



U.S. Department of the Interior  
U.S. Geological Survey

Prepared in cooperation with the  
PUERTO RICO ENVIRONMENTAL QUALITY BOARD

# Water-Quality Reconnaissance of Laguna Tortuguero, Vega Baja, Puerto Rico, March 1999-May 2000

Open-File Report 2006-1049

**Cover photograph**

View of the Laguna Tortuguero, Vega Baja, Puerto Rico.  
Photograph taken by Francisco Maldonado-Isales, September 2006.

# **Water-Quality Reconnaissance of Laguna Tortuguero, Vega Baja, Puerto Rico, March 1999-May 2000**

By Luis R. Soler-López, Senén Guzmán-Ríos, and Carlos Conde-Costas

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**U.S. Department of the Interior  
U.S. Geological Survey**

**U.S. Department of the Interior**  
Dirk Kempthorne, Secretary

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## Conversion Factors, Water-Quality Units, and Acronyms

Multiply	By	To obtain
<b>Length</b>		
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
<b>Area</b>		
hectare (ha)	2.471	acre
<b>Flow rate</b>		
cubic meter per second (m <sup>3</sup> /s)	35.31	cubic foot per second (ft <sup>3</sup> /s)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:  
 $^{\circ}\text{F} = (1.8 \times ^{\circ}\text{C}) + 32$

### Water-quality units used in this report

μS/cm	microsiemens per centimeter
mg/L	milligrams per liter
μg/L	micrograms per liter

### Acronyms used in this report:

PRDNER	Puerto Rico Department of Natural and Environmental Resources
PREQB	Puerto Rico Environmental Quality Board
USGS	U.S. Geological Survey



# Water-Quality Reconnaissance of Laguna Tortuguero, Vega Baja, Puerto Rico, March 1999-May 2000

By Luis R. Soler-López, Senén Guzmán-Ríos, and Carlos Conde-Costas

## Abstract

The Laguna Tortuguero, a slightly saline to freshwater lagoon in north-central Puerto Rico, has a surface area of about 220 hectares and a mean depth of about 1.2 meters. As part of a water-quality reconnaissance, water samples were collected at about monthly and near bi-monthly intervals from March 1999 to May 2000 at four sites: three stations inside the lagoon and one station at the artificial outlet channel dredged in 1940, which connects the lagoon with the Atlantic Ocean. Physical characteristics that were determined from these water samples were pH, temperature, specific conductance, dissolved oxygen, dissolved oxygen saturation, and discharge at the outlet canal. Other water-quality constituents also were determined, including nitrogen and phosphorus species, organic carbon, chlorophyll *a* and *b*, plankton biomass, hardness, alkalinity as calcium carbonate, and major ions. Additionally, a diel study was conducted at three stations in the lagoon to obtain data on the diurnal variation of temperature, specific conductance, dissolved oxygen, and dissolved oxygen saturation. The data analysis indicates the water quality of Laguna Tortuguero complies with the Puerto Rico Environmental Quality Board standards and regulations.

## Introduction

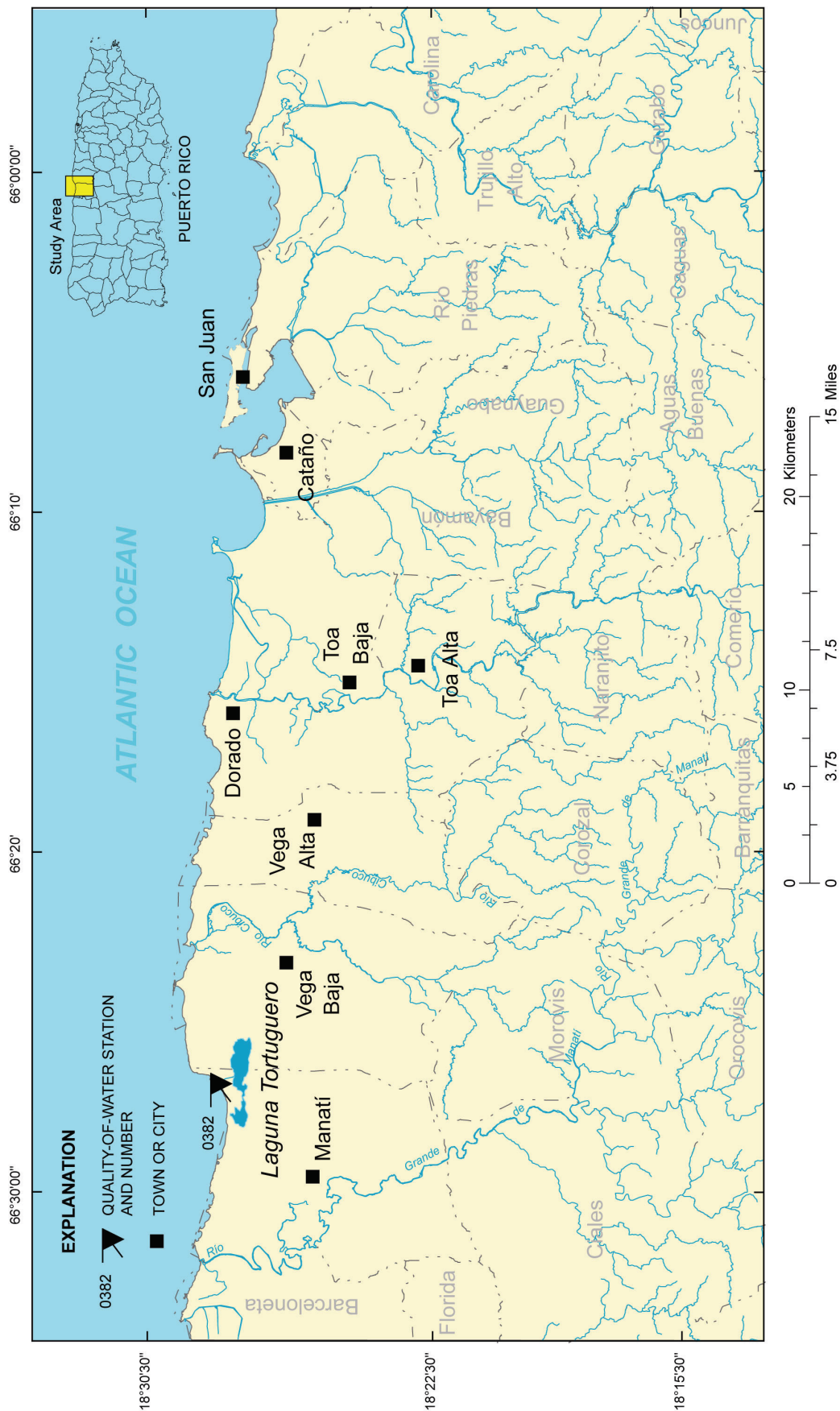
The Laguna Tortuguero is located in Vega Baja, Puerto Rico (fig. 1), about 30 kilometers (km) west of San Juan. This slightly saline to freshwater coastal lagoon, with specific conductance ranging from 800 to 1,700 microsiemens per centimeters ( $\mu\text{S}/\text{cm}$ ) at 25 degrees Celsius ( $^{\circ}\text{C}$ ), has a surface area of about 220 hectares (ha), a maximum depth of about 2.5 meters (m), and a mean depth of about 1.2 m (Quiñones and Fusté, 1977). An artificial outlet channel is present in the north-central part of the lagoon (fig. 2), which was dredged in 1940. Discharge from the lagoon to the Atlantic Ocean is mostly ground water, because the lagoon constitutes the principal ground-water discharge feature of the North Coast Limestone upper aquifer between the Río Grande de Manatí and the Río Cibuco (Cherry, 2001) (fig. 2). The Laguna Tortuguero and its immediate surroundings were designated a natural reserve area by the Puerto Rico Department of Natural and Environmental Resources (PRDNER) in 1978, because of its environmental

uniqueness. The Puerto Rico Environmental Quality Board (PREQB) classifies the Laguna Tortuguero as an SE Class lagoon, a surface-water body with exceptional ecological value (Puerto Rico Environmental Quality Board, 2003). As of today (2005), the lagoon is a passive recreational area that also is used as a natural "laboratory" for the scientific community.

In 1974-75, a baseline study was conducted to determine concentrations of chemical constituents and physical and biological characteristics in the Laguna Tortuguero. Additional data are needed to evaluate whether any substantial variations in water quality have occurred in the lagoon since the prior reconnaissance. The U.S. Geological Survey (USGS), in cooperation with the PREQB, conducted a study to determine concentrations of selected chemical constituents and physical and biological characteristics in the Laguna Tortuguero from March 1999 to May 2000. The results can be used by water managers to implement strategies to protect the lagoon and its function as a natural reserve.

