Report

Buzzards Bay Research Bacteriological Data Report

Department of Environmental Protection
Division of Water Pollution Control

BBP-89-19

The Buzzards Bay Project is sponsored by
The U.S. Environmental Protection Agency and
The Massachusetts Executive Office of Environmental Affairs

THE BUZZARDS BAY PROJECT

US Environmental Protection Agency
WQP-2100
John F. Kennedy Federal Building
Boston, MA 02203

Massachusetts Executive Office of
Environmental Affairs
100 Cambridge Street
Boston, MA 02202

FOREWORD

In 1984, Buzzards Bay was one of four estuaries in the country chosen to be part of the National Estuary Program. The Buzzards Bay Project was initiated in 1985 to protect water quality and the health of living resources in the bay by identifying resource management problems, investigating the causes of these problems, and recommending actions that will protect valuable resources from further environmental degradation. This multi-year project, jointly managed by United States Environmental Protection Agency and the Massachusetts Executive Office of Environmental Affairs, utilizes the efforts of local, state, and federal agencies, the academic community and local interest groups in developing a Master Plan that will ensure an acceptable and sustainable level of environmental quality for Buzzards Bay.

The Buzzards Bay Project is focusing on three priority problems: closure of shellfish beds, contamination of fish and shellfish by toxic metals and organic compounds, and high nutrient input and the potential pollutant effects. By early 1990, the Buzzards Bay Project will develop a Comprehensive Conservation and Management Plan to address the Project's overall objectives: to develop recommendations for regional water quality management that are based on sound information, to define the regulatory and management structure necessary to implement the recommendations, and to educate and involve the public in formulating and implementing these recommendations.

The Buzzards Bay Project has funded a variety of tasks that are intended to improve our understanding of the input, fate and effects of contaminants in coastal waters. The Project will identify and evaluate historic information as well as generate new data to fill information gaps. The results of these Project tasks are published in this Technical Series on Buzzards Bay.

This report represents the technical results of an investigation funded by the Buzzards Bay Project. The results and conclusions contained herein are those of the author(s). These conclusions have been reviewed by competent outside reviewers and found to be reasonable and legitimate based on the available data. The Management Committee of the Buzzards Bay Project accepts this report as technically sound and complete. The conclusions do not necessarily represent the recommendations of the Buzzards Bay Project. Final recommendations for resource management actions will be based upon the results of this and other investigations.

David A. Fierra

David Fierra, Chairman, Management Committee
Environmental Protection Agency

ACKNOWLEDGMENTS

The Division of Water Pollution Control's Technical Services Branch would like to thank those groups and individuals whose efforts contributed to the design and accomplishment of this study. In particular we would like to thank:

U.S. Environmental Protection Agency for partially funding this study and for initiating the Buzzards Bay Program;

Rosario Grasso, Chief of Bacteriology Lab, Lawrence Experiment Station and Michael Dowe, Assistant Aquatic Biologist who did the bacterial analyses. Mr. Dowe also kept all the data records and contributed the Laboratory Material and Methods Section;

George Minasian and the staff at Lawrence Experiment Station who performed the chemical analyses;

Kelly Ryan, Senior Sanitary Engineering Aide, who assisted in all the Buzzards Bay surveys and was in charge of the calibration and maintenance of all field equipment;

Linda Chandler, U.S. Food and Drug Administration, Davisville, RI, whose knowledge of ways of determining fecal sources of contamination was very helpful in formulating the study design;

Harold Crapo, National Oceanographic and Atmospheric Administration, Reading, MA, who provided us with rain data for Wareham and Westport;

Carl Wakefield, Health Agent, town of Wareham, who provided valuable information on potential sampling areas in Wareham, as well as background information on each site;

Ed Beebow and Jim Walsh, town of Westport, who provided information on potential sampling areas in Westport;

Tena Davies, S.E. Regional Office, DEQE, Lakeville, who provided the background bacteria data used in determining our sampling locations and information on the status of the shellfish closure areas; and

George Heufelder, Barnstable County Health and Environmental Department, for the valuable discussions and exchange of information which proved very useful in the study design and interpretation of data.

TABLE OF CONTENTS

ITEM	PAGE
Acknowledgments	iii
List of Tables	vii
List of Figures	xvii
Introduction	1
Sampling Design	3
Field Materials and Methods	9
Laboratory Materials and Methods	11
Results	15
Literature Cited	151

LIST OF TABLES

NUMBER	TITLE	PAGE
1	Summary of 1986 Buzzards Bay Bacteriological Surveys	4
2	Antecedent Rainfall as Recorded Three Days Prior to Sampling at Wareham/Onset, Buzzards Bay	5
3	Antecedent Rainfall as Recorded Three Days Prior to Sampling at Westport, Buzzards Bay	7
4	Analytical Methods Used at Lawrence Experiment Station	13
5	Preliminary Sites Throughout Buzzards Bay/Wareham Study Area Sampled on June 17, 1986	16
6	Temperature (°C), Dissolved Oxygen (mg/l), Percent Saturation (%) - June 17, 1986	17
7	Non-Point Source Bacteriological Data - June 17, 1986	18
8	Non-Point Source Physical Data - June 17, 1986	19
9	Non-Point Source Chemical Data - June 17, 1986	20
10	Agawam and Wareham River Sites Sampled on June 23, 1986	23
11	Temperature (°C), Dissolved Oxygen (mg/l), Percent Saturation (%) - June 23, 1986	24
12	Non-Point Source Bacteriological Data - June 23, 1986	25
13	Non-Point Source Physical Data - June 23, 1986	26
14	Non-Point Source Chemical Data - June 23, 1986	27
15	Upper Agawam River Sites Sampled on June 30, 1986	32
16	Temperature (°C), Dissolved Oxygen (mg/l), Percent Saturation (%) - June 30, 1986	33
17	Non-Point Source Bacteriological Data - June 30, 1986	34
18	Non-Point Source Physical Data - June 30, 1986	35
19	Non-Point Source Chemical Data - June 30, 1986	36
20	Wareham River Sites Sampled on July 7, 1986	41

LIST OF TABLES (CONTINUED)

NUMBER	TITLE	PAGE
21	Temperature (°C), Dissolved Oxygen (mg/l), Percent Saturation (%) - July 7, 1986	42
22	Non-Point Source Bacteriological Data - July 7, 1986	43
23	Non-Pont Source Physical Data - July 7, 1986	44
24	Non-Point Source Chemical Data - July 7, 1986	45
25	Wareham River Sites Sampled on July 9, 1986	48
26	Temperature (°C), Dissolved Oxygen (mg/l), Percent Saturation (%) - July 9, 1986	49
27	Non-Point Source Bacteriological Data - July 9, 1986	50
28	Non-Point Source Physical Data - July 9, 1986	51
29	Non-Point Source Chemical Data - July 9, 1986	52
30	Westport River Sites Sampled on July 14, 1986	55
31	Temperature (°C), Dissolved Oxygen (mg/l), Percent Saturation (%) - July 14, 1986	56
32	Non-Point Source Bacteriological Data - July 14, 1986	57
33	Non-Point Source Physical Data - July 14, 1986	58
34	Non-Point Source Chemical Data - July 14, 1986	59
35	Wareham River Sites Sampled on July 21, 1986	62
36	Temperature (°C), Dissolved Oxygen (mg/l), Percent Saturation (%) - July 21, 1986	63
37	Non-Point Source Bacteriological Data - July 21, 1986	64
38	Non-Point Source Physical Data - July 21, 1986	65
39	Non-Point Source Chemical Data - July 21, 1986	66
40	Source Differentiation of Fecal Streptococci Bacteria from Wareham River Sites - July 21, 1986	67
41	Westport River Sites Sampled on July 28, 1986	70

LIST OF TABLES (CONTINUED)

NUMBER	TITLE	PAGE
42	Temperature (°C), Dissolved Oxygen (mg/l), Percent Saturation (%) - July 28, 1986	71
43	Non-Point Source Bacteriological Data - July 28, 1986	72
44	Non-Point Source Physical Data - July 28, 1986	73
45	Non-Point Source Chemical Data - July 28, 1986	74
46	Wareham River Sites Sampled on August 3, 1986	77
47	Temperature (°C), Dissolved Oxygen (mg/l), Percent Saturation (%) - August 3, 1986	78
48	Non-Point Source Bacteriological Data - August 3, 1986	79
49	Non-Point Source Physical Data - August 3, 1986	80
50	Non-Point Source Chemical Data - August 3, 1986	81
51	Westport River Sites Sampled on August 4, 1986	85
52	Temperature (°C), Dissolved Oxygen (mg/l), Percent Saturation (%) - August 4, 1986	86
53	Non-Point Source Bacteriological Data - August 4, 1986	87
54	Non-Point Source Physical Data - August 4, 1986	88
55	Non-Point Source Chemical Data - August 4, 1986	89
56	Westport River Sites Sampled on August 10, 1986	92
57	Temperature (°C), Dissolved Oxygen (mg/l), Percent Saturation (%) - August 10, 1986	93
58	Non-Point Source Bacteriological Data - August 10, 1986	94
59	Non-Point Source Physical Data - August 10, 1986	95
60	Non-Point Source Chemical Data - August 10, 1986	96
61	Muddy Cove Sites Sampled on August 11, 1986	99
62	Temperature (°C), Dissolved Oxygen (mg/l), Percent Saturation (%) - August 11, 1986	100
63	Non-Point Source Bacteriological Data - August 11, 1986	101

LIST OF TABLES (CONTINUED)

NUMBER	TITLE	PAGE
64	Non-Point Source Physical Data - August 11, 1986	102
65	Non-Point Source Chemical Data - August 11, 1986	103
66	Source Differentiation of Fecal Streptococci Bacteria from Muddy Cove Sites - August 11, 1986	104
67	Westport River Sites Sampled on August 19, 1986	107
68	Temperature (°C), Dissolved Oxygen (mg/l), Percent Saturation (%) - August 19, 1986	108
69	Non-Point Source Bacteriological Data - August 19, 1986	109
70	Non-Point Source Physical Data - August 19, 1986	110
71	Non-Point Source Chemical Data - August 19, 1986	111
72	Sunset Cove Sites Sampled on August 26, 1986	114
73	Temperature (°C), Dissolved Oxygen (mg/l), Percent Saturation (%) - August 26, 1986	115
74	Non-Point Source Bacteriological Data - August 26, 1986	116
75	Non-Point Source Physical Data - August 26, 1986	117
76	Non-Point Source Chemical Data - August 26, 1986	118
77	Westport River Sites Sampled on September 17, 1986	121
78	Temperature (°C), Dissolved Oxygen (mg/l), Percent Saturation (%) - September 17, 1986	122
79	Non-Point Source Bacteriological Data - September 17, 1986	123
80	Non-Point Source Physical Data - September 17, 1986	124
81	Non-Point Source Chemical Data - September 17, 1986	125
82	Source Differentiation of Fecal Streptococci Bacteria from Westport River Sites - September 17, 1986	126
83	Sunset Cove Sites Sampled on September 24, 1986	129
84	Temperature (°C), Dissolved Oxygen (mg/l), Percent Saturation (%) - September 24, 1986	130

LIST OF TABLES (CONTINUED)

NUMBER	TITLE	PAGE
85	Non-Point Source Bacteriological Data - September 24, 1986	131
86	Non-Point Source Physical Data - September 24, 1986	132
87	Non-Point Source Chemical Data - September 24, 1986	133
88	Westport River Sites Sampled on October 2, 1986	136
89	Temperature (°C), Dissolved Oxygen (mg/l), Percent Saturation (%) - October 2, 1986	137
90	Non-Point Source Bacteriological Data - October 2, 1986	138
91	Non-Point Source Physical Data - October 2, 1986	139
92	Non-Point Source Chemical Data - October 2, 1986	140
93	Source Differentiation of Fecal Streptococci Bacteria from Westport River Sites - October 2, 1986	141
94	Broad Cove and East River Sites Sampled on October 8, 1986	144
95	Temperature (°C), Dissolved Oxygen (mg/l), Percent Saturation - October 8, 1986	145
96	Non-Point Source Bacteriological Data - October 8, 1986	146
97	Non-Point Source Physical Data - October 8, 1986	147
98	Non-Point Source Chemical Data - October 8, 1986	148

LIST OF FIGURES

NUMBER	TITLE	PAGE
1	Plots of Bacteriological Data - June 17, 1986	21
2	Plots of Bacteriological Data - June 23, 1986	28
3	Plots of Bacteriological Data - June 30, 1986	37
4	Plots of Bacteriological Data - July 7, 1986	46
5	Plots of Bacteriological Data - July 9, 1986	53
6	Plots of Bacteriological Data - July 14, 1986	60
7	Plots of Bacteriological Data - July 21, 1986	68
8	Plots of Bacteriological Data - July 28, 1986	75
9	Plots of Bacteriological Data - August 3, 1986	82
10	Plots of Bacteriological Data - August 4, 1986	90
11	Plots of Bacteriological Data - August 10, 1986	97
12	Plots of Bacteriological Data - August 11, 1986	105
13	Plots of Bacteriological Data - August 19, 1986	112
14	Plots of Bacteriological Data - August 26, 1986	119
15	Plots of Bacteriological Data - September 17, 1986	127
16	Plots of Bacteriological Data - September 24, 1986	134
17	Plots of Bacteriological Data - October 2, 1986	142
18	Plots of Bacteriological Data - October 8, 1986	149

INTRODUCTION

During the summer and fall of 1986, members of the Biology Section of the Massachusetts Division of Water Pollution Control - Technical Services Branch (TSB) with the assistance of personnel from the Bacteriology Laboratory at the Lawrence Experiment Station (LES) conducted a microbial indicator study at Buzzards Bay. The work was funded, in part, by a grant awarded by the U.S. Environmental Protection Agency (U.S. EPA) for the Buzzards Bay Project. The sites selected for study were areas impacted by non-point sources of fecal contamination which have resulted in closure of shellfish beds for harvesting or which will be closed in the future by the S.E. Regional Office - Shellfish Division of DEQE if the sources of bacterial contamination cannot be identified and corrected.

Sampling sites were in the towns of Wareham and Westport. In Wareham, sampling was conducted in the Agawam, Wareham and East Rivers, as well as at Muddy Cove and Sunset Cove. In Westport, sampling was conducted in the East Branch of the Westport River.

Since passage of the Federal Water Pollution Control Act of 1972 (PL92-500) there has been a major national effort to eliminate point sources of pollution to our water bodies. The same effort has not yet been made to control non-point sources of pollution. Yet, even with the construction of hundreds of municipal sewage treatment plants, areas are still closed for shellfishing and recreational purposes. The present study is an attempt to gather information on the relative impacts on water quality caused by non-point sources of pollution in fresh water and estuarine areas.

Several indicator organisms of fecal pollution were included in this study. Those sampled were:

mFC - Fecal coliform test and membrane filter procedure

mCP - *Clostridium perfringens* test and membrane filter procedure

mE - Enterococci test and membrane filter procedure

mKF - Streptococci test and membrane filter procedure

mTECH - *Escherichia coli* test and membrane filter procedure

A-1 - Fecal coliform test and Most Probable Number procedure

This was done to establish a data base for indicators that are gaining in importance and to examine, when possible, the magnitude of the bacterial counts and the differences in the bacterial assemblages associated with each non-point source of pollution considered.

The non-point sources which were sampled for possible fecal contamination were:

1) Housing areas in compliance with Massachusetts Title V;

2) Housing areas not in compliance with Title V;

3) Salt marsh areas;

4) A marina with a pump out facility for septage;

5) A marina without pump out facilities for septage; and

6) Agricultural land.

The initial proposal also included storm drains and water fowl populations but time constraints prevented the satisfactory sampling of either of these potential sources of contamination.

Historically, in the United States, either total coliform bacteria or fecal coliform bacteria (Most Probable Number) tests have been used to classify shellfish and recreational areas. But, in the past few years, the U.S. EPA has funded or conducted several studies to determine how various indicator organisms and their testing procedures function under different environmental conditions. In 1986, the U.S. EPA issued Ambient Water Quality Criteria for Bacteria (1986) which recommends the use of two indicator organisms: *Escherichia coli* and enterococci bacteria for use as the bacterial criteria for contact recreational waters. The U.S. EPA found that these two organisms or groups of organisms were the most highly correlated with highly creditable gastrointestinal illness in swimmers in fresh and marine waters, respectively. Much still remains to be learned about these indicators and their testing procedures. Thus, while the information obtained from the field data on non-point sources was a major part of this study, a second area of inquiry was oriented towards the laboratory work. Some of the questions examined by the Bacteriology Laboratory at the LES were:

1. What are the recoveries for the experimental tests (i.e., mE, mTECH, mCP) compared to those of the more familiar mKF, mFC, and A-1 tests?

2. What is colony formation like?

3. How do the false positive or false negative rates compare?

A third major aspect of this study was to use source differentiation of the fecal streptococci bacteria (U.S. EPA, 1978) as a way of determining the source of elevated bacterial counts. The kinds of sources which can be distinguished by this method are: insects, birds, warm-blooded animals, and vegetation. The identification of the type of source will aid in the establishment of mitigative measures to control non-point sources of fecal contamination.

SAMPLING DESIGN

Samples were typically collected on Mondays, beginning on June 17, 1986 and ending on October 8, 1986. In most cases, samples were collected on a falling tide. An effort was made to sample during the worst-case conditions for each particular non-point source. The non-point sources chosen for examination were:

1) A marina with a pump-out facility for septage;

2) A marina without a pump-out facility for septage;

3) Houses in compliance with Title V;

4) Houses not in compliance with Title V;

5) Salt marsh areas;

6) Agricultural areas;

7) Bird populations on the water; and

8) Storm drains/parking lot runoff (Table 1).

The marinas were to be sampled on busy, hot weekend mornings when boating use was heavy. However, the summer of 1986 was very wet with 13 weekends exhibiting some precipitation (National Oceanic and Atmospheric Administration, 1986) (Tables 2 & 3). Several sampling attempts had to be cancelled. The marinas were finally sampled with some boaters present, although on August 3 rain was threatening and on August 10, the second time that the marinas were sampled, rain was forecast. The marinas chosen for study were: Warr's Marina on the Wareham River, which has a septage pump-out facility for boats, and the Point Independence Yacht Club and the Onset Bay Marina, both of which are on Onset Bay, Wareham. Neither of these has pump-out facilities.

Title V is a state regulation which includes set-back requirements for cesspools and septic tank leaching fields from surface waters. Currently, 50 feet is required. In order to examine if this distance is adequate for the removal of bacteria in areas with sandy soils such as Buzzards Bay, two types of housing areas were chosen for study. These areas are located on the East Branch of the Westport River. The west side of the East Branch of the Westport River below Hix Bridge has an area of houses which are apparently in compliance with Title V. Another area on the east side has a section with homes that are apparently not in compliance with Title V. These distinctions were made by observation and not by measuring the actual distances between the leaching fields and the waters' edge. Sampling was done on the ebb part of a spring tide which was believed to represent the worst-case conditions.

Locations with agricultural impacts were chosen for study along the East Branch of the Westport River above Hix Bridge. Agricultural inputs were

TABLE 1

SUMMARY OF 1986 BUZZARDS BAY BACTERIOLOGICAL SURVEYS

SURVEY DESCRIPTION	DATE	SAMPLING PARAMETERS*						
		SD	mFC	mE	mTECH	KF	mCP	A-1
Salt marsh and bog drainage	6/17/86	-	X	X	X	X	-	X
Above and below Wareham POTW	6/23/86	-	X	-	X	X	X	-
Agawam River Watershed	6/30/86	-	X	X	X	X	-	X
Source differentiation - Wareham River	7/7/86	-	X	X	X	X	-	X
Resampling for source differentiation - Wareham River	7/9/86	X	X	X	X	X	-	X
Agricultural areas - Westport River	7/14/86	-	X	X	X	X	X	X
Resampling for source differentiation - Wareham River	7/21/86	X	X	X	X	X	-	X
Houses in and out of compliance Title V - Westport River	7/28/86	-	X	X	X	X	-	X
A marina with a holding tank - Wareham River	8/3/86	-	X	X	X	X	-	X
Houses in and out of compliance Title V - Westport River	8/4/86	-	X	X	X	X	X	X
A marina without holding tanks - Onset Bay	8/10/86	-	X	X	X	X	-	X
Marsh and bog drainage - Wareham	8/11/86	X	X	X	X	X	-	X
Houses in and out of compliance Title V - Westport River	8/19/86	-	X	X	X	X	X	X
Source differentiation of salt marsh area - Sunset Cove	8/26/86	-	X	X	X	X	X	X
Resampling for source differentiation - Westport River	9/17/86	X	X	X	X	X	-	X
Resampling Sunset Cove area	9/24/86	-	X	X	X	X	-	X
Source differentiation - Westport River	10/02/86	X	X	X	X	X	-	X
Examination of Broad Cove - East River	10/08/86	-	X	X	X	X	X	X

* SD - source differentiation of the fecal streptococci bacteria
mFC - fecal coliform bacteria - membrane filter test
mE - enterococci bacteria - membrane filter test
KF - fecal streptococci bacteria - membrane filter test
mTECH - *Escherichia coli* - membrane filter test
mCP - *Clostridium perfringens*
A-1 - fecal coliform bacteria - MPN test
X - indicates bacterial tests performed
\- - indicates bacterial tests not performed

TABLE 2

ANTECEDENT RAINFALL AS RECORDED*

THREE DAYS PRIOR TO SAMPLING AT

WAREHAM/ONSET, BUZZARDS BAY

SAMPLING DATE	DATES OF ANTECEDENT RAINFALL	INCHES OF RAINFALL	TOTAL INCHES OF RAINFALL
06-17-86	06-14-86	0	
	06-15-86	0	0
	06-16-86	0	
06-23-86	06-20-86	0.10	
	06-21-86	0	0.10
	06-22-86	0	
06-30-86	06-27-86	0	
	06-28-86	0	0
	06-29-86	0	
07-07-86	07-04-86	0	
	07-05-86	0	0
	07-06-86	0	
07-09-86	07-06-86	0	
	07-07-86	0	0
	07-08-86	0	
07-21-86	07-18-86	0	
	07-19-86	0	0
	07-20-86	0	
08-03-86	07-31-86	0	
	08-01-86	0	0
	08-02-86	0	
08-10-86	08-07-86	0	
	08-08-86	1.78	1.78
	08-09-86	0	
08-11-86	08-08-86	1.78	
	08-09-86	0	1.88
	08-10-86	0.10	
08-26-86	08-23-86	0	
	08-24-86	0.18	0.18
	08-25-86	0	

TABLE 2 (CONTINUED)

ANTECEDENT RAINFALL AS RECORDED*

THREE DAYS PRIOR TO SAMPLING AT

WAREHAM/ONSET, BUZZARDS BAY (CONTINUED)

SAMPLING DATE	DATES OF ANTECEDENT RAINFALL	INCHES OF RAINFALL	TOTAL INCHES OF RAINFALL
09-24-86	09-21-86	0	
	09-22-86	0	0.07
	09-23-86	0.07	
10-08-86	10-05-86	0.19	
	10-06-86	0	0.19
	10-07-86	0	

*As measured at nearest NOAA Station - Acushnet

TABLE 3

ANTECEDENT RAINFALL AS RECORDED*

THREE DAYS PRIOR TO SAMPLING AT

WESTPORT, BUZZARDS BAY

SAMPLING DATE	DATES OF ANTECEDENT RAINFALL	INCHES OF RAINFALL	TOTAL INCHES OF RAINFALL
07-14-86	07-11-86	0	
	07-12-86	0.74	1.67
	07-13-86	0.93	
07-28-86	07-25-86	0	
	07-26-86	0.02	0.11
	07-27-86	0.09	
08-04-86	08-01-86	0	
	08-02-86	0	0.64
	08-03-86	0.64	
09-17-86	09-14-86	0	
	09-15-86	0	0.73
	09-16-86	0.73	
10-02-86	09-29-86	0	
	09-30-86	0	0
	10-01-86	0	

*As measured at nearest NOAA Station - New Bedford

chiefly from grazing cattle, but some corn fields were also present in the study areas. Samples were collected along the shore and in drainage channels emanating from cow pastures. There are 32 active dairy and beef cattle farms along the East Branch of the Westport River, which have a total cow population of 3,900 (Westport River Watershed Committee, 1983).

Other non-point sources of fecal contamination were studied in Wareham in the Agawam, Wareham and East River basins and in Onset, Sunset and Muddy coves. Sampling locations were chosen to examine fecal contributions from the Wareham Publicly Owned Treatment Works (POTW), salt marsh areas, marinas, bird populations, and storm drains. However, during the sampling period migrating birds did not flock in the coves and marshes, so they were not sampled. Because no suitable rain storms occurred during the sampling weeks, storm drains were not sampled either.

In the Agawam River, sampling was conducted above and below the Wareham POTW. Bacterial sampling included analysis of Clostridium perfringens, as well as fecal coliform, enterococci and fecal streptococci bacteria. Triplicate samples were collected at each location in the river. The effluent from the Wareham POTW passes through sand filters before it is discharged into the Agawam River. There are four separate discharge pipes at the Wareham POTW. If the Clostridium counts had been elevated as well as the other bacterial parameters, then an effort would have been made to use the Clostridium perfringens as a tracer of the sewage treatment plant discharge. The bacterial counts, however, remained about the same at all sampling stations in the Agawam River chosen for study on that day. In addition, the Clostridium perfringens counts were low.

In the first few weeks of the study, samples were collected at 0', 50' and 100' intervals offshore. This sampling regime was abandoned when results showed no significant differences between these intervals. It had been hoped that a sample gradient would have been observed. Since a density gradient was never observed the sampling regime was altered so that more shoreline areas could be sampled.

In addition to the shoreline sampling for several indicator organisms, samples were also collected for differentiation of the fecal streptococci bacteria into their probable sources (U.S. EPA, 1978). Those included in the differentiation were: insects, warm-blooded animals, birds, and vegetative sources. This method was chosen because of its potential for use in managing areas impacted by non-point sources of pollution.

The sampling schedule for the Agawam and Wareham River basins was designed so that upper basin areas were sampled first for their bacterial assemblage and then each following week another non-point source further downstream was chosen for examination. Finally, samples were collected for source differentiation of the fecal streptococci bacteria in an area of the Wareham River offshore and below the Warr's Marina.

Source differentiation was also conducted at the East Branch of the Westport River upstream of the shellfish closure line which presently is located just below Great Island. Source differentiation was also accomplished at Muddy Cove in Wareham. A similar effort was made to do the same at Sunset Cove, Wareham, but on two separate occasions fecal streptococci colonies were not isolated from samples obtained from this area.

FIELD METHODS AND MATERIALS

Samples were collected from a Boston Whaler. Bacterial samples were collected in sterile glass containers held below the surface of the water (American Public Health Assoc., 1985). Samples were also collected for chlorides, specific conductivity, hardness, and suspended solids in a half-liter glass bottles. This bottle was previously rinsed twice with sample water and then filled to the shoulder of the bottle. If the water depth was more than four feet, a Kemmerer vertical water sampler was used to collect the sample. For sample depths less than four feet a surface grab sample was typically collected. Nutrient samples were also collected in half-liter bottles which were rinsed with sample water twice. Samples were analyzed for total phosphorus, Kjeldahl-nitrogen and ammonia-nitrogen. The nutrient samples were fixed in the field with 2 mls of concentrated sulfuric acid. A temperature compensated Orion meter was used for pH and temperature measurements in the field. When available, a Y.S.I model 33 salinity meter was used for specific conductivity and salinity.

All samples were placed in coolers containing ice and brought to the Lawrence Experiment Station for analysis. All samples were brought to LES within the six-hour holding period for the bacterial samples.

LABORATORY MATERIALS AND METHODS

Membrane Filtration

Depending upon the source of water, different volumes of water samples were passed through presterilized membrane filters (HA type; Millipore, 0.45 um pore size). If the sample volume was insufficient to provide an even distribution of bacteria on the filters then phosphate buffered $MgCl_2$ solution was first added to the funnels and the sample was added in turn to ensure accurate colony counts. Filter holders and funnels were sterilized for two minutes in an ultraviolet sterilizing apparatus.

Recovery Media

The following Difco media were prepared and used according to the manufacturer's instruction and those included in Standard Methods for the Examination of Water and Wastewater (1985): KF, mFC, mTECH, A-1. The mE media was prepared and used according to the method of M.A. Levin, et al. (Levin, 1975) as modified by A.P. Dufour (Dufour, 1980). The mCP media was prepared and used according to the method of Bisson and Cabelli (Bisson, 1979). A-1 (Difco) was prepared and used according to the manufacturer's instructions and the 12 tube MPN chart developed by James H. Redman (U.S. Food and Drug Administration, 1974). The mTECH was prepared and used according to the manufacturer's instructions and Dufour et al. 1981.

The A-1 was used as an MPN test. The KF, mCP, mE, mFC, and mTECH were used in membrane filter procedures.

Incubation Periods

Inoculated A-1 tubes were incubated for a two-hour resuscitation period at 35°C (Lab Line-Environette) and then transferred to a 44.5°C water bath incubator (Blue M or GCA/precision scientific) for 24 hours. The KF plates were incubated for 48 hours at 35°C (Lab-Line Environette). The mCP plates were incubated in a BBL Gas Pack Anaerobic jar for 24 hours at 45°C (Forma-HydroJac incubator). The mE plates were incubated at 41°C for 48 hours (Blue M). The mFC plates were sealed in water-tight plastic bags (Whirlpac) and incubated in a 44.5°C water bath incubator (Blue M or GCA precision scientific) for 24 hours. The mTECH plates were incubated for a two-hour resuscitation period at 35°C (Lab-Line Environette) and then sealed in water-tight plastic bags (Whirlpac) and transferred to a 44.5°C water bath incubator for 24 hours.

Source Differentiaton of Fecal Streptococci

If a sampling area was so designated, a representative amount of characteristic colonies growing on KF media were picked and streaked onto BHI agar slants (Difco) for source differentiation. Colonies were differentiated according to their sources, i.e. warm-blooded animal, bird, insect, and vegetation. The methods used for differentiation were according to Microbial Methods for Monitoring the Environment (1978) and included the

following tests: growth at 45°C, growth at 10°C, catalase production, starch hydrolyses, lactose fermentation, growth in 6.5% NaCl BHI broth, growth in pH 9.6 BHI broth, reduction of 0.1% methylene blue in milk and peptonization of litmus milk.

Quality Control

For purposes of quality control duplicate samples were collected and analyzed on a predetermined schedule. Typically every other week duplicates were analyzed for all tests except the A-1 MPN test.

Chemical and Physical Parameters

Samples for chemical and physical analysis were brought to the Lawrence Experiment Station (LES). Table 4 is a list of analytical methods used at LES.

