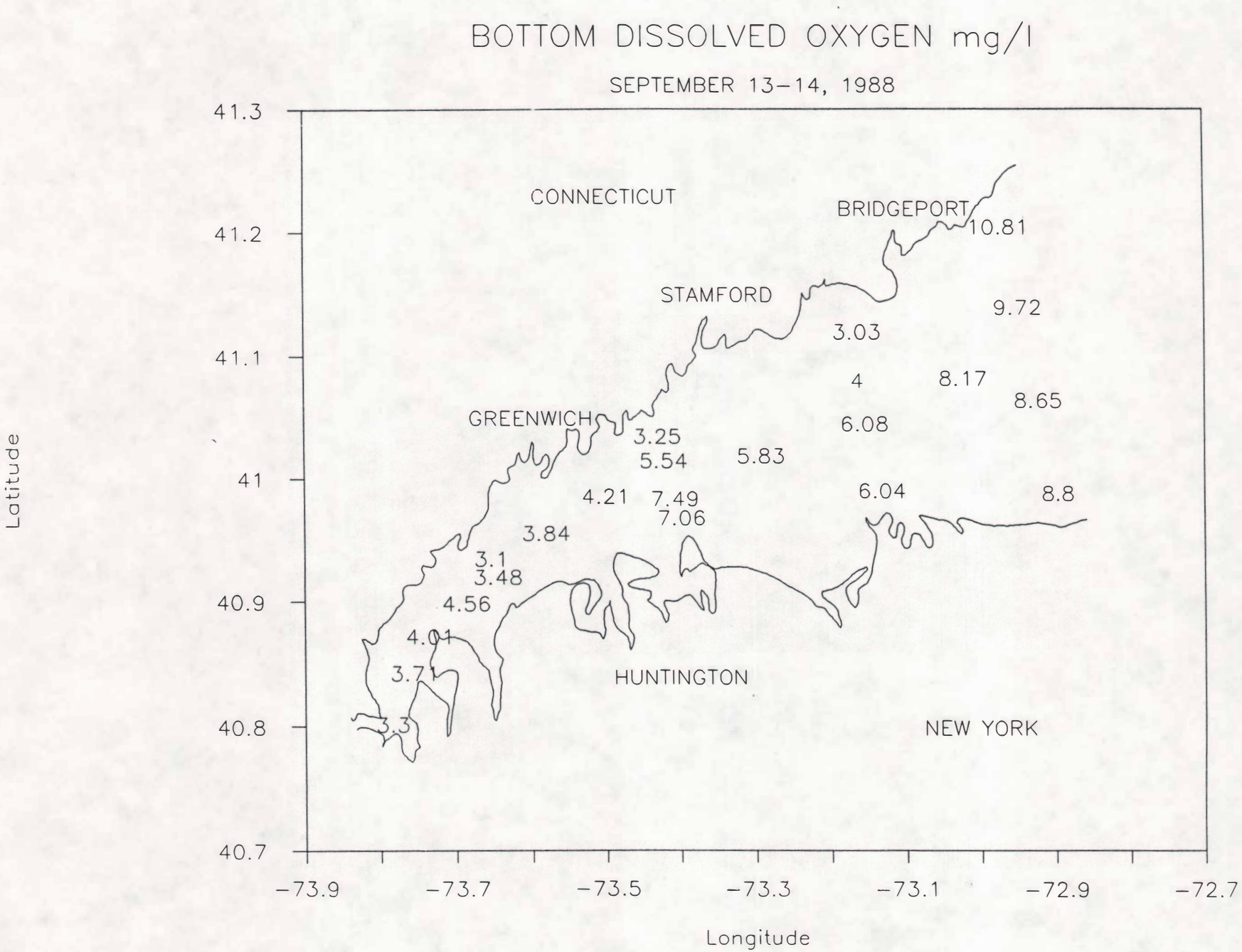

BOTTOM DISSOLVED OXYGEN mg/l
SEPTEMBER 13–14, 1988
CONNECTICUT
BRIDGEPORT
10.81
STAMFORD
9.72
3.03
4
8.17
8.65
6.08
GREENWICH
3.25
5.54
5.83
4.21
7.49
7.06
6.04
8.8
3.84
3.1
3.48
4.56
4.01
3.71
3.3
HUNTINGTON
NEW YORK
41.3
41.2
41.1
41
40.9
40.8
40.7
Latitude
−73.9
−73.7
−73.5
−73.3
−73.1
−72.9
−72.7
Longitude