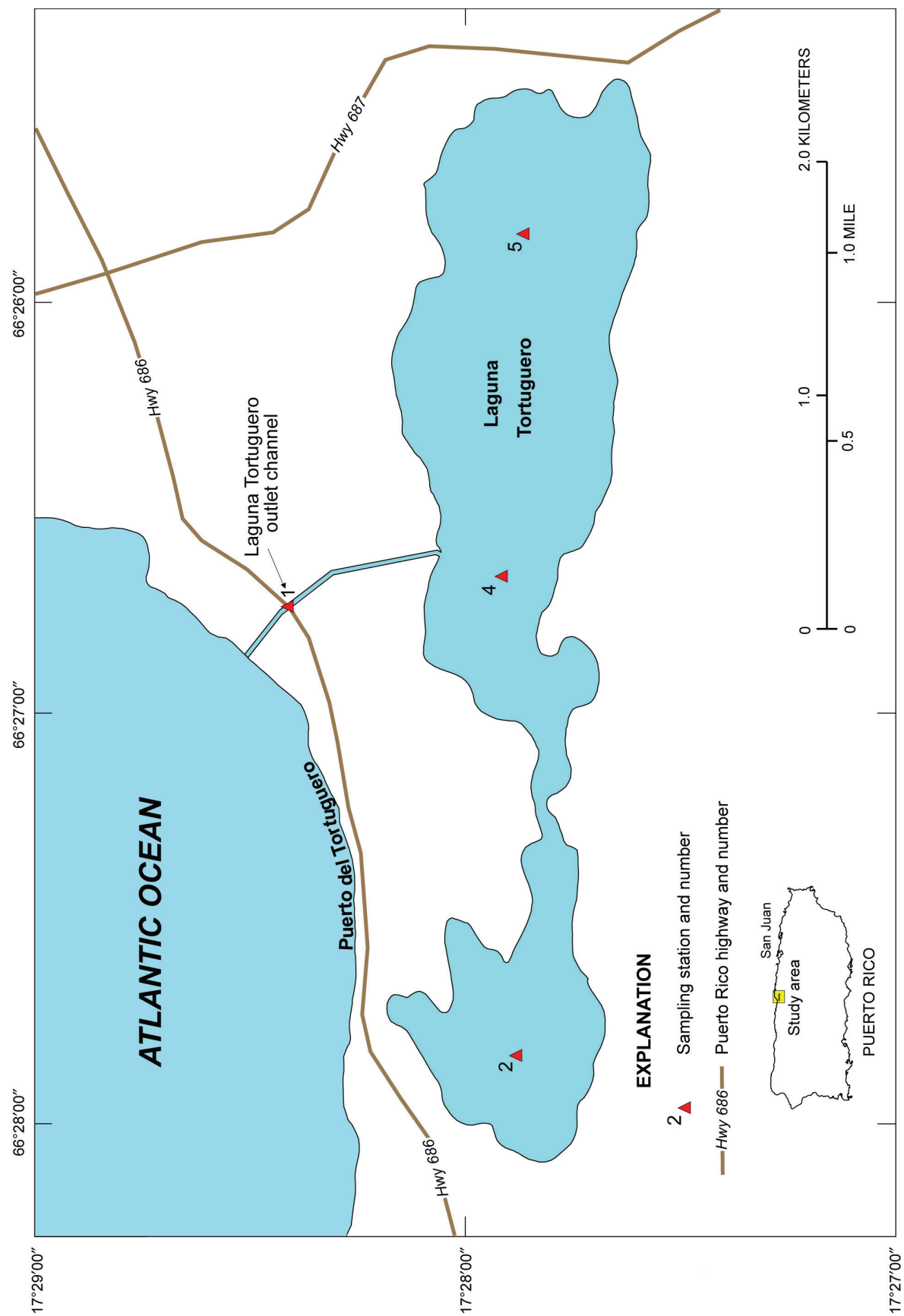
## Purpose and Scope

The purpose of this report is to present and summarize results of a water-quality reconnaissance for selected chemical constituents and physical and biological characteristics at four sites in and near the Laguna Tortuguero. Determinations were made for discharge, pH, temperature, specific conductance, dissolved oxygen, dissolved oxygen saturation, nitrogen and phosphorus species, organic carbon, chlorophyll *a* and *b*, plankton biomass, major ions, and alkalinity as calcium carbonate. Results also are presented for a diel study that was conducted during August 3-4, 2000, at three stations within the lagoon to obtain data on the diurnal variations of temperature, specific conductance, and dissolved oxygen. Diurnal variations in dissolved oxygen can be used in estimating community productivity because its concentration in water bodies is affected by biological metabolic processes, such as photosynthesis and respiration. Community productivity is defined as the rate in which new organic matter is created or consumed by autotrophic and heterotrophic processes, respectively. Aquatic autotrophic organisms produce organic matter by photosynthesis (or chemosynthesis) resulting in the production of carbohydrates and dissolved oxygen. Aquatic heterotrophic organisms incorporate organic matter into their tissue by respiration resulting in the synthesis of proteins and dissolved oxygen consumption.



**Figure 1.** Location of Laguna Tortuguero, Vega Baja, Puerto Rico, between the Río Cibuco and the Río Grande de Manatí, east and west of the towns of Manatí and Vega Baja, respectively.





**Figure 2.** Location of water-quality stations at Laguna Tortuguero, Vega Baja, Puerto Rico.

## Methods and Procedures

Water samples were collected at stations 2, 4, and 5 in the Laguna Tortuguero and at station 1 in the outlet channel of the lagoon (fig. 2) from March 1999 to May 2000. These sites were established to coincide with some of the locations sampled in the 1974-75 water-quality reconnaissance study (Quiñones and Fusté, 1977). The USGS station identification numbers, station names, and geographic coordinates are listed in table 1.

Water-quality constituents that were analyzed in the study include physical characteristics (pH, temperature, specific conductance, and dissolved oxygen), nitrogen and phosphorus species, organic carbon, chlorophyll *a* and *b*, plankton biomass, hardness, alkalinity as calcium carbonate, and major ions. Measurements of pH, temperature, specific conductance, and dissolved oxygen were obtained in the field at stations 1, 2, 4, and 5 by means of using a water-quality multi-parameter instrument. Instantaneous discharge was measured only at the outlet channel site (station 1) during sample collection. Surface-water samples (0.3-m deep) were collected by using the "hand-dip" method in the lagoon and by using depth- and width-integration techniques at the outlet channel. Determinations were made for nitrogen and phosphorus species, organic

carbon, chlorophyll *a* and *b*, plankton biomass, hardness, alkalinity and major ions according to USGS protocols (U.S. Geological Survey, 1998). All of these surface-water constituents were determined at stations 1, 2, 4, and 5, except for chlorophyll *a* and *b*, which were determined only at stations 2, 4, and 5.

The following were collected on a monthly basis: physical characteristics (pH, temperature, specific conductance, dissolved oxygen, and discharge), dissolved concentration for nutrients, total organic carbon concentration, chlorophyll *a* and *b* concentration, plankton biomass concentration, total hardness as calcium carbonate, and dissolved concentrations of major ions. The total concentration for nutrients and dissolved organic carbon were determined on a near bi-monthly basis. The water samples were analyzed at the former USGS Water Quality Research Laboratory in Ocala, Florida, and at the USGS National Water Quality Laboratory in Denver, Colorado. Water-quality constituents and physical and biological characteristics that were analyzed for this study are listed in table 2.

**Table 1.** U.S. Geological Survey (USGS) station identification numbers, station names, and geographic coordinates for the Laguna Tortuguero water-quality sampling stations.

USGS identification number	Station name	Latitude	Longitude
50038200	Laguna Tortuguero number 1 (outlet)	18°28'29"	66°26'50"
50038191	Laguna Tortuguero number 2	18°27'53"	66°27'50"
50038193	Laguna Tortuguero number 4	18°27'55"	66°26'40"
50038194	Laguna Tortuguero number 5	18°27'52"	66°25'50"

**Table 2.** Water-quality constituents and physical and biological characteristics analyzed and calculated at stations 1, 2, 4, and 5 in the Laguna Tortuguero, Vega Baja, Puerto Rico.

