



National Park Service, Fire Island National Seashore

and

Dowling College, Department of Earth and Marine Sciences

**Summer Water Quality Monitoring Program
2011**

FINAL REPORT

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TABLE OF CONTENTS

1. Summary	3
2. Introduction.....	3
2.1 Background.....	3
2.2 Study Area History.....	4
3. Objectives.....	6
4. Sampling Frequency.....	7
5. Data Management	7
6. Methods	7
7. Results	9
8. Discussion and Conclusion	10
9. References Cited	12
10. Acronyms Used	13
11. Index of Appendices	13

1. Summary:

Fire Island National Seashore (FINS) has identified 13 locations in Great South Bay to monitor for total and fecal coliform, chlorophyll-a, conductivity, dissolved oxygen (DO), nitrates, pH, phosphates, salinity, clarity, and temperature. These parameters are critical in determining long-term water quality conditions park-wide, with emphasis on summer season conditions

Methodology for monitoring parameters are provided by National Park Service (NPS) Director's Order #83 (NPS 1999), and the *Standard Methods for the Examination of Water and Wastewater*.

Criteria for determining water quality conditions in marine eco-systems are based on the type of contact (uses) people have with the water system. The United States Environmental Protection Agency (EPA) guidelines for primary contact (bathing) uses are employed by the National Park Service as criteria to monitor water quality. Public health risk and environmental health issues are both addressed in NPS Director's Order #83, which is currently implemented for water quality programs (i.e. recreation, boating, etc.)

2. Introduction:

2.1 Background:

Samples retrieved from locations identified by FINS are to be analyzed on a weekly basis for the following parameters: water temperature, pH, salinity, top and bottom water dissolved oxygen (DO), clarity, and chlorophyll-a, and total coliform counts (TCC), and fecal coliform counts (FCC).

Coliform analysis at all sites was performed using the standard membrane filter technique: Millipore Filtration System, as described in *Standard Methods for the Examination of Water and Wastewater*, 20th ed., 1998. Coliform bacteria are a group of specific micro-organisms whose concentration densities can be related quantitatively to contact recreation related health

hazards. Health concerns are related to possible exposure to infectious enteric diseases, such as cholera, typhoid fever and hepatitis, whose etiologic agents are excreted in feces and spread by water with fecal wastes (Cabelli et al., 1979 and 1983). Acceptable normal TCC of less than 2,400 colonies/100mL and FCC of less than 200 colonies/100mL are both used by the NPS and the EPA as maximum levels for primary contact recreational water quality (USEPA, 1994, 1998, a,b, 1997, 1995).

All data presented in this document will be available on the Internet for public access via <http://www.nature.nps.gov/im/gis/ftp/ftparchive.cfm> and the FINS Annual Water Quality Monitoring program. A GPS (Global Positioning System) receiver was used in 2009 to provide locations (site coordinates). The coordinates were entered into FINS GIS (Geographical Information System) database developed at Dowling College. All Water Quality data collected at FINS from the previous years have been incorporated into the GIS database to be developed by Dowling College (META DATA). [See Appendix A, Long Island South Shore Estuary Map with Sampling Stations.]

2.2 Study Area History:

Director's Order #83, enacted in 1999, states that the NPS (at FINS) is, "To ensure these facilities and services are operated in a safe and healthful manner, and according to existing public health laws and regulations, the NPS Public Health Program conducts health risk and environmental compliance assessments." Water Quality data is collected at FINS for the following purposes:

- (1) to monitor bacterial levels at public facilities under FINS jurisdiction for compliance with county, state, and federal, public health standards for primary contact recreation;
- (2) to monitor bacterial levels and other traditional water quality monitoring parameters at various sites within the Park and to determine trends in water quality; and

(3) to provide these data for the evaluation and review of FINS Resources Management Plan regarding fish and wildlife management, as well as for visitor public health and safety.

FINS initiated the long-term monitoring of several preliminarily identified sampling stations within the Great South Bay, Long Island, New York. These sites are to be monitored for physical and biological parameters utilized for assessment of water quality conditions in its estuarine waters. Water Quality parameters are monitored on a weekly basis from a period commencing approximately Memorial Day to Labor Day, annually. Methodology for monitoring parameters are provided by NPS Director's Order #83 (NPS, 1999) and the EPA and U.S. Public Health Administration (USPHA) approved Standard Methods for Examination of Water and Wastewater (20th Edition, 1998; American Public Health Water Environment Federation).