Figure 53

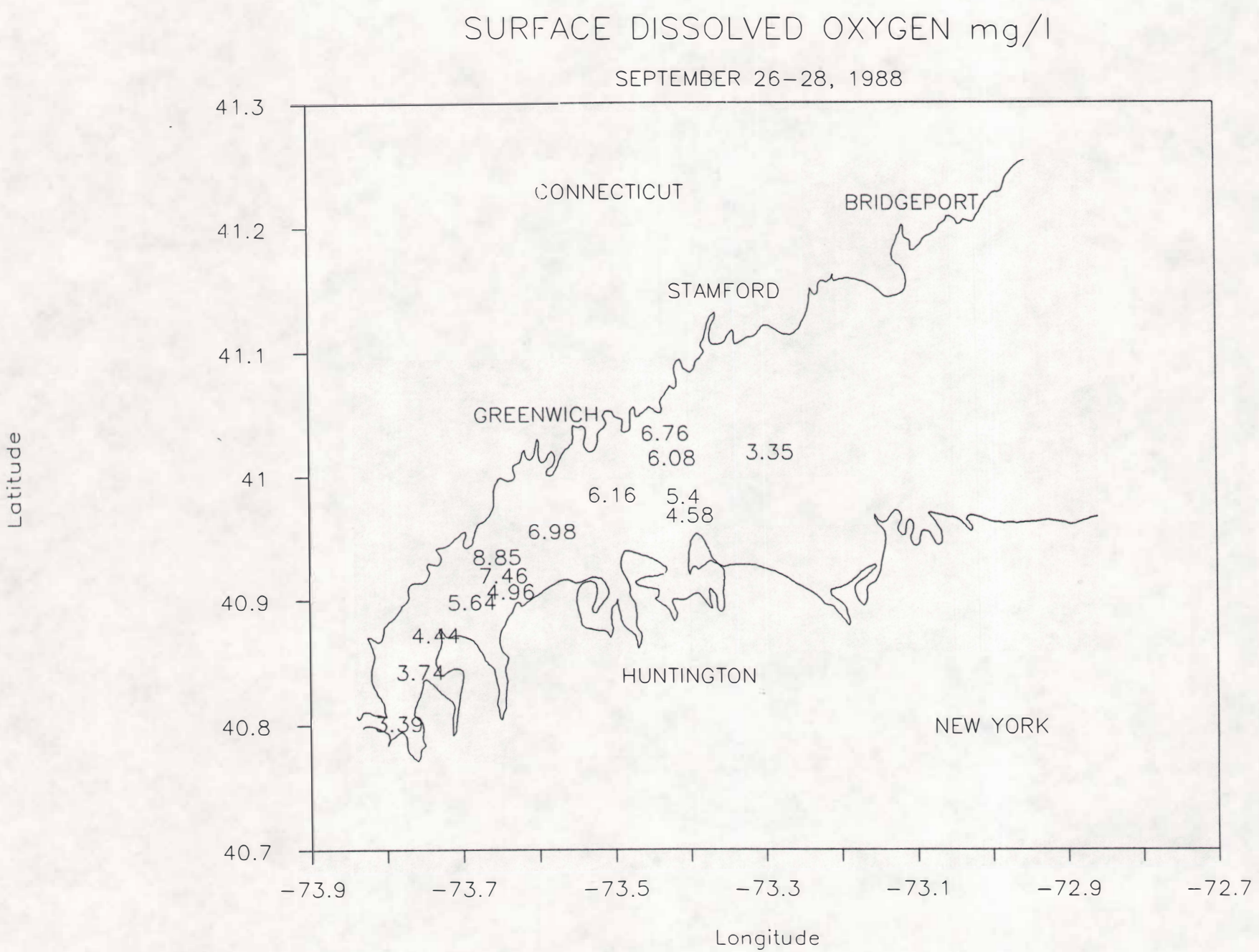

SURFACE DISSOLVED OXYGEN mg/l
SEPTEMBER 26-28, 1988
CONNECTICUT
BRIDGEPORT
STAMFORD
GREENWICH
HUNTINGTON
NEW YORK
6.76
6.08
3.35
6.16
5.4
4.58
6.98
8.85
7.46
4.96
5.64
4.44
3.74
3.39
41.3
41.2
41.1
41
40.9
40.8
40.7
-73.9
-73.7
-73.5
-73.3
-73.1
-72.9
-72.7
Latitude
Longitude