Station name	Constituents and physical and biological characteristics
Laguna Tortuguero number 1	pH, temperature, specific conductance, dissolved oxygen, dissolved-oxygen saturation percent, nutrients, organic carbon, plankton biomass, hardness as calcium carbonate, major ions, and discharge
Laguna Tortuguero number 2	pH, temperature, specific conductance, dissolved oxygen, dissolved-oxygen saturation percent, nutrients, organic carbon, chlorophyll <i>a</i> and <i>b</i> , hardness as calcium carbonate, major ions, and plankton biomass
Laguna Tortuguero number 4	pH, temperature, specific conductance, dissolved oxygen, dissolved-oxygen saturation percent, nutrients, organic carbon, chlorophyll <i>a</i> and <i>b</i> , hardness as calcium carbonate, major ions, and plankton biomass
Laguna Tortuguero number 5	pH, temperature, specific conductance, dissolved oxygen, dissolved-oxygen saturation percent, nutrients, organic carbon, chlorophyll <i>a</i> and <i>b</i> , hardness as calcium carbonate, major ions, and plankton biomass

## Water Quality of Laguna Tortuguero

The quality of surface water can be described in terms of its chemical constituents and physical and biological characteristics. The PREQB standards for SE-Class surface-water bodies, such as the Laguna Tortuguero, establish that no existing natural chemical constituents and physical and biological characteristics should be altered by human activities in order to preserve their existing natural phenomena and processes. Summaries of selected surface-water-quality data (March 1999 to May 2000) are presented in tables 3 to 7. Specifically, measurements of physical characteristics (pH, temperature, specific conductance, dissolved oxygen, and discharge) are given in table 3; nitrogen species concentrations are given in table 4; phosphorus species and organic carbon concentrations are given in table 5; values of biological characteristics (chlorophyll *a* and *b* and plankton biomass) are given in table 6; and concentrations of hardness, alkalinity, and major ions are given in table 7. The diel study for temperature, specific conductance, dissolved oxygen, and dissolved oxygen saturation are presented in table 8.

The Laguna Tortuguero is considered to be in a near-natural state (Puerto Rico Environmental Quality Board, 2003), so there are no specific values and concentrations established for the various chemical constituents and physical and biological characteristics. Therefore, in order to categorize these constituents and characteristics, the water quality of the

lagoon was compared with the PREQB standards for nearly comparable SB-Class water bodies; coastal and estuarine waters used for primary and secondary contact (for example, fishing and boating) and intended for the propagation and preservation of desirable species, including those that are threatened or endangered (Puerto Rico Environmental Quality Board, 2003). The Laguna Tortuguero fits part of this characterization because it is used as a recreational area and visitors often wade, fish, and boat in the lagoon.

Determinations of pH, temperature, dissolved oxygen, total nitrogen, and total phosphorus were made at stations 1, 2, 4, and 5 from March 1999 to May 2000 (fig. 3). The PREQB regulated standards should be between 7.3 to 8.5 units for pH, should not exceed 32.2 °C for temperature, should not be below 5.0 milligrams per liter (mg/L) for dissolved oxygen, should not exceed 5.0 mg/L for total nitrogen concentration, and should not exceed 1.0 mg/L for total phosphorus concentration. These standards should not be disrupted other than for natural reasons. Nearly all of the values and concentrations measured during this study were within the standards (fig. 3). However, one pH value at station 1 was outside the standard range, three dissolved oxygen concentrations at stations 2, 4, and 5 were below the standard, and one total nitrogen concentration at station 5 equaled the standard. The overall results indicate that the water quality of Laguna Tortuguero complies with the PREQB standards and regulations.

## 6 Water-Quality Evaluation of Laguna Tortuguero, Vega Baja, Puerto Rico, March 1999-May 2000

**Table 3.** Physical parameters at selected water-quality stations in the Laguna Tortuguero, Vega Baja, Puerto Rico, from March 1999 to May 2000.

[pH in standard units; T, temperature in degrees Celsius; SC, specific conductance in microsiemens per centimeter at 25°; DO, dissolved oxygen in milligrams per liter; DO sat, dissolved oxygen saturation in percent; Q, discharge in cubic meters per second, number in parenthesis is the U.S. Geological Survey laboratory parameter code; ---, no data]

50038191 Station 2	Time	pH (00400)	T (00010)	SC (00095)	DO (00300)	DO sat	Q (00061)
03/10/1999	1300	8.4	27.8	1,580	9.9	127	---
04/16/1999	1500	7.9	30.5	1,670	8.7	117	---
05/14/1999	1030	8.2	29.2	1,720	2.2	29	---
06/16/1999	1315	7.9	30.9	1,690	9.1	123	---
07/16/1999	1235	8.0	28.9	1,590	8.6	112	---
08/20/1999	1300	7.4	31.3	1,540	7.9	108	---
09/17/1999	1350	7.9	31.3	1,540	9.2	112	---
10/15/1999	1400	7.9	29.9	1,500	8.2	109	---
11/19/1999	1200	7.4	26.4	1,200	6.7	84	---
12/20/1999	1215	8.1	25.7	1,130	9.0	110	---
01/21/2000	1330	7.8	24.8	1,110	8.6	104	---
02/17/2000	1300	8.2	26.6	1,180	10.2	128	---
03/22/2000	1300	---	---	---	---	---	---
05/04/2000	1320	---	---	---	---	---	---
Mean		7.9	28.6	1,450	8.2	105	

50038193 Station 4	Time	pH	T	SC	DO	DO sat	Q
03/10/1999	1530	8.4	28.0	1,060	9.6	124	---
04/16/1999	1440	8.0	30.1	1,140	8.7	115	---
05/14/1999	1145	8.4	29.3	1,180	2.4	31	---
06/16/1999	1650	8.4	30.8	1,150	8.7	117	---
07/16/1999	1220	8.1	29.0	1,140	7.6	99	---
08/20/1999	1440	8.1	31.3	1,140	7.6	104	---
09/17/1999	1450	8.1	31.5	1,140	9.3	127	---
10/15/1999	1530	8.1	29.8	1,100	8.9	118	---
11/19/1999	1315	7.7	26.7	920	6.4	80	---
12/20/1999	1400	8.0	25.6	840	9.8	120	---
01/21/2000	1400	8.0	24.8	790	9.0	110	---
02/17/2000	1420	8.0	26.6	820	10.5	131	---
03/22/2000	1410	---	---	---	---	---	---
05/04/2000	1430	---	---	---	---	---	---
Mean		8.1	28.6	1,030	8.2	106	

**Table 3.** Physical parameters at selected water-quality stations in the Laguna Tortuguero, Vega Baja, Puerto Rico, from March 1999 to May 2000. —Continued

[pH in standard units; T, temperature in degrees Celsius; SC, specific conductance in microsiemens per centimeter at 25°; DO, dissolved oxygen in milligrams per liter; DO sat, dissolved oxygen saturation in percent; Q, discharge in cubic meters per second, number in parenthesis is the U.S. Geological Survey laboratory parameter code; ---, no data]

50038194 Station 5	Time	pH	T	SC	DO	DO sat	Q
03/10/1999	1640	8.4	27.9	1,060	10.1	129	---
04/16/1999	1550	7.9	30.3	1,120	9.1	122	---
05/14/1999	1415	8.4	29.7	1,150	2.9	38	---
06/16/1999	1600	8.4	30.9	1,150	9.0	121	---
07/16/1999	1425	8.1	29.4	1,160	9.1	120	---
08/20/1999	1615	8.3	31.8	1,120	8.0	110	---
09/17/1999	1545	8.3	31.8	1,140	9.8	135	---
10/15/1999	1645	8.3	29.9	1,090	9.4	124	---
11/19/1999	1345	7.8	26.9	960	7.9	99	---
12/20/1999	1445	8.2	25.7	830	9.2	112	---
01/21/2000	1415	8.1	24.6	780	9.6	116	---
02/17/2000	1520	8.3	26.8	820	11.3	142	---
03/22/2000	1450	---	---	---	---	---	---
05/04/2000	1400	---	---	---	---	---	---
Mean		8.2	28.8	1,030	8.8	114	

50038200 Station 1	Time	pH	T	SC	DO	DO sat	Q
03/10/1999	1200	7.8	27.5	1,010	6.4	82	0.14
04/21/1999	1210	7.8	29.5	1,100	6.2	82	0.17
05/14/1999	1100	7.9	29.5	1,160	6.8	90	0.17
06/16/1999	1230	8.1	31.0	710	6.2	84	0.27
07/16/1999	1330	7.8	29.7	1,070	6.6	90	0.48
08/20/1999	1315	7.9	31.5	1,170	6.2	85	0.27
09/17/1999	1430	8.1	31.5	1,140	9.3	87	0.35
10/15/1999	1355	7.1	30.0	1,080	6.4	85	0.28
11/19/1999	1230	7.7	26.7	860	6.4	80	1.09
12/20/1999	1220	7.7	25.5	820	7.0	86	0.98
01/21/2000	1355	7.9	24.5	780	7.5	90	0.78
02/17/2000	1340	8.0	27.0	810	7.4	93	0.48
03/22/2000	1330	---	---	---	---	---	---
05/04/2000	---	---	---	---	---	---	---
Mean		7.8	28.7	980	6.9	86	



## 8 Water-Quality Evaluation of Laguna Tortuguero, Vega Baja, Puerto Rico, March 1999-May 2000

**Table 4.** Nitrogen species concentrations at selected water-quality stations in the Laguna Tortuguero, Vega Baja, Puerto Rico from March 1999 to May 2000.