The EPA establishes criteria to determine conditions appropriate for “contact recreational” uses and consumptive uses of the estuary. These monitoring protocols are also critical in determining trends in ecosystem overall health. Sample locations were established in conjunction with FINS Natural Resources staff, for the purpose of obtaining information on the water quality conditions within the boundaries of FINS. Specific sample locations associated with “public health” concerns within park boundaries are those sites that are designated as boat recreation locations (i.e. docking, pump out facilities, etc.) or potential residential discharge locations (i.e. visitor centers and concession operations). All sites are “general monitoring” sites.

The quality of estuarine waters of Great South Bay over the last 25 years has been impacted by surface run-off from the land, wastewater discharges and atmospheric deposition from precipitation events. Water quality values in estuarine waters can fluctuate considerably due to tidal mixing, vertical water column mixing due to currents, winds and depth of water, bioturbation of bottom sediments, precipitation events, biological oxygen demand (BOD) loading, photosynthesis

intensity (bloom conditions) and seasonal water temperatures. For example, it has been demonstrated that total and FCC in coastal waters are consistently higher following precipitation events requiring the closure of shellfish harvesting areas as well as contact recreational beaches on Long Island (Cardenas, R. et.al, 1983).

3. Objectives:

Water Quality programs, even the most extensive, cannot detect all possible changes, or for that matter be an early warning system to unforeseen episodic emergencies such as oil spills. However, properly planned and extensive water quality programs can establish baseline/reference data points from which changes, whether anomalous or condition-based, such as seasonal perturbations, can be compared over time. In this capacity, Water Quality monitoring is a means by which the conditions of the resource can be maintained or improved. The NPS established Inventory and Monitoring (I&M) protocols to do just that; establishment of a means for understanding the conditions of aquatic resources so that critical questions about long-term trends of degradation, or, about the effectiveness of existing pollution abatement and resource management programs, can be addressed.

The Cooperative Agreement between NPS-FINS and Dowling College, Department of Earth and Marine Sciences (DEMS) has initiated this long-term process by designing its Water Quality activities around the basic academic services that, if conducted by professional analytical laboratories or contractors, would be prohibitively expensive.

4. Sampling Frequency:

All 13 sample sites within FINS are sampled approximately once per week. The actual day of that week is subject to weather and sea conditions, but remain centered around mid-day for relative consistency within the photosynthetic oxygen evolution daily cycle. The peak summer

visitation “season” is the main time period for this program (Between Memorial Day and Labor Day).

5. Data Management:

2011 Water Quality data will be made available for uploading to the USEPA – STORET system; a National water quality database upon approval by the FINS staff.

**FINS WQ-11
Summer 2011**

Water Quality Schedule

JUNE	JULY	AUGUST
Wed., Jun. 1	Mon., Jul. 4	Tues., Aug. 9
Mon., Jun. 6	Mon., Jul. 11	Fri., Aug. 19
Mon., Jun. 13	Tues., Jul. 19	Mon., Aug. 22
Mon., Jun. 20	Mon., Jul. 25	Wed., Aug. 31
Mon., Jun. 27		

6. Methods:

The quality of estuarine waters of Great South Bay, as well as the Atlantic Ocean waters surrounding FINS is determined largely by pollutant inputs such as treated and untreated sewage from recreational boats, residential buildings, industrial effluents, sewage sludge, other toxic waste leachates, and runoff from landfills. Concentrations of pollutants are controlled by chemical, physical, and biological processes in the marine environment (Dyer, 1973). Depending on a variety of environmental factors, water quality will fluctuate at any given time (Fleischer, J. and McFadden, R., 1979). These factors may include: tidal mixing, vertical mixing in the water column (by sun, wind and wave), bioturbation of bottom sediments, precipitation events (intensity and duration), BOD, photosynthesis by phytoplankton, and water temperature.

Precipitation is a known cause of intermittent corruption of water quality. Shock loads of pollutants from storm waters enter area waters via storm drains. TCC and FCC have been consistently higher following rainfall in local waters (Lettau, B., et.al, 1979).

Tidal currents and tidal flushing account for much of the transport and dilution in estuaries (Dyer, 1973). Sampling of all locations within FINS is performed irrespective of the tidal state.

Water Quality Parameters Measured

Total Coliform Counts (TCC)
Fecal Coliform Counts (FCC)
Chlorophyll-a
Depths
Dissolved Oxygen (DO)
pH
Salinity
Clarity
Water Temperature

Water Quality Parameter Methodologies

Total and Fecal Coliform Counts methodology

A100ml sample is passed through a 47mm 0.45µm filter under a vacuum. The resulting filter is placed in a Petri dish that has had a 2mL ampoule of m-ColiBlue is dispensed onto the absorbent pad. The filter is then transferred to the Petri dish, covered and then cultured at 35 ± 0.5 °C for 24 hours.