TABLE 4

ANALYTICAL METHODS USED AT LAWRENCE EXPERIMENT STATION

PARAMETER	METHOD	REPORTED AS
Suspended Solids	Filtration through standard glass fiber filter paper. Residue dried at 103-105°C. Gravimetric	mg/l S.S.
Total Kjeldahl-Nitrogen	Acid digestion using Technical BD-40 Block Digester. Colorimetric analysis (reaction of ammonia, sodium salicylate, sodium nitroprusside, and sodium hypochlorite in buffered alkaline medium) using Technicon Auto Analyzer II	mg/l TKN
Ammonia-Nitrogen	Phenate method, automated. Colorimetric analysis using Technicon Auto Analyzer II	mg/l NH_3-N
Nitrate-Nitrogen	Hydrazine reduction method, automated. Colorimetric analysis using Technicon Auto Analyzer II	mg/l NO_3-N
Total Phosphate	Acid digestion using Technicon BD-40 Block Digester. Ascorbic acid reduction colorimetric method using Technicon Auto Analyzer II	mg/l P
Conductivity	Wheatstone Bridge type meter. Yellow Springs Instrument conductivity bridge, Model 31	umhos/cm
Chloride	Argentometric (titration with silver nitrate)	mg/l Cl
Cadmium, copper, chromium, iron, lead, magnesium, manganese, nickel, zinc, hardness (Ca+Mg)	Atomic Absorption Spectrophotometry. Air-acetylene flame. Perkin-Elmer Model 403	mg/l

RESULTS

TABLE 5

PRELIMINARY SITES THROUGHOUT BUZZARDS BAY/WAREHAM STUDY AREA

SAMPLED ON JUNE 17, 1986

STATION NUMBER	DESCRIPTION	LATITUDE	LONGITUDE
0101	Off of salt marsh area, east side of Muddy Cove at approximately 20th Street, 50' from shore	41°45'13"	70°39'27"
0102	Off of salt marsh area, east side of Muddy Cove at approximately 20th Street, 100' from shore	41°45'13"	70°39'29"
0103	35' from shore approximately 50' downstream of 0101	41°45'03"	70°39'25"
0104	100' from shore, approximately 50' downstream of 0101	41°45'03"	70°39'29"
0105	Point of land on western shore approximately 60' from shore, just above Dummy Bridge	41°44'54"	70°39'28"
0106	200' downstream of 0105, 50' from shore in shellfish area	41°44'54"	70°39'25"
0107	West of Dummy Bridge in center of channel	41°44'54"	70°39'18"
0108	North of town boat ramp, approximately 35' from shore	41°44'49"	70°39'21"
0109	North of town boat ramp, approximately 120' from shore	41°44'49"	70°39'17"
0110	Gibbs Brook, at Cranberry Greens Mini Golf (Route 6 - Cranberry Highway)	41°45'25"	70°39'13"

TABLE 6

PRELIMINARY SITES THROUGHOUT BUZZARDS BAY/WAREHAM STUDY AREA

TEMPERATURE (°C), DISSOLVED OXYGEN (mg/l), PERCENT SATURATION (%)

JUNE 17, 1986

STATION NUMBER	TEMPERATURE	DISSOLVED OXYGEN	PERCENT SATURATION
0101	23.0	9.6	119
0102	22.5	9.1	130
0103	23.0	--	--
0104	22.5	--	--
0105	22.0	--	--
0106	22.0	--	--
0107	22.0	--	--
0108	22.0	--	--
0109	21.5	7.1	95
0110	22.0	7.0	81

TABLE 7

BUZZARDS BAY
NON-POINT SOURCE BACTERIOLOGICAL DATA

Station Number	Fecal Coliform Bacteria /100ml	Entero-cocci Bacteria /100ml	*Escherichia coli* /100ml	Strepto-cocci Bacteria /100ml	*Clostridium perfringens* /100ml	Fecal Coliform Bacteria MPN/100ml
**Date Collected: 06/17/86						
0101	90	<5	160	10	---	110
0101	110	<5	140	10	---	110
0102	90	5	90	10	---	110
0102	40	<5	70	10	---	179
0103	100	<5	130	10	---	88
0103	20	20	70	10	---	88
0104	60	<5	80	<10	---	54
0104	70	5	100	<10	---	70
0105	50	<5	50	<10	---	88
0105	70	10	40	<10	---	88
0106	90	<5	30	20	---	---
0106	70	<5	70	<10	---	---
0107	110	10	90	10	---	---
0107	120	5	40	30	---	---
0108	10	10	50	20	---	---
0108	40	5	50	20	---	---
0109	<10	<5	60	20	---	---
0109	<10	<5	30	20	---	---
0110	<10	5	50	20	---	---
0110	40	20	30	40	---	---

TABLE 8

BUZZARDS BAY
NON-POINT SOURCE PHYSICAL DATA

Station Number	pH (standard units)	Total Hardness (mg/l)	Suspended Solids (mg/l)	Specific Conductivity (µmhos/cm)
** Date Collected: 06/17/86				
0101	---	2380	---	---
0102	---	2565	---	---
0103	---	2955	---	---
0104	---	3060	---	---
0105	---	3675	---	---
0106	---	3675	---	---
0107	---	3675	---	---
0108	---	3870	---	---
0109	---	4690	---	---
0110	---	13	---	---

TABLE 9

BUZZARDS BAY
NON-POINT SOURCE CHEMICAL DATA

Station Number	Chloride (mg/l)	Total Kjeldahl-Nitrogen (mg/l)	Ammonia-Nitrogen (mg/l)	Total Phosphorus (mg/l)
** Date Collected: 06/17/86				
0101	---	1.60	0.03	0.17
0102	---	1.50	0.04	0.17
0103	---	1.80	0.26	0.12
0104	---	1.60	0.15	0.14
0105	---	1.60	0.04	0.11
0106	---	1.90	0.37	0.23
0107	---	1.10	0.50	0.11
0108	---	1.60	0.09	0.12
0109	---	2.30	0.39	0.21
0110	---	0.70	0.20	0.11
0101	---	1.60	0.03	0.17
0102	---	1.50	0.04	0.17
0103	---	1.80	0.26	0.12
0104	---	1.60	0.15	0.14
0105	---	1.60	0.04	0.11
0106	---	1.90	0.37	0.23
0107	---	1.10	0.50	0.11
0108	---	1.60	0.09	0.12
0109	---	2.30	0.39	0.21
0110	---	0.70	0.20	0.11

Figure 1

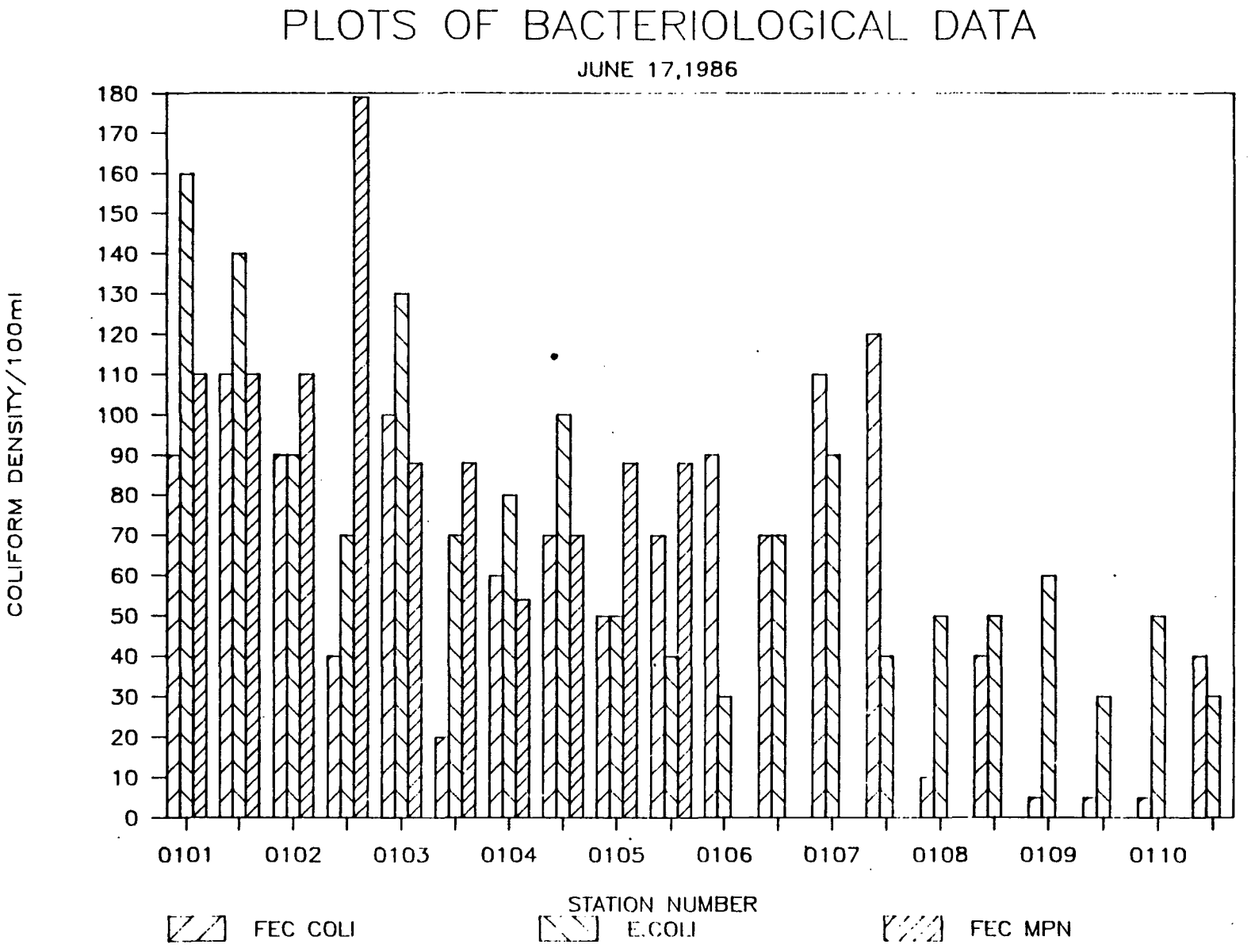

PLOTS OF BACTERIOLOGICAL DATA
JUNE 17,1986
COLIFORM DENSITY/100ml
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0101
0102
0103
0104
0105
0106
0107
0108
0109
0110
STATION NUMBER
FEC COLI
E.COLI
FEC MPN

Figure 1 (Continued)

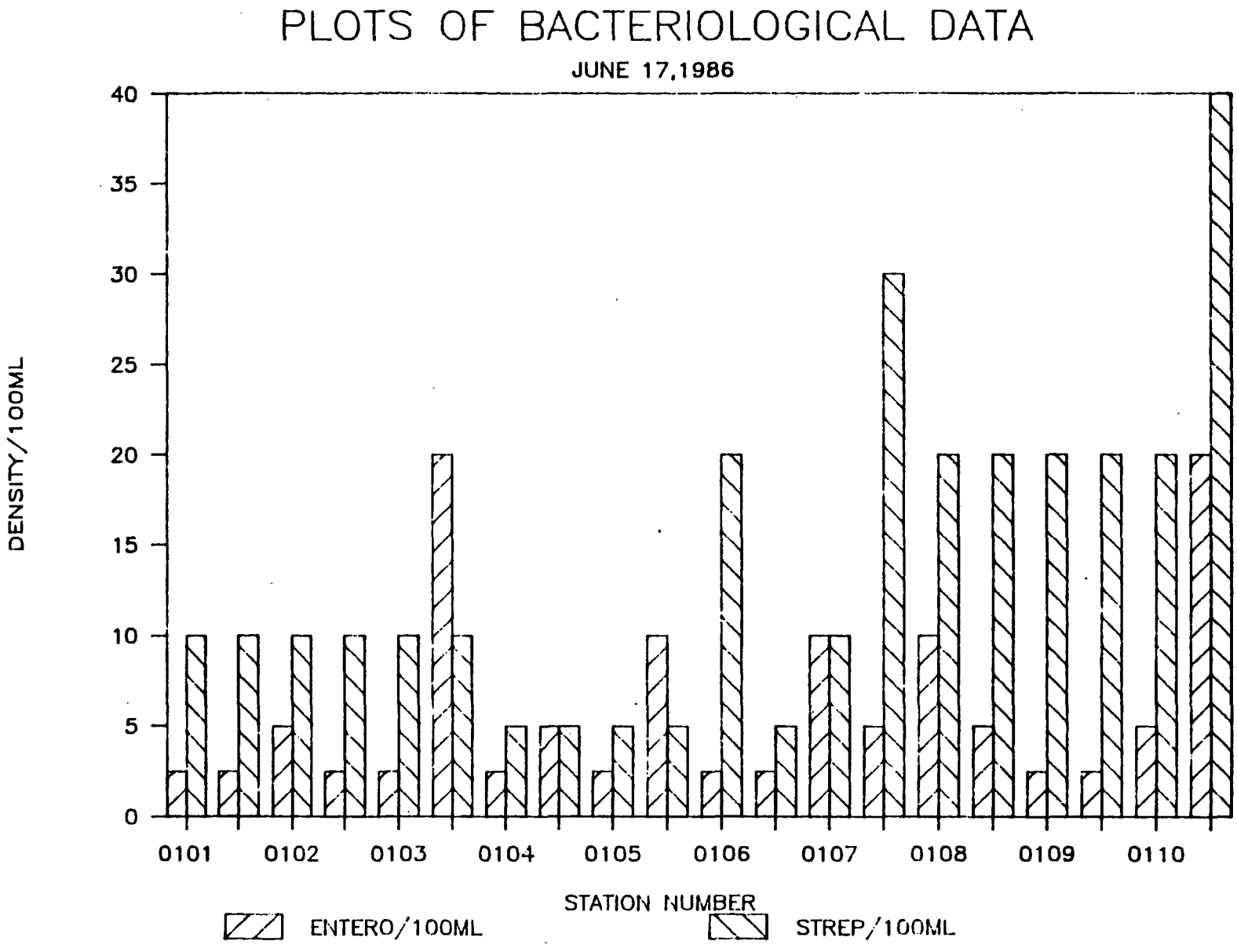


TABLE 10

AGAWAM AND WAREHAM RIVER SITES, WAREHAM

SAMPLED ON JUNE 23, 1986

STATION NUMBER	DESCRIPTION	LATITUDE	LONGITUDE
0201	Approximately 400' upstream of first discharge pipe at Wareham publicly-owned treatment plant located on Agawam River	42°35'00"	70°40'40"
0202	Approximately 50' downstream of first pipe at Wareham publicly-owned treatment plant, approximately 50' from shore	42°34'58"	70°40'41"
0203	Approximately 50' downstream of second pipe at Wareham publicly-owned treatment plant, approximately 50' from shore	42°34'57"	70°40'42"
0204	Approximately 50' downstream of second pipe, at Wareham publicly-owned treatment plant, approximately 100' from shore	42°34'56"	70°40'39"
0205	Approximately 50' downstream of fourth pipe at Wareham publicly-owned treatment plant, approximately 20' from shore	42°34'56"	70°40'43"
0206	Approximately 50' downstream of fourth pipe at Wareham publicly-owned treatment plant, approximately 100' from shore	42°34'55"	70°40'42"
0207	Approximately 300' downstream of fourth pipe at Wareham publicly-owned treatment plant, approximately 50' from shore	42°34'55"	70°40'43"
0208	Approximately 300' downstream of fourth pipe at Wareham publicly-owned treatment plant, approximately 100' from shore	42°34'54"	70°40'43"
0209	Just downstream of Sandwich Road (Route 6) Bridge, on Agawam River	41°46'25"	70°41'15"
0210	Under power lines just downstream of house on point of land close to Sandwich Road	41°45'40"	70°41'50"
0211	Off bird sanctuary, approximately 100' from shore	41°45'34"	70°42'37"
0212	Beside channel marker 30 in Wareham River	41°44'54"	70°42'21"

TABLE 11

AGAWAM AND WAREHAM RIVER SITES, WAREHAM

TEMPERATURE (°C), DISSOLVED OXYGEN (mg/l), PERCENT SATURATION (%)

JUNE 23, 1986

STATION NUMBER	TEMPERATURE	DISSOLVED OXYGEN	PERCENT SATURATION
0201	21.0	--	--
0202	21.0	7.2	81
0203	21.0	--	--
0204	21.0	--	--
0205	20.0	--	--
0206	21.0	--	--
0207	21.0	6.5	73
0208	21.0	--	--
0209	21.5	--	--
0210	21.0	6.8	81
0211	22.0	6.7	85
0212	21.0	6.7	88

TABLE 12

BUZZARDS BAY
NON-POINT SOURCE BACTERIOLOGICAL DATA

Station Number	Fecal Coliform Bacteria /100ml	Entero-cocci Bacteria /100ml	*Escherichia coli* /100ml	Strepto-cocci Bacteria /100ml	*Clostridium perfringens* /100ml	Fecal Coliform Bacteria MPN/100ml
**Date Collected: 06/23/86						
0201	340	---	300	225	<5	>248
0201	365	---	320	150	5	>248
0201	320	---	305	140	10	248
0202	390	---	325	325	<5	248
0202	320	---	260	225	5	248
0202	345	---	290	175	<5	179
0203	360	---	305	210	<5	>248
0203	310	---	290	250	<5	248
0203	300	---	340	240	5	>248
0204	390	---	295	205	<5	>248
0204	370	---	305	215	<5	248
0204	335	---	285	190	<5	88
0205	300	---	225	230	<5	---
0205	345	---	275	250	<5	---
0205	340	---	320	210	5	---
0206	300	---	305	220	<5	---
0206	310	---	300	210	<5	---
0206	320	---	315	170	<5	---
0207	365	---	320	120	<5	---
0207	350	---	365	215	10	---
0207	385	---	410	230	10	---
0208	330	---	305	395	<5	---
0208	335	---	310	205	<5	---
0208	350	---	315	230	<5	---
0209	475	---	390	145	5	---
0209	445	---	420	190	<5	---
0209	455	---	410	235	<5	---
0210	495	---	440	170	5	---
0210	510	---	405	80	10	---
0210	485	---	445	160	<5	---
0211	260	---	200	140	15	---
0211	200	---	230	115	10	---
0211	240	---	220	145	15	---
0212	40	---	90	40	<5	---
0212	60	---	75	45	5	---
0212	60	---	85	40	<5	---

TABLE 13

BUZZARDS BAY
NON-POINT SOURCE PHYSICAL DATA

Station Number	pH (standard units)	Total Hardness (mg/l)	Suspended Solids (mg/l)	Specific Conductivity (µmhos/cm)
** Date Collected: 06/23/86				
0201	6.80	315	4.0	2800
0202	6.0	415	6.0	2600
0203	6.60	363	2.50	2800
0204	6.70	443	2.0	3300
0205	6.0	700	4.0	5400
0206	4.10	430	---	3300
0207	6.80	750	4.0	6600
0208	6.60	367	2.50	4100
0209	7.20	1040	6.50	9200
0210	7.20	1270	11.0	11000
0211	7.60	2235	13.0	21000
0212	7.30	3795	15.0	29000

TABLE 14

BUZZARDS BAY
NON-POINT SOURCE CHEMICAL DATA

Station Number	Chloride (mg/l)	Total Kjeldahl-Nitrogen (mg/l)	Ammonia-Nitrogen (mg/l)	Total Phosphorus (mg/l)
** Date Collected: 06/23/86				
0201	---	2.10	0.10	0.18
0202	---	2.40	0.24	0.16
0203	---	1.60	0.11	0.12
0204	---	2.10	0.08	0.08
0205	---	3.0	0.99	0.26
0206	---	2.20	0.25	0.09
0207	---	1.80	0.39	0.16
0208	---	3.0	0.86	0.44
0209	---	1.50	0.27	0.11
0210	---	1.30	0.16	0.11
0211	---	2.0	0.11	0.13
0212	---	2.0	0.17	0.12

Figure 2

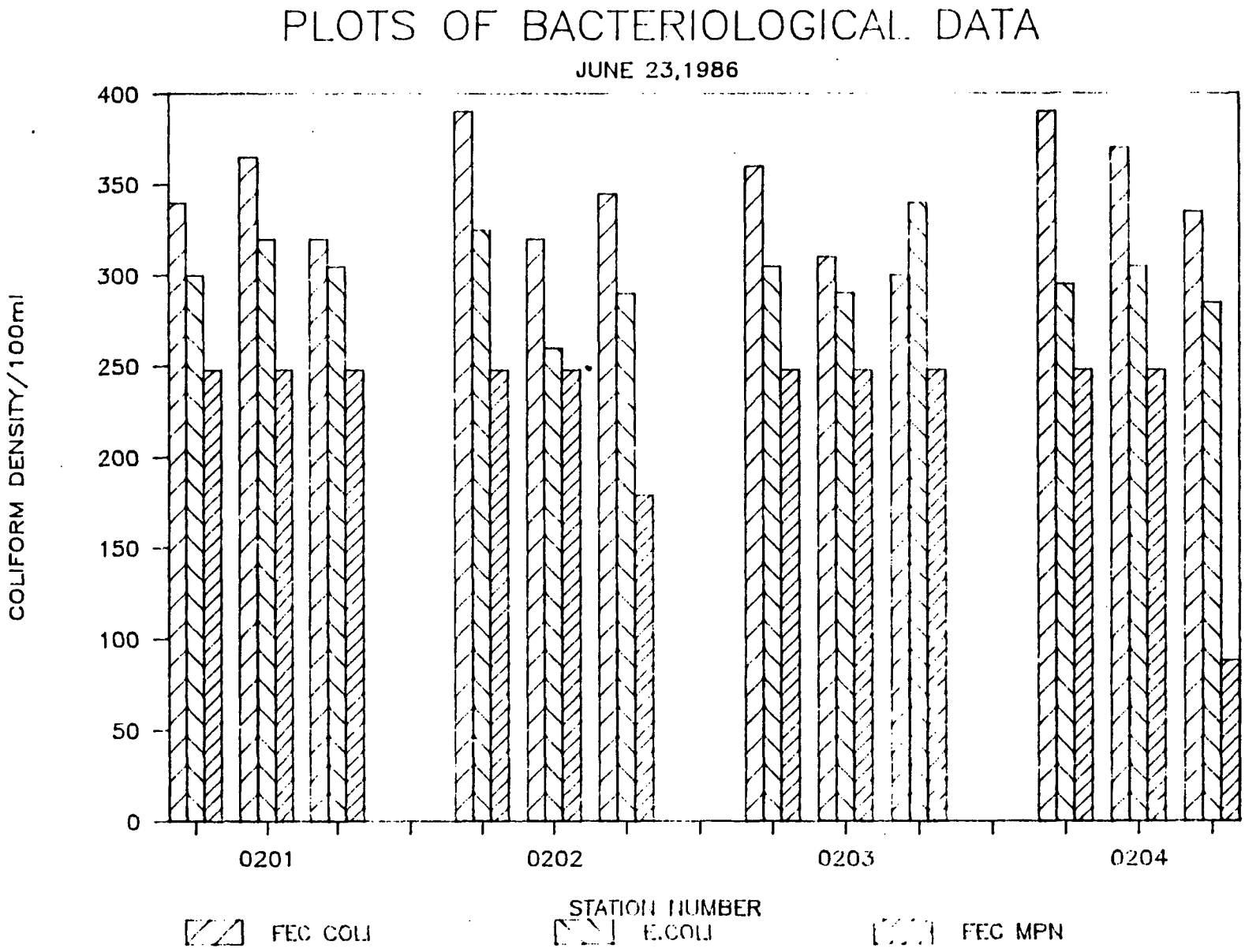

PLOTS OF BACTERIOLOGICAL DATA
JUNE 23,1986
COLIFORM DENSITY/100ml
400
350
300
250
200
150
100
50
0
0201
0202
0203
0204
STATION NUMBER
FEC COLI
E.COLI
FEC MPN

Figure 2 (Continued)

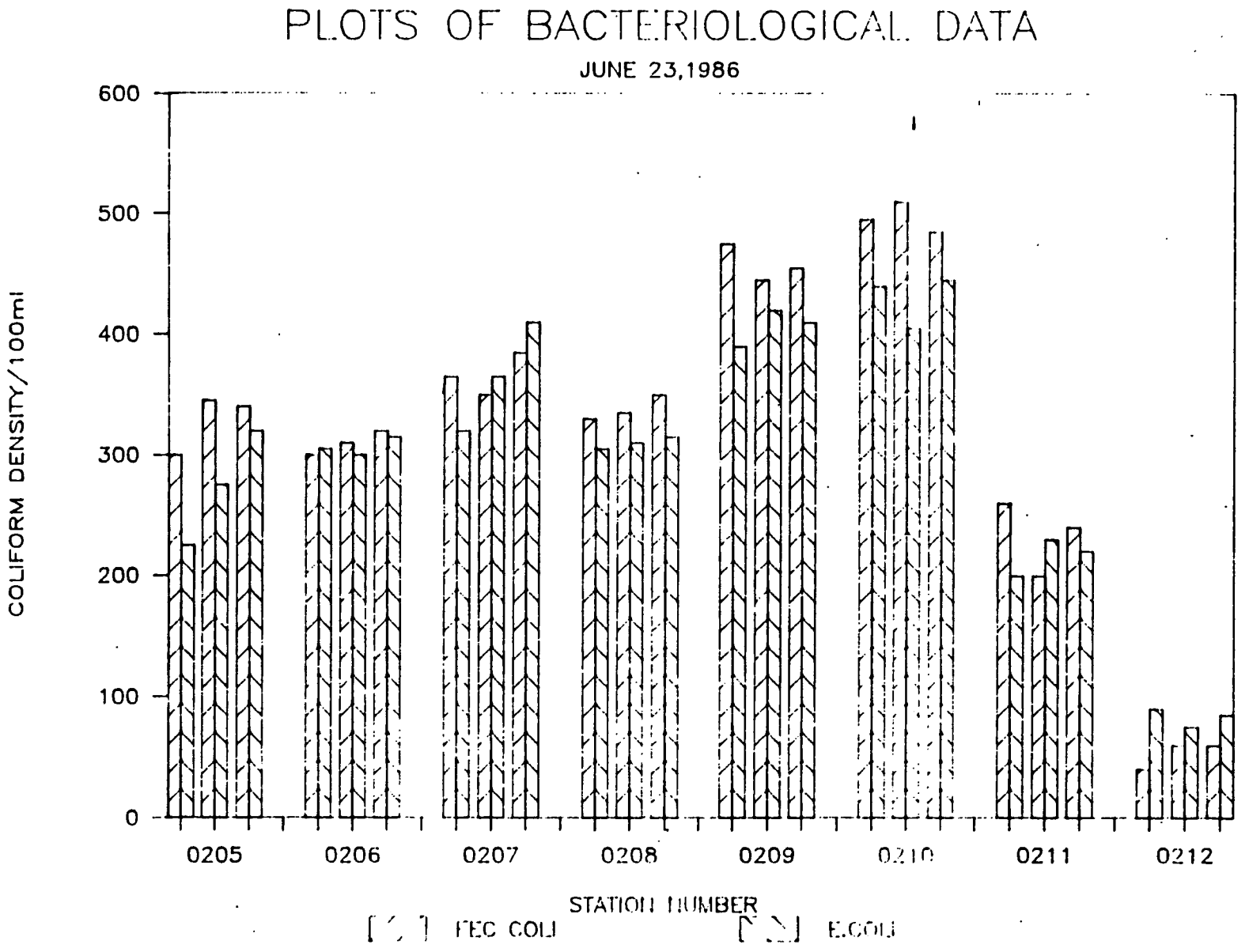


Figure 2 (Continued)

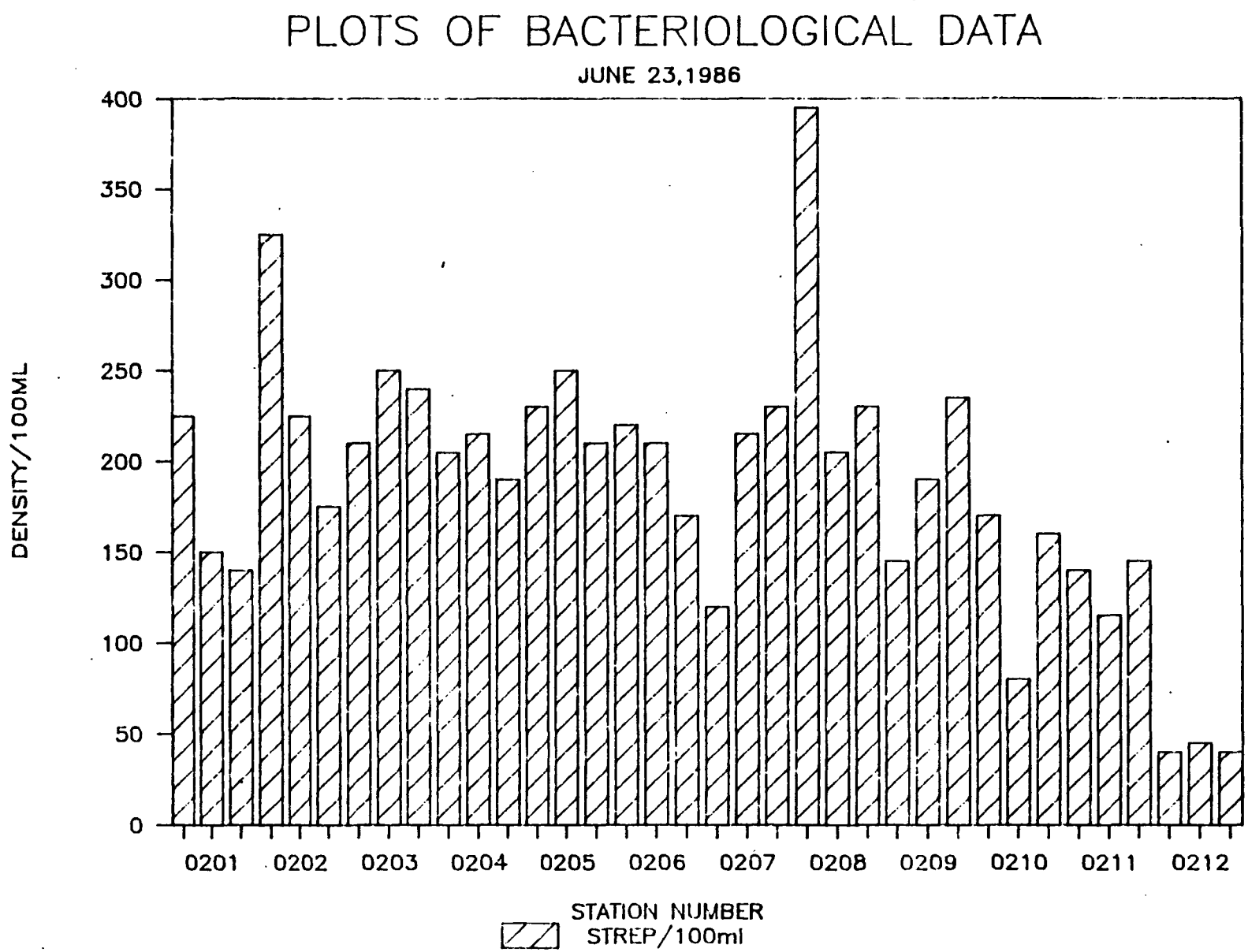


Figure 2 (Continued)

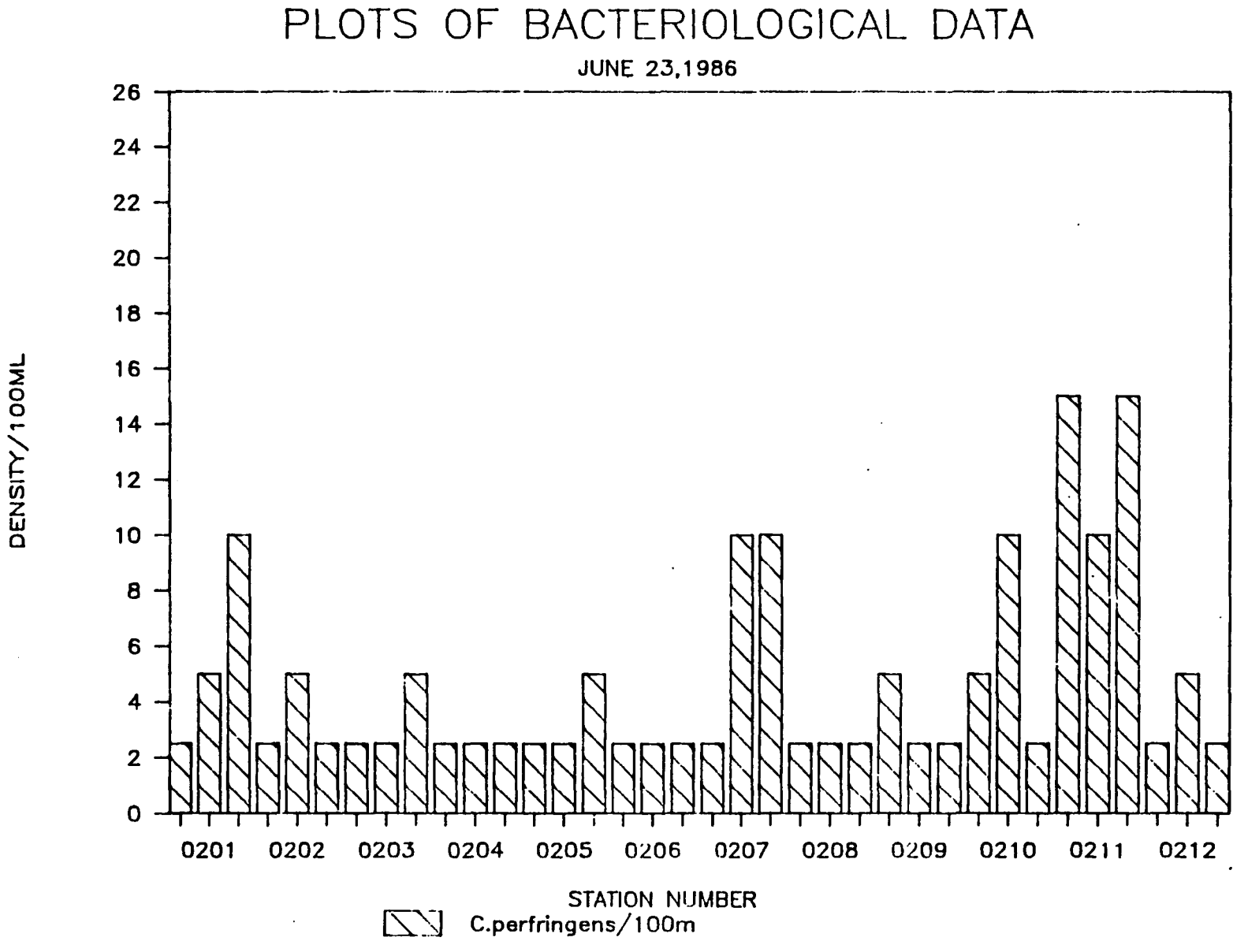


TABLE 15

UPPER AGAWAM RIVER SITES, WAREHAM

SAMPLED ON JUNE 30, 1986

STATION NUMBER	DESCRIPTION	LATITUDE	LONGITUDE
0301	Outlet Mill Pond at Route 28	41°45'45"	70°40'35"
0302	Maple Springs Brook off of Maple Springs Road near confluence with Mill Pond	41°46'45"	70°40'20"
0303	Outlet Glenn Charlie Pond	41°47'00"	70°39'25"
0304	Beach in Sunset Cove next to Town Beach	41°44'07"	70°43'27"
0305	Wareham Town Beach at Shell Point	41°44'06"	70°43'19"

TABLE 16

UPPER AGAWAM RIVER SITES, WAREHAM

TEMPERATURE (°C), DISSOLVED OXYGEN (mg/l), PERCENT SATURATION (%)

JUNE 30, 1986

STATION NUMBER	TEMPERATURE	DISSOLVED OXYGEN	PERCENT SATURATION
0301	23.0	8.5	99
0302	19.5	9.5	104
0303	22.0	6.6	76
0304	22.0	7.5	106
0305	21.0	8.6	113

TABLE 17

BUZZARDS BAY
NON-POINT SOURCE BACTERIOLOGICAL DATA

Station Number	Fecal Coliform Bacteria /100ml	Entero-cocci Bacteria /100ml	*Escherichia coli* /100ml	Strepto-cocci Bacteria /100ml	*Clostridium perfringens* /100ml	Fecal Coliform Bacteria MPN/100ml
**Date Collected: 06/30/86						
0301	<10	<10	<10	<10	---	8.70
0301	20	10	<10	<10	---	<8.70
0302	<10	10	10	<10	---	18
0302	10	<10	<10	<10	---	8.70
0303	5600	2300	3800	2500	---	>2480
0303	5000	4800	3000	5900	---	>2480
0304	<5	<5	<5	20	---	8.70
0304	<5	<5	<5	<5	---	<8.70
0305	<5	<5	<5	<5	---	8.70
0305	5	<5	5	20	---	<8.70

TABLE 18

BUZZARDS BAY
NON-POINT SOURCE PHYSICAL DATA

Station Number	pH (standard units)	Total Hardness (mg/l)	Suspended Solids (mg/l)	Specific Conductivity (µmhos/cm)
** Date Collected: 06/30/86				
0301	5.60	10	0.0	---
0302	6.20	3	2.50	---
0303	3.90	5	0.50	---
0304	7.80	1825	13.0	---
0305	8.10	1840	13.0	---
0301	5.60	10	0.0	---
0302	6.20	3	2.50	---
0303	3.90	5	0.50	---
0304	7.80	1825	13.0	---
0305	8.10	1840	13.0	---

TABLE 19

BUZZARDS BAY
NON-POINT SOURCE CHEMICAL DATA

Station Number	Chloride (mg/l)	Total Kjeldahl-Nitrogen (mg/l)	Ammonia-Nitrogen (mg/l)	Total Phosphorus (mg/l)
** Date Collected: 06/30/86				
0301	---	0.31	0.26	0.15
0302	---	0.27	0.03	0.08
0303	---	0.81	0.25	0.06
0304	---	2.30	0.15	0.24
0305	---	1.90	0.25	0.26