[All concentrations are in milligrams per liter and expressed as N, except where indicated. Number in parenthesis is the U.S. Geological Survey laboratory parameter code; ---, no data; <, less than]

Date	Time	Ammonia, dissolved (00608)	Ammonia, total (00610)	Nitrite, dissolved (00613)	Nitrite total (0015)	Nitrite plus nitrate, dissolved (00631)	Nitrite plus nitrate, total (00630)	Organic nitrogen, dissolved (00607)	Organic nitrogen, total (00605)	Nitrogen, total as N (00600)	Nitrogen, total as NO <sub>3</sub> (71887)
50038191 Laguna Tortuguero number 2											
03/10/1999	1300	0.06	---	<0.01	<0.01	0.11	---	0.40	---	0.58	---
04/16/1999	1500	0.28	0.29	0.01	0.01	0.22	0.23	0.80	1.21	1.73	---
05/14/1999	1030	0.47	0.47	<0.01	<0.01	0.21	0.22	0.60	1.13	1.82	---
06/16/1999	1315	0.24	0.15	0.02	0.01	0.25	0.24	0.59	0.72	1.14	5.05
07/16/1999	1235	0.11	---	<0.01	---	0.14	---	0.77	---	1.01	---
08/20/1999	1300	0.19	0.20	<0.01	<0.01	0.13	0.14	0.77	0.8	1.14	5.05
09/17/1999	1350	0.26	---	<0.01	---	0.20	---	0.57	---	1.07	---
10/15/1999	1400	0.28	0.27	<0.01	<0.01	0.18	0.18	0.67	0.83	1.28	5.67
11/19/1999	1200	0.23	---	<0.01	---	0.12	---	0.69	---	1.04	---
12/20/1999	1215	0.18	0.19	0.01	<0.01	0.21	0.21	0.50	0.74	1.11	4.91
01/21/2000	1330	0.16	---	<0.01	---	0.19	---	0.51	---	---	---
02/17/2000	1300	0.13	0.15	<0.01	<0.01	0.21	0.19	0.55	0.71	1.09	4.82
03/22/2000	1300	0.11	---	<0.01	---	---	---	0.58	---	---	---
05/04/2000	1320	0.22	0.22	0.01	0.01	0.34	0.34	0.70	1.08	1.64	7.26
Mean		0.21	0.24	0.01	0.01	0.19	0.22	0.62	0.90	1.17	5.46
50038193 Laguna Tortuguero number 4											
03/10/1999	1530	0.09	---	0.01	---	0.34	---	0.41	---	0.84	---
04/16/1999	1440	0.21	0.22	<0.01	0.01	0.42	0.43	0.68	0.98	1.63	---
05/14/1999	1145	0.23	0.26	0.01	0.01	0.52	0.53	0.90	1.04	1.62	---
06/16/1999	1650	0.13	0.14	0.02	0.02	0.38	0.38	0.75	0.86	1.38	6.11
07/16/1999	1220	0.19	---	<0.01	---	0.43	---	0.64	---	1.27	---
08/20/1999	1440	0.26	0.27	<0.01	0.01	0.41	0.40	0.69	1.03	1.70	7.53
09/17/1999	1450	0.28	---	0.01	---	0.42	---	0.47	---	1.19	---
10/15/1999	1530	0.28	0.29	0.02	0.02	0.45	0.45	0.56	0.81	1.55	6.86
11/19/1999	1315	0.25	---	0.01	---	0.52	---	0.66	---	1.43	---
12/20/1999	1400	0.29	0.29	0.02	0.03	1.90	1.90	0.40	0.53	2.70	12.0
01/21/2000	1400	0.23	---	0.02	---	1.20	---	0.33	---	1.76	---
02/17/2000	1420	0.24	0.27	0.02	0.03	1.10	1.10	0.73	0.56	1.90	8.41
03/22/2000	1410	0.23	---	0.08	---	0.83	1.00	0.53	---	2.00	8.85
05/04/2000	1430	0.20	0.21	0.02	0.02	0.58	0.58	0.61	0.70	1.49	
Mean		0.22	0.24	0.02	0.02	0.68	0.72	0.60	0.81	1.58	8.29

**Table 4.** Nitrogen species concentrations at selected water-quality stations in the Laguna Tortuguero, Vega Baja, Puerto Rico from March 1999 to May 2000.—Continued

[All concentrations are in milligrams per liter and expressed as N, except where indicated. Number in parenthesis is the U.S. Geological Survey laboratory parameter code; ---, no data; <, less than]

Date	Time	Ammonia, dissolved (00608)	Ammonia, total (00610)	Nitrite, dissolved (00613)	Nitrite total (0015)	Nitrite plus nitrate, dissolved (00631)	Nitrite plus nitrate, total (00630)	Organic nitrogen, dissolved (00607)	Organic nitrogen, total (00605)	Nitrogen, total as N (00600)	Nitrogen, total as NO <sub>3</sub> (71887)
50038194 Laguna Tortuguero number 5											
03/10/1999	1640	0.07	---	0.01	---	0.27	---	0.44	---	---	---
04/16/1999	1550	0.14	0.18	<0.01	0.01	0.18	0.24	0.8	1.42	1.84	---
05/14/1999	1415	0.17	0.22	<0.01	<0.01	0.27	0.26	0.75	4.48	4.96	---
06/16/1999	1600	0.10	0.10	0.01	0.01	0.23	0.23	0.66	0.72	1.03	4.56
07/16/1999	1425	0.08	---	<0.01	---	0.18	---	0.71	---	---	---
08/20/1999	1615	0.12	0.12	0.01	<0.01	0.13	0.12	0.75	0.88	1.12	4.96
09/17/1999	1545	0.20		<0.01	---	0.23	---	0.48	---	0.91	---
10/15/1999	1645	0.19	0.21	0.01	0.01	0.26	0.27	0.73	0.79	1.27	5.62
11/19/1999	1345	0.20	---	0.01	---	0.27	---	0.68	---	---	---
12/20/1999	1445	0.27	0.28	0.02	0.02	1.30	1.30	0.53	0.40	2.00	8.85
01/21/2000	1415	0.27	---	0.03	---	1.40	---	0.39	---	2.06	---
02/17/2000	1520	0.23	0.24	0.02	0.02	1.00	1.10	0.43	0.49	1.80	7.97
03/22/2000	1450	0.20	---	0.02	---	0.70	1.00	0.47	---	2.00	8.85
05/04/2000	1400	0.18	0.20	0.02	0.02	0.54	0.54	0.48	1.10	1.84	8.14
Mean		0.17	0.19	0.01	0.01	0.50	0.51	0.59	1.29	1.65	6.99
50038200 Laguna Tortuguero number 1											
03/10/1999	1200	0.19	0.19	0.01	0.01	0.31	0.32	0.47	0.74	1.25	---
04/21/1999	1210	0.28	0.28	0.01	0.01	0.31	0.30	0.82	1.02	1.61	---
05/14/1999	1100	0.30	0.31	0.01	0.01	0.54	0.54	0.67	1.09	1.94	---
06/16/1999	1230	0.22	0.23	0.02	0.02	0.40	0.41	0.65	0.87	1.51	6.68
07/16/1999	1330	---	---	---	---	---	---	---	---	---	---
08/20/1999	1315	0.26	0.27	<0.01	<0.01	0.25	0.25	0.73	0.93	1.45	6.42
09/17/1999	1430	0.29	---	0.02	---	0.35	---	0.61	---	---	---
10/15/1999	1355	0.32	0.33	0.02	0.02	0.44	0.45	0.78	0.87	1.65	7.30
11/19/1999	1230	0.25	---	0.01	---	0.40	---	0.73	---	---	---
12/20/1999	1220	0.28	0.28	0.03	0.03	1.40	1.40	0.56	0.57	2.25	10.2
01/21/2000	1355	0.26	---	0.03	---	1.40	---	0.44	---	---	---
02/17/2000	1340	0.27	0.29	0.03	0.02	1.10	1.10	0.43	0.51	1.90	8.41
03/22/2000	1330	0.30	---	0.02	---	0.75	1.00	---	---	---	8.85
05/04/2000	---	---	---	---	---	---	---	---	---	---	---
Mean		0.26	0.27	0.02	0.02	0.64	0.33	0.63	0.83	1.70	7.98

## 10 Water-Quality Evaluation of Laguna Tortuguero, Vega Baja, Puerto Rico, March 1999-May 2000

**Table 5.** Phosphorus species and organic carbon concentrations at selected water-quality stations in the Laguna Tortuguero, Vega Baja, Puerto Rico, from March 1999 to May 2000.