Chlorophyll-a methodology

A100ml sample is passed through a 47mm glass fiber TCLP filter under a vacuum to collect the pigment. The resulting filter is placed in a Teflon/Glass tissue grinder along with 5 ml 90% aqueous acetone solution and then it is macerated at 500rpm for 1-2 minutes. The resulting material is then transferred to a screw cap centrifuge with the total volume adjusted to 15ml using the 90% aqueous acetone solution and then the sample is allowed to steep for at least 2 hours at 4°C. The resulting sample is then centrifuged for 30min at 500g. The extract is transferred to a 1-cm cuvette and the optical density is read at 750 and 664 nm from an Unico 1100 Spectrophotometer. The sample is then acidified with 0.1 mL 0.1N HCl and the optical density is read again at 750 and 665 nm. The concentration of chlorophyll a µg/L is calculated.

Salinity methodology

YSI Model 30 - Salinity Conductivity Temperature Sensor

Temperature methodology

YSI Model 30 - Salinity Conductivity Temperature Sensor

Clarity methodology

12 inch Secchi Disk

Dissolved Oxygen (DO) methodology

YSI model 58 Dissolved Oxygen Meter

pH methodology

Orion model 230a pH Meter with low maintenance pH probe

7. Results: Summary

Dowling College FINS Great South Bay WQ Averages 2011

Sample Site	Salinity	Temp		DO (top)	DO (bot)	Total Coliform Average	Fecal Coliform Average	Clarity
	(ppth)	(C°)	pH	(mg/L)		(Colonies/100mL)		
1	27.3	24.2	7.81	7.1	8.3	52	0	86
2	27.0	24.8	7.85	7.2	6.3	109	10	67
3	26.2	24.8	7.92	5.8	4.5	164	1	58
4	25.8	25.0	7.98	7.7	7.7	13	0	84
5	25.6	25.0	7.76	7.7	7.3	60	1	93
6	25.0	25.0	7.57	5.2	4.6	106	7	54
7	25.3	25.2	7.72	7.4	6.4	61	1	72
8	24.7	25.0	7.60	6.3	3.5	123	4	72
9	24.7	25.1	7.67	7.7	7.6	32	1	77
10	24.9	25.1	7.49	6.5	3.8	107	3	56
11	24.6	25.1	7.77	7.8	8.2	46	4	71
12	24.5	24.9	7.53	7.6	7.3	26	1	85
13	26.1	25.0	7.89	7.7	7.7	37	1	70

8. Discussion and Conclusion:

The 2010 Water Quality Sampling Program year incorporated a laboratory area established at Dowling College exclusively for FINS weekly water sample analysis (Bordner, R. and J. Winter, 1978). The general State-of-the-Bay regarding temperature, salinity, and pH are characteristic of the Northeast Atlantic estuarine waters off Long Island (Duedall, et. al., 1979, O'Conner, D.J. 1977). The present monitored parameters are within the range which translates into a "normal" condition for such waters. Excessive values, if detected, could be indicative of waste discharges from point sources (i.e. boat basins, pump out stations, etc.)

The top/bottom dissolved oxygen values (DO) were robust and indicative of good oxygen saturation in top and bottom waters. Such values would contribute to fostering healthy estuarine biota (Pokryfki, T.D. and R.E. Randall, 1987).

The 2011 water quality-sampling year reflects a fully QA/QC, comprehensive sampling program. Bacteriological and chlorophyll-a values were tabulated and results tabulated. Dowling student(s) were trained and oriented as to boat operations and sampling procedures. Sampling DATA-SHEETS were prepared and are included as "raw data."

9. References:

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- . 1997. Method 1600: Membrane Filter Test Method for Enterococci In Water. Office of Water. <http://www.epa.gov/OST/beaches/entero.html> EPA # 821-R-97-004.
- . 1995 Update. Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water: EPA # 820/B-96-001.

10. Acronyms Used in 2009 Report:

ATL = Atlantic

BOD = Biological Oxygen Demand

Chl-a = chlorophyll-a

CFU = colony forming units, (number of colonies (coln) that are counted on a bacteriologic growth plate.)