Figure 54

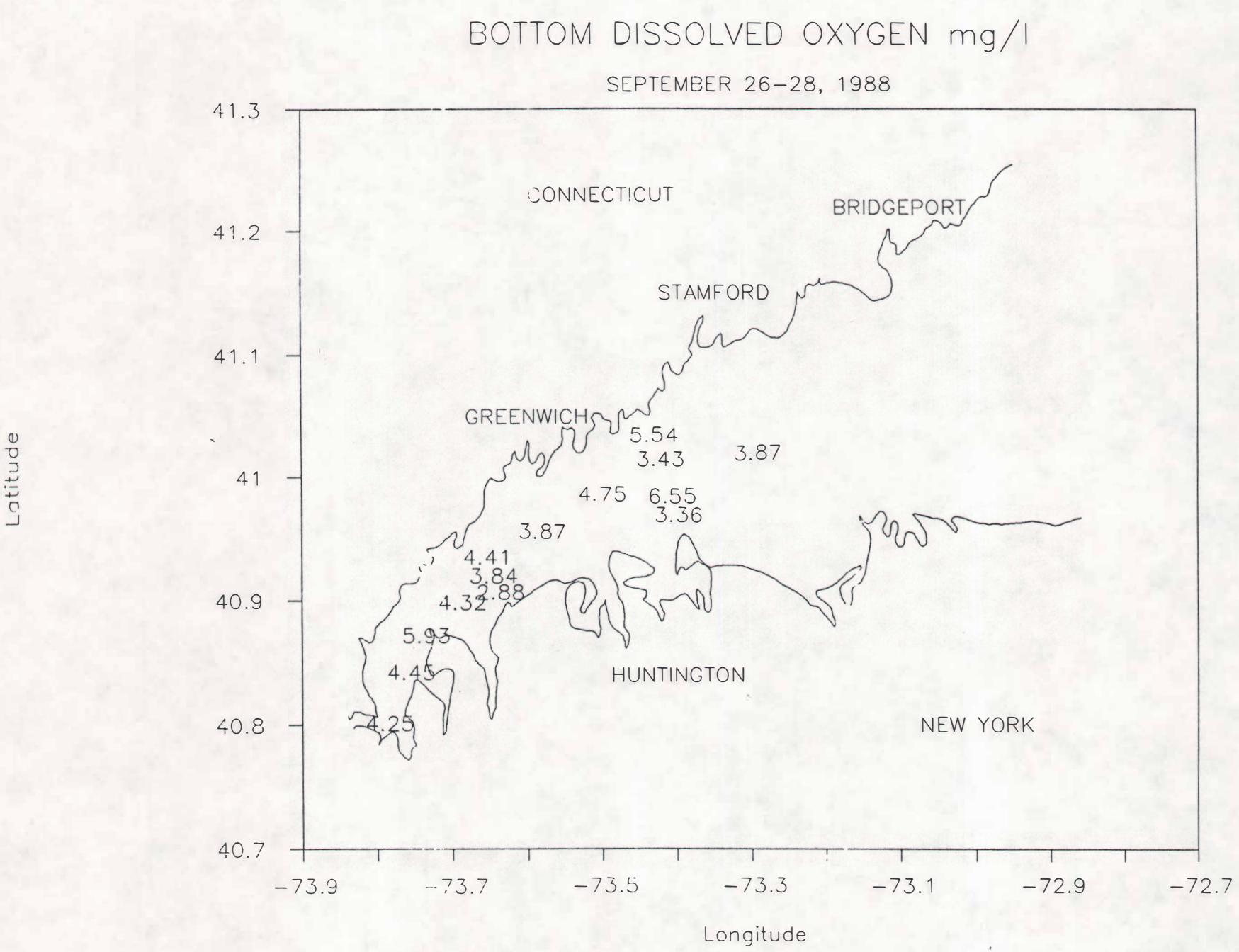

BOTTOM DISSOLVED OXYGEN mg/l
SEPTEMBER 26–28, 1988
CONNECTICUT
BRIDGEPORT
STAMFORD
GREENWICH
HUNTINGTON
NEW YORK
5.54
3.43
3.87
4.75
6.55
3.36
3.87
4.41
3.84
2.88
4.32
5.93
4.45
4.25
41.3
41.2
41.1
41
40.9
40.8
40.7
−73.9
−73.7
−73.5
−73.3
−73.1
−72.9
−72.7
Latitude
Longitude