[All concentrations are in milligrams per liter. Number in parenthesis is the U.S. Geological Survey laboratory parameter code; ---, no data; E, estimated; <, less than]

Date	Time	Phos- phorus, dissolved as P (00666)	Phos- phorus, total as P (00665)	Ortho phos- phorus, dissolved as P (00671)	Ortho phos- phorus, total as P (70507)	Ortho phos- phate, dissolved as PO <sub>4</sub> (00660)	Organic carbon, total as C (00680)	Organic carbon, dissolved as C (00681)
50038191 Laguna Tortuguero number 2								
03/10/1999	1300	< 0.02	---	<0.01	---	---	9.3	---
04/16/1999	1500	< 0.02	< 0.02	<0.01	0.01	---	9.5	9.0
05/14/1999	1030	< 0.02	< 0.02	<0.01	0.01	---	9.7	---
06/16/1999	1315	< 0.02	< 0.02	<0.01	0.01	---	12.0	11.0
07/16/1999	1235	< 0.02	---	<0.01	---	---	8.8	---
08/20/1999	1300	< 0.02	< 0.02	<0.01	0.01	---	8.9	8.9
09/17/1999	1350	< 0.02	---	<0.01	---	---	8.7	---
10/15/1999	1400	< 0.02	< 0.02	<0.01	0.01	---	8.4	7.9
11/19/1999	1200	< 0.02	---	0.03	---	0.09	7.7	---
12/20/1999	1215	< 0.02	< 0.02	0.03	0.03	0.09	10.0	8.9
01/21/2000	1330	< 0.02	---	0.01	---	0.03	8.8	---
02/17/2000	1300	< 0.02	< 0.02	0.02	0.01	0.06	8.7	8.7
03/22/2000	1300	< 0.02	---	0.01	---	---	9.0	---
05/04/2000	1320	< 0.02	< 0.02	<0.01	0.01	---	10.0	9.6
Mean			0.02	<0.01	0.01	0.07	9.2	9.1
50038193 Laguna Tortuguero number 4								
03/10/1999	1530	< 0.02	---	<0.01	---	---	8.5	---
04/16/1999	1440	E 0.02	< 0.02	<0.01	0.01	---	9.5	9.1
05/14/1999	1145	< 0.02	< 0.02	<0.01	0.01	---	9.7	---
06/16/1999	1650	E 0.02	0.02	0.02	0.01	0.06	12.0	9.6
07/16/1999	1220	0.04	---	<0.01	---	---	8.5	---
08/20/1999	1440	< 0.02	< 0.02	<0.01	0.01	---	8.9	8.3
09/17/1999	1450	< 0.02	---	<0.01	---	---	8.8	---
10/15/1999	1530	< 0.02	< 0.02	<0.01	0.01	---	8.2	7.9
11/19/1999	1315	< 0.02	---	0.02	---	0.06	7.5	---
12/20/1999	1400	< 0.02	< 0.02	0.03	0.03	0.09	6.3	5.6
01/21/2000	1400	< 0.02	---	0.02	---	0.06	6.1	---
02/17/2000	1420	0.02	< 0.02	<0.01	0.01	---	9.1	5.8
03/22/2000	1410	< 0.02	---	<0.01	---	---	6.0	---
05/04/2000	1430	< 0.02	< 0.02	<0.01	0.01	---	9.2	7.5
Mean		0.02	0.02	0.01	0.01	0.07	8.6	8.0

**Table 5.** Phosphorus species and organic carbon concentrations at selected water-quality stations in the Laguna Tortuguero, Vega Baja, Puerto Rico, from March 1999 to May 2000. —Continued

[All concentrations are in milligrams per liter. Number in parenthesis is the U.S. Geological Survey laboratory parameter code; ---, no data; E, estimated; <, less than]

Date	Time	Phos- phorus, dissolved as P (00666)	Phos- phorus, total as P (00665)	Ortho phos- phorus, dissolved as P (00671)	Ortho phos- phorus, total as P (70507)	Ortho phos- phate, dissolved as PO <sub>4</sub> (00660)	Organic carbon, total as C (00680)	Organic carbon, dissolved as C (00681)
50038194 Laguna Tortuguero number 5								
03/10/1999	1640	< 0.02	---	< 0.01	---	---	8.6	---
04/16/1999	1550	< 0.02	< 0.02	< 0.01	0.01	---	9.9	9.6
05/14/1999	1415	< 0.02	E 0.03	0.01	0.01	---	10.0	---
06/16/1999	1600	< 0.02	< 0.02	< 0.01	0.01	---	10.0	8.9
07/16/1999	1425	< 0.02	---	< 0.01	---	---	9.1	---
08/20/1999	1615	< 0.02	< 0.02	< 0.01	0.01	---	10.0	8.8
09/17/1999	1545	< 0.02	---	< 0.01	---	---	9.2	---
10/15/1999	1645	< 0.02	0.02	< 0.01	0.01	---	8.2	7.9
11/19/1999	1345	< 0.02	---	0.02	---	0.06	7.5	---
12/20/1999	1445	0.02	0.02	0.01	0.01	0.09	6.4	6.2
01/21/2000	1415	< 0.02	---	0.02	---	0.06	6.0	---
02/17/2000	1520	< 0.02	0.02	< 0.01	0.01	---	7.8	5.8
03/22/2000	1450	< 0.02	---	< 0.01	---	---	6.6	---
05/04/2000	1400	< 0.02	0.02	< 0.01	0.01	---	8.0	7.7
Mean			0.02	< 0.01	0.01	0.07	8.4	7.8
50038200 Laguna Tortuguero number 1								
03/10/1999	1200	< 0.02	< 0.02	< 0.01	0.01	---	8.5	---
04/21/1999	1210	E 0.03	< 0.02	< 0.01	0.01	0.03	9.5	9.5
05/14/1999	1100	< 0.02	< 0.02	< 0.01	0.01	---	9.2	---
06/16/1999	1230	< 0.02	< 0.02	< 0.01	0.01	---	10.0	9.3
07/16/1999	1330	---	---	---	---	---	9.6	---
08/20/1999	1315	< 0.02	< 0.02	< 0.01	< 0.01	---	9.3	8.7
09/17/1999	1430	< 0.02	---	< 0.01	< 0.01	---	8.9	---
10/15/1999	1355	< 0.02	< 0.02	< 0.01	< 0.01	0.06	8.2	7.9
11/19/1999	1230	< 0.02	< 0.02	0.03	---	0.09	8.4	---
12/20/1999	1220	< 0.02	< 0.02	< 0.02	< 0.01	0.06	10.2	6.2
01/21/2000	1355	0.01	---	0.01	---	0.03	5.5	---
02/17/2000	1340	< 0.02	< 0.02	< 0.01	< 0.01	---	5.9	5.7
03/22/2000	1330	---	---	---	---	---	6.3	---
05/04/2000	---	---	---	---	---	---	---	---
Mean		0.01	0.01	0.01	< 0.01	0.05	8.4	7.9

## 12 Water-Quality Evaluation of Laguna Tortuguero, Vega Baja, Puerto Rico, March 1999-May 2000

**Table 6.** Chlorophyll *a* and *b*, and plankton biomass concentration at selected water-quality stations in the Laguna Tortuguero, Vega Baja, Puerto Rico, from March 1999 to May 2000.

[Chlorophyll *a* and *b* in micrograms per liter, plankton biomass in milligrams per liter; Number in parenthesis is the U.S. Geological Survey laboratory parameter code; ---, no data; <, less than].

Date	Time	Chloro- phyll <i>a</i> (70953)	Chloro- phyll <i>b</i> (70954)	Biomass, plankton, dry weight (81354)	Biomass, plankton, ash weight (81353)	Biomass, plankton, ash-free weight (49953)
50038191 Laguna Tortuguero number 2						
03/10/1999	1300	0.57	<0.10	276.4	271.2	5.2
04/16/1999	1500	2.60	<0.10	459.7	447.3	12.4
05/14/1999	1030	0.76	<0.10	272.0	264.8	7.2
06/16/1999	1315	2.30	<0.10	275.0	268.2	6.8
07/16/1999	1235	1.20	<0.10	271.4	264.8	6.6
08/20/1999	1300	0.83	<0.10	273.2	267.8	5.4
09/17/1999	1350	1.10	<0.10	272.6	267.2	5.4
10/15/1999	1400	1.20	<0.10	271.4	264.2	7.2
11/19/1999	1200	1.80	<0.10	263.6	258.2	5.4
12/20/1999	1215	2.30	<0.10	261.2	254.8	6.4
01/21/2000	1330	1.90	<0.10	274.2	268.4	5.8
02/17/2000	1300	2.20	<0.10	277.8	270.6	7.2
03/22/2000	1300	2.10	<0.10	366.4	356.8	9.6
05/04/2000	1320	2.60	<0.10	305.3	297.6	7.7
Mean		1.70	<0.10	294.3	287.3	7.0
50038194 Laguna Tortuguero number 5						
03/10/1999	1640	0.76	<0.10	272.6	268.4	4.2
04/16/1999	1550	1.30	<0.10	460.0	448.7	11.3
05/14/1999	1415	0.58	<0.10	262.8	257.4	5.4
06/16/1999	1600	1.80	<0.10	260.0	254.2	5.8
07/16/1999	1425	1.80	<0.10	273.8	267.6	6.2
08/20/1999	1615	0.79	<0.10	286.4	278.2	8.2
09/17/1999	1545	2.30	<0.10	273.0	267.2	5.8
10/15/1999	1645	1.30	<0.10	268.0	261.0	7.0
11/19/1999	1345	1.10	<0.10	264.8	258.2	6.6
12/20/1999	1445	1.60	<0.10	267.2	261.0	6.2
01/21/2000	1415	0.99	<0.10	271.4	266.2	5.2
02/17/2000	1520	1.80	<0.10	273.0	267.2	5.8
03/22/2000	1450	1.30	<0.10	305.6	298.4	7.2
05/04/2000	1400	1.90	<0.10	343.0	335.7	7.3
Mean		1.40	<0.10	291.5	285.0	6.5