CONF = Confluent (unable to distinguish total counts of prescribed bacteria)

CSO = Combined Sewer Outflows

DO = Dissolved Oxygen

FCC = Fecal Coliform Counts

NYS = New York State

NTU's = Nephelometric Turbidity Units

TCC = Total Coliform Counts

TNTC = Too-Numerous-To-Count

11. Appendices:

A – Long Island South Shore Estuary map with Sampling Stations

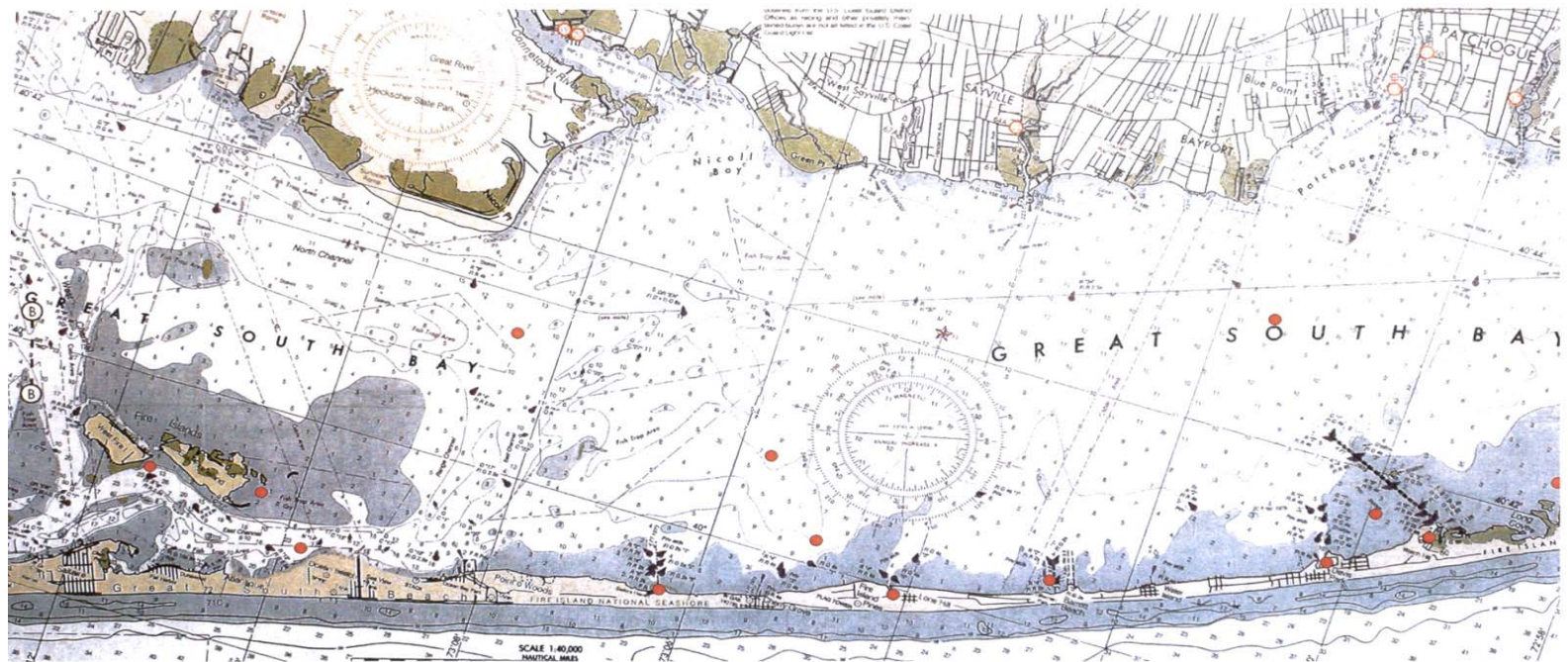
B – Data Summary

C – Average Value Charts

D – Tables of Averages and Ranges

Appendix A

Long Island South Shore Estuary Map with Sampling Stations



Appendix B

Data summary

Site 1	Clarity	Salinity	T-bot	T-top	pH	DO-bot	DO-top	FC	TC
	(in)	(ppt)	(°C)	(°C)		(mg/L)	(mg/L)	col/100ml	col/100ml
1-Jun	60	25.9	23.7	23.7	7.8	24	8.0	0	26
6-Jun	180	26.4	19.4	19.9	7.08	8.9	9.1	0	40
13-Jun	120	23.2	21.0	21.3	7.40	8.5	8.8	0	55
20-Jun	175	27.2	23.3	23.4	7.80	6.7	6.8	0	150
27-Jun	79	26.5	25.7	25.7	7.15	7.2	7.1	0	93
4-Jul	123	28.5	23.5	24.1	7.93	6.3	6.1	0	21
11-Jul	42	27.1	27.0	27.1	8.16	7.4	7.3	0	50
19-Jul	48	28.6	25.2	25.3	8.60	5.9	6.3	0	35
25-Jul	50	29.2	25.9	25.9		6.4	6.7	0	45
9-Aug	43	29.1	27.0	27.0	8.06	6.0	6.1	1	71
19-Aug	90	28.3	24.6	24.6	8.06	6.9	6.7	0	16
22-Aug	60	27.9	23.8	23.8	8.10	6.67	6.58	0	4
31-Aug	51	27.2	22.5	22.5	7.58	7.37	7.13	0	75