Figure 3

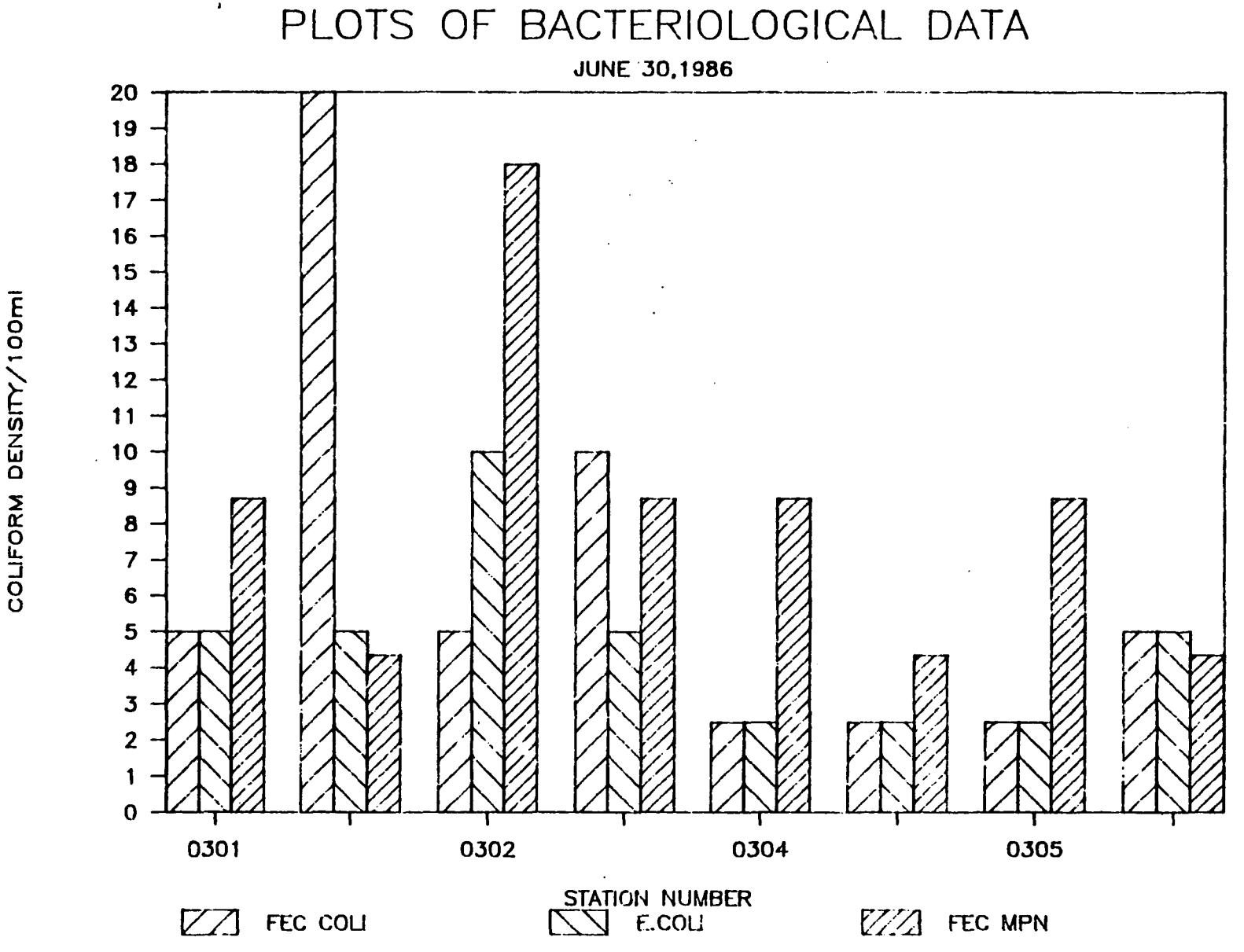

PLOTS OF BACTERIOLOGICAL DATA
JUNE 30,1986
COLIFORM DENSITY/100ml
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
0301
0302
0304
0305
STATION NUMBER
FEC COLI
E.COLI
FEC MPN

Figure 3 (Continued)

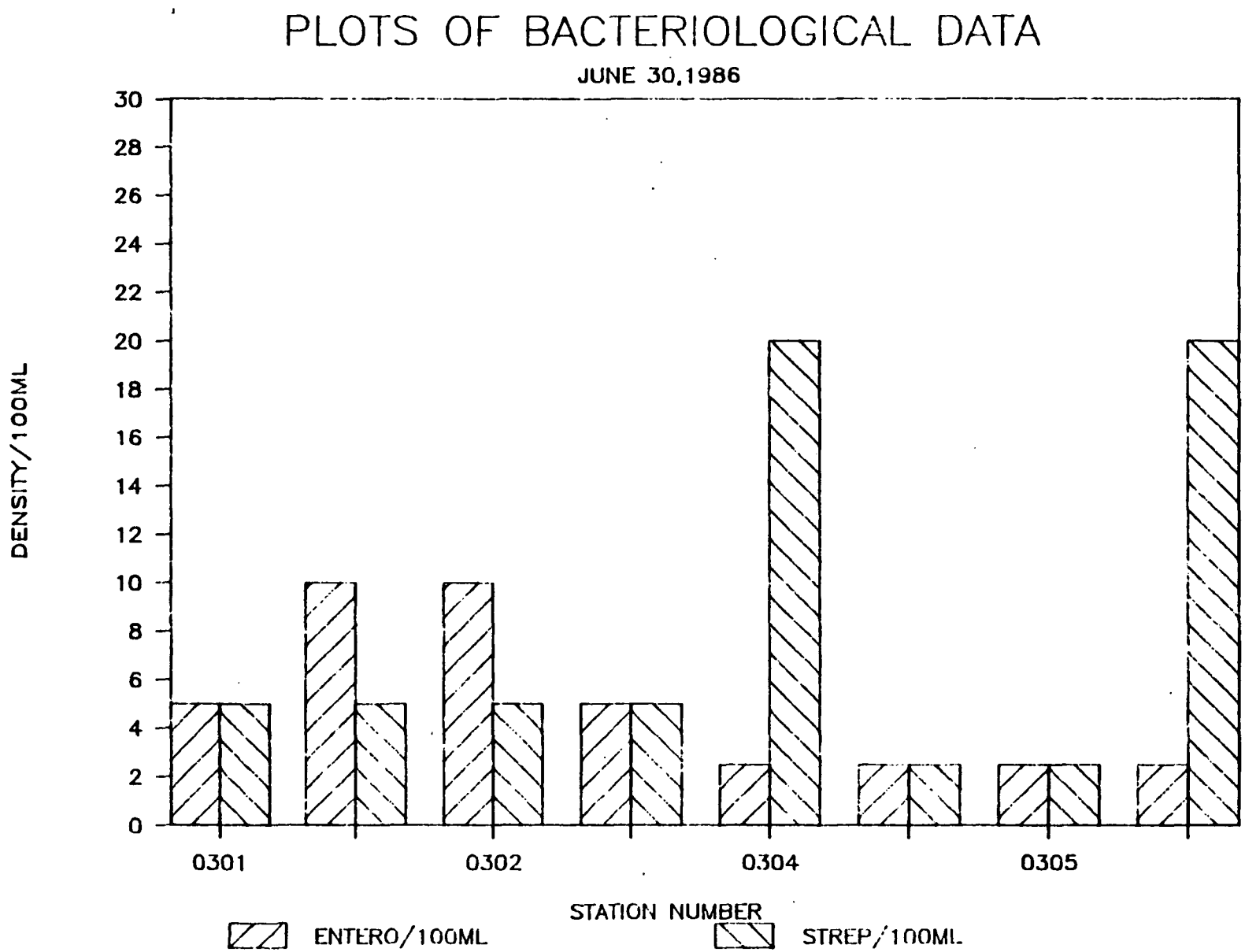


Figure 3 (Continued)

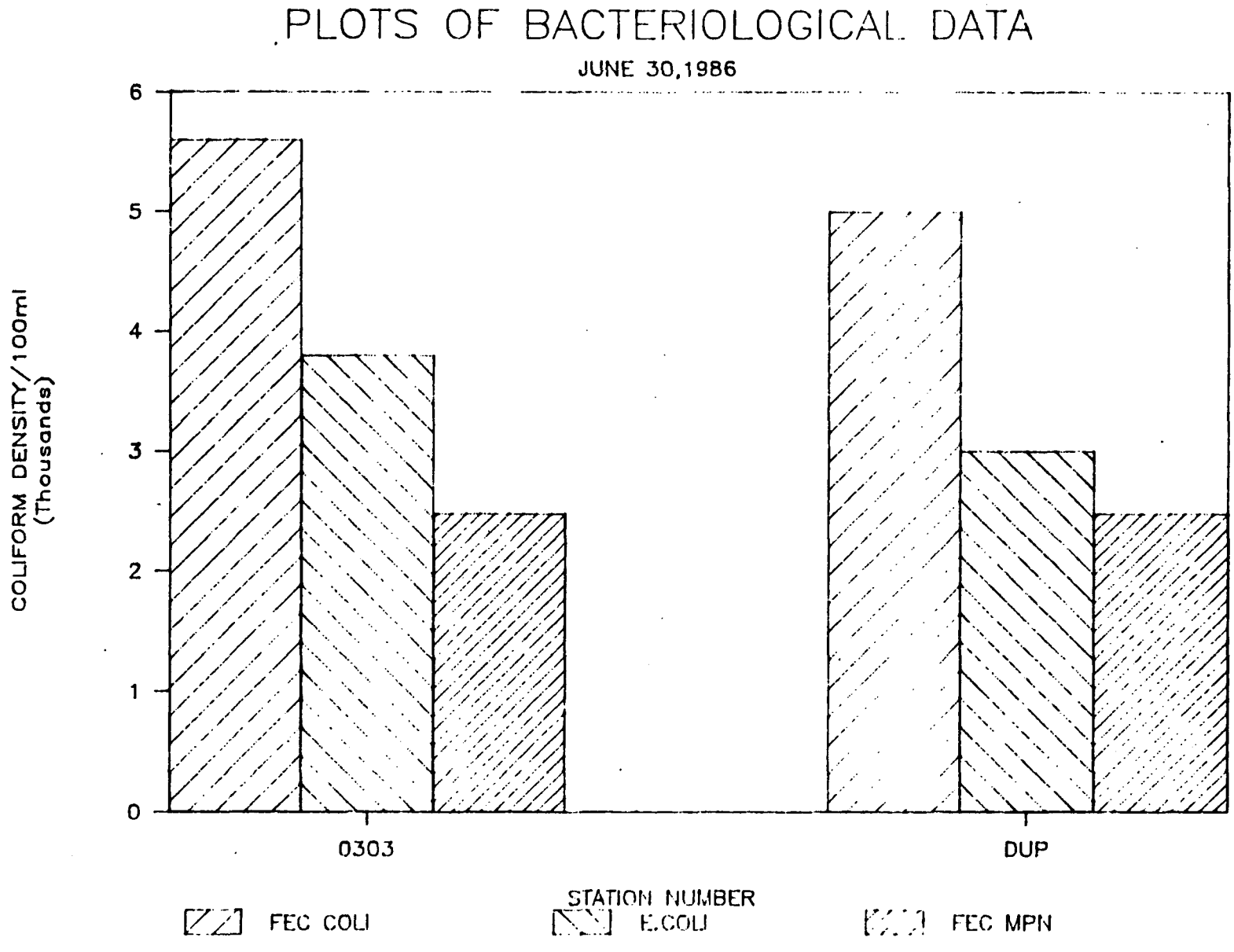


Figure 3 (Continued)

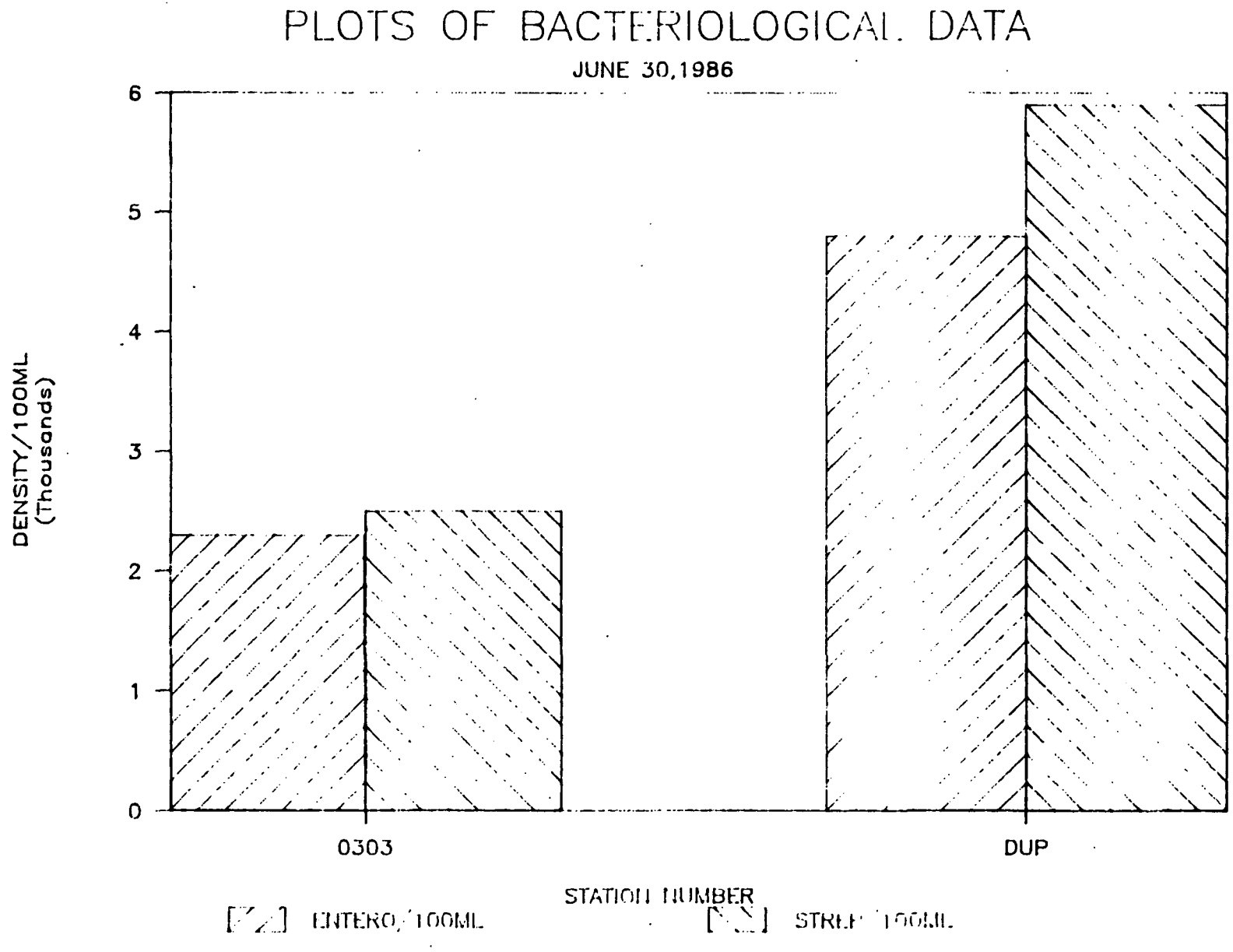


TABLE 20

WAREHAM RIVER SITES, WAREHAM

SAMPLED ON JULY 7, 1986

STATION NUMBER	DESCRIPTION	LATITUDE	LONGITUDE
0401	Sampled along eastern shore downstream of buoy 28, sampled onshore in front of brown 2-story house	41°45'03"	70°42'09"
0402	50' offshore of 0401	41°45'03	70°42'12"
0403	100' offshore of 0401	41°45'03"	70°42'14"
0404	Downstream of 0401 in front of last house before Crab Cove Marina, sampled onshore	41°44'57"	70°42'04"
0405	50' offshore of 0404	41°44'57"	70°42'06"
0406	100' offshore of 0404	41°44'56"	70°42'09"
0407	In front of house just downstream of Warr's Marina, sampled onshore	41°45'09"	70°42'32"
0408	50' offshore of 0407	41°45'09"	70°42'30"
0409	100' offshore of 0407	41°45'09"	70°42'28"
0410	In front of house just before Broad Marsh Cove, sampled onshore	41°44'57"	70°42'33"
0411	50' offshore of 0410	41°44'55"	70°42'32"
0412	100' offshore of 0410	41°44'54"	70°42'29"

TABLE 21

WAREHAM RIVER SITES, WAREHAM

TEMPERATURE (°C), DISSOLVED OXYGEN (mg/l), PERCENT SATURATION (%)

JULY 7, 1986

STATION NUMBER	TEMPERATURE	DISSOLVED OXYGEN	PERCENT SATURATION
0401	24.0	--	--
0402	24.0	7.0	97
0403	23.0	--	--
0404	24.0	--	--
0405	24.0	7.5	100
0406	24.0	--	--
0407	24.5	--	--
0408	23.5	7.5	104
0409	24.0	--	--
0410	24.5	--	--
0411	24.0	4.7	65
0412	24.0	--	--

TABLE 22

BUZZARDS BAY
NON-POINT SOURCE BACTERIOLOGICAL DATA

Station Number	Fecal Coliform Bacteria /100ml	Entero-cocci Bacteria /100ml	*Escherichia coli* /100ml	Strepto-cocci Bacteria /100ml	*Clostridium perfringens* /100ml	Fecal Coliform Bacteria MPN/100ml
**Date Collected: 07/07/86						
0401	<10	<10	10	<10	---	18
0402	<10	<10	10	10	---	29
0403	<10	<10	<10	<10	---	18
0404	<10	10	<10	<10	---	8.70
0405	20	<10	10	<10	---	<8.70
0406	<10	<10	<10	<10	---	<8.70
0407	20	<10	<10	20	---	8.70
0408	<10	<10	<10	<10	---	18
0409	<10	<10	20	<10	---	<8.70
0410	<10	<10	10	10	---	18
0411	10	<10	<10	10	---	<8.70
0412	<10	<10	10	<10	---	8.70

TABLE 23

BUZZARDS BAY
NON-POINT SOURCE PHYSICAL DATA

Station	pH (standard units)	Total Hardness (mg/l)	Suspended Solids (mg/l)	Specific Conductivity (µmhos/cm)
** Date Collected: 07/07/86				
0401	3.10	4290	3.50	---
0402	8.0	3315	2.0	---
0403	8.0	2945	2.50	---
0404	7.80	2980	11.0	---
0405	7.70	2825	2.50	---
0406	8.0	2504	0.0	---
0407	7.80	2560	37.0	---
0408	7.30	3545	1.50	---
0409	7.40	2760	0.0	---
0410	8.0	3070	24.0	---
0411	7.80	3360	6.0	---
0412	8.0	3550	0.50	---

TABLE 24

BUZZARDS BAY
NON-POINT SOURCE CHEMICAL DATA

Station Number	Chloride (mg/l)	Total Kjeldahl-Nitrogen (mg/l)	Ammonia-Nitrogen (mg/l)	Total Phosphorus (mg/l)
** Date Collected: 07/07/86				
0401	---	1.50	0.45	0.10
0402	---	1.60	0.15	0.15
0403	---	1.60	0.05	0.08
0404	---	1.40	0.13	0.08
0405	---	1.60	0.83	0.10
0406	---	1.0	0.20	0.09
0407	---	2.10	0.26	0.22
0408	---	1.40	0.06	0.11
0409	---	1.40	0.12	0.10
0410	---	1.50	0.56	0.12
0411	---	0.92	<0.02	0.09
0412	---	0.87	<0.02	0.10

Figure 4

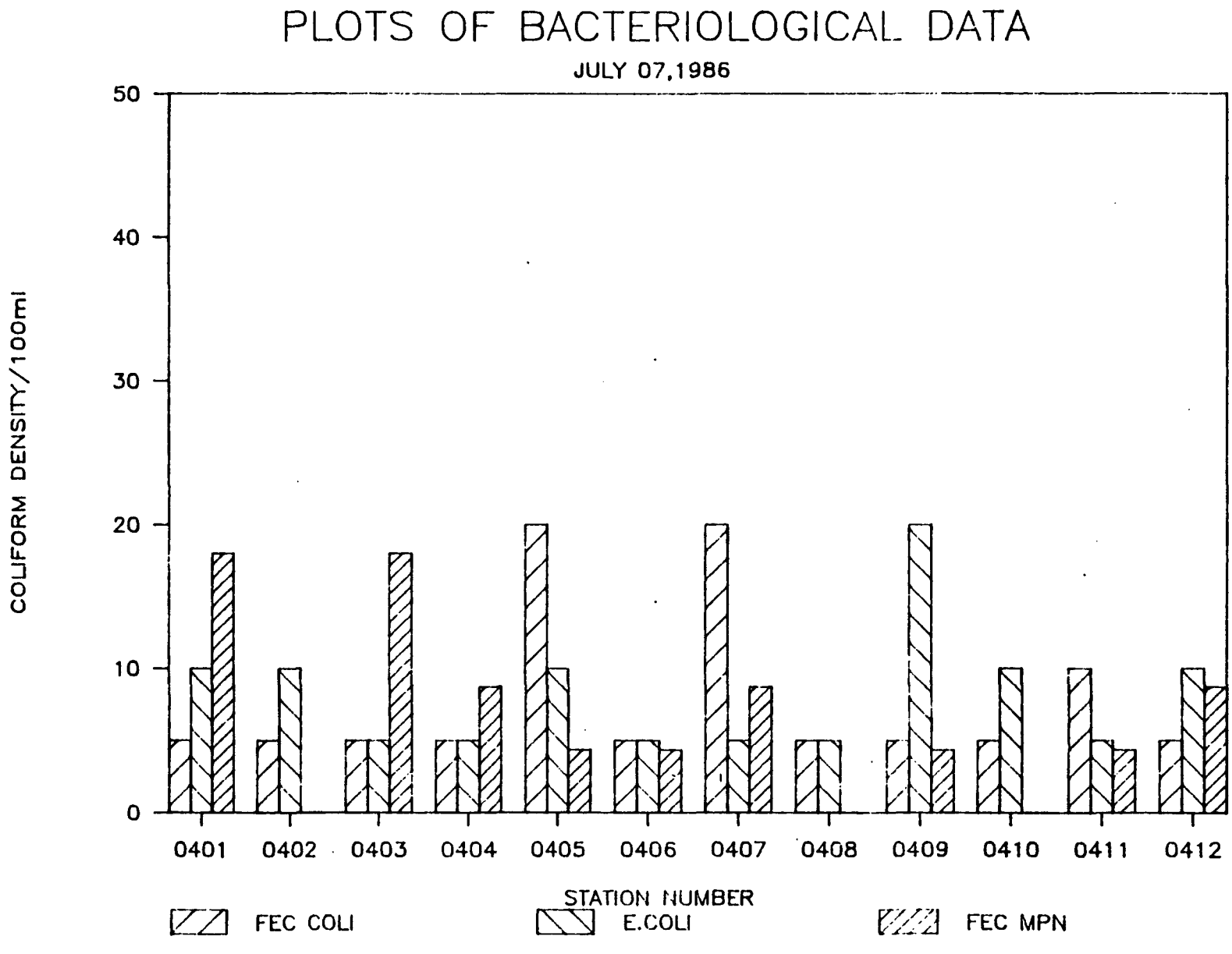

PLOTS OF BACTERIOLOGICAL DATA
JULY 07,1986
COLIFORM DENSITY/100ml
50
40
30
20
10
0
0401
0402
0403
0404
0405
0406
0407
0408
0409
0410
0411
0412
STATION NUMBER
FEC COLI
E.COLI
FEC MPN

Figure 4 (Continued)

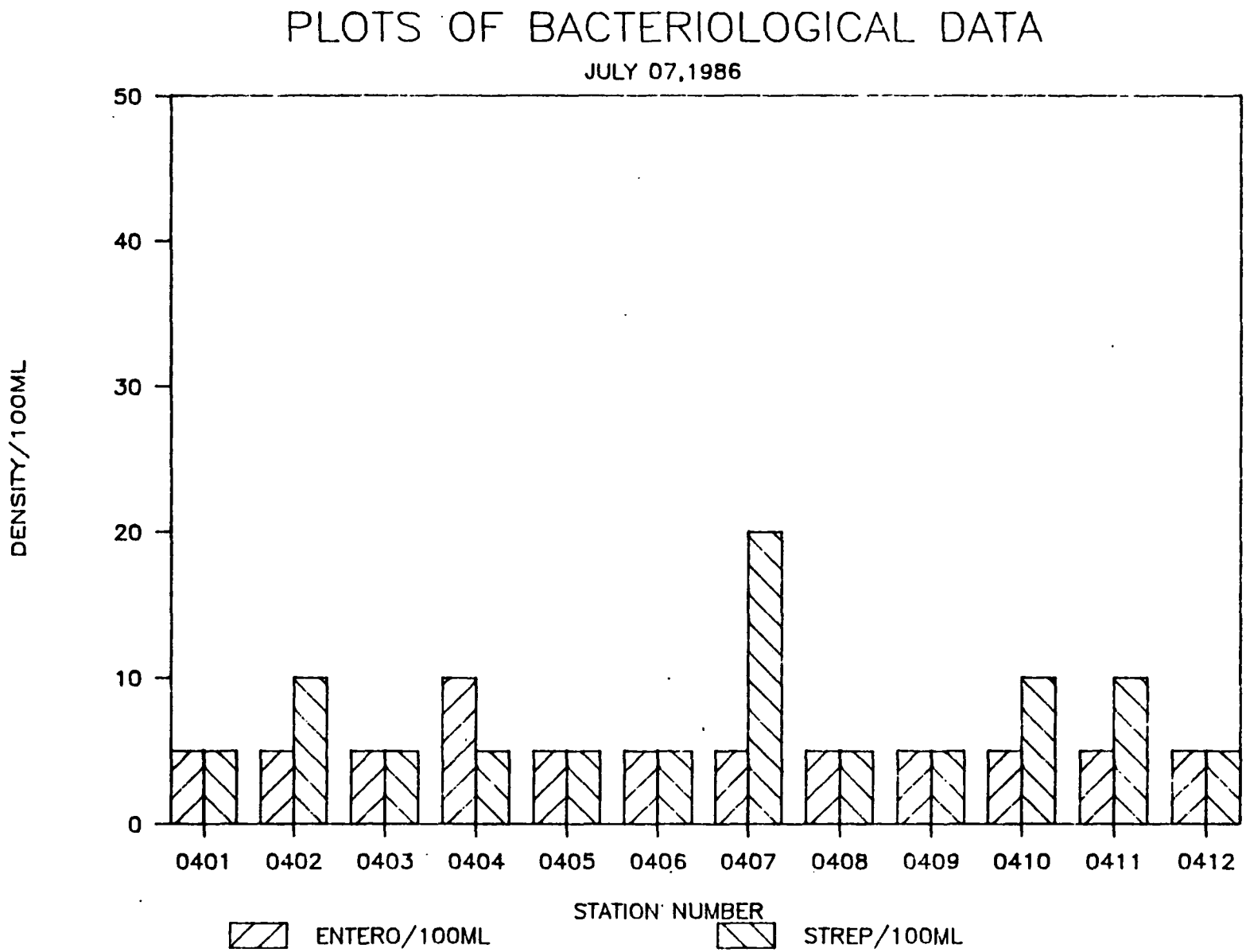


TABLE 25

WAREHAM RIVER SITES, WAREHAM

SAMPLED ON JULY 9, 1986

STATION NUMBER	DESCRIPTION	LATITUDE	LONGITUDE
0501	Below railroad bridge on east side of Wareham River opposite British Landing condominiums	41°41'16"	70°42'36"
0502	Approximately 50' downstream of 0501	41°41'13"	70°42'35"
0503	Small cove near Oak Hill Road	41°45'19"	70°42'25"
0504	Near intersection of Oak Hill Road and Oak Street	41°45'18"	70°42'19"
0505	Above Crab Cove along Oak Street	41°44'55"	70°42'03"
0506	Just east and upstream of buoy 26	41°44'57"	70°42'08"
0507	Just downstream of Crab Cove close to Parkwood Drive	41°44'54"	70°42'13"
0508	Just downstream of buoy 26	41°44'54"	70°42'18"
0509	Just downstream of and west of buoy 26	41°44'50"	70°42'22"
0510	Just upstream of buoy 24	41°44'53"	70°42'29"

TABLE 26

WAREHAM RIVER SITES, WAREHAM

TEMPERATURE (°C), DISSOLVED OXYGEN (mg/l), PERCENT SATURATION (%)

JULY 9, 1986

STATION NUMBER	TEMPERATURE	DISSOLVED OXYGEN	PERCENT SATURATION
0501	25.5	7.3	105
0502	25.5	--	--
0503	26.5	8.2	120
0504	26.0	--	--
0505	26.0	8.9	122
0506	26.0	--	--
0507	26.0	8.7	119
0508	25.5	--	--
0509	25.6	7.0	96
0510	25.5	7.2	99

TABLE 27

BUZZARDS BAY
NON-POINT SOURCE BACTERIOLOGICAL DATA

Station Number	Fecal Coliform Bacteria /100ml	Entero-cocci Bacteria /100ml	*Escherichia coli* /100ml	Strepto-cocci Bacteria /100ml	*Clostridium perfringens* /100ml	Fecal Coliform Bacteria MPN/100ml
**Date Collected: 07/09/86						
0501	55	<5	45	<5	---	41
0501	50	<5	10	<5	---	---
0502	30	<5	5	10	---.	18
0503	15	<5	<5	35	---	8.70
0503	5	<5	<5	15	---	---
0504	<5	<5	<5	<5	---	18
0505	15	<5	20	5	---	29
0506	10	<5	5	10	---	18
0507	10	<5	15	50	---	29
0507	<5	<5	5	40	---	---
0508	65	<5	75	<5	---	41
0509	90	5	40	5	---	179
0510	135	<5	105	<5	---	248

TABLE 28

BUZZARDS BAY
NON-POINT SOURCE PHYSICAL DATA

Station Number	pH (standard units)	Total Hardness (mg/l)	Suspended Solids (mg/l)	Specific Conductivity (µmhos/cm)
** Date Collected: 07/09/86				
0501	8.0	3640	5.0	29000
0502	8.0	2800	7.50	32000
0503	8.0	2320	12.0	29500
0504	8.20	2400	9.50	28000
0505	7.50	2110	12.0	25000
0506	7.20	2450	7.50	27000
0507	7.30	2015	7.50	28000
0508	7.70	2525	6.0	27750
0509	7.90	1930	8.50	25500
0510	7.80	2420	13.0	26000

TABLE 29

BUZZARDS BAY
NON-POINT SOURCE CHEMICAL DATA

Station Number	Chloride (mg/l)	Total Kjeldahl-Nitrogen (mg/l)	Ammonia-Nitrogen (mg/l)	Total Phosphorus (mg/l)
** Date Collected: 07/09/86				
0501	---	2.0	0.30	0.13
0502	---	2.40	0.15	0.12
0503	---	2.80	0.01	0.11
0504	---	2.20	0.05	0.12
0505	---	2.20	0.10	0.13
0506	---	2.0	0.45	0.15
0507	---	2.30	0.20	0.12
0508	---	2.90	0.20	0.13
0509	---	2.20	0.20	0.15
0510	---	3.0	0.25	0.13

Figure 5

PLOTS OF BACTERIOLOGICAL DATA

JULY 09,1986

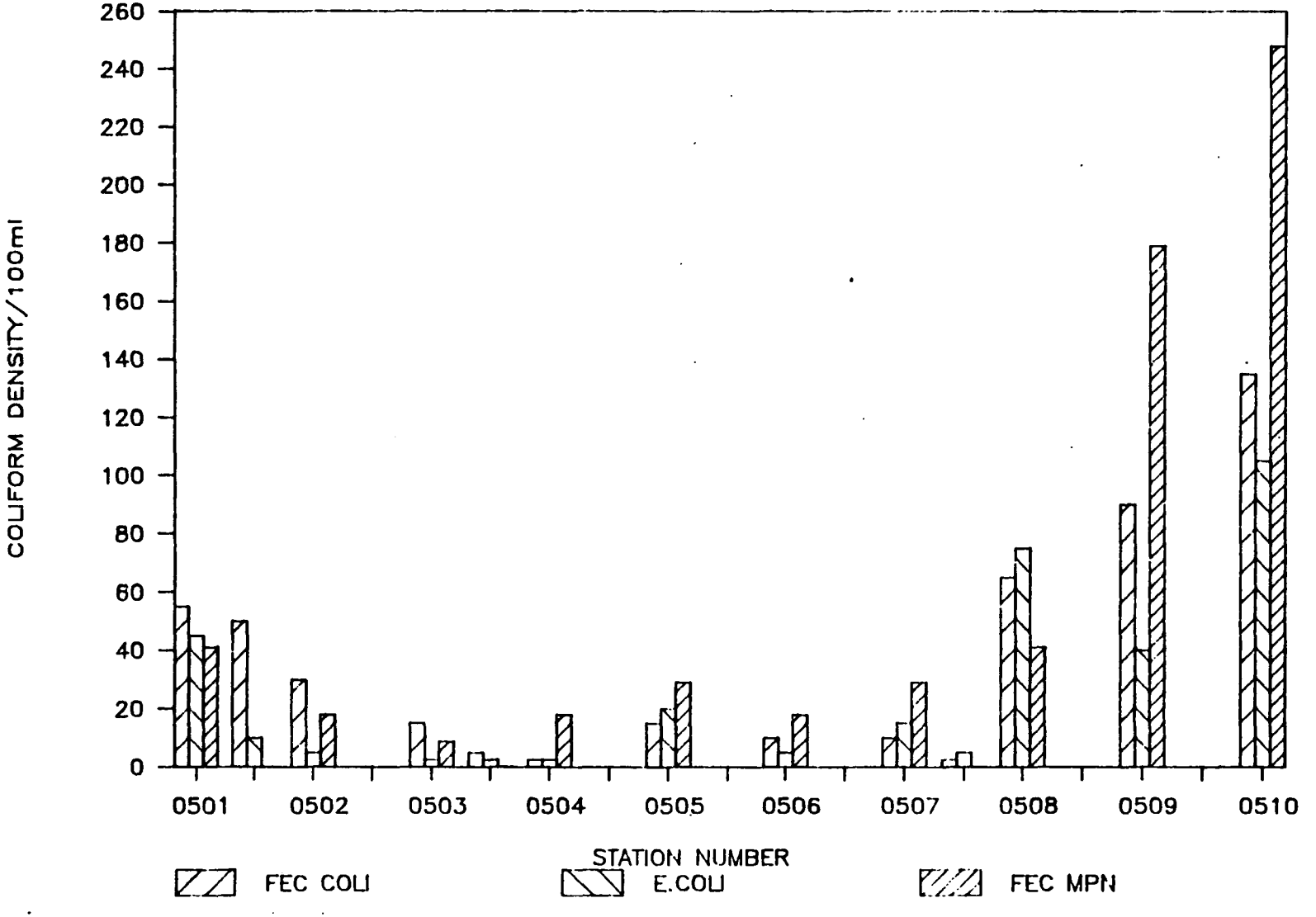


Figure 5 (Continued)