Figure 55

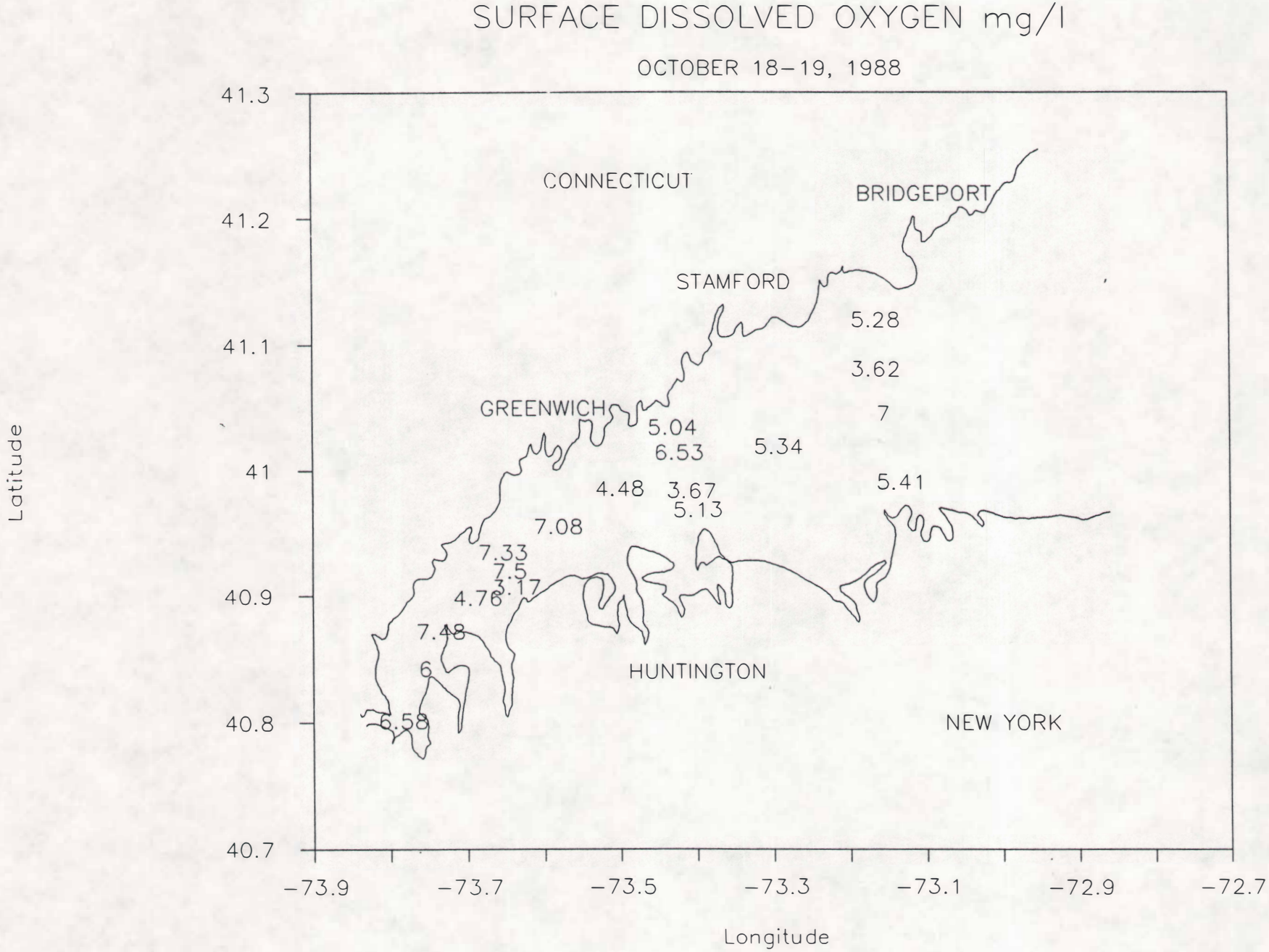

SURFACE DISSOLVED OXYGEN mg/l
OCTOBER 18–19, 1988
CONNECTICUT
BRIDGEPORT
STAMFORD
GREENWICH
HUNTINGTON
NEW YORK
5.28
3.62
7
5.04
6.53
5.34
5.41
4.48
3.67
5.13
7.08
7.33
7.5
3.17
4.76
7.48
6
6.58
41.3
41.2
41.1
41
40.9
40.8
40.7
−73.9
−73.7
−73.5
−73.3
−73.1
−72.9
−72.7
Latitude
Longitude