Site 2	Clarity	Salinity	T-bot	T-top	pH	DO-bot	DO-top	FC	TC
	(in)	(ppt)	(°C)	(°C)		(mg/L)	(mg/L)	col/100ml	col/100ml
1-Jun	48	25.9	23.9	24.2	7.85	7.8	8.1	0	30
6-Jun	142	25.5	21.9	22.1	6.97	8.7	9.1	2	11
13-Jun	90	22.8	21.4	21.5	6.98	8.6	8.1	6	54
20-Jun	86	26.8	24.0	24.0	7.64	7.1	7.1	0	300
27-Jun	94	26.5	26.0	26.0	8.02	6.5	7.5	30	98
4-Jul	72	27.4	25.6	25.8	8.08	7.2	7.3	0	80
11-Jul	43	27.1	27.3	27.4	8.14	6.9	7.4	14	77
19-Jul	45	28.1	25.3	25.8	8.23	6.5	6.1	11	54
25-Jul	51	29.3	26.4	26.4		6.5	6.6	3	54
9-Aug	41	28.8	26.8	27.0	8.20	1.4	6.1	40	169
19-Aug	63	27.3	24.7	24.9	8.01	4.8	6.3	13	282
22-Aug	45	27.8	24.3	24.4	8.02	5.85	6.40	10	120
31-Aug	55	27.5	22.4	22.4	8.02	4.84	7.58	2	85

Site 3	Clarity	Salinity	T-bot	T-top	pH	DO-bot	DO-top	FC	TC
	(in)	(ppt)	(°C)	(°C)		(mg/L)	(mg/L)	col/100ml	col/100ml
1-Jun	36	25.5	24.6	24.8	7.80	4.9	5.5	1	51
6-Jun	68	25.4	22.1	22.3	7.31	7.9	8.1	1	26
13-Jun	99	22.2	20.7	21.3	7.07	7.8	7.9	1	64
20-Jun	89	25.5	24.2	24.3	7.68	6.5	6.5	0	555
27-Jun	53	25.3	26.3	26.3	7.97	5.0	6.1	0	50
4-Jul	58	27.0	26.2	26.3	9.77	7.2	6.2	0	145
11-Jul	44	25.2	26.9	27.5	8.06	4.3	5.8	0	89
19-Jul	46	27.1	25.4	25.7	8.21	5.0	5.3	0	58
25-Jul	41	26.9	26.0	26.0		2.3	4.7	0	11
9-Aug	44	27.9	26.5	27.3	7.88	7.8	4.5	2	452
19-Aug	62	26.5	24.6	25.0	7.62	0.0	3.4	10	230
22-Aug	46	28.3	23.6	24.0	7.93	0.08	5.48	1	164
31-Aug	67	27.8	21.1	22.2	7.77	0.10	6.50	3	243

Site 4	Clarity	Salinity	T-bot	T-top	pH	DO-bot	DO-top	FC	TC
	<i>(in)</i>	<i>(ppt)</i>	<i>(°C)</i>	<i>(°C)</i>		<i>(mg/L)</i>	<i>(mg/L)</i>	<i>col/100ml</i>	<i>col/100ml</i>
1-Jun	60	25.1	24.2	24.2	8.01	8.8	8.5	0	3
6-Jun	110	25.1	22.4	22.5	6.47	10.5	9.7	0	4
13-Jun	146	22.6	21.3	21.8	6.97	8.9	8.7	0	0
20-Jun	81	25.7	24.2	24.2	7.87	8.1	8.0	0	30
27-Jun	54	25.1	25.9	26.0	8.10	8.1	7.9	0	2
4-Jul	66	26.6	26.2	26.3	10.17	7.8	7.5	0	12
11-Jul	36	25.3	27.6	27.6	8.16	7.5	7.4	0	29
19-Jul	44	26.2	25.5	26.0	8.24	6.5	7.2	0	10
25-Jul	54	26.9	26.8	26.8		5.7	6.5	0	2
9-Aug	89	27.3	27.3	27.3	7.98	7.3	7.1	3	27
19-Aug	153	26.8	24.5	24.5	7.91	6.8	7.1	0	2
22-Aug	86	27.0	24.6	24.7	7.97	7.39	7.32	0	6
31-Aug	115	26.2	22.7	22.7	7.93	6.83	6.80	0	45