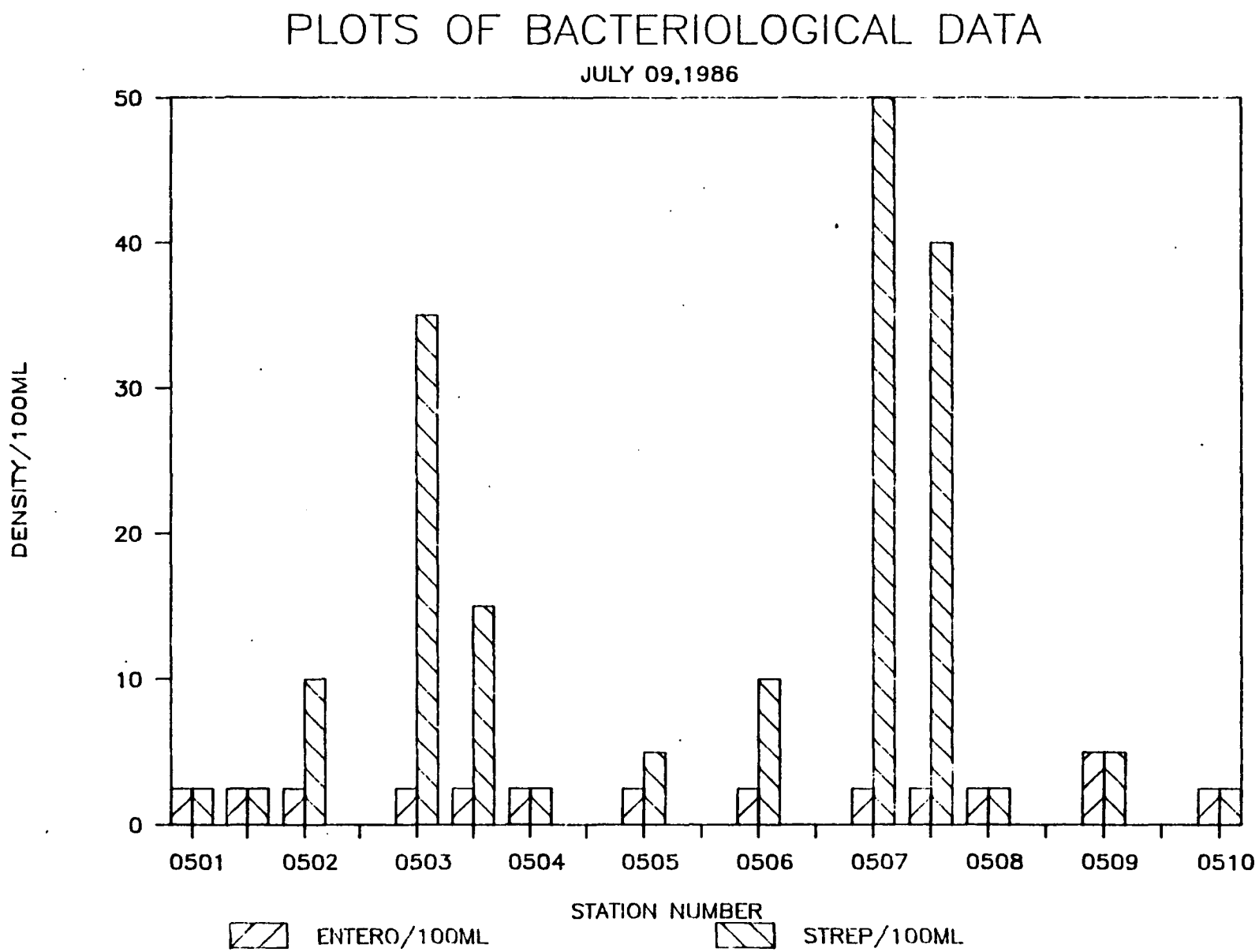


TABLE 30

WESTPORT RIVER SITES, WESTPORT

SAMPLED ON JULY 14, 1986

STATION NUMBER	DESCRIPTION	LATITUDE	LONGITUDE
0601	Snell's Creek sampled at Jessie's Neck Cove	41°34'40"	71°0''35"
0602	Unnamed brook that enters Jessie's Neck Cove	41°34'45"	71°04'37"
0603	Along shore of farm at Pelegs Point	41°35'30"	71°04'15"
0604	Drainage ditch approximately 100' upstream from 0603	41°35'35"	71°04'13
0605	Approximately 100' offshore of 0604	41°35'35"	71°04'10"
0606	Approximately 100' offshore of 0603	41°35'30"	71°04'13"
0607	Head of Kirby Brook Cove	41°35'45"	71°04'15
0608	Head of Everett Cove	41°36'30"	71°03'45
0609	Mouth of Everett Cove	41°36'35"	71°03'50"
0610	Just downstream of Hix Bridge, collected mid-stream	41°34'15"	71°04'30"

TABLE 31

WESTPORT RIVER SITES, WESTPORT

TEMPERATURE (°C), DISSOLVED OXYGEN (mg/l), PERCENT SATURATION (%)

JULY 14, 1986

STATION NUMBER	TEMPERATURE	DISSOLVED OXYGEN	PERCENT SATURATION
0601	18.0	7.7	81
0602	22.2	5.5	63
0603	22.1	6.3	80
0604	21.2	--	--
0605	21.2	5.9	74
0606	21.3	--	--
0607	17.5	7.5	79
0608	21.8	8.0	92
0609	21.0	5.1	57
0610	21.3	7.2	90

TABLE 32

BUZZARDS BAY
NON-POINT SOURCE BACTERIOLOGICAL DATA

Station Number	Fecal Coliform Bacteria /100ml	Entero-cocci Bacteria /100ml	*Escherichia coli* /100ml	Strepto-cocci Bacteria /100ml	*Clostridium perfringens* /100ml	Fecal Coliform Bacteria MPN/100ml
**Date Collected: 07/14/86						
0601	4000	2100	---	6000	40	---
0601	4600	2300	6000	6000	40	>2480
0602	4400	2200	6000	2420	100	---
0602	7400	1760	7800	2060	60	>2480
0603	2080	340	2200	480	20	---
0603	1600	380	3000	480	20	2480
0604	2400	280	1900	400	<20	---
0604	2100	400	2400	380	<20	2480
0605	2000	160	3100	260	<20	---
0605	1700	240	2100	240	<20	>2480
0606	1840	360	1560	360	20	---
0606	1900	440	1900	220	20	>2480
0607	2240	1660	3100	3200	<20	---
0607	2100	1580	4300	4000	<20	2480
0608	---	6000	---	5600	80	---
0608	50000	6000	---	7200	<20	>2480
0609	---	10000	---	3800	20	---
0609	80000	10000	---	3600	<20	>2480
0610	2200	80	1700	60	<20	---
0610	2400	120	1500	60	<20	2480

TABLE 33

BUZZARDS BAY
NON-POINT SOURCE PHYSICAL DATA

Station Number	pH (standard units)	Total Hardness (mg/l)	Suspended Solids (mg/l)	Specific Conductivity (µmhos/cm)
** Date Collected: 07/14/86				
0601	6.60	64	2.50	---
0602	7.0	1500	15.0	---
0603	7.0	3030	9.0	---
0604	7.50	3500	8.0	---
0605	7.70	3280	6.0	---
0606	7.50	1070	7.50	---
0607	6.0	13	2.0	---
0608	6.80	176	17.0	---
0609	6.70	643	24.0	---
0610	7.70	4240	9.0	---

TABLE 34

BUZZARDS BAY
NON-POINT SOURCE CHEMICAL DATA

Station Number	Chloride (mg/l)	Total Kjeldahl-Nitrogen (mg/l)	Ammonia-Nitrogen (mg/l)	Total Phosphorus (mg/l)
** Date Collected: 07/14/86				
0601	---	0.92	0.12	0.16
0602	---	2.40	0.10	0.16
0603	---	2.50	0.11	0.12
0604	---	5.20	0.13	0.28
0605	---	1.60	0.10	0.11
0606	---	1.70	0.10	0.11
0607	---	0.66	0.25	0.14
0608	---	2.50	0.45	0.31
0609	---	2.60	0.20	0.24
0610	---	2.0	0.15	0.14

Figure 6

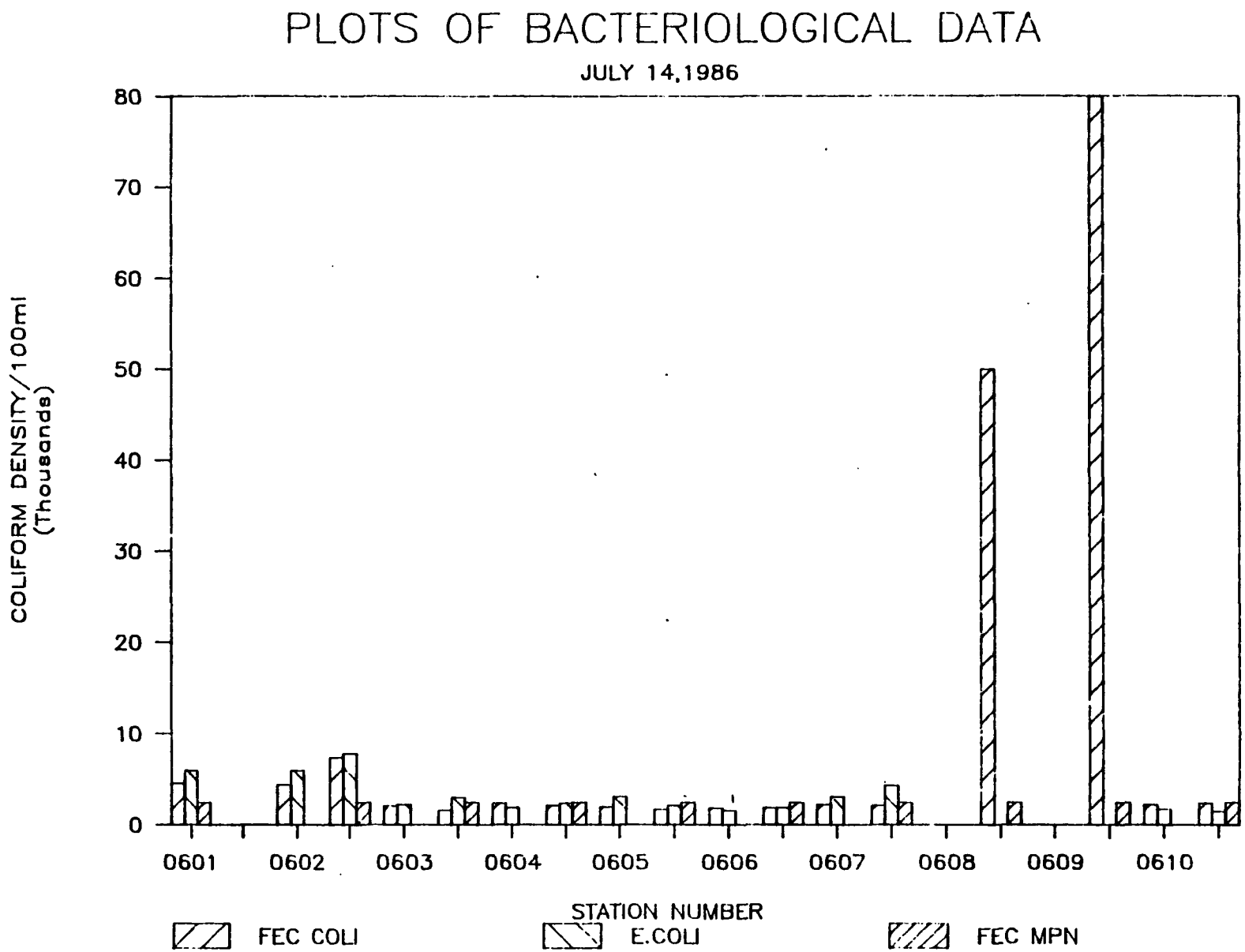

PLOTS OF BACTERIOLOGICAL DATA
JULY 14,1986
COLIFORM DENSITY/100ml
(Thousands)
80
70
60
50
40
30
20
10
0
0601
0602
0603
0604
0605
0606
0607
0608
0609
0610
STATION NUMBER
FEC COLI
E.COLI
FEC MPN

Figure 6 (Continued)

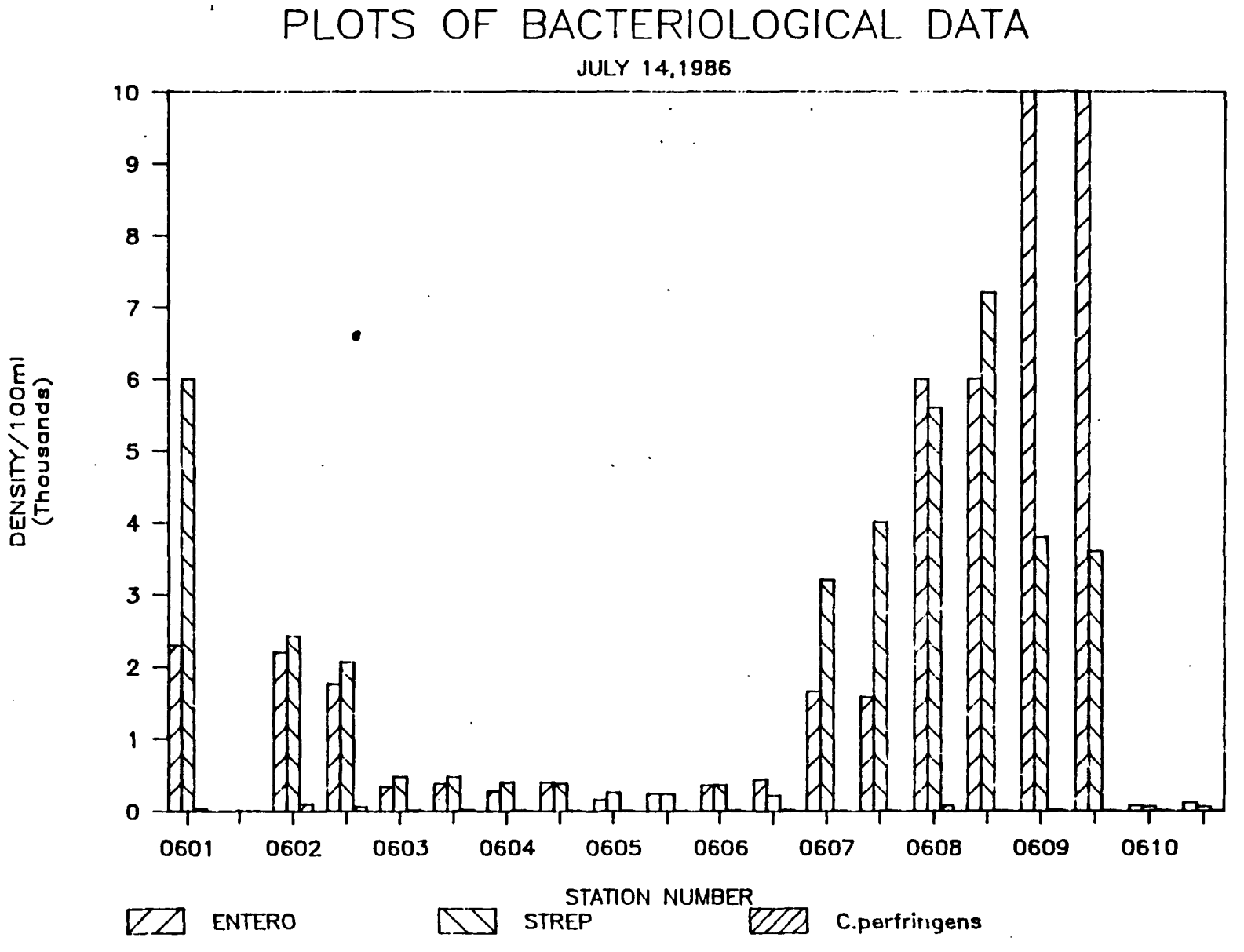


TABLE 35

WAREHAM RIVER SITES, WAREHAM

SAMPLED ON JULY 21, 1986

STATION NUMBER	DESCRIPTION	LATITUDE	LONGITUDE
0701	Off dock, below railroad bridge	41°45'25"	70°42'46"
0702	Opposite shore from 0701, approximately 20'from shore	41°45'22"	70°42'43"
0703	Approximately 200' downstream of 0702, just upstream of Cape Cod Shipbuilding	41°45'19"	70°42'39"
0704	Just upstream of British Landing condominiums	41°45'13"	70°42'37"
0705	In front of British Landing condominiums, approximately 200' from shore	41°45'12"	70°42'35"
0706	Opposite shore from 0705 in front of red garage, approximately 300' from shore	41°45'21"	70°42'32"
0707	In front of Warr's Marina, approximately 100' off of next to last slipway	41°45'10"	70°42'33"
0708	Just off of last slipway at Warr's Marine	41°45'05"	70°42'33"
0709	Below Marina, in front of gray house, approximately 100' from shore	41°45'04"	70°42'31"
0710	Opposite Marina, just past channel marker #22	41°44'51"	70°42'22"
0711	Onshore, just upstream of town landing	41°44'54"	70°42'06"
0712	Onshore, just downstream of town landing	41°44'53"	70°42'08"

TABLE 36

WAREHAM RIVER SITES, WAREHAM

TEMPERATURE (°C), DISSOLVED OXYGEN (mg/l), PERCENT SATURATION (%)

JULY 21, 1986

STATION NUMBER	TEMPERATURE	DISSOLVED OXYGEN	PERCENT SATURATION
0701	25.2	5.4	77
0702	24.5	6.4	86
0703	24.4	6.2	88
0704	24.4	5.1	69
0705	24.7	5.4	73
0706	24.7	5.7	77
0707	24.7	5.4	73
0708	24.6	5.7	77
0709	24.8	6.1	86
0710	25.0	6.7	90
0711	25.1	8.1	109
0712	25.0	8.8	125

TABLE 37

BUZZARDS BAY
NON-POINT SOURCE BACTERIOLOGICAL DATA

Station Number	Fecal Coliform Bacteria /100ml	Entero-cocci Bacteria /100ml	*Escherichia coli* /100ml	Strepto-cocci Bacteria /100ml	*Clostridium perfringens* /100ml	Fecal Coliform Bacteria MPN/100ml
**Date Collected: 07/21/86						
0701	90	15	90	105	---	179
0702	125	30	130	145	---	70
0703	105	15	95	185	---	248
0704	250	50	205	90	---	248
0705	320	40	270	135	---	>248
0706	140	15	100	70	---	179
0707	230	70	255	135	---	410
0708	170	25	125	120	---	179
0709	160	5	105	40	---	179
0710	75	5	80	40	---	110
0711	85	<5	65	35	---	139
0712	80	10	70	40	---	179

TABLE 38

BUZZARDS BAY
NON-POINT SOURCE PHYSICAL DATA

Station Number	pH (standard units)	Total Hardness (mg/l)	Suspended Solids (mg/l)	Specific Conductivity (µmhos/cm)
** Date Collected: 07/21/86				
0701	7.80	3970	10.0	29000
0702	7.80	4010	8.50	28000
0703	2.80	3790	14.0	31000
0704	7.70	3690	5.0	28000
0705	7.60	3870	8.0	27000
0706	7.60	3930	10.0	28000
0707	7.70	3640	5.0	28000
0708	7.60	3890	10.0	28000
0709	7.20	4090	8.0	31000
0710	7.70	4170	14.0	28000
0711	7.80	4400	35.0	30000
0712	2.80	4475	22.0	29000

TABLE 39

BUZZARDS BAY
NON-POINT SOURCE CHEMICAL DATA

Station Number	Chloride (mg/l)	Total Kjeldahl-Nitrogen (mg/l)	Ammonia-Nitrogen (mg/l)	Total Phosphorus (mg/l)
** Date Collected: 07/21/86				
0701	---	1.80	0.10	0.14
0702	---	1.60	0.05	0.11
0703	---	2.30	0.05	0.12
0704	---	1.90	0.05	0.12
0705	---	1.80	0.10	0.11
0706	---	2.50	0.05	0.16
0707	---	2.30	0.05	0.19
0708	---	2.40	0.20	0.18
0709	---	1.80	0.05	0.16
0710	---	2.0	<0.02	0.15
0711	---	1.80	0.20	0.20
0712	---	1.80	0.02	0.14

TABLE 40

SOURCE DIFFERENTIATION OF FECAL STREPTOCOCCI BACTERIA

FROM WAREHAM RIVER SITES

JULY 21, 1986

STATION NUMBER	NUMBER OF COLONIES TESTED	NUMBER OF NON-FECAL STREPTOCOCCI	NUMBER OF GROUP Q STREPTOCOCCI	NUMBER FROM WARM-BLOODED ANIMALS	NUMBER FROM LIVESTOCK AND POULTRY	NUMBER FROM INSECTS	NUMBER FROM VEGETATION
0701	5	1	0	3	0	1	0
0702	5	4	0	0	0	1	0
0703	5	2	1	2	0	0	0
0704	5	2	0	3	0	0	0
0705	5	0	0	4	0	1	0
0706	5	2	0	3	0	0	0
0707	5	0	0	5	0	0	0
0708	5	2	0	3	0	0	0
0709	5	3	0	2	0	0	0
0710	5	3	0	2	0	0	0
0711	4	4	0	0	0	0	0
0712	4	3	0	1	0	0	0
Totals	58	26	1	28	0	3	0
Percent		45	2	48	0	5	0

Figure 7

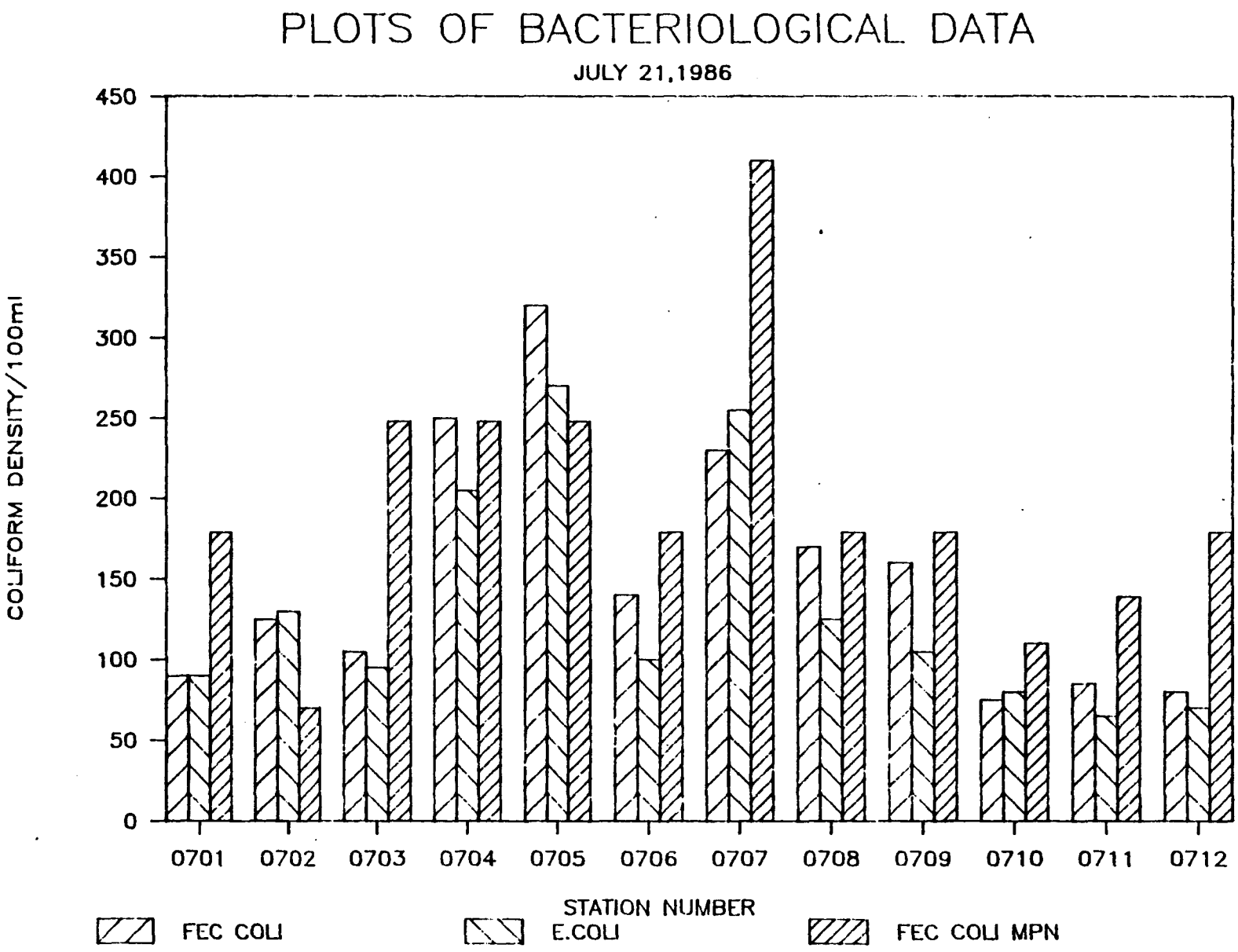

PLOTS OF BACTERIOLOGICAL DATA
JULY 21,1986
COLIFORM DENSITY/100ml
450
400
350
300
250
200
150
100
50
0
0701
0702
0703
0704
0705
0706
0707
0708
0709
0710
0711
0712
STATION NUMBER
FEC COLI
E.COLI
FEC COLI MPN

Figure 7 (Continued)

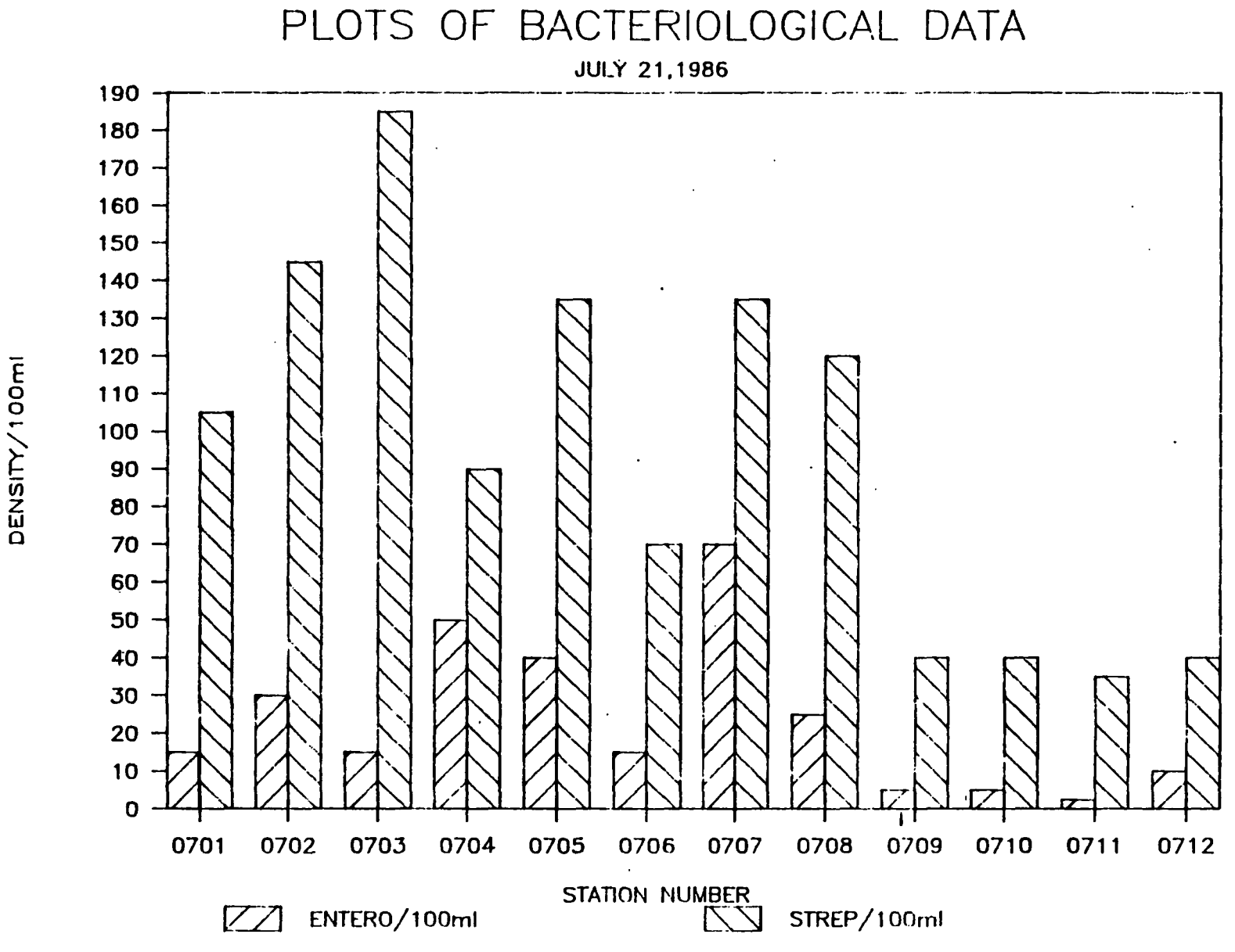


TABLE 41

WESTPORT RIVER SITES, WESTPORT

SAMPLED ON JULY 28, 1986

STATION NUMBER	DESCRIPTION	LATITUDE	LONGITUDE
0801	Just downstream of Jessie's Neck, approximately 30' from western shore	41°34'51	71°04'30"
0802	Same as 0801, approximately 150' from shore	41°34'50"	71°04'29"
0803	Mid-channel, opposite Jessie's Neck	41°34'49"	71°04'28"
0804	One-third of way off eastern shore, opposite Jessie's Neck	41°34'48"	71°04'27"
0805	Approximately 200' from eastern shore	41°34'47"	71°04'26"
0806	Approximately 40' from eastern shore	41°34'45"	71°04'25"
0807	Mid-channel just south Hix Bridge	41°34'15"	71°04'30"
0808	Just south Lakes Island	41°33'33"	71°04'18"
0809	Mouth Codman Cove, close to western shore	41°33'36"	71°03'39"
0810	Off of Little Pine Island in main channel	41°33'00"	71°03'13"
0811	Level with northern end of Great Island approximately 200' off of mainland	41°32'39"	71°03'09"
0812	Off northern end of Great Island	41°32'43"	71°03'40"

TABLE 42

WESTPORT RIVER SITES, WESTPORT

TEMPERATURE (°C), DISSOLVED OXYGEN (mg/l), PERCENT SATURATION (%)

JULY 28, 1986

STATION NUMBER	TEMPERATURE	DISSOLVED OXYGEN	PERCENT SATURATION
0801	27.7	7.8	110
0802	27.4	8.8	122
0803	27.4	11.2	156
0804	27.3	8.4	117
0805	27.2	8.6	119
0806	27.2	8.4	124
0807	27.2	8.7	121
0808	27.5	9.2	137
0809	26.6	9.7	143
0810	26.4	8.5	123
0811	26.2	8.0	110
0812	26.0	11.2	162

TABLE 43

BUZZARDS BAY
NON-POINT SOURCE BACTERIOLOGICAL DATA

Station Number	Fecal Coliform Bacteria /100ml	Entero-cocci Bacteria /100ml	Escherichia coli /100ml	Strepto-cocci Bacteria /100ml	Clostridium perfringens /100ml	Fecal Coliform Bacteria MPN/100ml
**Date Collected: 07/28/86						
0801	125	<5	115	<5	---	179
0801	100	<5	95	<5	---	---
0802	120	<5	160	<5	---	139
0802	75	5	100	<5	---	---
0803	55	<5	60	<5	---	18
0803	50	5	50	<5	---	---
0804	15	<5	30	<5	---	29
0804	10	<5	40	<5	---	---
0805	10	<5	55	<5	---	29
0805	15	<5	35	<5	---	---
0806	35	5	15	<5	---	29
0806	15	<5	25	<5	---	---
0807	15	5	20	<5	---	8.70
0807	5	---	35	<5	---	---
0808	5	<5	<5	<5	---	8.70
0808	5	<5	<5	<5	---	---
0809	5	<5	<5	<5	---	<8.70
0809	<5	<5	<5	<5	---	---
0810	5	<5	<5	<5	---	<8.70
0810	5	10	<5	<5	---	---
0811	5	<5	<5	<5	---	8.70
0811	<5	<50	5	<5	---	---
0812	<5	<50	<5	<5	---	<8.70
0812	<5	<50	<5	<5	---	---

TABLE 44

BUZZARDS BAY
NON-POINT SOURCE PHYSICAL DATA

Station Number	pH (standard units)	Total Hardness (mg/l)	Suspended Solids (mg/l)	Specific Conductivity (µmhos/cm)
** Date Collected: 07/28/86				
0801	7.80	3200	8.50	27000
0802	7.80	2700	8.0	26000
0803	7.50	3100	17.0	27000
0804	3.10	4480	14.0	30000
0805	8.10	3225	7.50	28000
0806	7.60	4510	15.0	29500
0807	8.10	3540	20.0	28000
0808	7.30	3870	16.0	29000
0809	6.50	5620	12.0	32000
0810	8.20	7745	7.50	33000
0811	8.0	6990	2.0	30000
0812	8.10	7745	7.50	31000