Figure 56

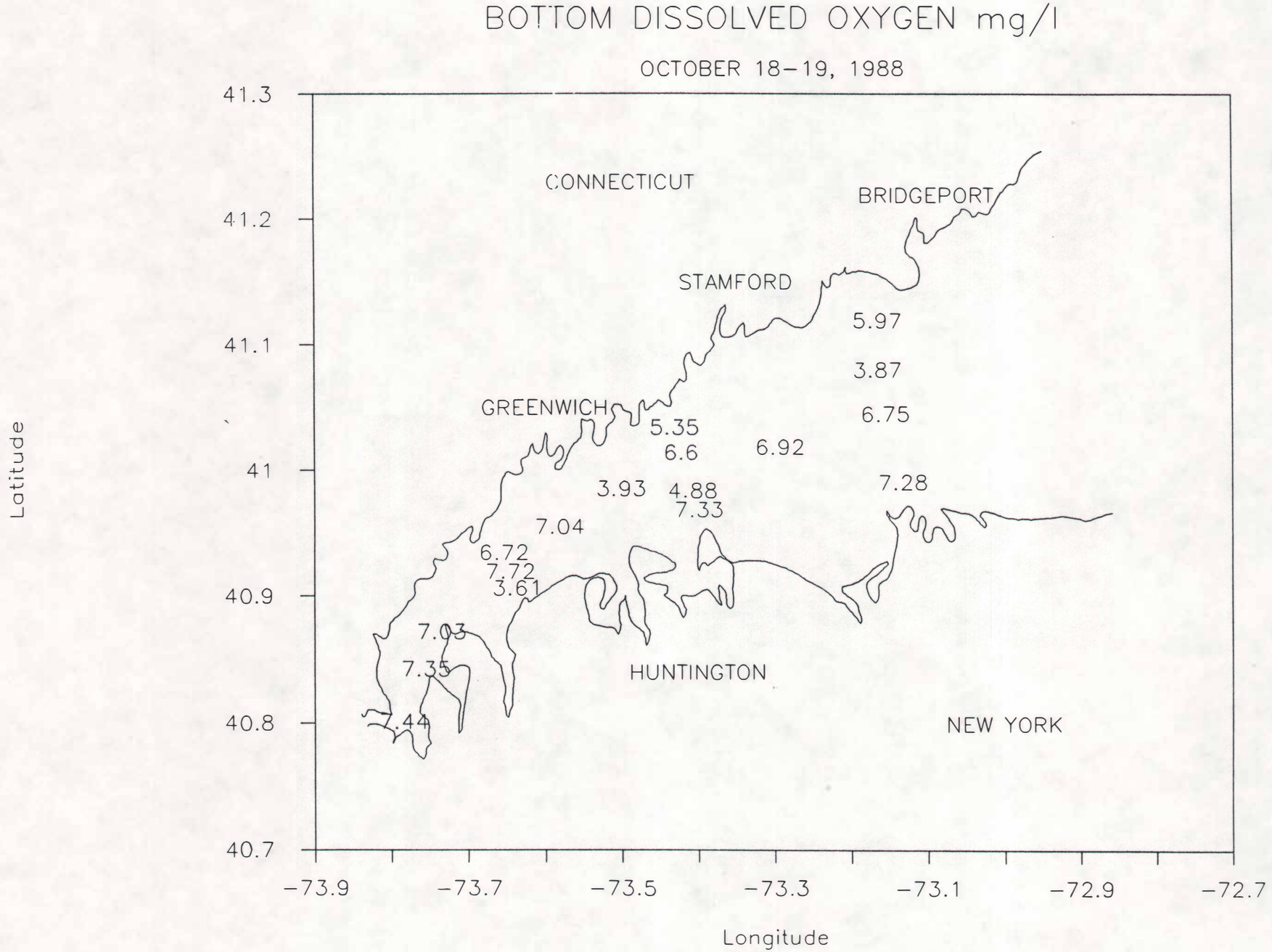

BOTTOM DISSOLVED OXYGEN mg/l
OCTOBER 18–19, 1988
CONNECTICUT
BRIDGEPORT
STAMFORD
GREENWICH
HUNTINGTON
NEW YORK
5.97
3.87
6.75
5.35
6.6
6.92
7.28
3.93
4.88
7.33
7.04
6.72
7.72
3.61
7.03
7.35
7.44
41.3
41.2
41.1
41
40.9
40.8
40.7
−73.9
−73.7
−73.5
−73.3
−73.1
−72.9
−72.7
Latitude
Longitude