Site 5	Clarity	Salinity	T-bot	T-top	pH	DO-bot	DO-top	FC	TC
	<i>(in)</i>	<i>(ppt)</i>	<i>(°C)</i>	<i>(°C)</i>		<i>(mg/L)</i>	<i>(mg/L)</i>	<i>col/100ml</i>	<i>col/100ml</i>
1-Jun	96	25.1	24.1	24.2	7.93	8.8	8.3	0	4
6-Jun	94	25.0	22.2	22.3	6.69	10.3	9.7	0	9
13-Jun	92	22.4	21.0	21.6	6.98	9.6	9.1	0	3
20-Jun	82	25.3	24.0	24.0	7.52	7.4	7.2	0	500
27-Jun	67	25.0	25.8	26.7	7.45	7.1	8.0	0	60
4-Jul	74	26.0	25.6	25.8	8.09	6.9	7.2	0	20
11-Jul	58	25.1	27.0	27.6	8.13	4.9	7.4	0	35
19-Jul	47	25.9	25.0	26.4	8.24	6.3	7.4	0	3
25-Jul	54	26.4	26.7	26.7		5.5	6.8	0	12
9-Aug	89	27.3	27.5	27.5	8.12	7.8	7.9	10	80
19-Aug	178	26.4	24.5	24.5	8.08	7.3	7.8	0	23
22-Aug	123	27.3	24.1	24.5	7.96	6.50	7.20	1	16
31-Aug	157	26.2	22.5	22.7	7.87	6.20	6.82	0	11

Site 6	Clarity	Salinity	T-bot	T-top	pH	DO-bot	DO-top	FC	TC
	<i>(in)</i>	<i>(ppt)</i>	<i>(°C)</i>	<i>(°C)</i>		<i>(mg/L)</i>	<i>(mg/L)</i>	<i>col/100ml</i>	<i>col/100ml</i>
1-Jun	36	24.9	24.2	24.6	7.72	6.3	5.4	5	70
6-Jun	64	24.5	21.9	22.0	6.65	7.3	6.4	0	35
13-Jun	60	20.9	20.7	21.5	6.81	6.8	6.9	0	0
20-Jun	60	24.7	24.3	24.3	6.94	5.5	5.8	2	132
27-Jun	58	24.4	26.2	26.5	7.86	4.8	5.2	0	33
4-Jul	71	25.3	25.8	25.9	7.89	3.8	4.7	47	127
11-Jul	41	24.3	26.9	27.7	7.96	2.2	5.3	3	213
19-Jul	35	25.7	25.5	25.7	8.10	4.0	4.5	3	72
25-Jul	38	26.2	26.7	26.7		3.7	3.9	0	120
9-Aug	54	26.6	27.3	27.6	7.85	4.3	4.9	5	145
19-Aug	81	25.3	24.8	24.9	7.74	2.3	4.7	20	220
22-Aug	56	26.8	24.5	24.6	7.63	4.70	5.00	0	34
31-Aug	50	26.0	22.3	22.5	7.64	4.80	5.19	0	182

Site 7	Clarity	Salinity	T-bot	T-top	pH	DO-bot	DO-top	FC	TC
	<i>(in)</i>	<i>(ppt)</i>	<i>(°C)</i>	<i>(°C)</i>		<i>(mg/L)</i>	<i>(mg/L)</i>	<i>col/100ml</i>	<i>col/100ml</i>
1-Jun	36	25.3	24.8	24.8	7.90	5.6	8.0	0	45
6-Jun	114	25.0	22.7	23.4	6.10	8.3	9.1	1	51
13-Jun	96	21.2	21.3	21.4	6.41	8.3	9.2	0	15
20-Jun	75	24.9	24.6	24.8	7.70	6.4	7.3	0	330
27-Jun	52	24.7	26.4	26.5	8.06	6.5	7.4	0	71
4-Jul	79	25.6	25.8	26.4	8.13	6.3	7.3	0	84
11-Jul	43	24.8	27.7	28.4	8.22	6.5	7.3	0	10
19-Jul	29	25.9	25.6	26.9	8.26	6.2	7.7	0	26
25-Jul	45	25.7	25.9	25.9		5.1	6.1	0	78
9-Aug	104	26.4	27.6	27.6	7.98	7.0	6.4	8	30
19-Aug	62	25.7	24.7	24.7	7.83	6.2	6.5	0	16
22-Aug	132	26.7	24.3	24.1	7.94	5.85	6.10	0	23
31-Aug	64	26.6	22.5	23.1	8.06	4.64	7.88	0	10