TABLE 45

BUZZARDS BAY
NON-POINT SOURCE CHEMICAL DATA

Station Number	Chloride (mg/l)	Total Kjeldahl-Nitrogen (mg/l)	Ammonia-Nitrogen (mg/l)	Total Phosphorus (mg/l)
** Date Collected: 07/28/86				
0801	---	2.0	0.10	0.19
0802	---	1.60	0.05	0.12
0803	---	1.20	0.03	0.14
0804	---	1.70	0.04	0.12
0805	---	1.50	0.04	0.12
0806	---	1.20	0.05	0.14
0807	---	1.40	0.10	0.14
0808	---	1.60	0.04	0.11
0809	---	1.30	0.10	0.10
0810	---	1.80	0.05	0.11
0811	---	1.20	0.10	0.09
0812	---	1.10	0.02	0.09

Figure 8

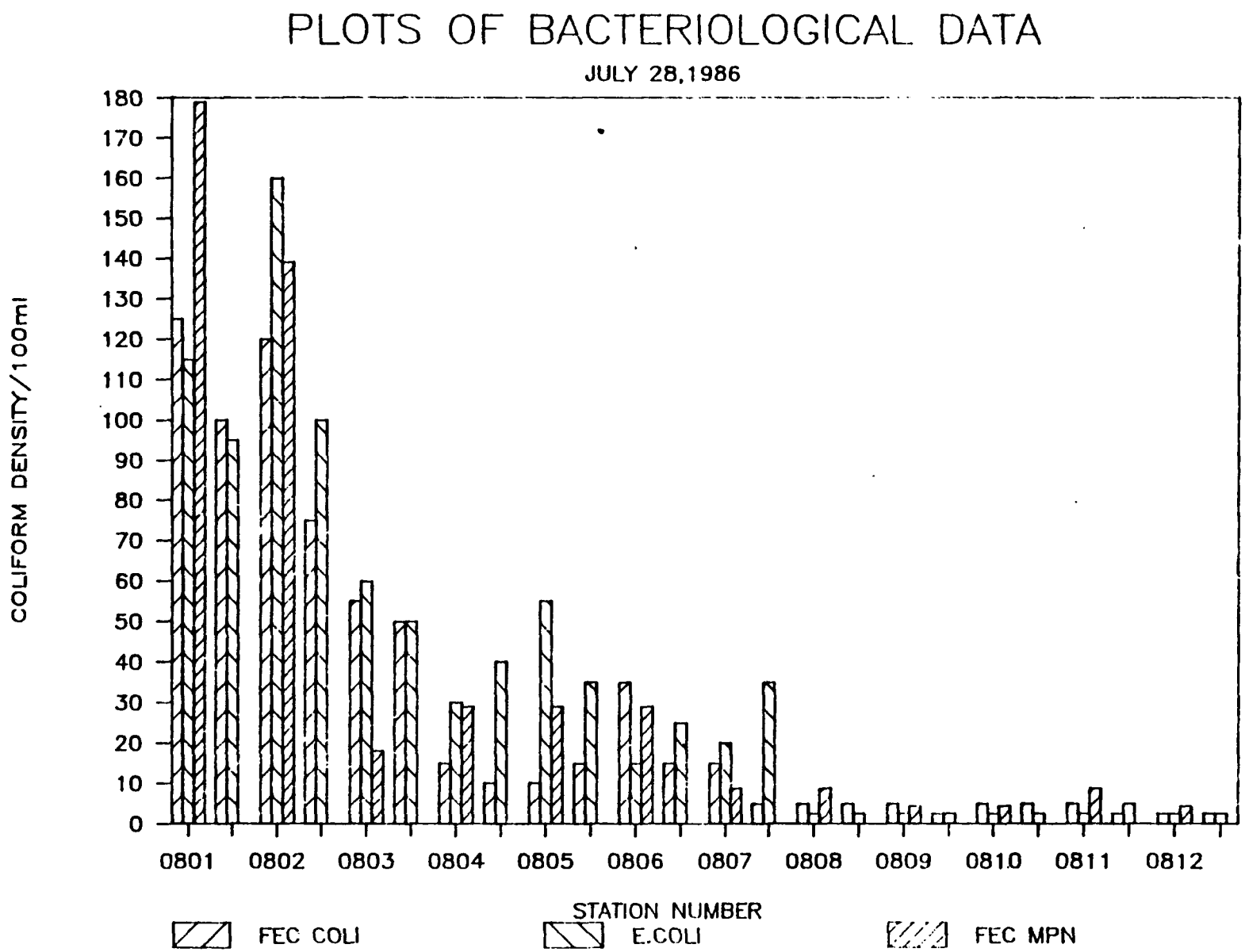

PLOTS OF BACTERIOLOGICAL DATA
JULY 28,1986
COLIFORM DENSITY/100ml
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0801
0802
0803
0804
0805
0806
0807
0808
0809
0810
0811
0812
STATION NUMBER
FEC COLI
E.COLI
FEC MPN

Figure 8 (Continued)

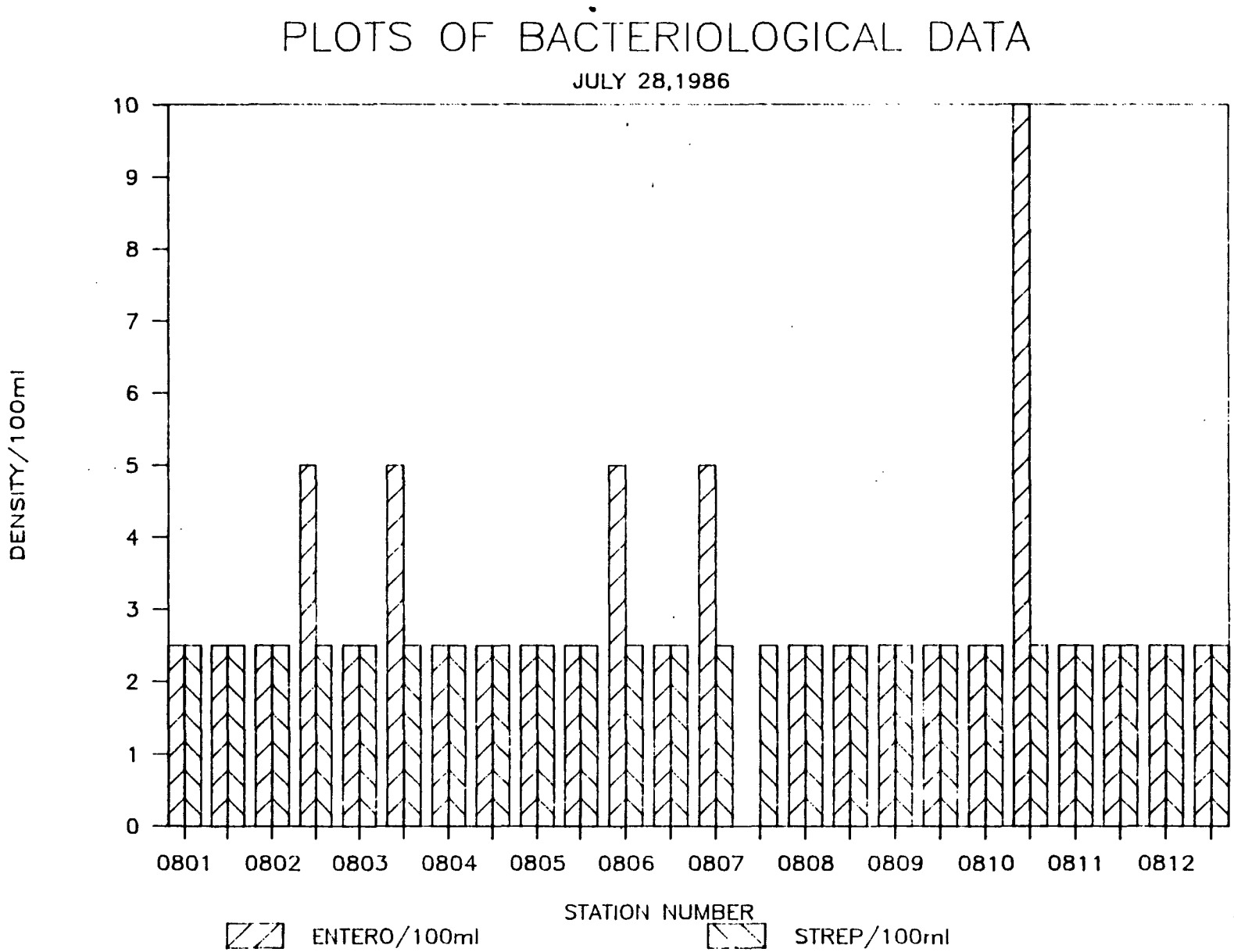


TABLE 46

WAREHAM RIVER SITES, WAREHAM

SAMPLED ON AUGUST 3, 1986

STATION NUMBER	DESCRIPTION	LATITUDE	LONGITUDE
0901	Just north of British Landing condominiums	41°45'19"	70°42'41"
0902	In front of British Land condominiums, off slumping sea wall	41°45'18"	70°42'39"
0903	End of British Land condominiums, just north of the tower	41°45'15"	70°42'37"
0904	Storm drain flowing out of sea wall in front of boat crane at Warr's Marina	41°45'14"	70°42'37"
0905	First slipway in Warr's Marina, behind a cabin cruiser	41°45'11"	70°42'32"
0906	In next to last slipway at Warr's Marina	41°45'06"	70°42'31"
0907	In next to last slipway at Warr's Marina, Wareham, behind same boat as in 0906 two to three minutes later	41°45'06"	70°42'29"
0908	Just below last slipway behind a fishing boat	41°45'07"	70°42'31"
0909	Open water south of Warr's Marina		
0916	Chemical sample collected at same location as 0907	41°45'06"	70°42'29"

TABLE 47

WAREHAM RIVER SITES, WAREHAM

TEMPERATURE (°C), DISSOLVED OXYGEN (mg/l), PERCENT SATURATION (%)

AUGUST 3, 1986

STATION NUMBER	TEMPERATURE	DISSOLVED OXYGEN*	PERCENT SATURATION
0901	25.0	--	--
0902	25.0	--	--
0903	25.1	--	--
0904	25.1	--	--
0905	25.0	--	--
0906	--	--	--
0907	--	--	--
0908	25.1	--	--
0909	24.8	--	--
0910	--	--	--

* Dissolved oxygen was not tested

TABLE 48

BUZZARDS BAY
NON-POINT SOURCE BACTERIOLOGICAL DATA

Station Number	Fecal Coliform Bacteria /100ml	Entero-cocci Bacteria /100ml	*Escherichia coli* /100ml	Strepto-cocci Bacteria /100ml	*Clostridium perfringens* /100ml	Fecal Coliform Bacteria MPN/100ml
**Date Collected: 08/03/86						
0901	80	<20	120	20	---	88
0902	20	20	20	40	---	248
0903	<100	<100	200	100	---	87
0904	100	<20	80	<20	---	41
0905	240	<20	60	<20	---	88
0906	12000	<100	22000	<100	---	>24800
0907	40	<20	40	<20	---	41
0908	40	<20	20	20	---	41
0909	<20	20	20	40	---	54

TABLE 49

BUZZARDS BAY
NON-POINT SOURCE PHYSICAL DATA

Station Number	pH (standard units)	Total Hardness (mg/l)	Suspended Solids (mg/l)	Specific Conductivity (µmhos/cm)
** Date Collected: 08/03/86				
0901	7.50	2660	6.0	---
0902	5.40	2790	4.50	---
0903	7.50	2900	5.0	---
0904	7.10	2830	8.0	---
0905	6.90	2940	15.0	---
0906	7.80	2940	7.50	---
0909	7.70	2790	6.0	---
0910	7.60	2790	7.0	---

TABLE 50

BUZZARDS BAY
NON-POINT SOURCE CHEMICAL DATA

Station Number	Chloride (mg/l)	Total Kjeldahl-Nitrogen (mg/l)	Ammonia-Nitrogen (mg/l)	Total Phosphorus (mg/l)
** Date Collected: 08/03/86				
0901	10500.0	1.80	0.10	0.16
0902	10500.0	1.40	0.10	0.20
0903	11750.0	1.30	0.10	0.15
0904	11750.0	2.70	0.10	0.14
0905	12000.0	3.0	0.10	0.14
0906	11750.0	3.0	0.10	0.15
0909	11750.0	2.20	0.30	0.11
0910	11250.0	1.70	0.20	0.14

Figure 9

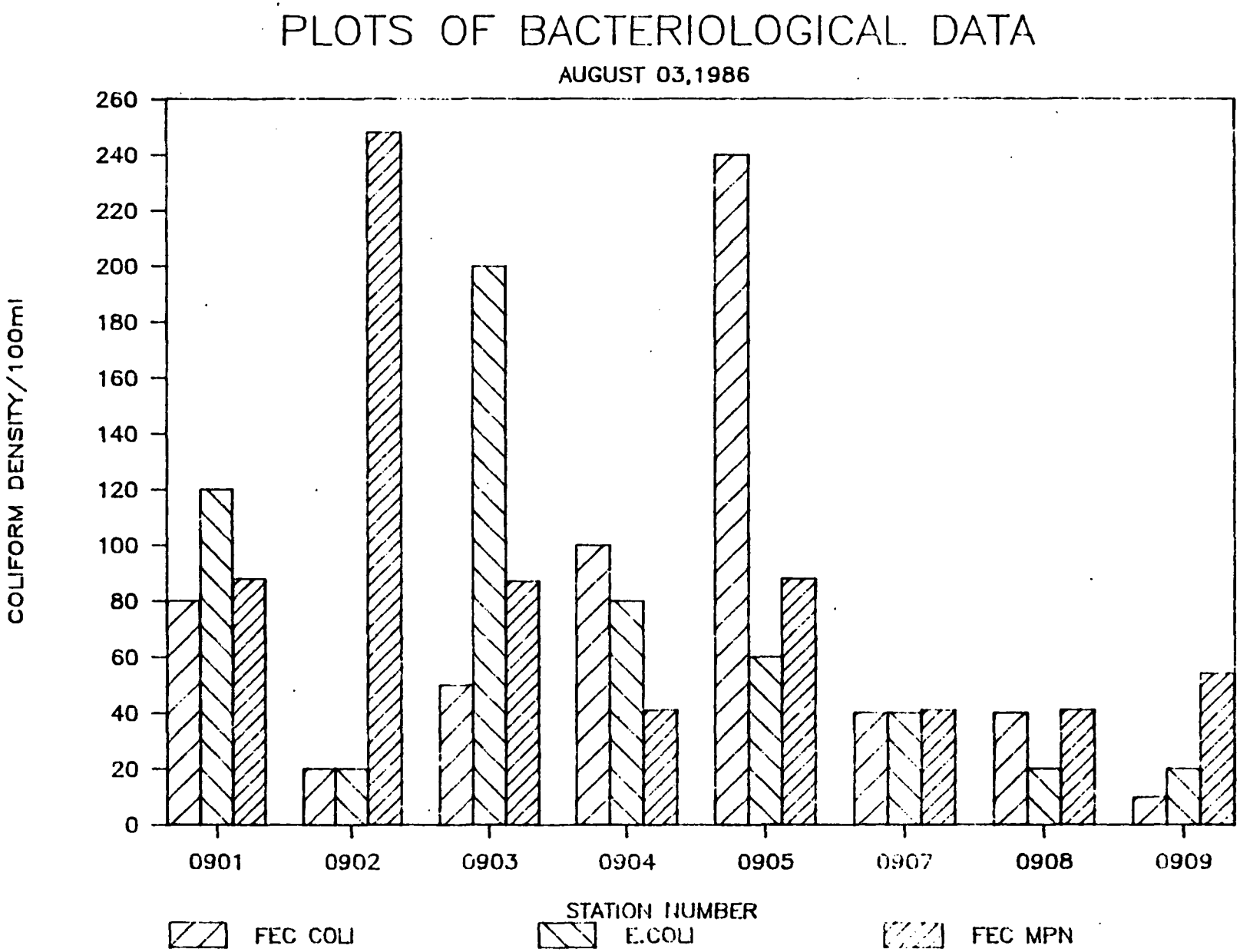

PLOTS OF BACTERIOLOGICAL DATA
AUGUST 03,1986
COLIFORM DENSITY/100ml
260
240
220
200
180
160
140
120
100
80
60
40
20
0
0901
0902
0903
0904
0905
0907
0908
0909
STATION NUMBER
FEC COLI
E.COLI
FEC MPN

Figure 9 (Continued)

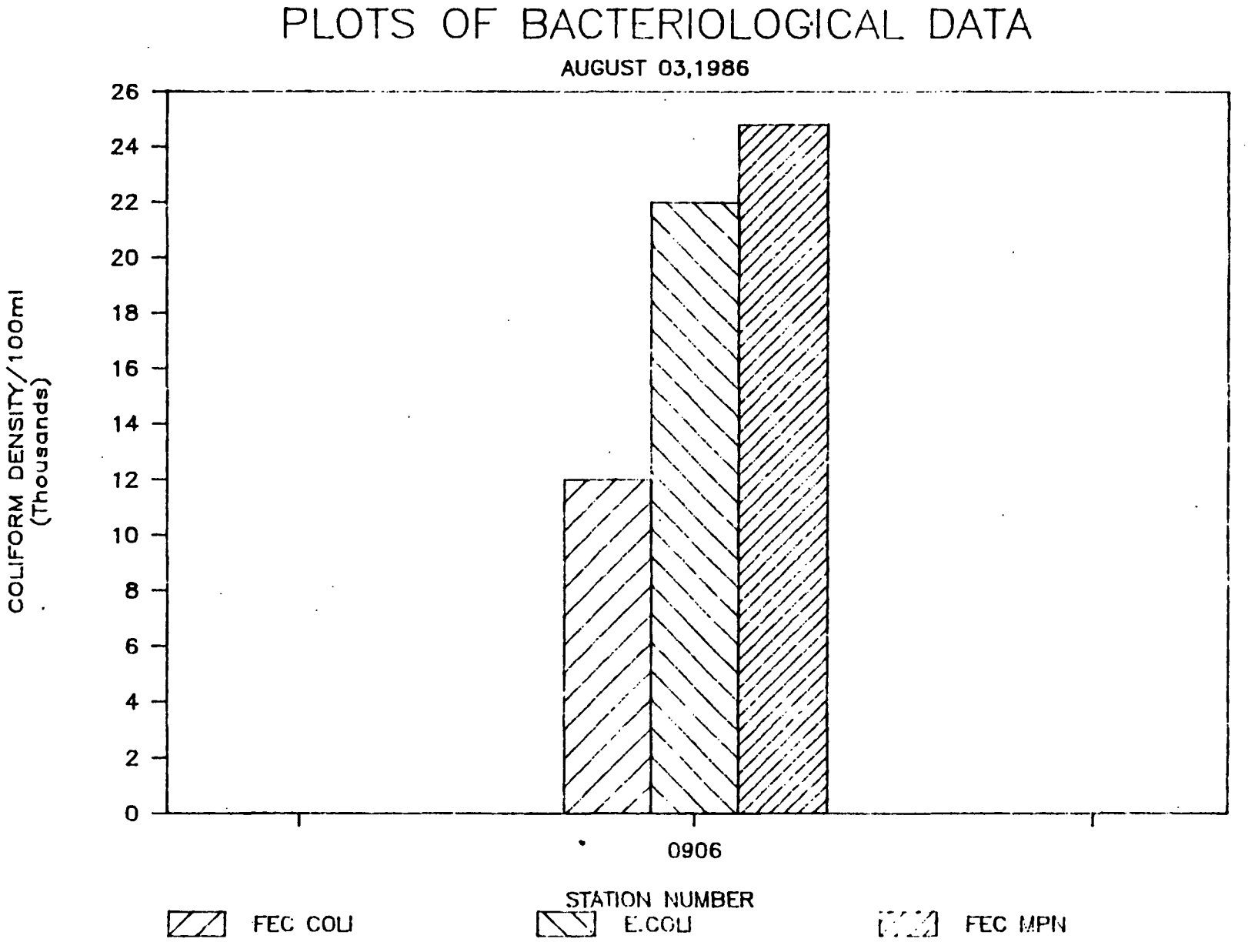


Figure 9 (Continued)

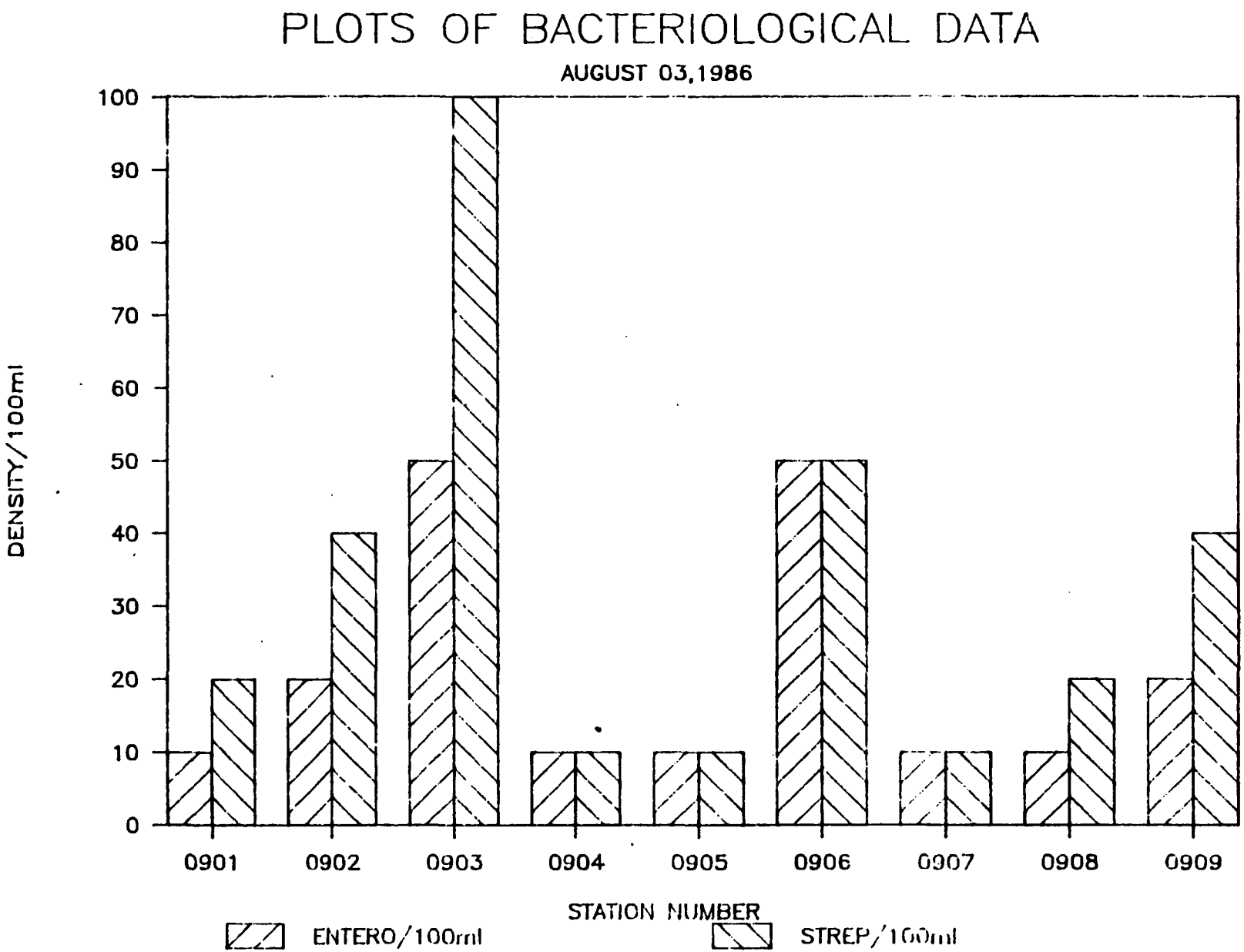


TABLE 51

WESTPORT RIVER SITES, WESTPORT

SAMPLED ON AUGUST 4, 1986

STATION NUMBER	DESCRIPTION	LATITUDE	LONGITUDE
1001	North of Hix Bridge, just south of Widow Point, cove on western shore	41°35'50"	71°04'00"
1002	Opposite shore, approximately 100' from shoreline	41°35'50"	71°04'03"
1003	Mid-channel just below Allen Creek	41°35'00"	71°04'15"
1004	Snell's Creek Cove	41°34'40"	71°04'30"
1005	Mid channel level with Jessie's Neck	41°34'35"	71°04'20"
1006	East side of river level with Jessie's Neck	41°34'30"	71°04'17"
1007	South of Hix Bridge, in channel by Upper Spectacle Island opposite cornfield	41°33'18"	71°03'26"
1008	In channel at southern end of Upper Spectacle Island, opposite house with flagpole	41°33'11"	71°03'22"
1009	Even with northern end of Lower Spectacle Island approximately 50' from shore opposite cottages	41°33'07"	71°03'20"
1010	Even with middle Lower Spectacle Island approximately 50' from shore, in front of yellow house	41°33'08"	71°03'17"
1011	Southern end of Lower Spectacle Island approximately 50' from shore just south red cabin	41°33'02"	71°03'14"
1012	Just south of houses, opposite wooded area, approximately 50' from shore	41°32'56"	71°03'11"
1013	In channel between Big Pine Island and Great Island	41°32'42"	71°03'25"

TABLE 52

WESTPORT RIVER SITES, WESTPORT

TEMPERATURE (°C), DISSOLVED OXYGEN (mg/l), PERCENT SATURATION (%)

AUGUST 4, 1986

STATION NUMBER	TEMPERATURE	DISSOLVED OXYGEN	PERCENT SATURATION
1001	24.8	6.0	77
1002	25.3	6.9	89
1003	25.6	6.3	82
1004	25.7	6.1	84
1005	26.1	6.5	89
1006	26.2	6.7	87
1007	26.1	6.2	90
1008	26.5	--	--
1009	26.5	7.0	103
1010	26.3	--	--
1011	26.3	--	--
1012	26.2	7.3	106
1013	26.1	7.5	109

TABLE 53

BUZZARDS BAY
NON-POINT SOURCE BACTERIOLOGICAL DATA

Station Number	Fecal Coliform Bacteria /100ml	Entero-cocci Bacteria /100ml	*Escherichia coli* /100ml	Strepto-cocci Bacteria /100ml	*Clostridium perfringens* /100ml	Fecal Coliform Bacteria MPN/100ml
**Date Collected: 08/04/86						
1001	9800	700	12000	1100	<100	11000
1002	34000	410	31000	1300	<20	>2480
1003	4200	400	5000	300	<100	1800
1004	2400	40	2800	60	<20	2480
1005	2100	60	5300	120	20	>2480
1006	4000	180	5100	200	<20	2480
1007	<20	<20	<20	<20	<20	18
1008	20	<20	<20	<20	<20	18
1009	20	<20	20	<20	<20	8.70
1010	20	<20	40	<20	20	18
1011	40	20	<20	<20	<20	41
1012	<20	<20	60	20	<20	41
1013	<20	<20	60	<20	20	41

TABLE 54

BUZZARDS BAY
NON-POINT SOURCE PHYSICAL DATA

Station Number	pH (standard units)	Total Hardness (mg/l)	Suspended Solids (mg/l)	Specific Conductivity (µmhos/cm)
** Date Collected: 08/04/86				
1001	6.10	1260	12.0	---
1002	7.30	1370	15.0	---
1003	7.40	1770	3.0	---
1004	7.40	1850	4.0	---
1005	7.60	1980	2.0	---
1006	7.50	1920	1.0	---
1007	7.80	3210	1.0	---
1008	7.30	2940	3.0	---
1009	7.80	3050	5.0	---
1010	7.30	3210	5.0	---
1011	7.70	3130	6.0	---
1012	2.70	3130	6.0	---
1013	6.80	3100	15.0	---

TABLE 55

BUZZARDS BAY
NON-POINT SOURCE CHEMICAL DATA

Station Number	Chloride (mg/l)	Total Kjeldahl-Nitrogen (mg/l)	Ammonia-Nitrogen (mg/l)	Total Phosphorus (mg/l)
** Date Collected: 08/04/86				
1001	5250.0	2.60	0.03	0.18
1002	5250.0	2.30	0.05	0.16
1003	7250.0	4.70	0.10	0.32
1004	7500.0	2.0	0.05	0.13
1005	7750.0	2.10	0.10	0.12
1006	7250.0	2.0	0.02	0.13
1007	13000.0	2.10	0.10	0.12
1008	13250.0	1.90	0.05	0.14
1009	13250.0	2.20	0.10	0.17
1010	13000.0	1.50	0.03	0.12
1011	13250.0	2.20	0.10	0.13
1012	13250.0	2.20	0.05	0.13
1013	14000.0	2.20	0.20	0.12

Figure 10

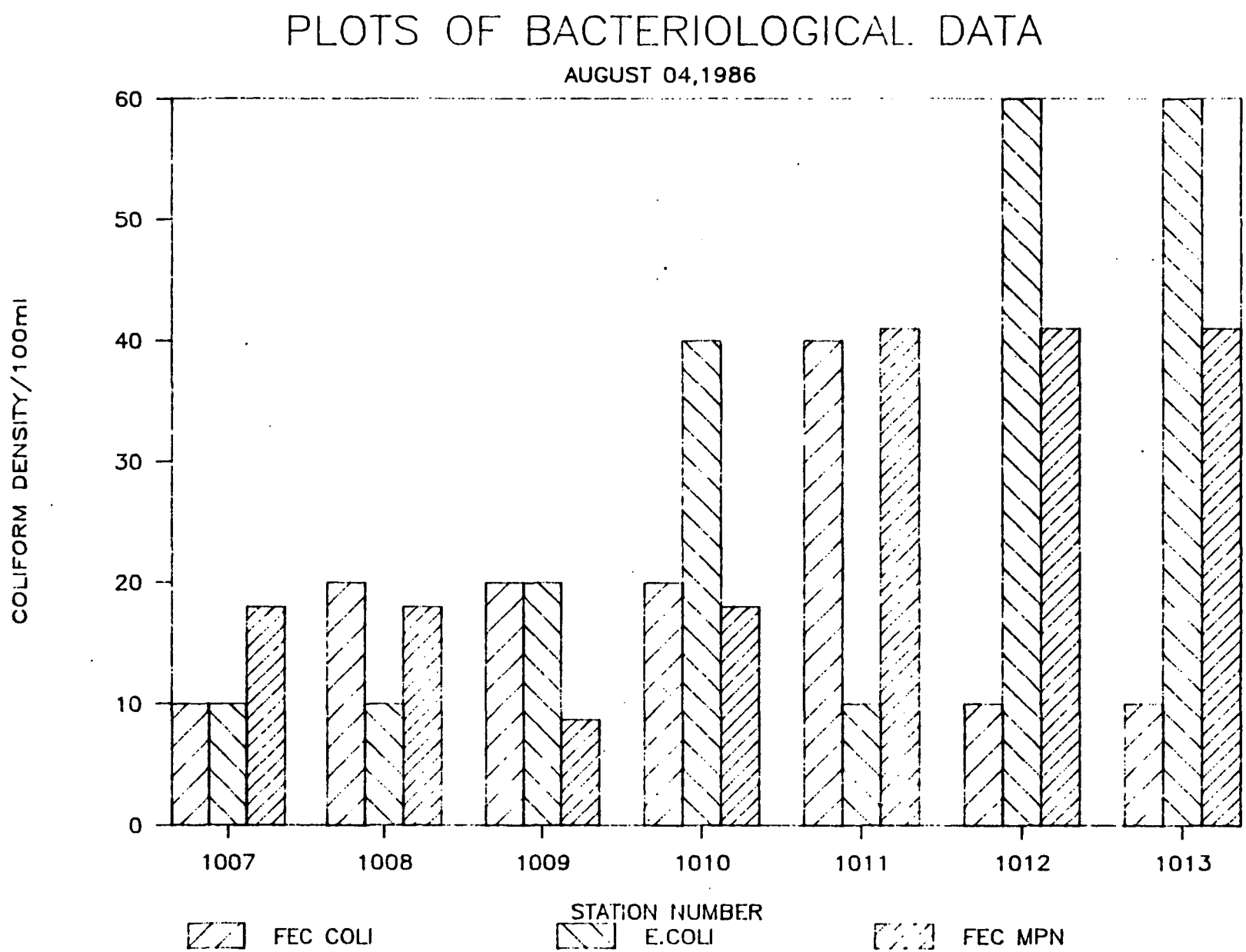

PLOTS OF BACTERIOLOGICAL DATA
AUGUST 04,1986
COLIFORM DENSITY/100ml
60
50
40
30
20
10
0
1007
1008
1009
1010
1011
1012
1013
STATION NUMBER
FEC COLI
E.COLI
FEC MPN

Figure 10 (Continued)