Time	Chloro- phyll <i>a</i> (70953)	Chloro- phyll <i>b</i> (70954)	Biomass, plankton, dry weight (81354)	Biomass, plankton, ash weight (81353)	Biomass, plankton, ash-free weight (49953)
50038193 Laguna Tortuguero number 4					
1530	2.20	<0.1	261.4	254.8	6.6
1440	2.00	<0.1	456.3	445.7	10.6
1145	0.51	<0.1	279.2	271.6	7.6
1650	2.10	<0.1	266.6	261.4	5.2
1220	2.30	<0.1	274.0	267.4	6.6
1440	1.10	<0.1	273.6	267.2	6.4
1450	1.50	<0.1	276.2	270.0	6.2
1530	1.80	<0.1	275.0	267.4	7.6
1315	1.40	<0.1	270.4	263.6	6.8
1400	1.60	<0.1	271.2	265.4	5.8
1400	1.20	<0.1	272.4	266.6	5.8
1420	1.60	<0.1	271.2	264.8	6.4
1410	1.70	<0.1	268.2	274.4	6.2
1430	1.60	<0.1	339.3	336.8	2.5
	1.60	<0.1	290.1	283.6	6.5
50038200 Laguna Tortuguero number 1					
1200	---	---	---	---	---
1210	---	---	281.6	272.6	9.0
1100	---	---	275.4	268.8	6.6
1230	---	---	277.2	270.4	6.8
1330	---	---	275.4	268.6	6.8
1315	---	---	281.4	276.0	5.4
1430	---	---	274.8	268.6	6.2
1355	---	---	273.0	265.8	7.2
1230	---	---	276.4	269.4	7.0
1220	---	---	274.8	268.6	6.2
1355	---	---	275.6	270.2	5.4
1340	---	---	275.2	269.0	6.2
1330	---	---	269.4	262.8	6.6
---	---	---	---	---	---
1200	---	---	300.9	293.7	6.6



**Table 7.** Total hardness and alkalinity as calcium carbonate, and major ions concentration at selected water-quality stations in the Laguna Tortuguero, Vega Baja, Puerto Rico, from March 1999 to May 2000.

[All concentrations are in milligrams per liter. Number in parenthesis is the U.S. Geological Survey laboratory parameter code; ---, no data; <, less than]

Date	Time	Hardness, total as CaCO <sub>3</sub> (00900)	Acid neutralizing capacity as CaCO <sub>3</sub> (00410)	Calcium, dissolved as Ca (00915)	Magnesium, dissolved as Mg (00925)	Potassium, dissolved as K (00935)	Sodium, dissolved as Na (00930)	Chloride, dissolved as Cl (00940)	Fluoride, dissolved as F (00950)	Silica, dissolved as SiO <sub>2</sub> (00955)	Sulfate, dissolved as SO <sub>4</sub> (00945)
50038191 Laguna Tortuguero number 2											
03/10/1999	1300	239	116	56	24	5.4	200	380	<0.1	5.7	46
04/16/1999	1500	245	116	57	25	5.9	210	410	<0.1	7.9	50
05/14/1999	1030	274	125	65	27	7.0	220	420	<0.1	9.4	51
06/16/1999	1315	256	105	58	27	6.3	230	410	<0.1	9.3	55
07/16/1999	1235	212	93	47	23	5.2	190	370	<0.1	8.0	48
08/20/1999	1300	249	100	57	26	5.8	190	390	<0.1	11.0	50
09/17/1999	1350	237	110	57	23	5.2	190	360	<0.1	11.0	47
10/15/1999	1400	223	---	53	22	5.1	180	360	<0.1	10.0	46
11/19/1999	1200	194	97	48	18	4.0	140	280	<0.1	8.7	35
12/20/1999	1215	204	---	52	18	3.7	130	260	<0.1	8.0	31
01/21/2000	1330	200	---	52	17	3.8	120	240	<0.1	7.0	29
02/17/2000	1300	211	121	55	18	4.0	140	270	<0.1	6.4	32
03/22/2000	1300	---	---	---	---	---	---	---	---	---	---
05/04/2000	1320	---	---	---	---	---	---	---	---	---	---
Mean		229	109	55	22	5.1	178	346	<0.1	8.5	43
50038193 Laguna Tortuguero number 4											
03/10/1999	1530	189	112	46	18	3.5	120	230	<0.1	6.3	27
04/16/1999	1440	195	115	45	20	4.3	130	260	<0.1	7.7	31
05/14/1999	1145	206	115	48	21	3.9	130	260	<0.1	9.2	33
06/16/1999	1650	198	98	43	22	4.6	150	270	<0.1	9.9	34
07/16/1999	1220	199	110	45	21	4.3	140	240	<0.1	9.2	30
08/20/1999	1440	206	---	48	21	4.5	150	270	<0.1	10.0	33
09/17/1999	1450	207	120	50	20	3.9	130	240	<0.1	10.0	30
10/15/1999	1530	211	---	53	19	4.2	120	250	<0.1	11.0	29
11/19/1999	1315	183	115	47	16	3.2	95	180	<0.1	9.0	23
12/20/1999	1400	214	---	61	15	2.5	73	150	<0.1	7.7	20
01/21/2000	1400	198	---	56	14	2.5	70	130	<0.1	7.0	18
02/17/2000	1420	193	139	54	14	2.6	76	150	<0.1	6.3	20
03/22/2000	1410	191	---	50	16	3.0	95	180	---	6.5	23
05/04/2000	1430	193	---	46	19	3.6	110	220	---	7.9	29
Mean		199	116	49	18	3.6	114	216	<0.1	8.4	27

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**Table 7.** Total hardness and alkalinity as calcium carbonate, and major ions concentration at selected water-quality stations in the Laguna Tortuguero, Vega Baja, Puerto Rico, from March 1999 to May 2000.—Continued

[All concentrations are in milligrams per liter. Number in parenthesis is the U.S. Geological Survey laboratory parameter code; ---, no data; <, less than]

Date	Time	Hard- ness, total as CaCO <sub>3</sub> (00900)	Acid neutra- lizing capacity as CaCO <sub>3</sub> (00410)	Calci- um, dis- solved as Ca (00915)	Mag- nesium, dis- solved as Mg (00925)	Potas- sium, dis- solved as K (00935)	So- dium, dis- solved as Na (00930)	Chlo- ride, dis- solved as Cl (00940)	Fluo- ride, dis- solved as F (00950)	Silica, dis- solved as SiO <sub>2</sub> (00955)	Sulfate, dis- solved as SO <sub>4</sub> (00945)
50038194 Laguna Tortuguero number 5											
03/10/1999	1640	191	114	45	19	3.6	120	240	<0.1	6.3	27
04/16/1999	1550	187	107	42	20	4.3	140	260	<0.1	7.9	31
05/14/1999	1415	199	107	45	21	4.8	140	260	<0.1	9.2	33
06/16/1999	1600	189	94	41	21	4.6	150	280	<0.1	9.9	35
07/16/1999	1425	185	92	41	20	4.4	140	250	<0.1	9.5	31
08/20/1999	1615	196	100	44	21	4.2	140	260	<0.1	10.0	32
09/17/1999	1545	197	100	46	20	4.1	140	240	<0.1	10.0	30
10/15/1999	1645	205	---	49	20	4.2	120	250	<0.1	11.0	29
11/19/1999	1345	176	103	44	16	3.3	110	200	<0.1	8.8	25
12/20/1999	1445	202	---	56	15	2.7	78	150	<0.1	8.0	20
01/21/2000	1415	195	---	55	14	2.5	69	140	<0.1	7.0	18
02/17/2000	1520	188	136	52	14	2.6	78	140	<0.1	6.3	19
03/22/2000	1450	186	---	48	16	2.9	92	180	---	6.5	23
05/04/2000	1400	196	---	47	19	3.5	110	220	---	8.0	29
Mean		192	106	47	18	3.7	116	219	<0.1	8.5	27
50038200 Laguna Tortuguero number 1											
03/10/1999	1200	198	120	48	19	3.8	120	230	<0.1	6.4	28
04/21/1999	1210	214	110	51	21	4.5	140	270	<0.1	8.4	33
05/14/1999	1100	215	120	50	22	5.2	140	280	<0.1	9.2	33
06/16/1999	1230	205	110	46	22	4.8	150	280	<0.1	10.0	34
07/16/1999	1330	190	100	43	20	4.4	140	240	<0.1	8.8	32
08/20/1999	1315	204	110	47	21	4.5	150	270	<0.1	10.0	33
09/17/1999	1430	205	110	49	20	4.1	130	250	<0.1	10.0	30
10/15/1999	1355	217	120	54	20	4.3	120	250	<0.1	11.0	30
11/19/1999	1230	174	112	45	15	3.2	92	180	<0.1	8.4	23
12/20/1999	1220	204	125	57	15	2.7	70	150	<0.1	7.8	20
01/21/2000	1355	200	149	57	14	2.5	70	140	<0.1	6.8	19
02/17/2000	1340	190	143	54	14	2.6	77	150	<0.1	6.3	20
03/22/2000	1330	191	---	50	16	3.0	94	180	< 0.1	6.5	23
05/04/2000	---	---	---	---	---	---	---	---	---	---	---
Mean		200	119	50	19	3.9	117	224	<0.1	8.6	28