Site 8	Clarity	Salinity	T-bot	T-top	pH	DO-bot	DO-top	FC	TC
	<i>(in)</i>	<i>(ppt)</i>	<i>(°C)</i>	<i>(°C)</i>		<i>(mg/L)</i>	<i>(mg/L)</i>	<i>col/100ml</i>	<i>col/100ml</i>
1-Jun	38	25.0	23.7	24.3	7.84	1.6	7.0	8	38
6-Jun	84	25.2	21.5	22.1	6.07	7.8	8.4	2	62
13-Jun	109	20.3	20.8	21.4	6.60	4.8	8.4	3	79
20-Jun	89	24.5	24.1	24.0	7.61	5.8	6.4	1	281
27-Jun	72	24.6	25.5	26.3		6.5	6.7	0	25
4-Jul	78	25.1	25.1	25.7	7.98	5.3	5.4	21	301
11-Jul	50	24.8	26.7	27.5	8.10	0.1	5.9	4	254
19-Jul	44	25.5	25.5	27.1	8.12	0.2	6.1	0	11
25-Jul	43	25.9	25.7	25.7		0.2	5.2	0	32
9-Aug	61	26.2	27.4	27.5	7.83	4.0	4.8	5	120
19-Aug	84	24.0	23.8	24.9	7.74	1.5	4.9	5	275
22-Aug	92	24.7	23.7	24.6	7.84	0.09	5.81	2	11
31-Aug	93	25.7	23.1	23.5	7.90	7.96	7.30	1	113

Site 9	Clarity	Salinity	T-bot	T-top	pH	DO-bot	DO-top	FC	TC
	<i>(in)</i>	<i>(ppt)</i>	<i>(°C)</i>	<i>(°C)</i>		<i>(mg/L)</i>	<i>(mg/L)</i>	<i>col/100ml</i>	<i>col/100ml</i>
1-Jun	69	24.8	24.4	24.4	8.01	9.3	9.2	0	10
6-Jun	89	24.6	22.3	22.3	5.66	9.9	9.4	2	17
13-Jun	97	20.4	21.7	22.0	6.74	10.4	9.6	0	12
20-Jun	79	24.8	24.0	24.0	7.20	7.8	7.7	0	120
27-Jun	74	24.8	27.0	27.1	8.12	7.4	7.5	0	30
4-Jul	112	25.1	25.9	25.9	8.18	7.6	7.5	1	26
11-Jul	50	24.5	27.7	27.7	8.17	8.0	7.9	0	5
19-Jul	36	25.2=1	26.0	26.7	8.20	9.2	7.6	1	21
25-Jul	48	24.7	25.9	25.9		7.2	7.0	0	3
9-Aug	72	26.1	27.6	27.7	8.20	7.5	6.8	12	102
19-Aug	132	25.2	24.6	24.6	7.83	6.7	6.8	0	12
22-Aug	90	26.4	24.1	24.1	7.91	6.95	6.68	0	3
31-Aug	55	25.5	23.3	23.3	7.87	0.38	6.93	0	50

Site 10	Clarity	Salinity	T-bot	T-top	pH	DO-bot	DO-top	FC	TC
	<i>(in)</i>	<i>(ppt)</i>	<i>(°C)</i>	<i>(°C)</i>		<i>(mg/L)</i>	<i>(mg/L)</i>	<i>col/100ml</i>	<i>col/100ml</i>
1-Jun	33	25.3	23.7	25.1	7.70	1.0	6.9	1	41
6-Jun	60	24.7	21.9	22.2	6.04	5.6	8.4	0	45
13-Jun	58	21.8	21.7	21.6	6.79	4.1	8.2	2	83
20-Jun	49	24.4	23.4	24.0	7.34	5.5	6.6	0	210
27-Jun	59	24.4	25.8	26.6	6.97	3.8	5.9	6	16
4-Jul	54	25.1	25.7	26.0	7.80	4.5	5.2	0	250
11-Jul	47	24.8	27.2	28.0	7.87	2.5	5.5	0	115
19-Jul	50	25.9	25.3	26.6	8.10	3.8	6.1	0	38
25-Jul	44	25.7	25.8	25.8		4.6	5.9	0	93
9-Aug	44	26.1	27.2	27.9	7.90	4.1	5.9	10	155
19-Aug	82	24.5	24.7	24.7	7.76	1.3	5.5	9	101
22-Aug	74	25.7	24.0	24.5	7.86	0.20	5.52	1	33
31-Aug	69	25.3	22.6	22.9	7.70	8.61	9.05	4	214