Figure 57

APPENDIX I

Solute $O_2$

Method: Winkler Titration (modified)

Reagents:

A. 2.2 M Manganous Sulfate: 91.2 $MnSO_4 \cdot H_2O$/250 ml (distilled water, solvent). Stable.

B. Alkaline Iodine Solution: Dissolve 100 g NaOH in 100 ml distilled water. Dissolve 60 g potassium iodide (KI) in 90 ml distilled water and mix two solutions slowly. Stable

C. Concentrated Sulfuric Acid

D. Starch Indicator: Suspend 1 g of starch in 150 ml of distilled water and add 20% NaOH (while stirring) until the solution becomes clear. Add concentrated HCl until the solution turns acidic, then add 1 ml of glacial acetic acid. Dilute to 500 ml with distilled water. Stable several months.

E. Standard Thiosulfate Solution (0.01 N): 1.59 g anhydrous sodium thiosulfate/1 liter (distilled water, solvent). Refrigerate. Stable several months.

Sample Size: 10 ml

Procedure

1. Collect sample in a 20-60 ml preweighed plastic syringe. Avoid trapping air bubbles in the sample. Weigh sample + syringe and convert sample mass to sample volume ($V_s$) using appropriate temperature and density.

2. Add 0.1 reagent A and 0.1 ml of reagent B through the tip of the syringe with an automatic pipette. Carefully mix the sample and reagents until a white to brown colored precipitate fills the volume. Let stand ~5 mins. and then mix again.

3. After ~5 mins., add 0.1 ml concentrated sulfuric acid (reagent C) through the tip of the syringe using an automatic pipette. Mix until the precipitate is entirely dissolved.

4. Add sample to a glass scintillation vial and begin stirring on a magnetic stirrer using a magnetic "flea". Insert a Gilmont burette containing reagent E.

5. Add reagent E slowly until the sample becomes a straw color, and then add 5-10 drops of starch indicator (D) to turn the sample to a deep blue. Titrate the sample until it becomes clear. Record final volume of solium thiosulfate added ($V_{titr}$).

Calculations

$$O_2 \text{ (uM)} = (0.01 \times V_{titr} / (4 \times V_s) \times 1 \times 10^6$$

LONG ISLAND SOUND STUDY
DISSOLVED OXYGEN VALUES
mg/l

| DATE | STATION | SURFACE | BOTTOM |
|---|---|---|---|
| APRIL 4-6, 1988 | A2M | 11.7 | 11.1 |
| | A4 | 13.5 | 13.2 |
| | B3M | 13.7 | 12.3 |
| | C2 | | |
| | D3M | 12.6 | 11.8 |
| | F3M | 13.7 | 11.3 |
| | H6M | | |
| APRIL 17-19, 1988 | A2M | 11.29 | 11.52 |
| | A4 | 12.07 | 10.74 |
| | B3M | 10.6 | 10.87 |
| | C2 | 10.34 | 10.09 |
| | D3M | 10.07 | 9.93 |
| | F3M | 11 | 9.99 |
| | H6M | | |
| MAY 9-11 , 1988 | A2M | 10.05 | 9.73 |
| | A4 | 12.06 | 9.72 |
| | B3M | 13.47 | 9.52 |
| | C2 | 10.28 | 9.46 |
| | D3M | 9.61 | 9.03 |
| | F3M | 10.46 | 9.38 |
| | H6M | | |
| MAY 25-26 , 1988 | A2M | 8.21 | 7.84 |
| | A4 | 9.72 | 7.49 |
| | B3M | 9.61 | 7.65 |
| | C2 | 8.09 | 8.38 |
| | D3M | 9.59 | 7.63 |
| | F3M | 9.77 | 8.17 |
| | H6M | | |
| JUNE 13-15, 1988 | A2M | 6.42 | 6.31 |
| | A4 | 11.02 | 6.01 |
| | B3M | 9.57 | 6.93 |
| | C2 | 8.61 | 7.73 |
| | D3M | 9.08 | 7.63 |
| | F3M | 9.68 | 8.07 |
| | H6M | | |
| JUNE 27-29, 1988 | A2M | 7.48 | 5.71 |
| | A4 | 9.37 | 4.27 |
| | B3M | 9.72 | 5.01 |
| | C2 | 8.94 | 5.99 |
| | D3M | 7.77 | 6.28 |
| | F3M | 8.18 | 6.35 |
| | H6M | | |
| JULY 11-13, 1988 | A2M | 5.65 | 4.96 |
| | A4 | 6.71 | 4.33 |
| | B3M | 10.34 | 4.95 |