**Table 8.** Diel study data on temperature, specific conductance, dissolved oxygen, and dissolved oxygen saturation, at selected water-quality stations in the Laguna Tortuguero, Vega Baja, Puerto Rico, August 3-4, 2000.

[Temperature in degrees Celsius; specific conductance in microsiemens per centimeter at 25°; dissolved oxygen in milligrams per liter; dissolved oxygen saturation in percent]

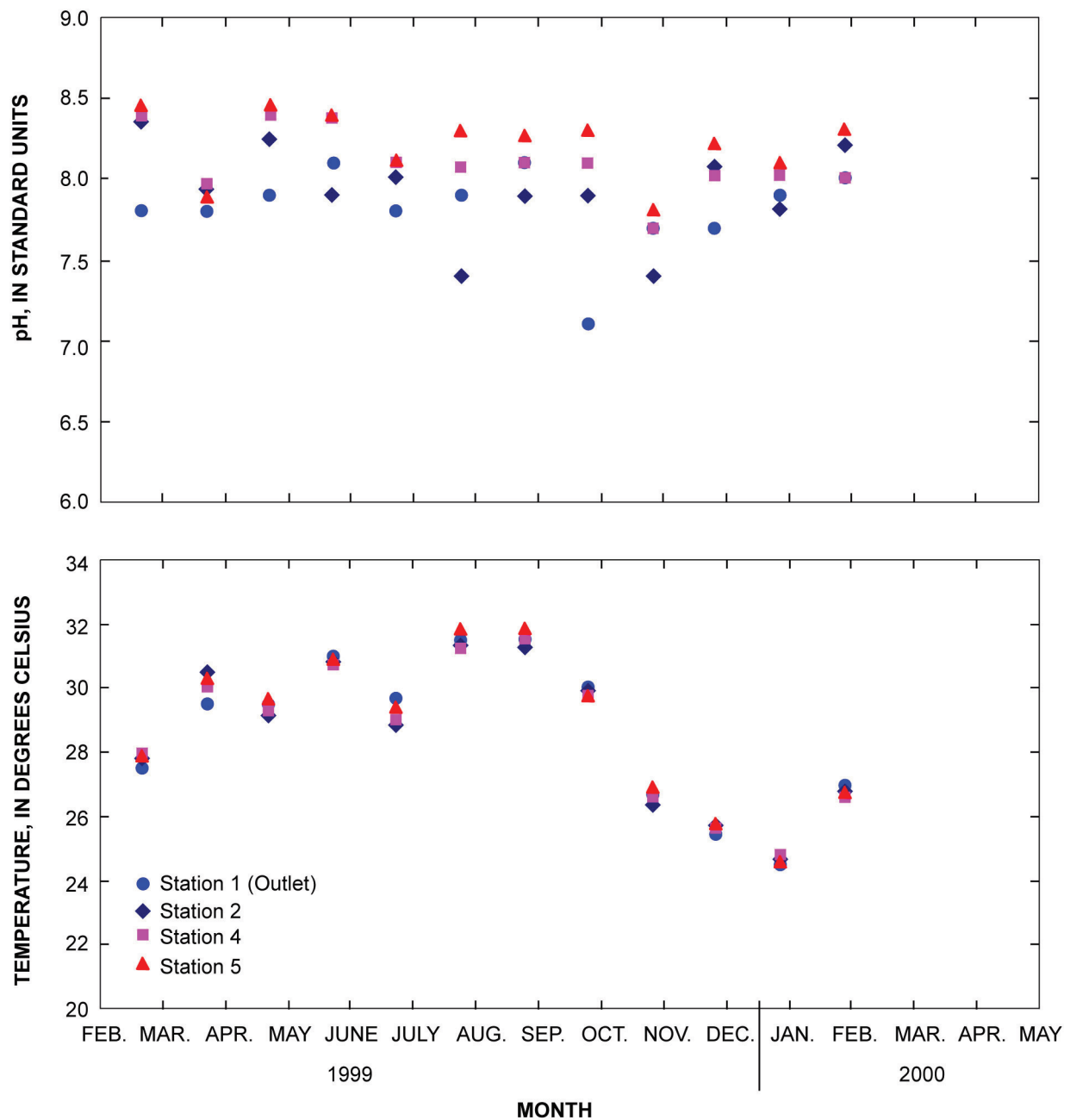
Date	Time	Temperature	Specific conductance	Dissolved oxygen	Dissolved oxygen saturation
50038191 Laguna Tortuguero number 2					
08/03/2000	1042	29.84	1,500	8.08	107
08/03/2000	1140	29.89	1,500	8.27	110
08/03/2000	1242	30.12	1,500	8.68	115
08/03/2000	1340	30.40	1,500	8.28	111
08/03/2000	1440	30.69	1,500	7.75	105
08/03/2000	1547	30.98	1,500	7.75	105
08/03/2000	1646	31.06	1,500	8.30	113
08/03/2000	1745	31.01	1,500	8.44	114
08/03/2000	1847	30.91	1,500	8.24	112
08/03/2000	1950	30.71	1,500	8.04	108
08/03/2000	2110	30.53	1,500	7.84	105
08/03/2000	2215	30.43	1,500	7.66	103
08/03/2000	2310	30.22	1,500	7.47	99
08/04/2000	0018	30.11	1,500	7.48	99
08/04/2000	0100	29.90	1,500	7.65	102
08/04/2000	0210	29.90	1,500	7.27	97
08/04/2000	0307	29.81	1,500	7.18	95
08/04/2000	0410	29.75	1,500	7.18	95
08/04/2000	0513	29.63	1,500	6.98	92
08/04/2000	0605	29.60	1,500	7.51	99
08/04/2000	0700	29.53	1,500	7.49	99
08/04/2000	0810	29.51	1,500	8.01	106

Time	Temperature	Specific conductance	Dissolved oxygen	Dissolved oxygen saturation
50038193 Laguna Tortuguero number 4				
1030	29.52	1,100	7.62	100
1130	29.57	1,100	7.58	100
1230	29.85	1,100	8.43	112
1330	29.97	1,100	8.12	108
1433	30.20	1,100	7.50	100
1540	30.38	1,100	7.70	103
1637	30.39	1,100	8.15	110
1737	30.36	1,100	7.88	106
1838	30.47	1,100	8.05	108
1940	30.36	1,100	7.72	104
2056	30.24	1,100	7.52	100
2210	29.92	1,100	7.50	100
2300	29.93	1,100	7.53	100
0007	29.90	1,100	7.48	99
0110	29.60	1,100	7.35	97
0220	29.50	1,100	6.88	91
0315	29.34	1,100	6.84	90
0420	29.30	1,100	6.89	91
0522	29.21	1,100	6.79	89
0614	29.19	1,100	7.29	95
0710	29.18	1,100	7.26	95
0823	29.21	1,100	7.83	102

**Table 8.** Diel study data on temperature, specific conductance, dissolved oxygen, and dissolved oxygen saturation, at selected water-quality stations in the Laguna Tortuguero, Vega Baja, Puerto Rico, August 3-4, 2000.—Continued