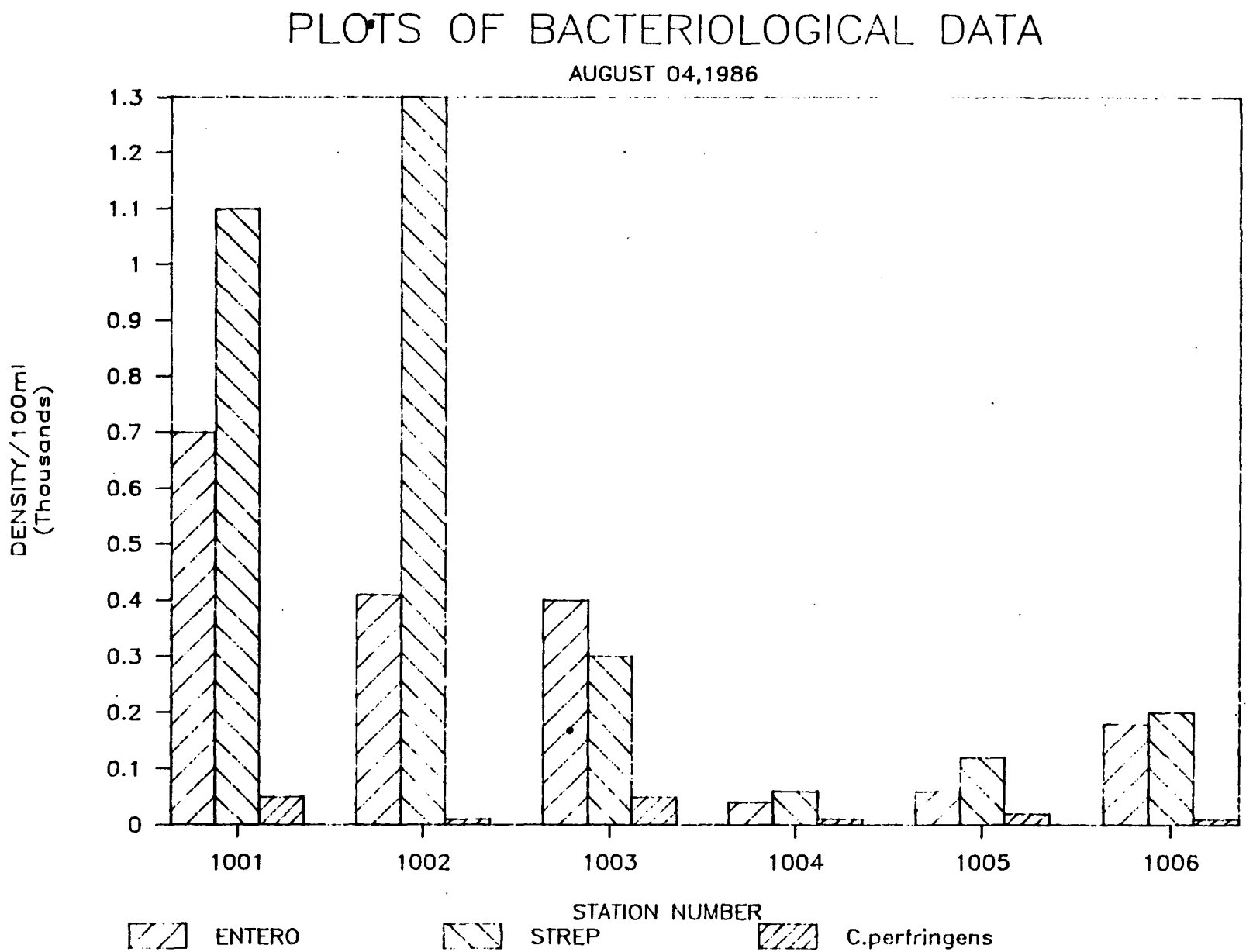


TABLE 56

ONSET BAY SITES, WAREHAM

SAMPLED ON AUGUST 10, 1986

STATION NUMBER	DESCRIPTION	LATITUDE	LONGITUDE
1101	West of Point Independence Yacht Club, approximately 200' from shore	41°44'24"	70°38'16"
1102 to 1105	Between slipways at Point Independence Yacht Club	41°44'30"	70°38'16"
1106	Between Point Independence Yacht Club and Onset Bay Marina	41°44'34"	70°38'13"
1107 to 1113	Between slipways at Onset Bay Marina	41°44'38"	70°38'09"
1114	East of Onset Bay Marina	41°44'37"	70°37'58"
1115	Approximately 100' off Monument Heights	41°44'34"	70°37'37"

TABLE 57

ONSET BAY SITES, WAREHAM

TEMPERATURE (°C), DISSOLVED OXYGEN (mg/l), PERCENT SATURATION (%)

AUGUST 10, 1986

STATION NUMBER	TEMPERATURE	DISSOLVED OXYGEN*	PERCENT SATURATION
1101	22.3	--	--
1102	22.6	--	--
1103	--	--	--
1104	22.8	--	--
1105	22.8	--	--
1106	22.8	--	--
1107	22.1	--	--
1108	22.3	--	--
1109	23.1	--	--
1110	22.5	--	--
1111	--	--	--
1112	--	--	--
1113	--	--	--
1114	23.0	--	--
1115	23.2	--	--

*Dissolved oxygen not tested

TABLE 58

BUZZARDS BAY
NON-POINT SOURCE BACTERIOLOGICAL DATA

Station Number	Fecal Coliform Bacteria /100ml	Entero-cocci Bacteria /100ml	*Escherichia coli* /100ml	Strepto-cocci Bacteria /100ml	*Clostridium perfringens* /100ml	Fecal Coliform Bacteria MPN/100ml
**Date Collected: 08/10/86						
1101	20	10	<10	<10	---	29
1102	60	60	<10	50	---	110
1103	70	40	10	<10	---	41
1104	30	10	<10	<10	---	54
1105	30	<10	<10	<10	---	54
1106	<10	<10	<10	<10	---	88
1107	20	10	20	<10	---	54
1108	40	<10	10	<10	---	70
1109	40	<10	<10	<10	---	88
1110	10	10	<10	<10	---	8.70
1111	<10	<10	10	<10	---	<8.70
1112	60	<10	<10	<10	---	139
1113	330	<10	30	<10	---	>248
1114	10	<10	<10	<10	---	<8.70
1115	<10	<10	<10	<10	---	29

TABLE 59

BUZZARDS BAY
NON-POINT SOURCE PHYSICAL DATA

Station Number	pH (standard units)	Total Hardness (mg/l)	Suspended Solids (mg/l)	Specific Conductivity (µmhos/cm)
** Date Collected: 08/10/86				
1101	8.0	4064	4.50	---
1102	8.0	5095	6.0	---
1104	8.0	4039	5.0	---
1105	8.0	5535	1.0	---
1106	8.0	4950	9.0	---
1107	7.80	5585	8.0	---
1108	8.0	5560	2.0	---
1109	8.0	6605	0.5	---
1110	8.0	5260	3.5	---
1112	8.0	6665	2.0	---
1114	7.80	7970	2.0	---
1115	7.20	5695.	11.0	---

TABLE 60

BUZZARDS BAY
NON-POINT SOURCE CHEMICAL DATA

Station Number	Chloride (mg/l)	Total Kjeldahl-Nitrogen (mg/l)	Ammonia-Nitrogen (mg/l)	Total Phosphorus (mg/l)
** Date Collected: 08/10/86				
1101	16250.0	1.20	<0.02	0.34
1102	16500.0	1.0	0.02	0.12
1104	16250.0	1.80	0.10	0.14
1105	16500.0	1.20	0.10	0.15
1106	16250.0	0.68	<0.02	0.12
1107	16250.0	1.60	<0.02	0.20
1108	16250.0	2.20	0.10	0.09
1109	16500.0	2.60	<0.02	0.09
1110	16500.0	1.70	0.02	0.10
1112	16500.0	2.10	0.02	0.11
1114	16500.0	1.90	0.04	0.10
1115	16500.0	1.80	0.04	0.11

Figure 11

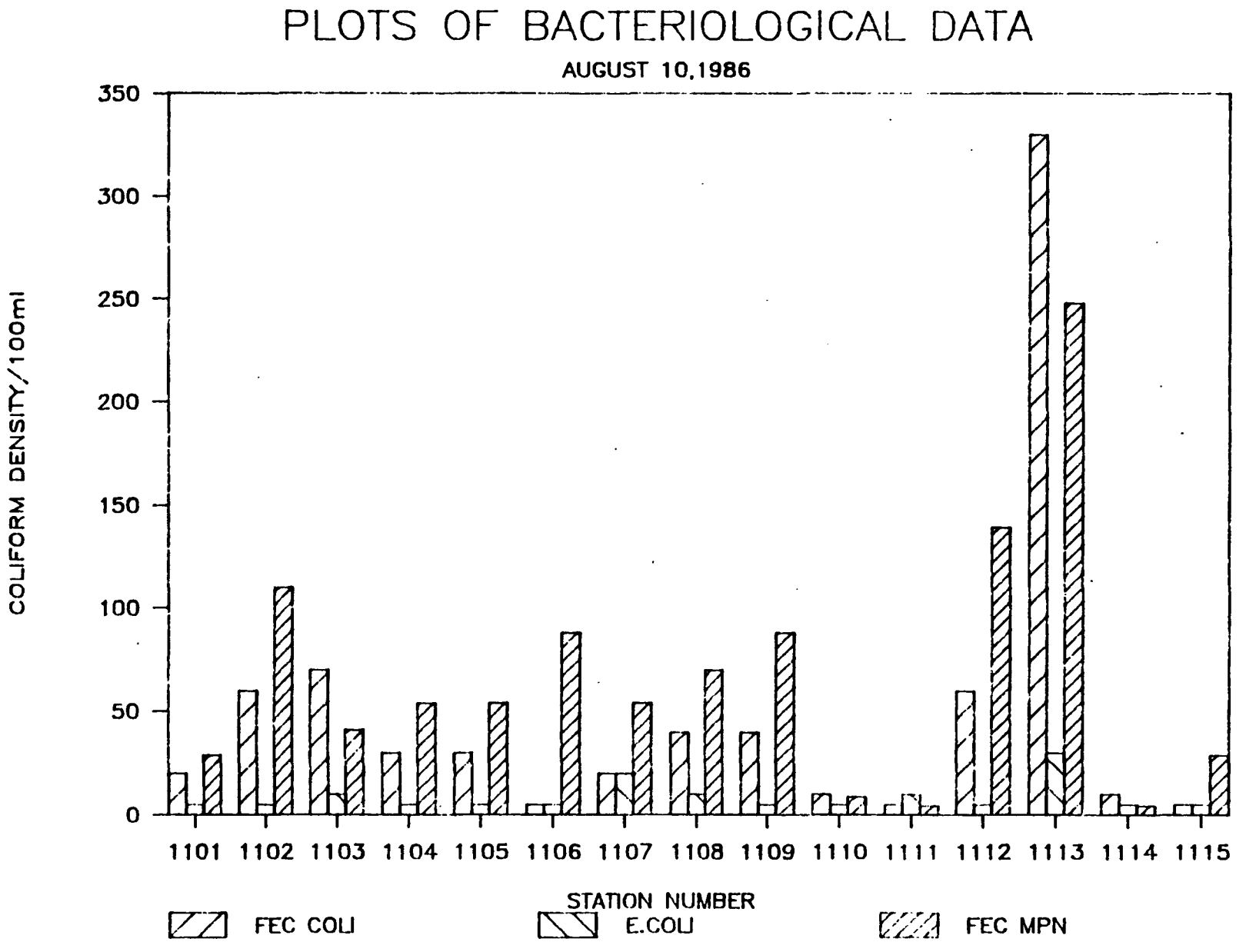

PLOTS OF BACTERIOLOGICAL DATA
AUGUST 10,1986
COLIFORM DENSITY/100ml
350
300
250
200
150
100
50
0
1101 1102 1103 1104 1105 1106 1107 1108 1109 1110 1111 1112 1113 1114 1115
STATION NUMBER
FEC COLI
E.COLI
FEC MPN

Figure 11 (Continued)

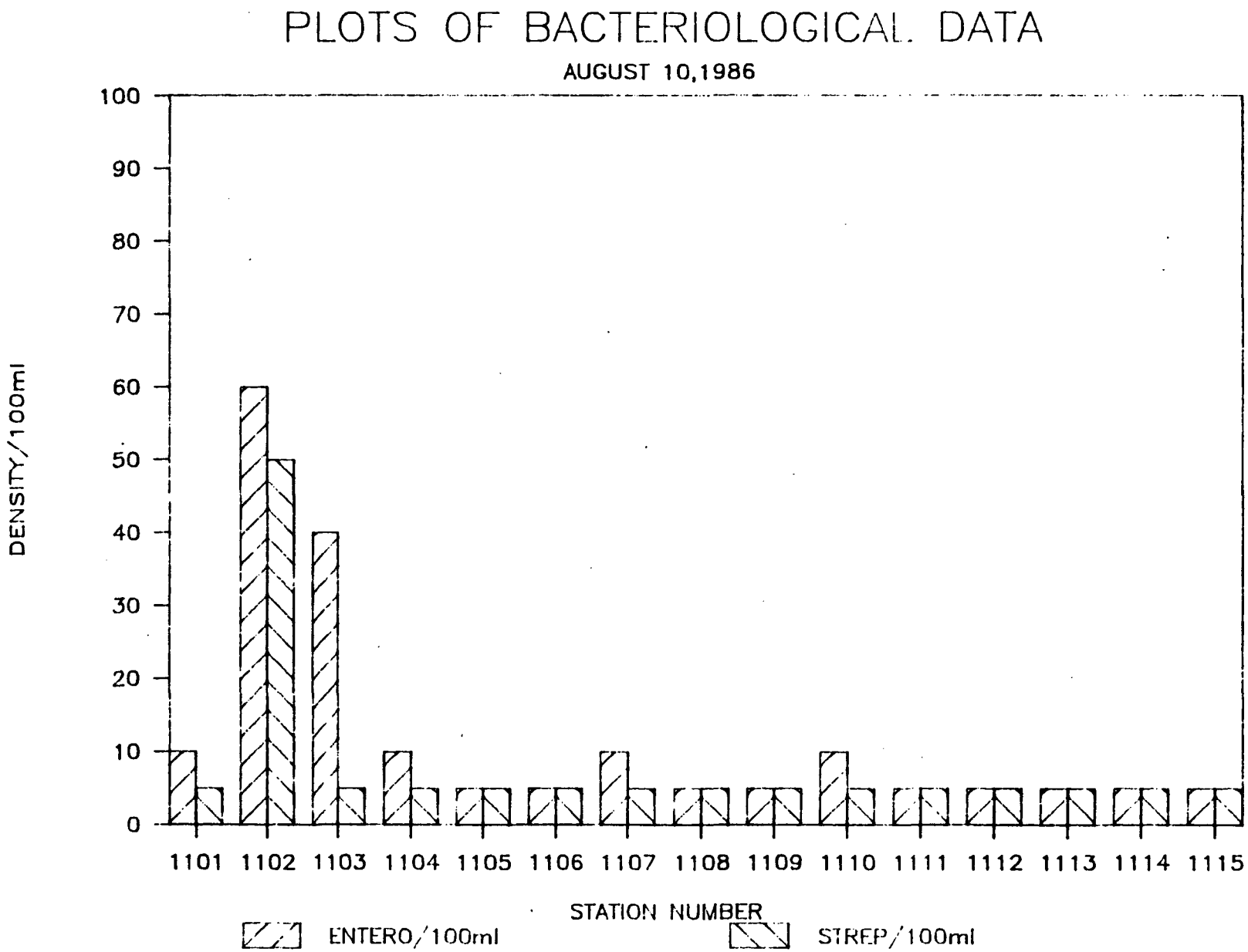


TABLE 61

MUDDY COVE SITES, WAREHAM

SAMPLED ON AUGUST 11, 1986

STATION NUMBER	DESCRIPTION	LATITUDE	LONGITUDE
1201	Unnamed brook on western shore of Muddy Cove	41°44'55"	70°39'38"
1202	Mid-way up unnamed brook	41°44'56"	70°39'41"
1203	Wind row in unnamed brook	41°44'55"	70°39'44"
1204	Unnamed brook which drains Beaverdam Pond	41°45'12"	70°39'38"
1205	Gibbs Brook by Ocean Spray factory, approximately 100' from culvert	41°45'22"	70°39'06"
1206	Same as 1205, approximately 25' from culvert	41°45'19"	70°39'07"
1207	Small cove by Ocean Spray factory	41°45'18"	70°39'06"
1208	Confluence of unnamed brook with the cove on eastern shore of Muddy Cove	41°45'15"	70°39'06"
1209	Approximately 100' upstream of 1208	41°45'14"	70°39'04"
1210	Just south of last bend in channel in Muddy Cove	41°44'56"	70°39'33"
1211	Just south of Dummy Bridge, collected midstream	41°44'50"	70°39'09"
1212	Gibbs Brook behind Cranberry Greens Mini-Golf	41°45'25"	70°39'16"

TABLE 62

MUDDY COVE SITES, WAREHAM

TEMPERATURE (°C), DISSOLVED OXYGEN (mg/l), PERCENT SATURATION (%)

AUGUST 11, 1986

STATION NUMBER	TEMPERATURE	DISSOLVED OXYGEN	PERCENT SATURATION
1201	27.6	8.0	105
1202	28.4	--	--
1203	28.8	7.9	108
1204	29.3	9.9	144
1205	27.2	7.8	98
1206	--	--	--
1207	27.0	--	--
1208	29.2	7.2	94
1209	29.7	6.5	90
1210	26.2	8.6	125
1211	24.5	8.7	123
1212	26.7	6.9	86

TABLE 63

BUZZARDS BAY
NON-POINT SOURCE BACTERIOLOGICAL DATA

Station Number	Fecal Coliform Bacteria /100ml	Entero-cocci Bacteria /100ml	*Escherichia coli* /100ml	Strepto-cocci Bacteria /100ml	*Clostridium perfringens* /100ml	Fecal Coliform Bacteria MPN/100ml
**Date Collected: 08/11/86						
1201	335	45	350	155	---	540
1202	365	35	250	125	---	540
1203	400	35	250	65	---	540
1204	85	10	65	65	---	41
1205	250	105	350	525	---	540
1206	240	210	265	245	---	290
1207	195	70	240	745	---	540
1208	95	70	75	495	---	179
1209	90	50	80	480	---	248
1210	10	10	10	45	---	29
1211	<5	<5	<5	<5	---	<8.70
1212	200	135	235	150	---	290

TABLE 64

BUZZARDS BAY
NON-POINT SOURCE PHYSICAL DATA

Station Number	pH (standard units)	Total Hardness (mg/l)	Suspended Solids (mg/l)	Specific Conductivity (µmhos/cm)
** Date Collected: 08/11/86				
1201	6.70	1670	7.50	---
1202	6.80	1020	6.50	---
1203	7.30	818	6.0	---
1204	7.70	2085	24.0	---
1205	6.0	466	3.50	---
1206	---	---	---	---
1207	6.90	605	5.0	---
1208	6.90	325	1.50	---
1209	7.0	590	2.0	---
1210	8.10	1420	3.0	---
1211	8.0	4340	3.0	---
1212	6.90	59	1.50	---

TABLE 65

BUZZARDS BAY
NON-POINT SOURCE CHEMICAL DATA

Station Number	Chloride (mg/l)	Total Kjeldahl-Nitrogen (mg/l)	Ammonia-Nitrogen (mg/l)	Total Phosphorus (mg/l)
** Date Collected: 08/11/86				
1201	7000.0	2.60	0.20	0.11
1202	4250.0	2.70	0.03	0.12
1203	5250.0	2.60	0.02	0.16
1204	8750.0	3.30	0.02	0.45
1205	1750.0	2.60	0.30	0.14
1207	2500.0	1.70	0.10	0.08
1208	1250.0	2.40	0.20	0.11
1209	2500.0	2.10	0.02	0.09
1210	16000.0	2.0	0.10	0.10
1211	16500.0	2.0	0.10	0.09
1212	17.0	0.56	0.20	0.04

TABLE 66

SOURCE DIFFERENTIATION OF FECAL STREPTOCOCCI BACTERIA

FROM MUDDY COVE SITES

AUGUST 11, 1986

STATION NUMBER	NUMBER OF COLONIES TESTED	NUMBER OF NON-FECAL STREPTOCOCCI	NUMBER OF GROUP Q STREPTOCOCCI	NUMBER FROM WARM-BLOODED ANIMALS	NUMBER FROM LIVESTOCK AND POULTRY	NUMBER FROM INSECTS	NUMBER FROM VEGETATION
1201	5	0	4	1	0	0	0
1202	5	0	2	3	0	0	0
1203	5	3	0	2	0	0	0
1204	-	-	-	-	0	-	0
1205	5	0	1	3	0	1	0
1206	5	2	0	1	0	2	0
1207	5	0	0	0	0	5	0
1208	5	0	1	2	0	2	0
1209	5	1	0	0	0	4	0
1210	5	2	0	3	0	0	0
1211	1	1	-	-	0	-	0
1212	5	0	0	3	0	2	0
Total	51	9	8	18	0	16	0
Percent		17.6	15.7	35.3	0	31.4	0

Figure 12

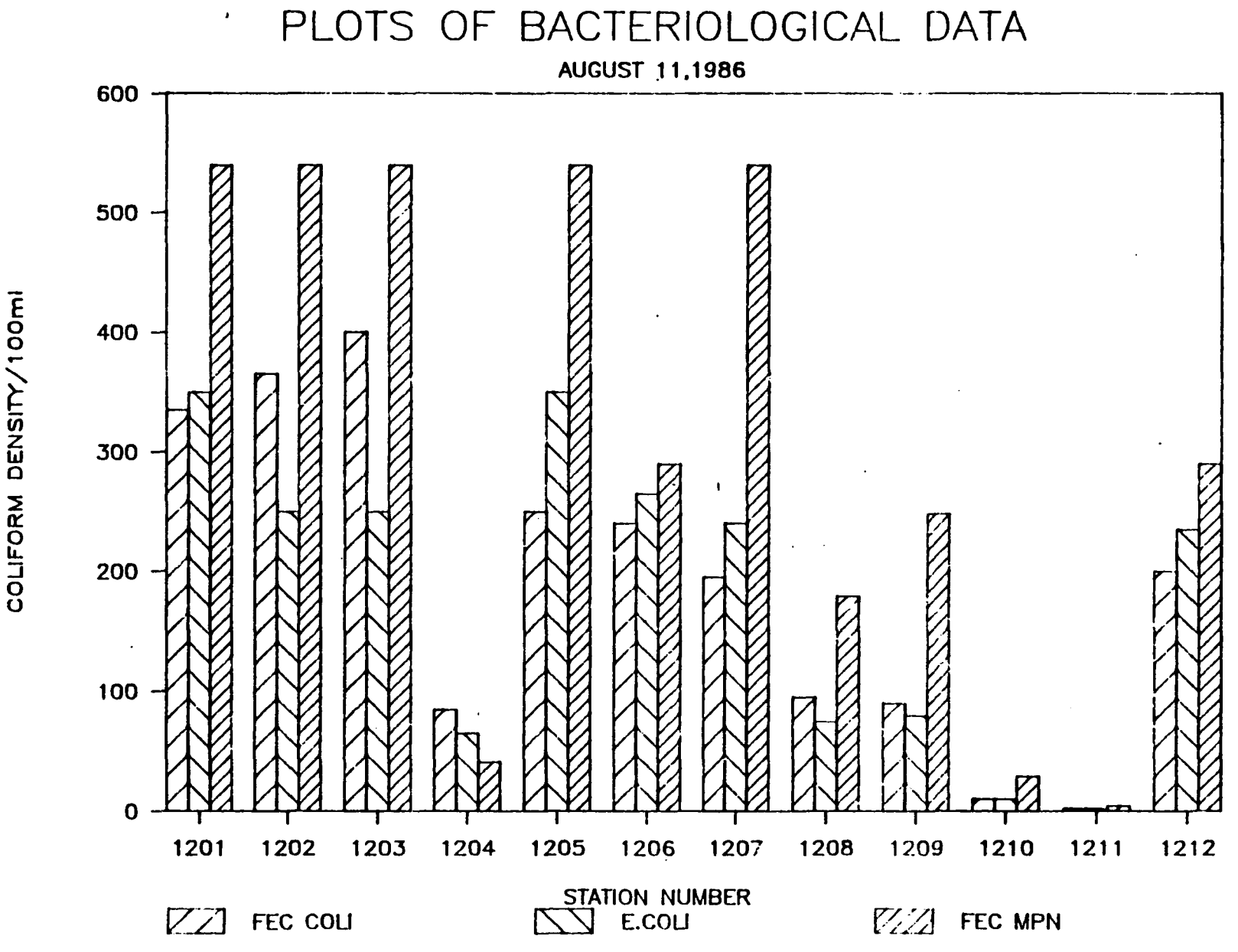

PLOTS OF BACTERIOLOGICAL DATA
AUGUST 11,1986
COLIFORM DENSITY/100ml
600
500
400
300
200
100
0
1201
1202
1203
1204
1205
1206
1207
1208
1209
1210
1211
1212
STATION NUMBER
FEC COLI
E.COLI
FEC MPN

Figure 12 (Continued)

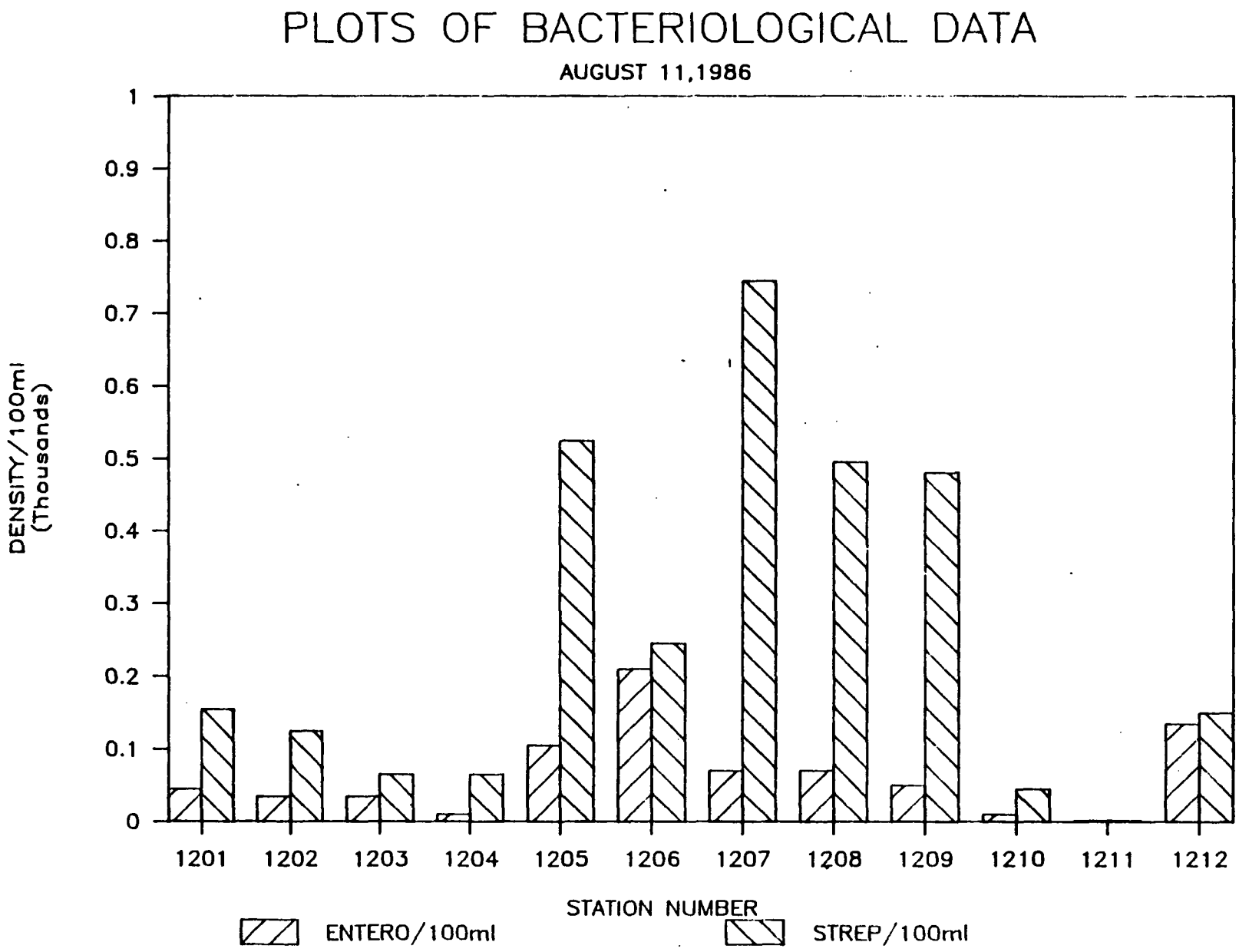


TABLE 67

WESTPORT RIVER SITES, WESTPORT

SAMPLED ON AUGUST 19, 1986

STATION NUMBER	DESCRIPTION	LATITUDE	LONGITUDE
1301	Below Hix Bridge along western shore, next to wetland, approximately 20' from shore, above housing area	41°33'52"	71°04'28"
1302	Unnamed tributary, just north of Gull Rock	41°33'48"	71°04'29"
1303	Below first two houses, just north of first pier	41°33'40"	71°04'26"
1304	In front of house with gabled roof, approximately 20' from shore just south of first pier	41°33'38"	71°04'26"
1305	In front of second house with flagpole, white house with beach wall	41°33'36"	71°04'23"
1306	Just south of first group of houses, opposite wooded area below rocky shoals	41°33'29"	71°04'18"
1307	On eastern shore opposite meadow, approximately 50' from shore	41°33'14"	71°03'21"
1308	Just south of red house with TV dish, approximately 50' from shore	41°33'08"	71°03'15"
1309	Opposite white cottage, two other small cottages north of it	41°33'06"	71°03'13"
1310	Opposite white two story house	41°33'04"	71°03'12"
1311	Just south of gray cottage	41°33'02"	71°03'11"
1312	Just south of last house, opposite southern end of Little Pond Island	41°32'58"	71°03'10"

TABLE 68

WESTPORT RIVER SITES, WESTPORT

TEMPERATURE (°C), DISSOLVED OXYGEN (mg/l), PERCENT SATURATION (%)

AUGUST 19, 1986

STATION NUMBER	TEMPERATURE	DISSOLVED OXYGEN	PERCENT SATURATION
1301	22.6	5.8	75
1302	21.2	5.2	65
1303	22.6	5.7	74
1304	22.6	5.9	81
1305	22.7	5.8	75
1306	22.7	5.6	77
1307	22.4	5.9	79
1308	22.6	6.1	84
1309	22.4	6.3	84
1310	22.6	6.2	85
1311	22.8	6.4	88
1312	22.7	4.9	67

TABLE 69

BUZZARDS BAY
NON-POINT SOURCE BACTERIOLOGICAL DATA

Station Number	Fecal Coliform Bacteria /100ml	Entero-cocci Bacteria /100ml	*Escherichia coli* /100ml	Strepto-cocci Bacteria /100ml	*Clostridium perfringens* /100ml	Fecal Coliform Bacteria MPN/100ml
**Date Collected: 08/19/86						
1301	1000	80	60	340	<20	1390
1302	500	80	500	60	<20	700
1303	1100	120	900	120	<20	540
1304	1100	60	200	60	<20	1390
1305	800	120	400	140	<20	700
1306	600	60	1000	80	<20	880
1307	75	5	100	10	5	248
1308	45	<5	50	<5	<5	248
1309	60	<5	30	<5	<5	110
1310	50	5	25	<5	5	179
1311	65	<5	60	5	<5	41
1312	90	<5	85	<5	<5	139

TABLE 70

BUZZARDS BAY
NON-POINT SOURCE PHYSICAL DATA

Station Number	pH (standard units)	Total Hardness (mg/l)	Suspended Solids (mg/l)	Specific Conductivity (µmhos/cm)
** Date Collected: 08/19/86				
1301	7.70	3020	7.50	---
1302	7.50	2530	7.0	---
1303	7.70	3790	7.50	---
1304	7.60	3825	10.0	---
1305	7.30	4065	8.0	---
1306	7.50	4000	10.0	---
1307	7.40	4565	5.50	---
1308	7.70	4905	8.0	---
1309	7.30	4710	5.0	---
1310	7.70	4735	4.50	---
1311	7.90	5050	6.50	---
1312	7.50	4970	10.0	---

TABLE 71

BUZZARDS BAY
NON-POINT SOURCE CHEMICAL DATA

Station Number	Chloride (mg/l)	Total Kjeldahl-Nitrogen (mg/l)	Ammonia-Nitrogen (mg/l)	Total Phosphorus (mg/l)
** Date Collected: 08/19/86				
1301	12250.0	1.70	0.40	0.12
1302	12250.0	1.30	0.20	0.10
1303	12250.0	0.89	0.20	0.15
1304	12500.0	1.90	0.30	0.12
1305	12250.0	1.40	0.20	0.12
1306	12750.0	0.95	0.10	0.12
1307	15000.0	1.30	0.10	0.14
1308	15000.0	1.30	0.10	0.10
1309	15250.0	1.20	0.20	0.10
1310	15250.0	1.40	0.08	0.10
1311	15250.0	1.60	0.13	0.10
1312	15250.0	1.40	0.14	0.12

Figure 13

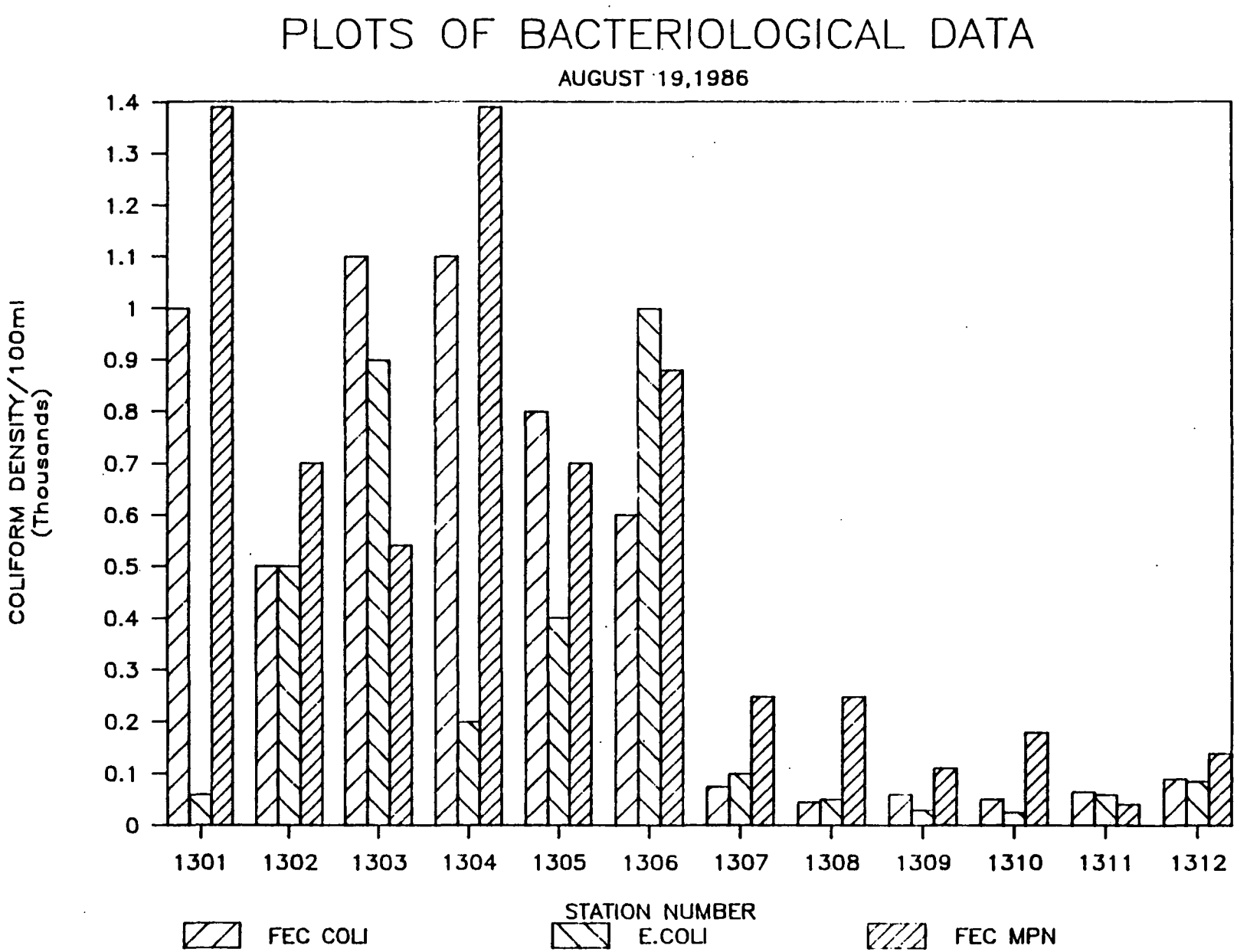

PLOTS OF BACTERIOLOGICAL DATA
AUGUST 19,1986
COLIFORM DENSITY/100ml
(Thousands)
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1301
1302
1303
1304
1305
1306
1307
1308
1309
1310
1311
1312
STATION NUMBER
FEC COLI
E.COLI
FEC MPN