| | | | |
|---|---|---|---|
| | C2 | 4.88 | 5.73 |
| | D3M | 9.29 | 5.13 |
| | F3M | 7.17 | 3.64 |
| | H6M | | |
| JULY 25-26, 1988 | A2M | 9.01 | 3.04 |
| | A4 | 10.86 | 3.06 |
| | B3M | 10.22 | 2.87 |
| | C2 | 5.95 | 3.98 |
| | D3M | 3.61 | 4.38 |
| | F3M | | |
| | H6M | | |
| AUGUST 2-4, 1988 | A2M | 3.81 | 2.87 |
| | A4 | 6.48 | 1.96 |
| | B3M | 8.28 | 3.9 |
| | C2 | 7.64 | 4.89 |
| | D3M | 6.98 | 2.96 |
| | F3M | 5.76 | 3.97 |
| | H6M | | |
| AUGUST 15-16, 1988 | A2M | 2.71 | 2.1 |
| | A4 | 5.51 | 1.43 |
| | B3M | 5.57 | 2.03 |
| | C2 | 3.35 | 1.97 |
| | D3M | 5.39 | 2.83 |
| | F3M | 6.2 | 3.19 |
| | H6M | | |
| SEPT. 13-14, 1988 | A2M | 3.91 | 3.3 |
| | A4 | 4.83 | 4.01 |
| | B3M | 4.12 | 3.48 |
| | C2 | 5.29 | 4.21 |
| | D3M | 7.61 | 7.49 |
| | F3M | 7.11 | 6.08 |
| | H6M | | |
| SEPT. 26+28, 1988 | A2M | 3.39 | 4.25 |
| | A4 | 4.44 | 5.93 |
| | B3M | 7.46 | 3.84 |
| | C2 | 6.16 | 4.75 |
| | D3M | 5.4 | 6.55 |
| | F3M | | |
| | H6M | | |
| OCT. 18-19, 1988 | A2M | 6.58 | 7.44 |
| | A4 | 7.48 | 7.03 |
| | B3M | 7.5 | 7.72 |
| | C2 | 4.48 | 3.93 |
| | D3M | 3.67 | 4.88 |
| | F3M | 7 | 6.75 |
| | H6M | | |
| NOVEMBER 16,1988 | A2M | 5.54 | 7.09 |
| | A4 | 7.19 | 7.39 |
| | B3M | 8.9 | 6.63 |
| | C2 | | |