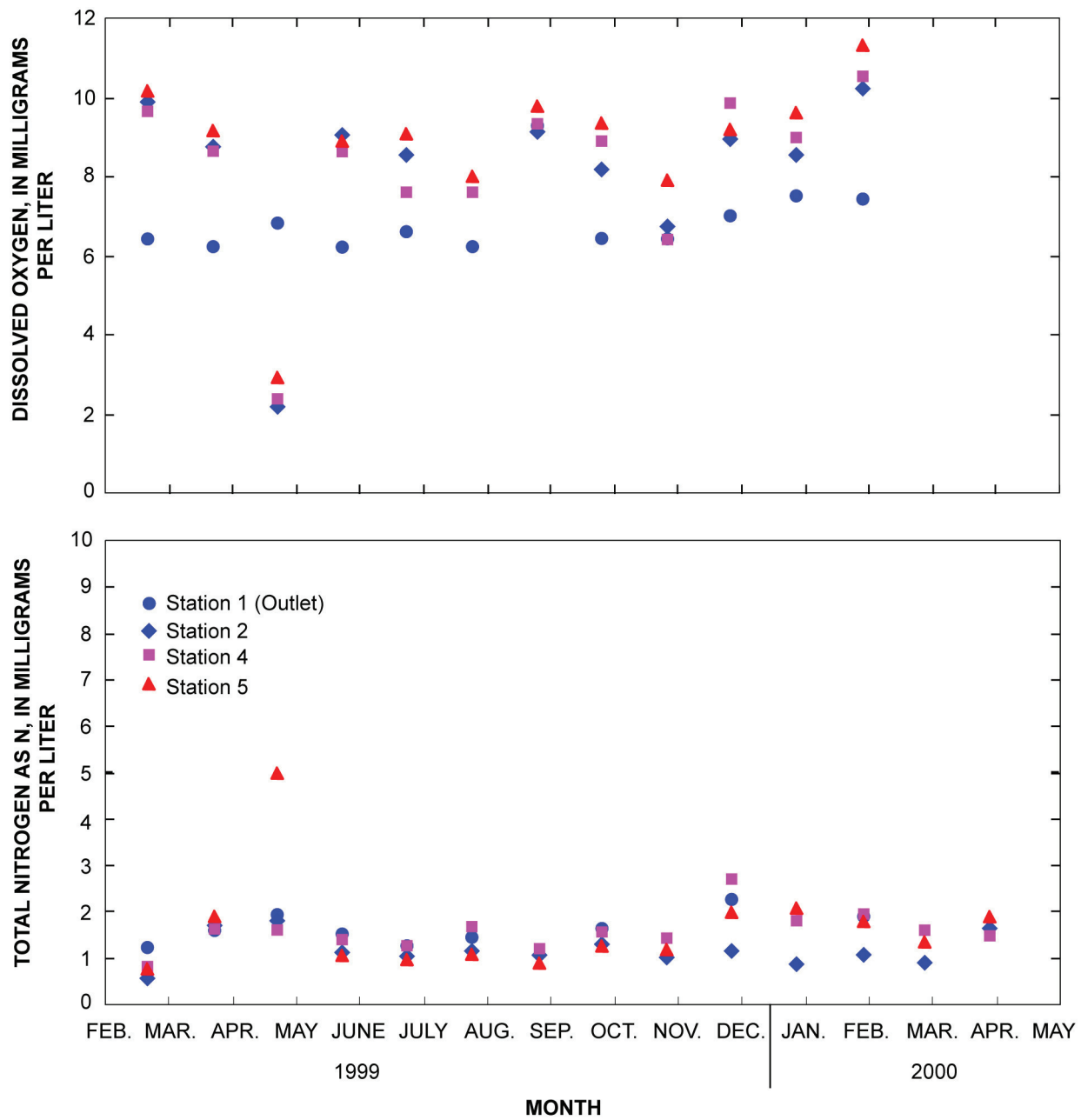
[Temperature in degrees Celsius; specific conductance in microsiemens per centimeter at 25°; dissolved oxygen in milligrams per liter; dissolved oxygen saturation in percent]

Date	Time	Temperature	Specific conductance	Dissolved oxygen	Dissolved oxygen saturation
50038194 Laguna Tortuguero number 5					
08/03/2000	1020	29.66	1,100	8.33	110
08/03/2000	1120	29.79	1,100	8.31	110
08/03/2000	1225	30.03	1,100	8.59	114
08/03/2000	1320	30.23	1,100	8.91	118
08/03/2000	1425	30.50	1,100	8.02	108
08/03/2000	1533	30.76	1,100	8.47	115
08/03/2000	1630	30.79	1,100	8.34	113
08/03/2000	1727	30.69	1,100	8.45	114
08/03/2000	1831	30.64	1,100	8.42	113
08/03/2000	1928	30.57	1,100	8.18	110
08/03/2000	2046	30.46	1,100	8.00	108
08/03/2000	2200	30.37	1,100	7.97	107
08/03/2000	2332	30.16	1,100	7.77	103
08/04/2000	2400	29.90	1,100	7.59	101
08/04/2000	0120	30.07	1,100	7.74	103
08/04/2000	0235	29.96	1,100	7.24	96
08/04/2000	0330	29.85	1,100	7.22	96
08/04/2000	0430	29.79	1,100	7.24	96
08/04/2000	0532	29.72	1,100	7.15	94
08/04/2000	0620	29.61	1,100	7.74	102
08/04/2000	0730	29.57	1,100	7.84	103
08/04/2000	0830	29.63	1,100	8.24	109

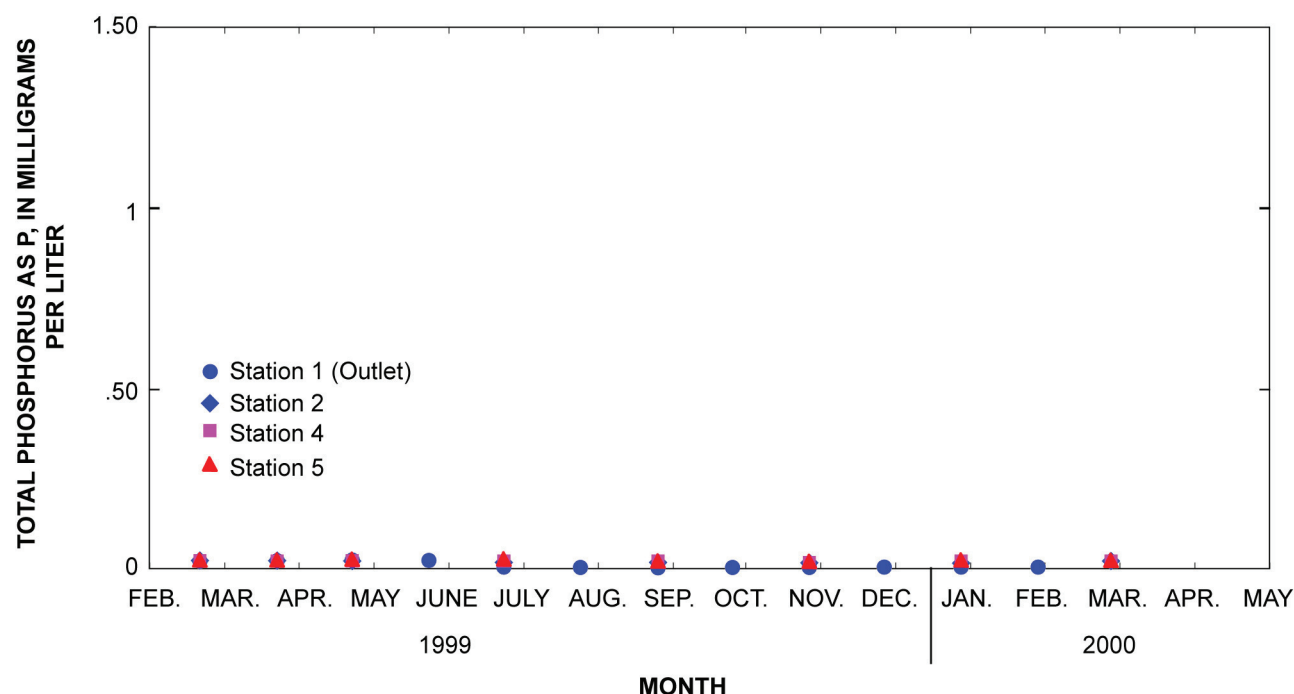


**Figure 3.** Temperature and pH measurements, and dissolved oxygen, total nitrogen, and total phosphorus concentration at stations 1, 2, 4, and 5 in and near the Laguna Tortuguero, March 1999 to May 2000.





**Figure 3.** Temperature and pH measurements, and dissolved oxygen, total nitrogen, and total phosphorus concentration at stations 1, 2, 4, and 5 in and near the Laguna Tortuguero, March 1999 to May 2000.—Continued



**Figure 3.** Temperature and pH measurements, and dissolved oxygen, total nitrogen, and total phosphorus concentration at stations 1, 2, 4, and 5 in and near the Laguna Tortuguero, March 1999 to May 2000.—Continued

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