Figure 13 (Continued)

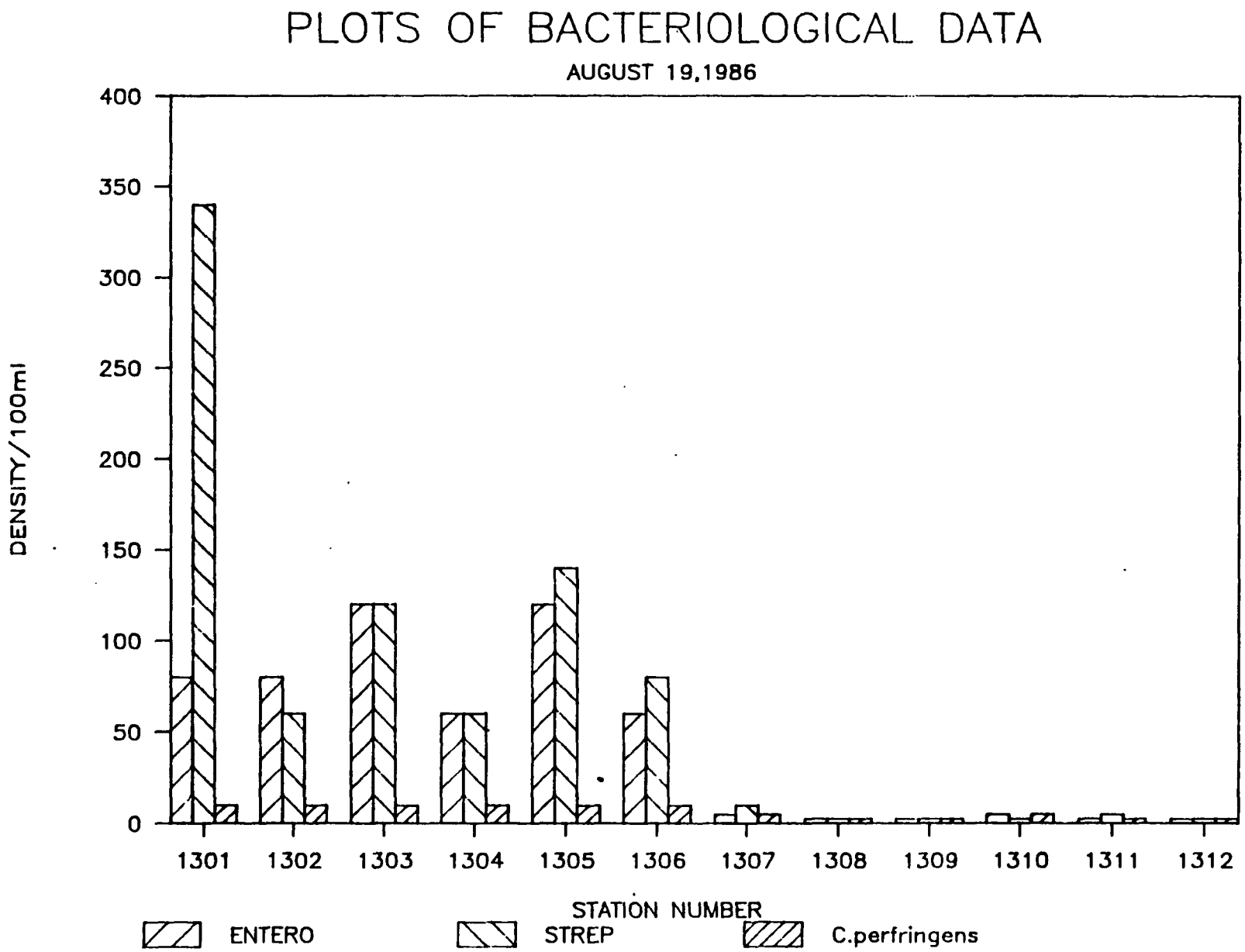


TABLE 72

SUNSET COVE SITES, WAREHAM

SAMPLED ON AUGUST 26, 1986

STATION NUMBER	DESCRIPTION	LATITUDE	LONGITUDE
1401	Up major unnamed tributary in Broad Marsh, approximately 1/8 of a mile from where it crosses Great Neck Road	41°44'56"	70°39'39"
1402	Approximately half way down same tributary to Broad Marsh in Sunset Cove	41°45'04"	70°39'41"
1403	Mouth of tributary, approximately 100' from shore	41°45'05"	70°39'44"
1404	Southern shore of cove near Helminth Avenue	41°45'17"	70°39'49"
1405	Small cove near Northport Road and Central Avenue, on southern side of Broad Marsh Cove	41°45'27"	70°39'16"
1406	Sunset Cove by Onset Avenue	41°44'42"	70°39'56"
1407	Northern tip of Sunset Island, in front of group of seven houses close to shore	41°44'39"	70°40'00"
1408	Offshore of Sunset Island	41°45'16"	70°39'17"
1409	Backside of Sunset Island near West Avenue and Second Street	41°45'17"	70°39'15"

TABLE 73

SUNSET COVE SITES, WAREHAM

TEMPERATURE (°C), DISSOLVED OXYGEN (mg/l), PERCENT SATURATION (%)

AUGUST 26, 1986

STATION NUMBER	TEMPERATURE	DISSOLVED OXYGEN	PERCENT SATURATION
1401	23.6	5.8	76
1402	24.1	5.8	76
1403	22.6	7.0	96
1404	22.3	7.5	100
1405	22.3	7.5	100
1406	23.3	7.7	106
1407	22.6	7.6	104
1408	22.2	7.5	100
1409	22.7	8.2	112

TABLE 74

BUZZARDS BAY
NON-POINT SOURCE BACTERIOLOGICAL DATA

Station Number	Fecal Coliform Bacteria /100ml	Entero-cocci Bacteria /100ml	*Escherichia coli* /100ml	Strepto-cocci Bacteria /100ml	*Clostridium perfringens* /100ml	Fecal Coliform Bacteria MPN/100ml
**Date Collected: 08/26/86						
1401	2	<20	<2	<20	---	<8.70
1401	4	<20	<2	<20	---	---
1402	2	<20	<2	<20	---	<8.70
1402	<2	<20	<2	<20	---	---
1403	<2	<20	<2	<20	---	29
1403	4	<20	<2	<20	---	---
1404	<2	<10	<2	<10	---	<8.70
1404	<2	<10	<2	<10	---	---
1405	<2	<10	<2	<10	---	<8.70
1405	<2	<10	<2	<10	---	---
1406	<2	<10	<2	<10	---	<8.70
1406	<2	<10	<2	<10	---	---
1407	<2	<10	<2	<10	---	<8.70
1407	<2	<10	<2	<10	---	---
1408	<2	<20	<2	<20	---	<8.70
1408	<2	<20	<2	<20	---	---
1409	<2	<20	<2	<20	---	8.70
1409	<2	<20	<2	<20	---	---

TABLE 75

BUZZARDS BAY
NON-POINT SOURCE PHYSICAL DATA

Station Number	pH (standard units)	Total Hardness (mg/l)	Suspended Solids (mg/l)	Specific Conductivity (µmhos/cm)
** Date Collected: 08/26/86				
1401	7.60	4755	25.0	---
1402	7.70	4340	5.0	---
1403	7.80	5140	6.50	---
1404	7.80	6230	5.0	---
1405	7.50	5430	2.0	---
1406	7.90	5840	4.50	---
1407	7.80	5775	8.0	---
1408	7.70	5520	2.50	---
1409	7.90	6080	4.0	---

TABLE 76

BUZZARDS BAY
NON-POINT SOURCE CHEMICAL DATA

Station Number	Chloride (mg/l)	Total Kjeldahl-Nitrogen (mg/l)	Ammonia-Nitrogen (mg/l)	Total Phosphorus (mg/l)
** Date Collected: 08/26/86				
1401	10750.0	1.60	0.10	0.18
1402	11500.0	1.20	0.10	0.16
1403	16000.0	1.20	0.10	0.09
1404	16500.0	0.66	0.04	0.10
1405	16500.0	0.90	0.05	0.11
1406	16250.0	1.10	0.20	0.08
1407	16250.0	1.10	0.02	0.06
1408	16500.0	0.99	0.10	0.08
1409	16500.0	0.95	<0.02	0.05

Figure 14

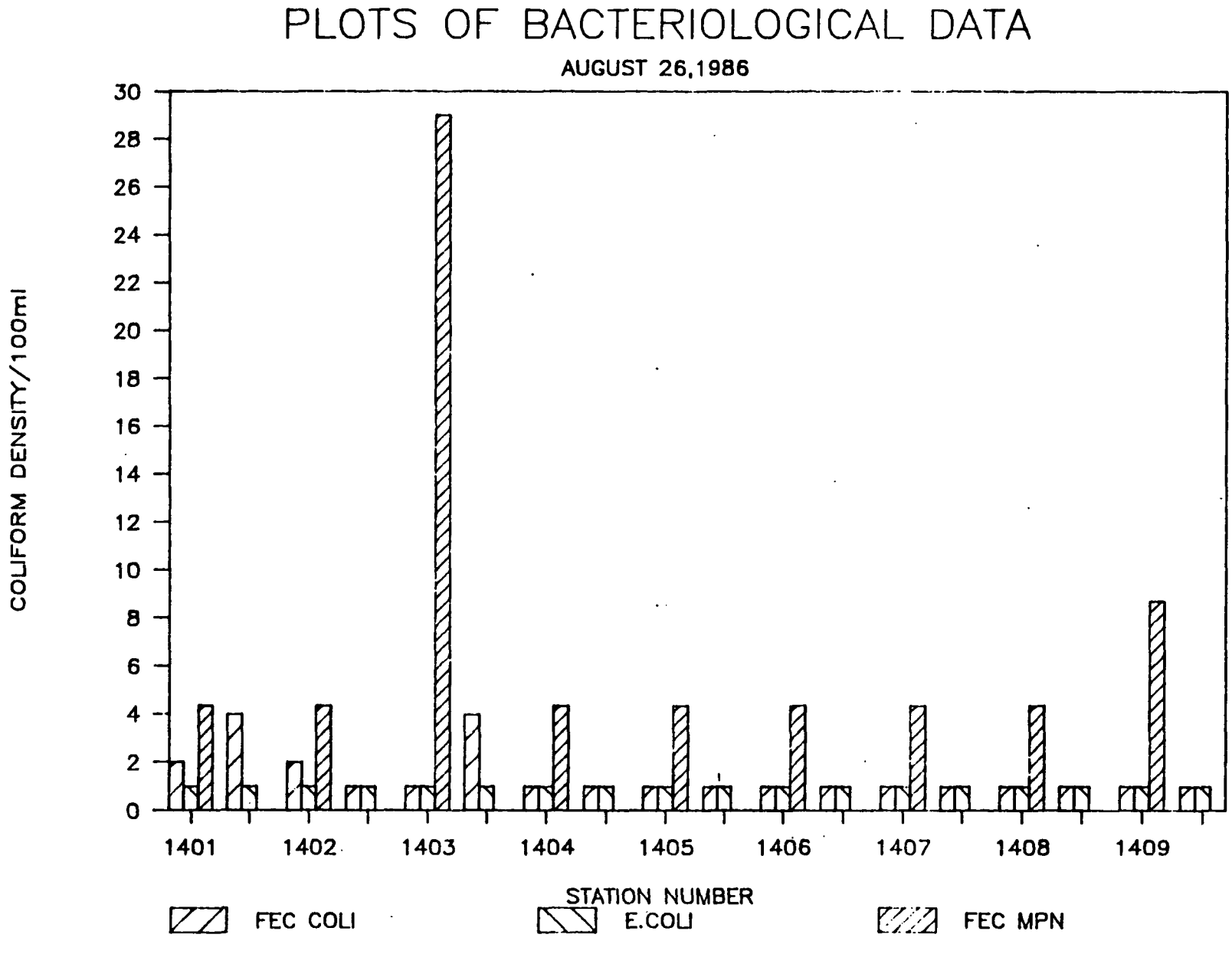

PLOTS OF BACTERIOLOGICAL DATA
AUGUST 26,1986
COLIFORM DENSITY/100ml
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
1401
1402
1403
1404
1405
1406
1407
1408
1409
STATION NUMBER
FEC COLI
E.COLI
FEC MPN

Figure 14 (Continued)

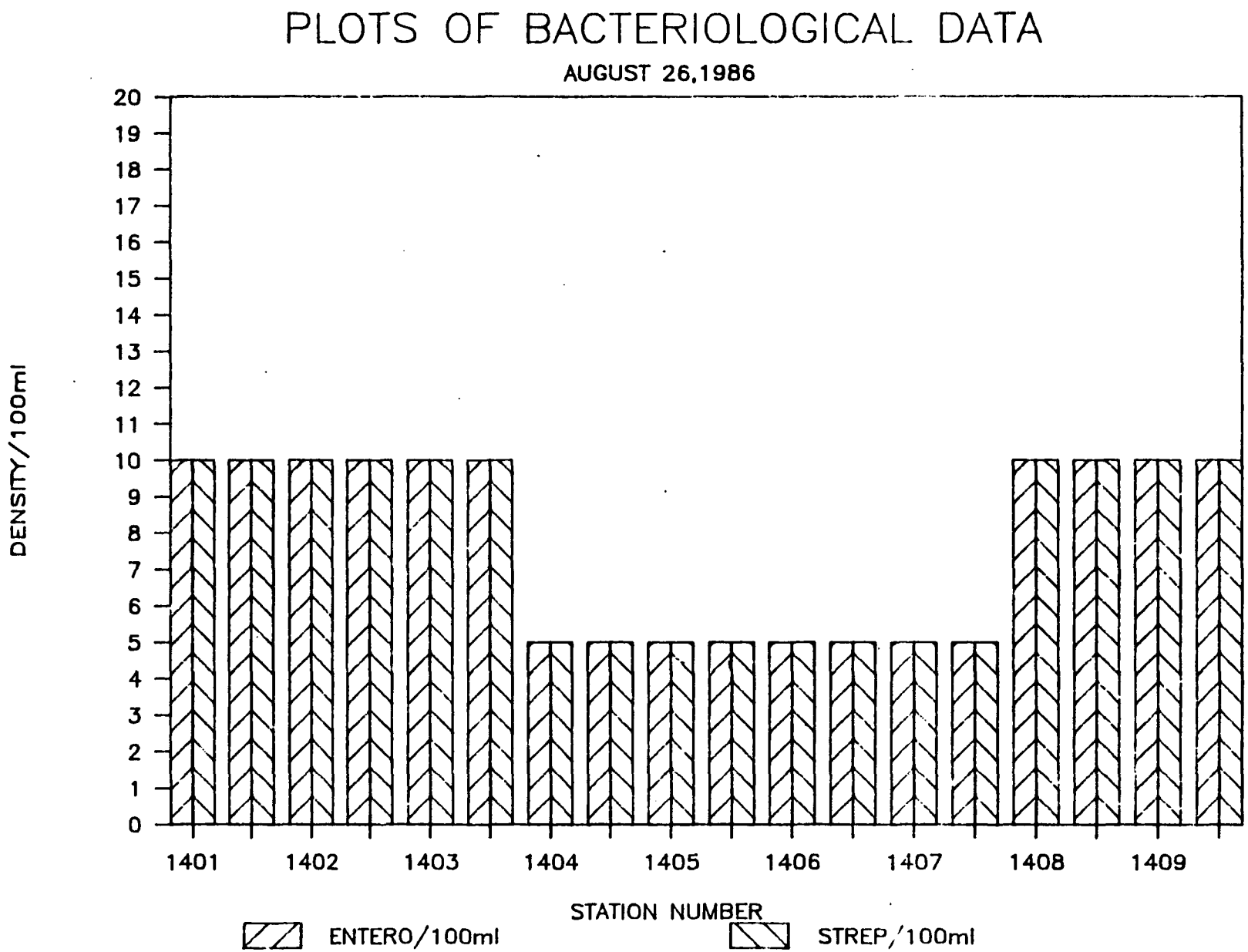


TABLE 77

WESTPORT RIVER SITES, WESTPORT

SAMPLED ON SEPTEMBER 17, 1986

STATION NUMBER	DESCRIPTION	LATITUDE	LONGITUDE
1501	Head of Jessie's Neck Cove	41°35'05"	71°04'30"
1502	Mouth of Jessies' Neck Cove	41°34'45"	71°04'27"
1503	Offshore of Cornell Point	41°35'15"	71°04'20"
1504	Drainage ditch at Cornell Point	41°35'17"	71°04'18"
1505	Drainage ditch southwest of Peleg's Point	41°35'20"	71°04'10"
1506	Second drainage ditch southwest of Peleg's Point	41°35'22"	71°04'10"
1507	Outlet of Kirby Brook	41°35'40"	71°04'12"
1508	Mouth of Everett Cove	41°36'15"	71°03'45"
1509	Cove opposite Peleg's Point	41°35'20"	71°03'50"
1510	Unnamed stream north of Allen Creek	41°35'15"	71°04'10"

TABLE 78

WESTPORT RIVER SITES, WESTPORT

TEMPERATURE (°C), DISSOLVED OXYGEN (mg/l), PERCENT SATURATION (%)

SEPTEMBER 17, 1986

STATION NUMBER	TEMPERATURE	DISSOLVED OXYGEN	PERCENT SATURATION
1501	15.3	8.6	96
1502	16.6	7.1	87
1503	16.8	7.6	87
1504	--	--	--
1505	16.7	5.3	61
1506	16.5	5.8	67
1507	17.8	9.3	109
1508	18.9	9.3	106
1509	--	--	--
1510	18.4	8.3	98

TABLE 79

BUZZARDS BAY
NON-POINT SOURCE BACTERIOLOGICAL DATA

Station Number	Fecal Coliform Bacteria /100ml	Entero-cocci Bacteria /100ml	*Escherichia coli* /100ml	Strepto-cocci Bacteria /100ml	*Clostridium perfringens* /100ml	Fecal Coliform Bacteria MPN/100ml
**Date Collected: 09/17/86						
1501	900	125	1110	210	---	880.0
1502	90	15	220	40	---	410.0
1503	90	45	60	25	---	87.0
1504	70	40	160	65	---	540
1505	180	45	170	50	---	87.0
1506	1000	130	400	170	---	110.0
1507	170	10	190	20	---	410.0
1508	2900	160	1500	4000	---	>2480.0
1509	2100	80	2100	100	---	>2480.0
1510	60	15	160	40	---	410.0

TABLE 80

BUZZARDS BAY
NON-POINT SOURCE PHYSICAL DATA

Station Number	pH (standard units)	Total Hardness (mg/l)	Suspended Solids (mg/l)	Specific Conductivity (µmhos/cm)
** Date Collected: 09/17/86				
1501	7.20	12350	5.00	---
1502	7.60	3385	3.50	---
1503	7.90	2600	2.00	---
1505	6.40	2575	3.00	---
1506	7.00	2120	2.00	---
1507	7.90	2400	3.00	---
1508	5.90	1820	6.00	---
1510	7.80	2755	9.00	---

TABLE 81

BUZZARDS BAY
NON-POINT SOURCE CHEMICAL DATA

Station Number	Chloride (mg/l)	Total Kjeldahl-Nitrogen (mg/l)	Ammonia-Nitrogen (mg/l)	Total Phosphorus (mg/l)
** Date Collected: 09/17/86				
1501	9500.0	1.20	0.04	0.11
1502	12500.0	1.10	0.04	0.10
1503	12000.0	1.80	0.15	0.09
1505	11000.0	1.90	0.03	0.11
1506	8000.0	2.00	0.11	0.08
1507	8500.0	2.10	0.05	0.84
1508	5500.0	1.50	0.01	0.18
1510	10500.0	2.20	0.08	0.10

TABLE 82

SOURCE DIFFERENTIATION OF FECAL STREPTOCOCCI BACTERIA

FROM WESTPORT RIVER SITES

SEPTEMBER 17, 1986

STATION NUMBER	NUMBER OF COLONIES TESTED	NUMBER OF NON-FECAL STREPTOCOCCI	NUMBER FROM GROUP Q STREPTOCOCCI	NUMBER OF WARM-BLOODED ANIMALS	NUMBER FROM LIVESTOCK AND POULTRY	NUMBER FROM INSECTS	NUMBER FROM VEGETATION
1501	5	0	2	3	0	0	0
1502	5	0	1	4	0	0	0
1503	5	0	0	5	0	0	0
1504	5	0	1	4	0	0	0
1505	5	1	1	3	0	0	0
1506	5	0	1	4	0	0	0
1507	5	0	2	3	0	0	0
1508	5	0	1	4	0	0	0
1509	5	0	1	4	0	0	0
1510	3	0	1	2	0	0	0
Totals	48	1	11	36	0	0	0
Percent		2.1	22.9	75	0	0	0

Figure 15

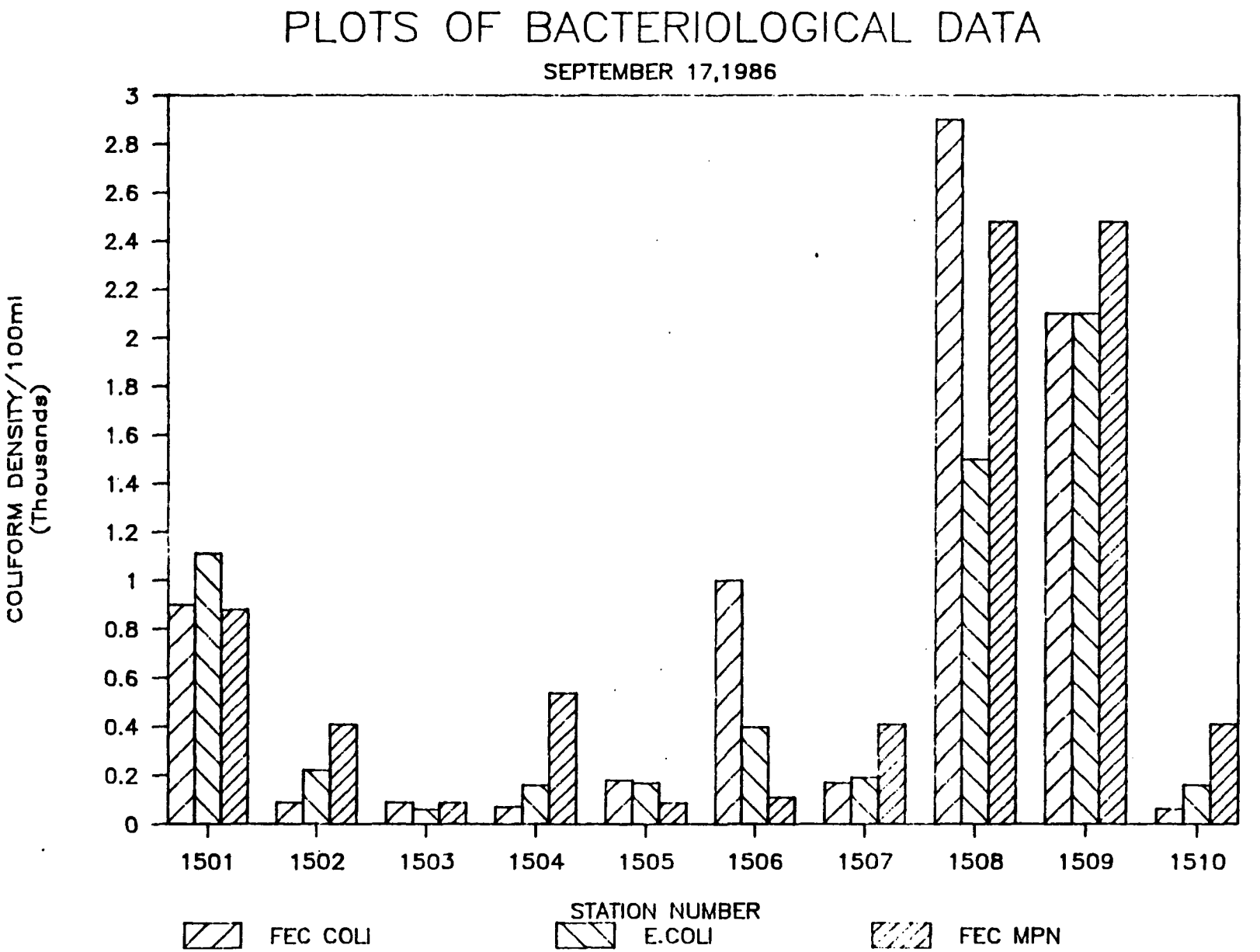

PLOTS OF BACTERIOLOGICAL DATA
SEPTEMBER 17,1986
COLIFORM DENSITY/100ml
(Thousands)
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1501
1502
1503
1504
1505
1506
1507
1508
1509
1510
STATION NUMBER
FEC COLI
E.COLI
FEC MPN

Figure 15 (Continued)

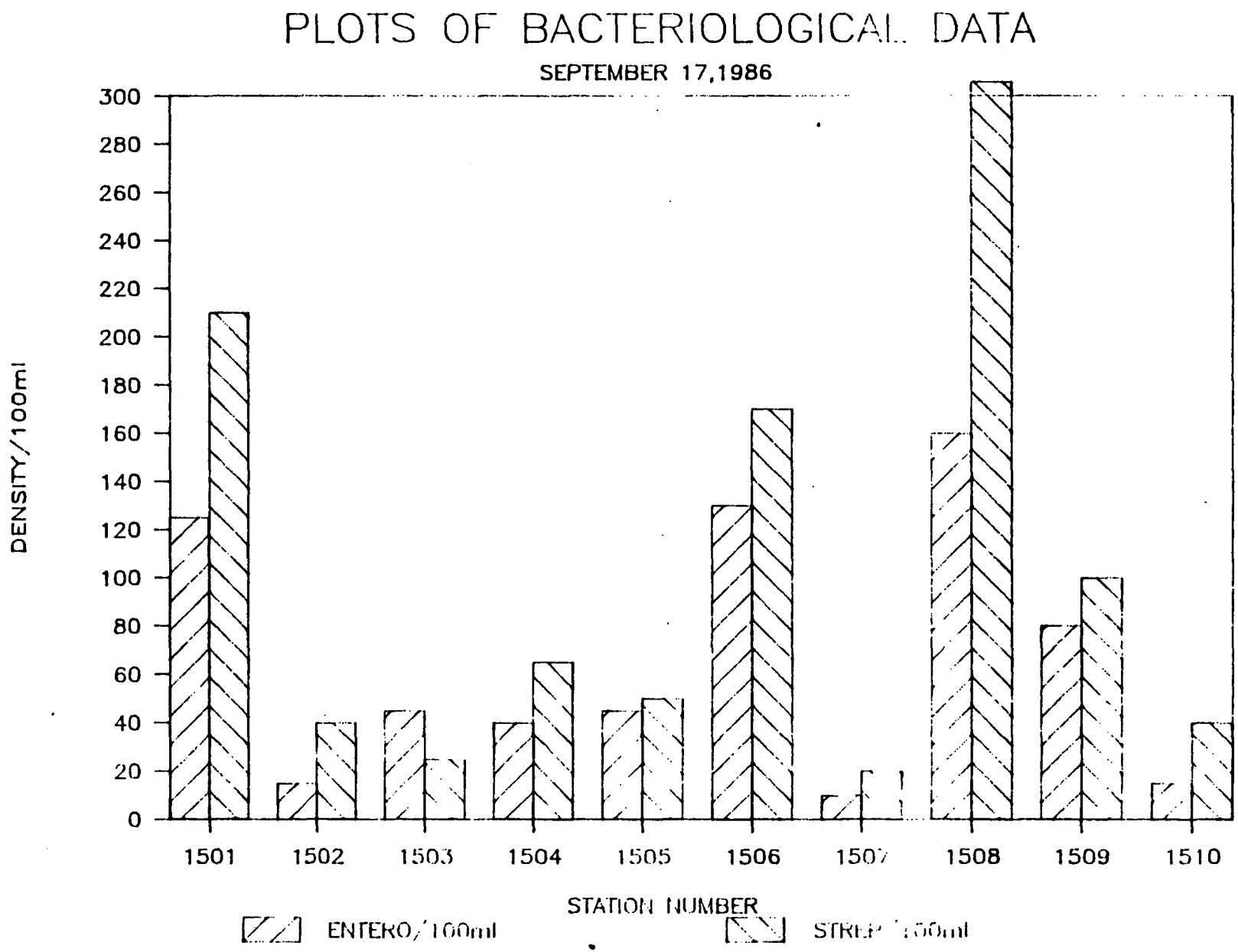


TABLE 83

SUNSET COVE SITES, WAREHAM

SAMPLED ON SEPTEMBER 24, 1986

STATION NUMBER	DESCRIPTION	LATITUDE	LONGITUDE
1601	Unnamed stream approximately one-half way between Broad Marsh Cove and Great Neck Road	41°44'51"	70°40'57"
1602	Unnamed stream near confluence with Broad Marsh Cove	41°44'46"	70°40'46"
1603	Small cove near Verve Avenue sampled approximately 20' from shore	41°44'39"	70°40'47"
1604	Cove near Northport Avenue	41°44'34"	70°40'28"
1605	Southeastern section of cove by Onset Avenue in northeast corner of Sunset Cove	41°44'39"	70°39'55"
1606	Same cove as in 1605, northwestern section approximately 200-300' to Western Avenue and houses	41°44'43"	70°39'58"
1607	In front of houses northern tip of Sunset Island closest to Onset Avenue, approximately 15' from shore	41°44'38"	70°40'00"
1608	In front of houses southwestern end of Sunset Island, approximately 15' from shore	41°44'30"	70°40'08"
1609	Inner side of Sunset Island near 5th Street	41°44'32"	70°39'57"
1610	Inner side of Sunset Island near 2nd Street	41°44'27"	70°40'03"

TABLE 84

SUNSET COVE SITES, WAREHAM

TEMPERATURE (°C), DISSOLVED OXYGEN (mg/l), PERCENT SATURATION (%)

SEPTEMBER 24, 1986

STATION NUMBER	TEMPERATURE	DISSOLVED OXYGEN	PERCENT SATURATION
1601	18.3	5.3	66
1602	19.3	5.3	67
1603	18.5	7.4	94
1604	18.5	6.6	84
1605	18.5	7.1	90
1606	20.0	6.2	81
1607	18.8	6.9	87
1608	18.8	6.6	84
1609	19.5	4.1	53
1610	18.6	7.1	90

TABLE 85

BUZZARDS BAY
NON-POINT SOURCE BACTERIOLOGICAL DATA

Station Number	Fecal Coliform Bacteria /100ml	Entero-cocci Bacteria /100ml	*Escherichia coli* /100ml	Strepto-cocci Bacteria /100ml	*Clostridium perfringens* /100ml	Fecal Coliform Bacteria MPN/100ml
**Date Collected: 09/24/86						
1601	8	<4	16	<4	---	29.0
1602	<4	<4	<4	<4	---	<8.70
1603	4	<4	4	<4	---	<8.70
1604	4	<4	<4	<4	---	<8.70
1605	4	<4	<4	<4	---	18.0
1606	4	<4	<4	<4	---	18.0
1607	<4	<4	<4	<4	---	8.70
1608	<4	<4	<4	<4	---	<8.70
1609	<4	<4	<4	<4	---	8.70
1610	<4	<4	<4	<4	---	<8.70

TABLE 86

BUZZARDS BAY
NON-POINT SOURCE PHYSICAL DATA

Station Number	pH (standard units)	Total Hardness (mg/l)	Suspended Solids (mg/l)	Specific Conductivity (µmhos/cm)
** Date Collected: 09/24/86				
1601	6.90	4300	3.00	---
1602	4.80	3527	3.50	---
1603	---	4340	4.00	---
1604	7.60	4094	5.00	---
1605	8.50	4144	2.00	---
1606	7.70	3718	24.00	---
1607	7.90	3782	12.00	---
1608	7.90	3798	6.00	---
1609	7.90	4340	18.00	---
1610	7.70	4258	9.50	---

TABLE 87

BUZZARDS BAY
NON-POINT SOURCE CHEMICAL DATA

Station Number	Chloride (mg/l)	Total Kjeldahl-Nitrogen (mg/l)	Ammonia-Nitrogen (mg/l)	Total Phosphorus (mg/l)
** Date Collected: 09/24/86				
1601	15600.0	2.30	0.14	0.11
1602	15200.0	2.30	0.29	0.08
1603	16400.0	1.40	0.05	0.08
1604	16400.0	2.10	0.08	0.08
1605	16400.0	1.30	0.05	0.10
1606	16000.0	1.60	0.09	0.08
1607	16000.0	1.50	0.07	0.08
1608	16400.0	2.40	0.08	0.08
1609	16400.0	2.30	0.09	0.08
1610	16800.0	2.30	0.06	0.08