Site 11	Clarity	Salinity	T-bot	T-top	pH	DO-bot	DO-top	FC	TC
	<i>(in)</i>	<i>(ppt)</i>	<i>(°C)</i>	<i>(°C)</i>		<i>(mg/L)</i>	<i>(mg/L)</i>	<i>col/100ml</i>	<i>col/100ml</i>
1-Jun	60	25.0	24.3	24.3	7.82	9.2	8.6	3	11
6-Jun	121	25.0	22.5	22.5	5.94	9.7	9.5	0	22
13-Jun	50	22.1	21.5	22.1	8.02	11.8	10.1	0	5
20-Jun	53	24.8	24.1	24.0	7.40	8.0	7.7	0	45
27-Jun	96	23.7	26.2	26.2	7.40	7.5	7.5	0	15
4-Jul	92	25.4	25.9	25.9	8.05	7.1	7.0	0	70
11-Jul	58	25.2	27.9	27.9	8.20	7.7	7.4	0	4
19-Jul	42	24.7	26.1	27.2	8.17	8.9	7.2	1	10
25-Jul	41	24.4	26.1	26.1		6.9	6.7	0	0
9-Aug	44	26.3	27.9	27.9	8.08	7.2	7.0	50	270
19-Aug	144	24.8	24.5	24.5	7.84	6.4	6.5	0	24
22-Aug	69	23.0	23.8	23.7	8.10	7.48	7.60	0	20
31-Aug	52	25.3	23.4	23.5	8.18	8.61	9.05	0	101

Site 12	Clarity	Salinity	T-bot	T-top	pH	DO-bot	DO-top	FC	TC
	<i>(in)</i>	<i>(ppt)</i>	<i>(°C)</i>	<i>(°C)</i>		<i>(mg/L)</i>	<i>(mg/L)</i>	<i>col/100ml</i>	<i>col/100ml</i>
1-Jun	93	24.8	24.1	24.1	7.29	7.4	7.5	0	12
6-Jun	92	24.0	21.5	21.9	5.87	9.4	9.2	0	6
13-Jun	110	22.3	22.3	22.4	7.45	9.3	8.9	0	4
20-Jun	90	24.1	23.7	23.7	6.62	7.3	7.2	0	83
27-Jun	92	24.4	25.7	25.9	7.09	7.4	7.1	0	32
4-Jul	105	24.4	25.7	25.7	7.84	7.0	7.1	0	60
11-Jul	67	24.3	27.3	27.4	8.08	7.6	7.7	1	4
19-Jul	52	24.8	25.5	27.0	8.05	5.9	7.3	0	5
25-Jul	53	25.2	26.4	26.4		5.1	6.4	0	2
9-Aug	56	25.3	27.3	27.2	8.06	7.8	7.8	7	72
19-Aug	103	25.0	24.7	24.7	7.78	6.5	6.6	0	10
22-Aug	84	24.8	24.3	24.4	8.14	7.28	7.83	0	11
31-Aug	108	25.2	22.9	23.4	8.06	7.19	8.67	0	41

Site 13	Clarity	Salinity	T-bot	T-top	pH	DO-bot	DO-top	FC	TC
	<i>(in)</i>	<i>(ppt)</i>	<i>(°C)</i>	<i>(°C)</i>		<i>(mg/L)</i>	<i>(mg/L)</i>	<i>col/100ml</i>	<i>col/100ml</i>
1-Jun	40	25.2	24.3	24.3	8.17	9.4	9.2	0	0
6-Jun	89	24.0	22.1	22.1	7.55	9.9	9.8	3	13
13-Jun	74	21.8	21.8	22.2	7.25	8.8	8.8	0	10
20-Jun	67	25.8	24.0	24.0	8.17	7.9	7.7	0	64
27-Jun	53	25.5	26.1	26.2	7.44	8.1	7.9	0	26
4-Jul	61	26.4	25.8	25.8	8.26	7.7	7.6	0	26
11-Jul	42	26.3	27.9	27.9	8.18	7.7	7.7	0	32
19-Jul	31	27.1	25.4	26.6	8.21	6.5	6.8	0	17
25-Jul	45	27.7	27.0	27.0		6.0	6.8	0	4
9-Aug	60	28.7	27.1	27.1	8.18	6.8	6.7	6	66
19-Aug	108	27.3	24.6	24.8	7.91	6.2	6.6	0	2
22-Aug	125	27.0	24.3	24.5	7.86	7.34	6.95	0	12
31-Aug	113	26.0	22.5	23.1	7.52	7.21	7.26	1	213