| | | | |
|---|---|---|---|
| | D3M | 9.04 | 8.59 |
| | F3M | 7.59 | 8.18 |
| | H6M | 7.94 | 8.57 |
| JANUARY 23,1989 | A2M | 13.3 | 13.14 |
| | A4 | 14.14 | 13.09 |
| | B3M | 14.75 | 13.46 |
| | C2 | 12.41 | 12.17 |
| | D3M | 13.08 | 12.17 |
| | F3M | 12.3 | 11.05 |
| | H6M | 11.99 | 10.27 |
| FEBRUARY 6, 1989 | A2M | 11.71 | 13.47 |
| | A4 | 11.37 | 12.96 |
| | B3M | 11.67 | 11.13 |
| | C2 | 9.89 | 11.51 |
| | D3M | 11.09 | 12.04 |
| | F3M | 11.69 | 11.5 |
| | H6M | 10.63 | 11.72 |
| FEBRUARY 22,1989 | A2M | 8.25 | 11.73 |
| | A4 | 13.14 | 12.53 |
| | B3M | 13.81 | 12.89 |
| | C2 | 13.23 | 12.3 |
| | D3M | 13.03 | 12.19 |
| | F3M | | |
| | H6M | 9.35 | 8.76 |
| MARCH 13, 1989 | A2M | 13.51 | 13.07 |
| | A4 | 14.44 | 13.95 |
| | B3M | 14.28 | 13.77 |
| | C2 | 12.04 | 13.45 |
| | D3M | 13.1 | 12.6 |
| | F3M | 13.65 | 11.65 |
| | H6M | 11.66 | 12.83 |
| MARCH 23, 1989 | A2M | 13.53 | 13.61 |
| | A4 | 15.07 | 10.77 |
| | B3M | 13.11 | 12.03 |
| | C2 | 14.39 | 10.66 |
| | D3M | 11.89 | 10.98 |
| | F3M | 14.19 | 12.65 |
| | H6M | 11.71 | 11.1 |
| APRIL 3,1989 | A2M | 11.27 | 9.95 |
| | A4 | 11.05 | 9.35 |
| | B3M | 13.77 | 12.22 |
| | C2 | 12.72 | 12.01 |
| | D3M | 11.22 | 12.13 |
| | F3M | 12.33 | 11.75 |
| | H6M | 12.76 | 11.93 |
| APRIL 17, 1989 | A2M | 9.06 | 8.56 |
| | A4 | 9.1 | 9.27 |
| | B3M | 10.21 | 9.24 |
| | C2 | | |
| | D3M | 9.55 | 7.99 |

| | | | |
|---|---|---|---|
| | F3M | 8.16 | 9.37 |
| | H6M | 10.31 | 9.51 |
| MAY 9,1989 | A2M | 7.44 | 8.11 |
| | A4 | 8.26 | 8.61 |
| | B3M | 8.18 | 5.47 |
| | C2 | 10.44 | 8.99 |
| | D3M | 8.19 | 7.27 |
| | F3M | 9.52 | 8.89 |
| | H6M | 10.59 | 8.3 |
| MAY 23, 1989 | A2M | 5.74 | 3.29 |
| | A4 | | |
| | B3M | 13.46 | 5.79 |
| | C2 | 10.88 | 8.18 |
| | D3M | 10.24 | 7.35 |
| | F3M | 10.07 | 5.18 |
| | H6M | 10.81 | 8.29 |
| JUNE 20, 1989 | A2M | 5.11 | 5.21 |
| | A4 | 5.88 | 4.91 |
| | B3M | 7.54 | 4.29 |
| | C2 | 9.92 | 5.7 |
| | D3M | 9.9 | 5.57 |
| | F3M | 5.57 | 8.63 |
| | H6M | 9.18 | 6.07 |
| JULY 6, 1989 | A2M | 5.67 | 4.37 |
| | A4 | 6.71 | 4.33 |
| | B3M | 10.34 | 4.94 |
| | C2 | 4.88 | 5.73 |
| | D3M | 9.29 | 5.13 |
| | F3M | 7.17 | 3.64 |
| | H6M | 8.24 | 5.64 |
| JULY 24, 1989 | A2M | 4.99 | 4.82 |
| | A4 | 4.67 | 3.88 |
| | B3M | 7.28 | 2.93 |
| | C2 | 10.57 | 5.07 |
| | D3M | 10.17 | 5.91 |
| | F3M | 3.68 | 2.83 |
| | H6M | 6.2 | 2.87 |
| AUGUST 7, 1989 | A2M | 4.59 | 3.36 |
| | A4 | 9.56 | 1.86 |
| | B3M | 9.04 | 2.06 |
| | C2 | 7 | 2.86 |
| | D3M | 9.9 | 4 |
| | F3M | 8.95 | 4.71 |
| | H6M | 5.28 | 1.9 |
| AUGUST 21, 1989 | A2M | 2.64 | 2.82 |
| | A4 | 3 | 2.95 |
| | B3M | 4.75 | 2.66 |
| | C2 | 8.19 | 5.2 |
| | D3M | 6.91 | 5.32 |
| | F3M | 4.3 | 1.97 |

| | | | |
|---|---|---|---|
| | H6M | 5.93 | 2.56 |
| SEPTEMBER 6,1989 | A2M | 4.1 | 4.38 |
| | A4 | 7.13 | 6.04 |
| | B3M | 7.1 | 6.54 |
| | C2 | 6.8 | 5.96 |
| | D3M | 6.87 | 4.84 |
| | F3M | 6.36 | 5.68 |
| | H6M | 6.44 | 3.9 |

C