Figure 16

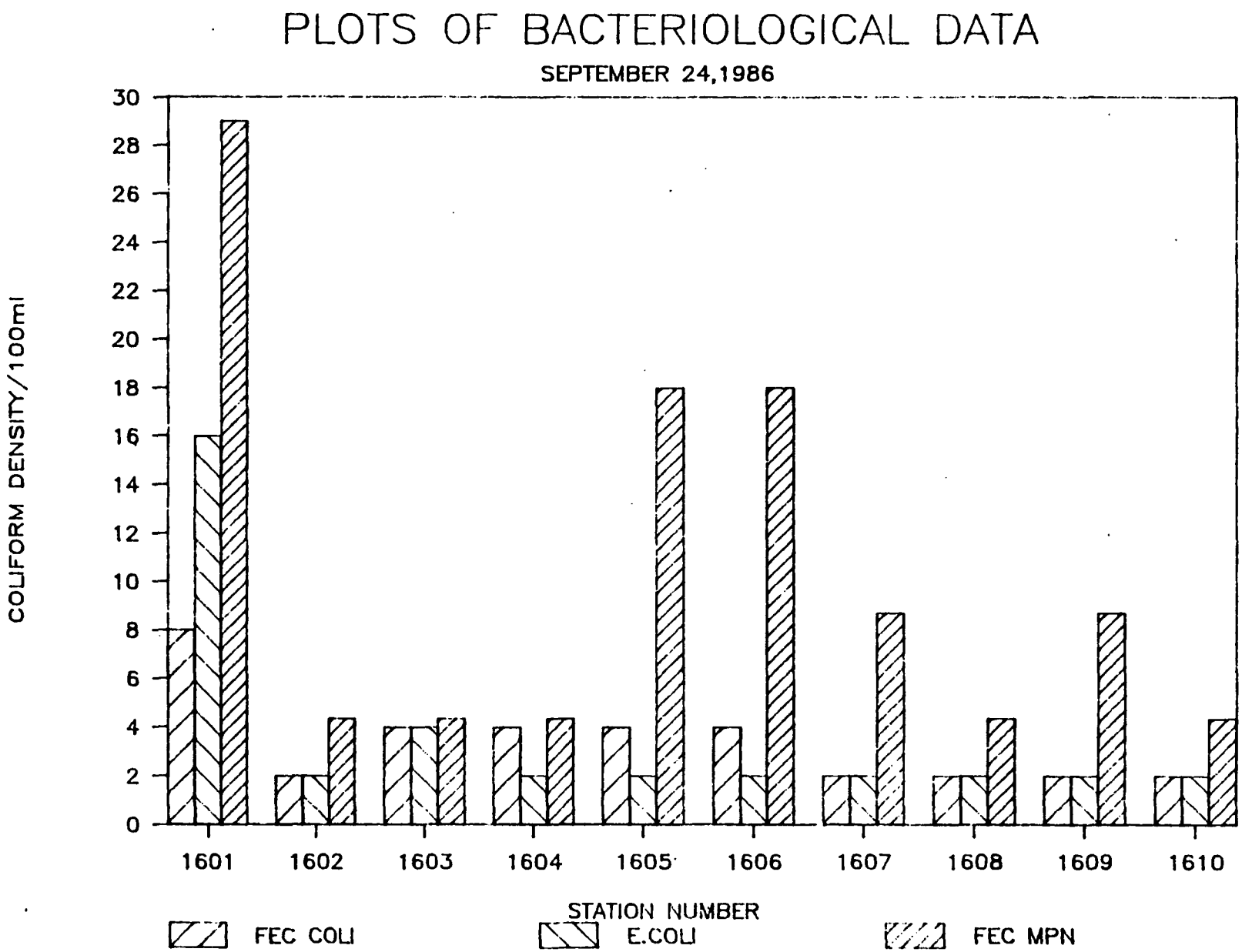

PLOTS OF BACTERIOLOGICAL DATA
SEPTEMBER 24,1986
COLIFORM DENSITY/100ml
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
1601
1602
1603
1604
1605
1606
1607
1608
1609
1610
STATION NUMBER
FEC COLI
E.COLI
FEC MPN

Figure 16 (Continued)

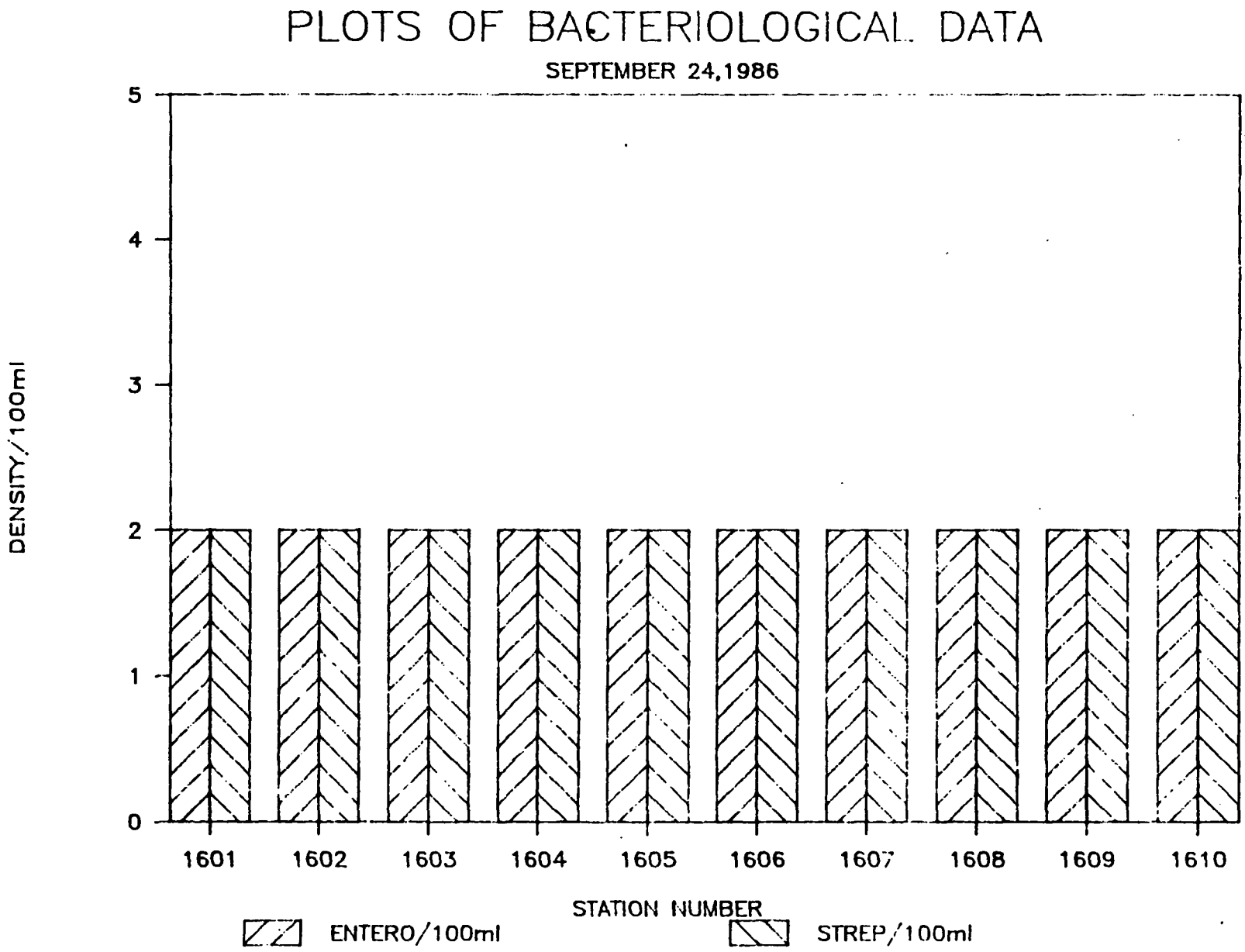


TABLE 88

WESTPORT RIVER SITES, WESTPORT

SAMPLED ON OCTOBER 2, 1986

STATION NUMBER	DESCRIPTION	LATITUDE	LONGITUDE
1701	Unnamed tributary at Drift Road just north of Snell Corner	41°35'10"	71°05'00"
1702	Opposite dead end road off of Drift Road just north of Snell Corner at unnamed tributary	41°35'15"	71°04'58"
1703	Head of Jessie's Neck Cove, sampled from dirt road	41°35'10"	71°04'35"
1704	Approximately 300 feet upstream of 1703, sampled from bridge	41°35'10"	71°04'36"
1705	Entrance to Jessie's Neck Cove	41°34'45"	71°04'35"
1706	Jessie's Neck Cove just south of 1703	41°35'02"	71°04'35"
1707	Confluence Snell Creek with mainstem Westport River at Jessie's Neck Cove	41°34'40"	71°04'33"
1708	Eastern shore of Westport River opposite Peleg's Point	41°35'30"	71°04'00"
1709	Cove just south of 1708	41°35'29"	71°04'00"
1710	Unnamed tributary to Snell Creek just above its confluence with Snell Creek, same tributary as 1702	41°35'30"	71°04'40"
1711	Snell Creek just above confluence with unnamed tributary sampled in 1710	41°35'14"	71°04'40"
1712	Drift Road at Snell Creek	41°35'20"	71°04'45"

TABLE 89

WESTPORT RIVER SITES, WESTPORT

TEMPERATURE (°C), DISSOLVED OXYGEN (mg/l), PERCENT SATURATION (%)

OCTOBER 2, 1986

STATION NUMBER	TEMPERATURE	DISSOLVED OXYGEN*	PERCENT SATURATION
1701	16.0	--	--
1702	16.6	--	--
1703	17.4	--	--
1704	16.4	--	--
1705	--	--	--
1706	19.3	--	--
1707	20.1	--	--
1708	--	--	--
1709	21.0	--	--
1710	--	--	--
1711	16.4	--	--
1712	16.4	--	--

* Dissolved oxygen samples not obtained

TABLE 90

BUZZARDS BAY
NON-POINT SOURCE BACTERIOLOGICAL DATA

Station Number	Fecal Coliform Bacteria /100ml	Entero-cocci Bacteria /100ml	*Escherichia coli* /100ml	Strepto-cocci Bacteria /100ml	*Clostridium perfringens* /100ml	Fecal Coliform Bacteria MPN/100ml
**Date Collected: 10/02/86						
1701	12000	4000	12000	5000	---	8800.0
1701	---	1400	---	---	---	---
1702	24000	10000	36000	7000	---	17900.0
1702	---	100	---	---	---	---
1703	20000	4400	5000	3500	---	>24800.0
1703	---	1800	---	---	---	---
1704	18000	8000	40000	9000	---	>24800.0
1704	---	600	---	---	---	---
1705	1600	600	700	600	---	1390.0
1705	4000	400	3500	1000	---	---
1706	14000	1200	13000	1100	---	17900.0
1706	---	100	---	---	---	---
1707	4300	300	4500	500	---	4100.0
1707	3500	<100	3800	<100	---	---
1708	20000	400	16000	3000	---	8800.0
1708	---	<100	---	---	---	---
1709	600	<100	1500	800	---	1390.0
1709	500	<100	1300	100	---	---
1710	11000	100	13000	2000	---	13900.0
1710	---	6000	---	7500	---	---
1711	19000	9000	25000	6000	---	17900.0
1712	25000	1200	20000	5000	---	13900.0

TABLE 91

BUZZARDS BAY
NON-POINT SOURCE PHYSICAL DATA

Station Number	pH (standard units)	Total Hardness (mg/l)	Suspended Solids (mg/l)	Specific Conductivity (µmhos/cm)
** Date Collected: 10/02/86				
1701	6.80	17	23.00	---
1702	6.10	16	13.00	---
1703	6.80	420	14.00	---
1704	7.00	27	9.00	---
1706	7.00	1560	1.00	---
1707	7.30	1710	6.00	---
1709	7.30	2460	4.00	---
1711	6.90	13	2.00	---
1712	6.70	20	3.50	---

TABLE 92

BUZZARDS BAY
NON-POINT SOURCE CHEMICAL DATA

Station Number	Chloride (mg/l)	Total Kjeldahl-Nitrogen (mg/l)	Ammonia-Nitrogen (mg/l)	Total Phosphorus (mg/l)
** Date Collected: 10/02/86				
1701	26.0	0.82	0.13	0.16
1702	10.0	0.98	0.27	0.25
1703	2150.0	2.50	0.43	0.32
1704	54.0	2.40	1.20	0.68
1706	8500.0	1.90	0.39	0.19
1707	11500.0	1.40	0.11	0.16
1709	11250.0	2.80	0.14	0.28
1711	34.0	1.50	0.10	0.12
1712	33.0	1.20	0.09	0.20

TABLE 93

SOURCE DIFFERENTIATION OF FECAL STREPTOCOCCI BACTERIA

FROM WESTPORT RIVER SITES

OCTOBER 2, 1986

STATION NUMBER	NUMBER OF COLONIES TESTED	NUMBER OF NON-FECAL STREPTOCOCCI	NUMBER OF GROUP Q STREPTOCOCCI	NUMBER FROM WARM-BLOODED ANIMALS	NUMBER FROM LIVESTOCK AND POULTRY	NUMBER FROM INSECTS	NUMBER FROM VEGETATION
1701	5	0	0	5	0	0	0
1702	5	0	1	4	0	0	0
1703	5	0	0	4	0	1	0
1704	5	0	0	5	0	0	0
1705	5	0	0	5	0	0	0
1706	5	1	0	4	0	0	0
1707	5	1	0	4	0	0	0
1708	5	0	0	5	0	0	0
1709	5	1	0	4	0	0	0
1710	5	1	0	4	0	0	0
1711	5	0	0	5	0	0	0
1712	5	0	0	5	0	0	0
Total	60	4	1	54	0	1	0
Percent		6.6	1.7	90	0	1.7	0

Figure 17

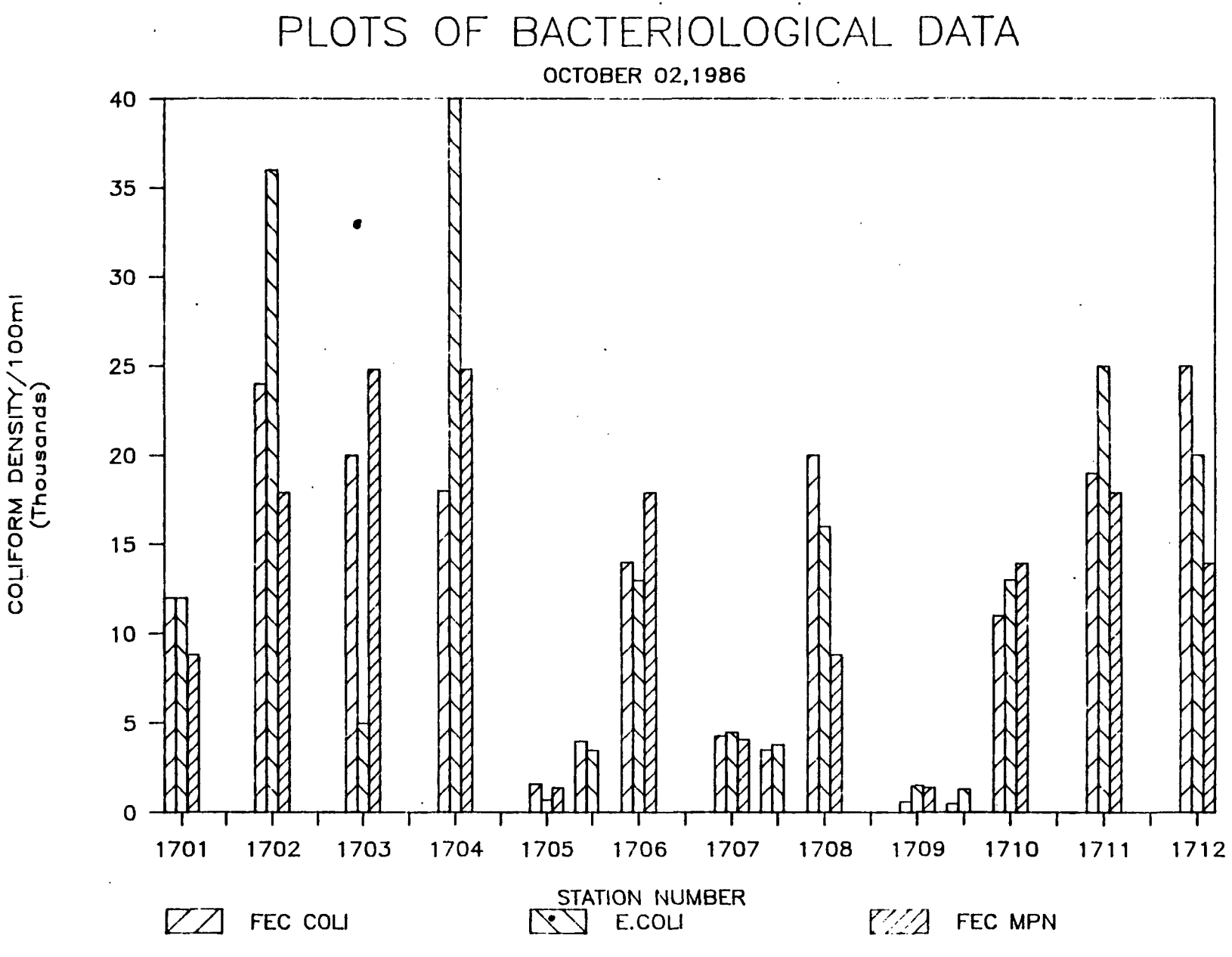

PLOTS OF BACTERIOLOGICAL DATA
OCTOBER 02,1986
COLIFORM DENSITY/100ml
(Thousands)
40
35
30
25
20
15
10
5
0
1701
1702
1703
1704
1705
1706
1707
1708
1709
1710
1711
1712
STATION NUMBER
FEC COLI
E.COLI
FEC MPN

Figure 17 (Continued)

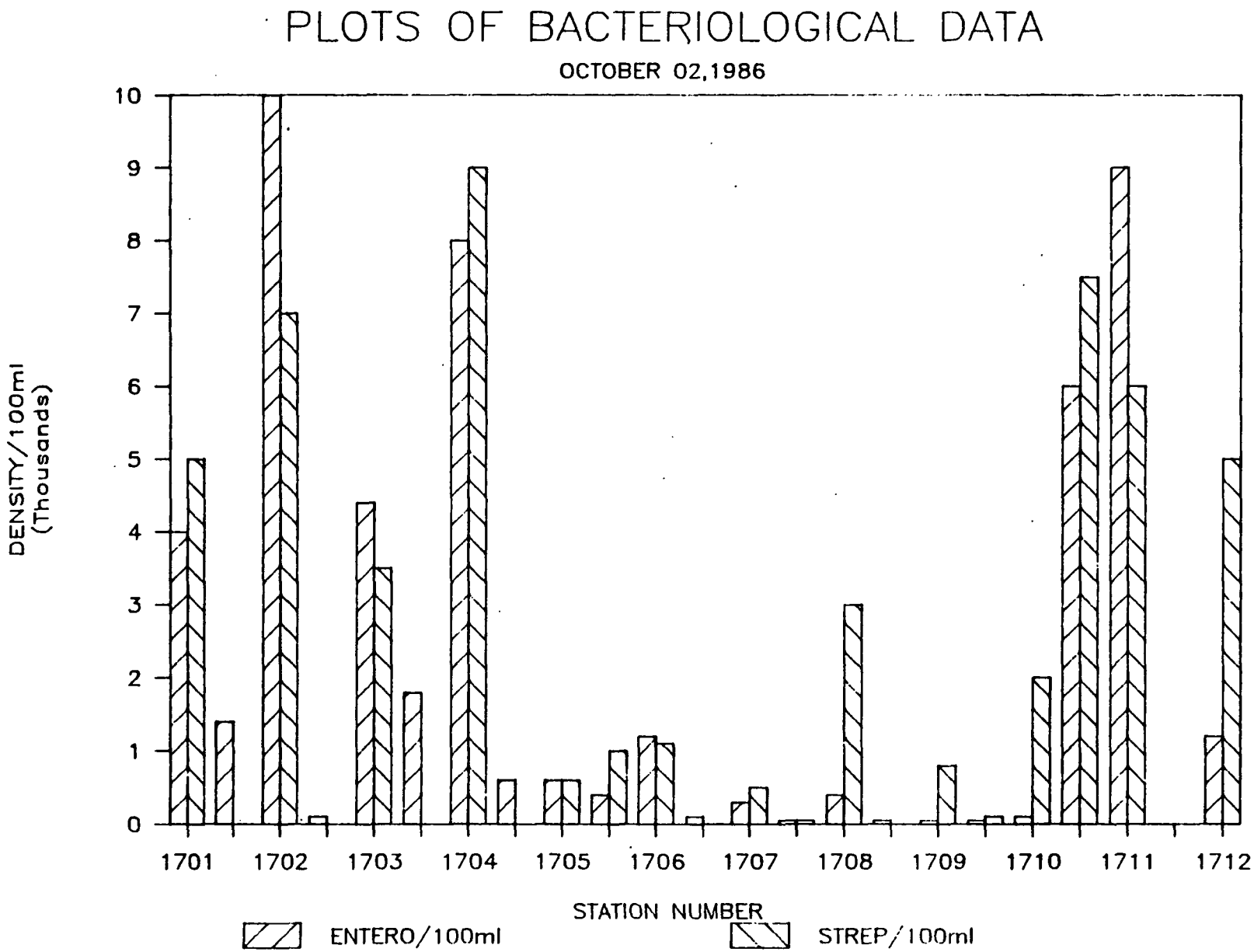


TABLE 94

BROAD COVE AND EAST RIVER SITES, WAREHAM

SAMPLED ON OCTOBER 8, 1986

STATION NUMBER	DESCRIPTION	LATITUDE	LONGITUDE
1801	Broad Cove just north of Dummy Bridge	41°44'53"	70°39'19"
1802	Broad Cove at outfall on northwestern shore along Riverside Drive	41°44'58"	70°39'13"
1803	Approximately 60' to right of 1802	41°45'02"	70°39'10"
1804	Head of Broad Cove	41°45'04"	70°39'07"
1805	Along southeastern shore of Broad Cove, in front of house near Pleasantview Road, approximately 20' from shore	41°44'58"	70°39'05"
1806	At second outfall in little cove near Sandlewood Lane, approximately 50' from shore	41°44'54"	70°39'05"
1807	At East River, near Sandlewood Lane, approximately 50' from shore	50' 41°44'41"	70°39'18"
1808	Center of cove at town boat ramp on western shore of Broad Cove	41°44'40"	70°39'20"

TABLE 95

BROAD COVE AND EAST RIVER SITES, WAREHAM

TEMPERATURE (°C), DISSOLVED OXYGEN (mg/l), PERCENT SATURATION (%)

OCTOBER 8, 1986

STATION NUMBER	TEMPERATURE	DISSOLVED OXYGEN	PERCENT SATURATION
1801	14.1	7.9	96
1802	13.3	8.1	91
1803	--	--	--
1804	--	--	--
1805	--	--	--
1806	13.8	8.1	93
1807	14.1	8.5	98
1808	14.4	7.4	85

TABLE 96

BUZZARDS BAY
NON-POINT SOURCE BACTERIOLOGICAL DATA

Station Number	Fecal Coliform Bacteria /100ml	Entero-cocci Bacteria /100ml	*Escherichia coli* /100ml	Strepto-cocci Bacteria /100ml	*Clostridium perfringens* /100ml	Fecal Coliform Bacteria MPN/100ml
**Date Collected: 10/08/86						
1801	<5	<5	5	<5	<5	8.70
1802	<5	<5	5	<5	<5	18.0
1803	<5	<5	<5	<5	<5	87.0
1804	<5	5	5	<5	<5	54.0
1805	10	5	<5	<5	5	<8.70
1806	10	10	20	<5	<5	8.70
1807	5	<5	5	5	<5	18.0
1808	10	5	<5	<5	<5	8.70

TABLE 97

BUZZARDS BAY
NON-POINT SOURCE PHYSICAL DATA

Station Number	pH (standard units)	Total Hardness (mg/l)	Suspended Solids (mg/l)	Specific Conductivity (µmhos/cm)
** Date Collected: 10/08/86				
1801	8.00	2710	0.50	---
1802	8.00	4490	20.0	---
1806	7.90	2860	0.50	---
1807	8.00	3250	37.0	---
1808	8.00	5670	11.0	---

TABLE 98

BUZZARDS BAY
NON-POINT SOURCE CHEMICAL DATA

Station Number	Chloride (mg/l)	Total Kjeldahl-Nitrogen (mg/l)	Ammonia-Nitrogen (mg/l)	Total Phosphorus (mg/l)
** Date Collected: 10/08/86				
1801	17820.0	1.40	0.06	0.08
1802	16880.0	0.90	<0.02	0.05
1806	16880.0	2.00	0.02	0.05
1807	17190.0	1.60	0.05	0.08
1808	17190.0	1.90	0.11	0.06

Figure 18

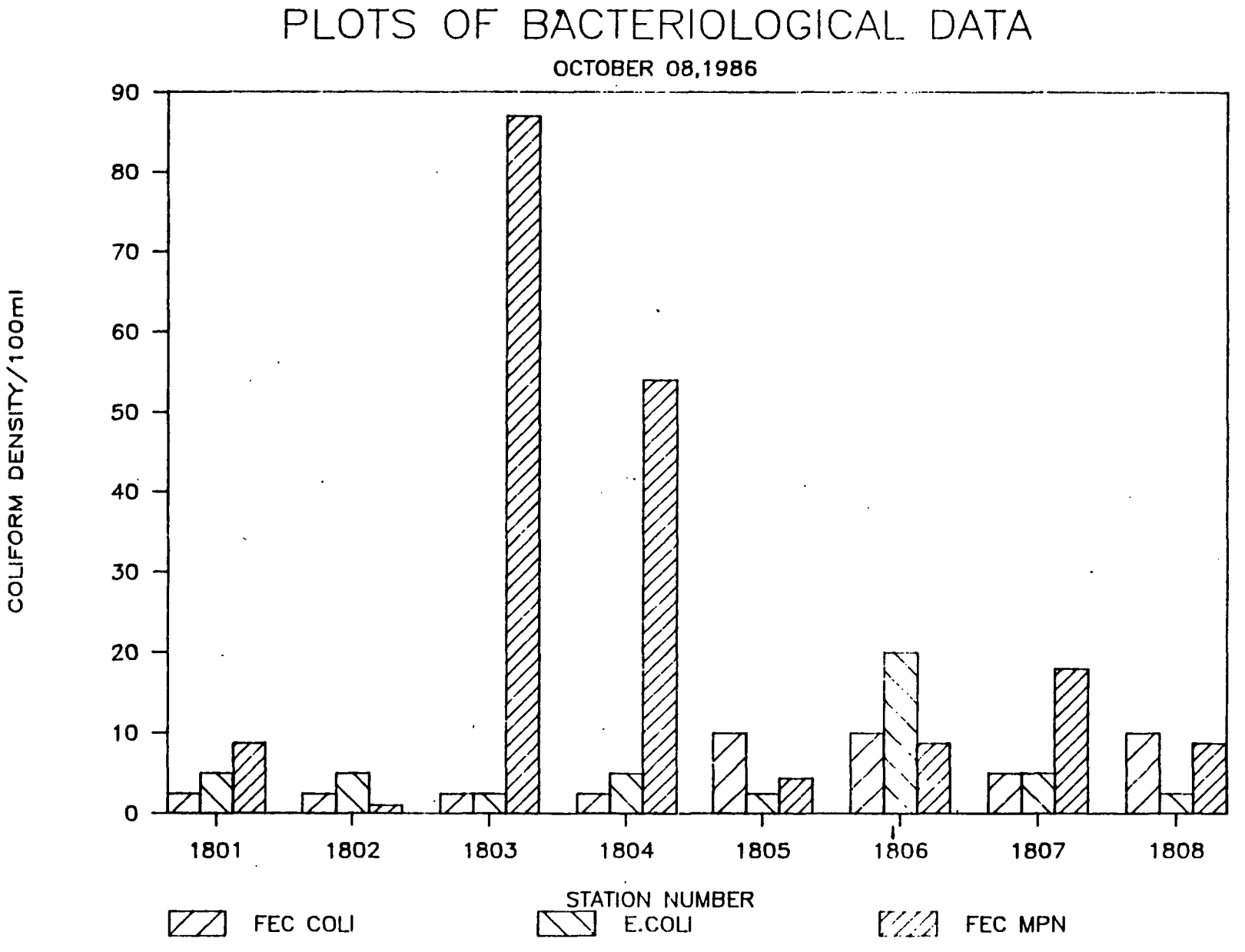
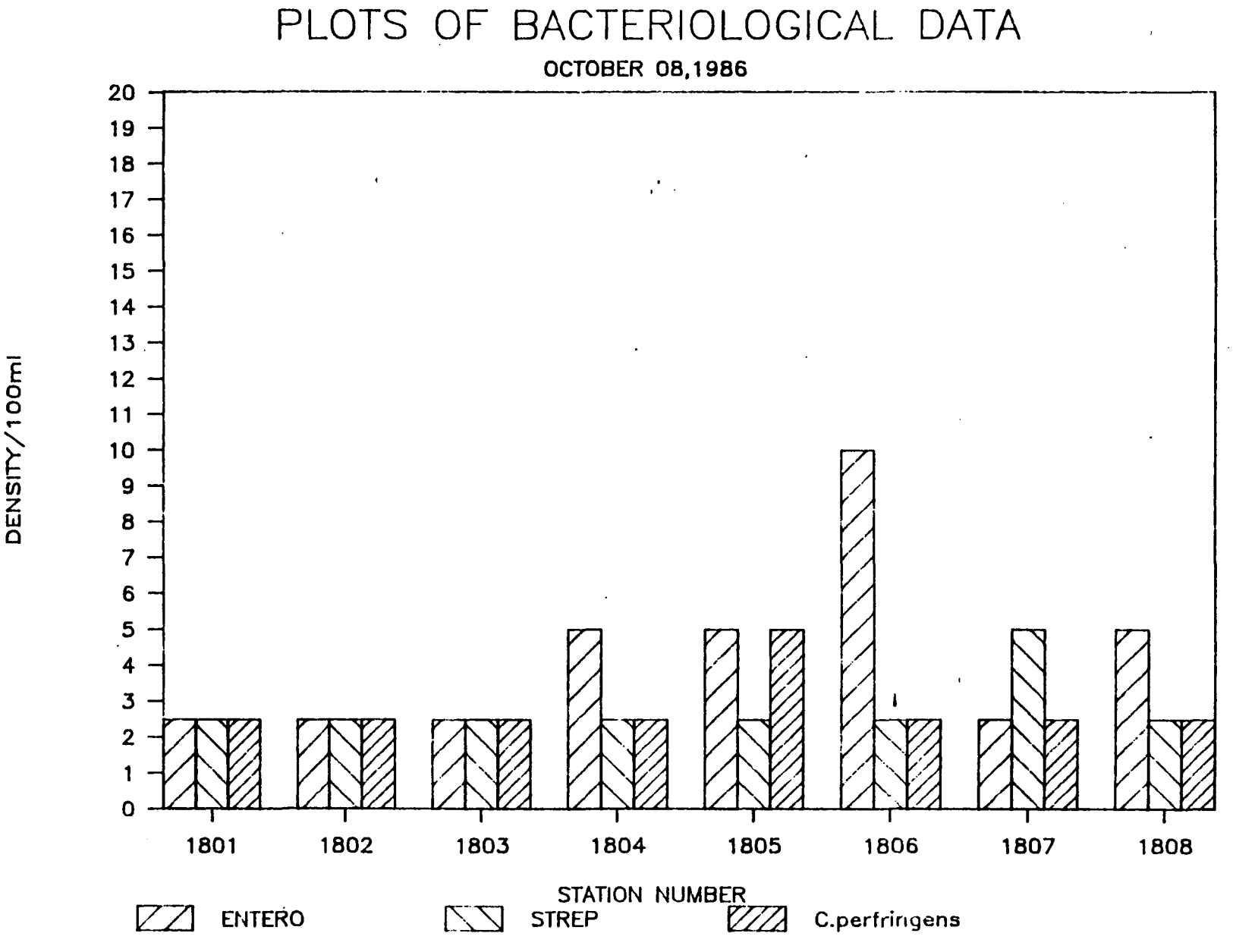

PLOTS OF BACTERIOLOGICAL DATA
OCTOBER 08,1986
COLIFORM DENSITY/100ml
90
80
70
60
50
40
30
20
10
0
1801
1802
1803
1804
1805
1806
1807
1808
STATION NUMBER
FEC COLI
E.COLI
FEC MPN

Figure 18 (Continued)



LITERATURE CITED

American Public Health Assoc. 1985. Standard Methods for the Examination of Water and Wastewater. 16th Edition. American Public Health Assoc., New York. p. 1268.

Bisson, J.W. and V.J. Cabelli. 1979. "Membrane Filter Enumeration Method for Clostridium perfringens." Applied and Environmental Microbiology. 37:55-66.

Cabelli, V. 1983. Health Effects Criteria for Marine Recreational Waters. U.S. Environmental Protection Agency. Health Effects Research Laboratory. Rhode Island. p. 98.

Dufour, A.P. 1980. Abstracts of the Annual Meeting, American Society for Microbiology. Abstract #Q69.

Dufour, A.P., E.R. Strictland and V.J. Cabelli. 1981. "Membrane Filter Method for Enumerating Escherichia coli." Applied and Environmental Microbiology. 41: 1152-1158.

Levin, M.A., J.R. Fischer and V.J. Cabelli. 1975. "Membrane Filter Technique for Enumeration of Enterococci in Marine Waters." Appl. Microbiology. 30: 66-71.

National Oceanic and Atmospheric Administration. 1986. Record of River and Climatological Observations for New Bedford and Acushnet, Mass. (Unpublished memo).

Redman, James H. 1974. "A Simpler Multiple Fermentation Tube Test for Monitoring the Bacteriological Quality of Shellfish Harvest Waters. The Examination of Twelve 1.0 ml Sample Portions." In: Proceedings of the 8th National Shellfish Sanitation Workshop. Edit. D. Wilt. U.S. Public Health Service, New Orleans. pp 123-131.

U.S. Army Corps of Engineers. 1986. Cape Cod Canal Tide Tables.

U.S. Environmental Protection Agency. 1986. Ambient Water Quality Criteria for Bacteria - 1986. Office of Water Regulations and Standards. Washington, D.C. p. 18.

U.S. Environmental Protection AGency. 1978. Microbiological Methods for Monitoring the Environment Water and Wastes. Cincinnati, Ohio. p. 135-153.

Westport River Watershed Committee. 1983. Rural Clean Water Program Westport River Watershed Project. p. 108.