2005 Martin Reservoir Report

Rivers and Reservoirs Monitoring Program

Alabama Department of Environmental Management

Field Operations Division
Environmental Indicator's Section
Aquatic Assessment Unit
March 2011

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Table of Contents

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Created in the 1920's by the completion of Martin Dam, Martin Reservoir is approximately 31 miles long and contains over 40,000 acres of surface water. It is the second reservoir on the Tallapoosa River in Alabama, located downstream of Harris Reservoir.

The Alabama Department of Environmental Management (ADEM) intensively monitored Martin Reservoir as part of the 2005 assessment of the Alabama, Coosa, and Tallapoosa (ACT) River basins under the Rivers and Reservoirs Monitoring Program (RRMP). Implemented in 1990, the objectives of this program were to provide data that can be used to assess current water quality condition, identify trends in water quality conditions, and to develop Total Maximum Daily Loads (TMDLs) and water quality criteria. Descriptions of all RRMP monitoring activities are available in ADEM's 2005 monitoring strategy.

Specific water quality criteria for nutrient management was implemented in 2002 at three locations on Martin Reservoir, which have been monitored by ADEM since the early 1990's. These criteria represent the maximum growing season mean (April-October) chlorophyll *a* (chl *a*) concentrations allowable while still fully supporting the reservoir's Swimming and Fish and Wildlife [(S/F&W)] use classification.

The purpose of this report is to summarize data collected at eleven stations in Martin Reservoir during the 2005 growing season and to evaluate trends in mean lake trophic status and nutrient concentrations using ADEM's historic dataset. Monthly and mean concentrations of nutrients [total nitrogen (TN); total phosphorus (TP)], algal biomass/productivity [chlorophyll *a* (chl *a*)]; algal growth potential testing (AGPT), sediment [total suspended solids (TSS)], and trophic state [Carlson's trophic state index (TSI)] were compared to ADEM's existing data and established criteria.

METHODS

Specific location information can be found in Table 1, a station map is provided in Figure 1. The mainstem of Martin Reservoir was sampled in the dam forebay, the mid reservoir, and at two locations in the upper reservoir (transition area). Six tributary embayment stations were sampled in the upper (Hillabee and Coley Creek) and mid, (Elkahatchee, Manoy, Sandy, and Blue Creek) reservoir. Kowaliga Creek constitutes a very large portion of the lower reservoir and is treated as a mainstem station in this report.

Water quality assessments were conducted at monthly intervals April-October. All samples were collected, preserved, stored, and transported according to procedures in the ADEM Field Operations Division Standard Operating Procedures (SOP), Surface Water Quality Assurance Project Plan (QAPP), and Quality Management Plan (QMP).

Mean annual TN, TP, chl *a*, and TSS were calculated to evaluate water quality conditions at each site. For mainstem stations, monthly concentrations of these parameters were graphed with the closest available USGS flow data and ADEM's previously collected data to help interpret the 2005 results.

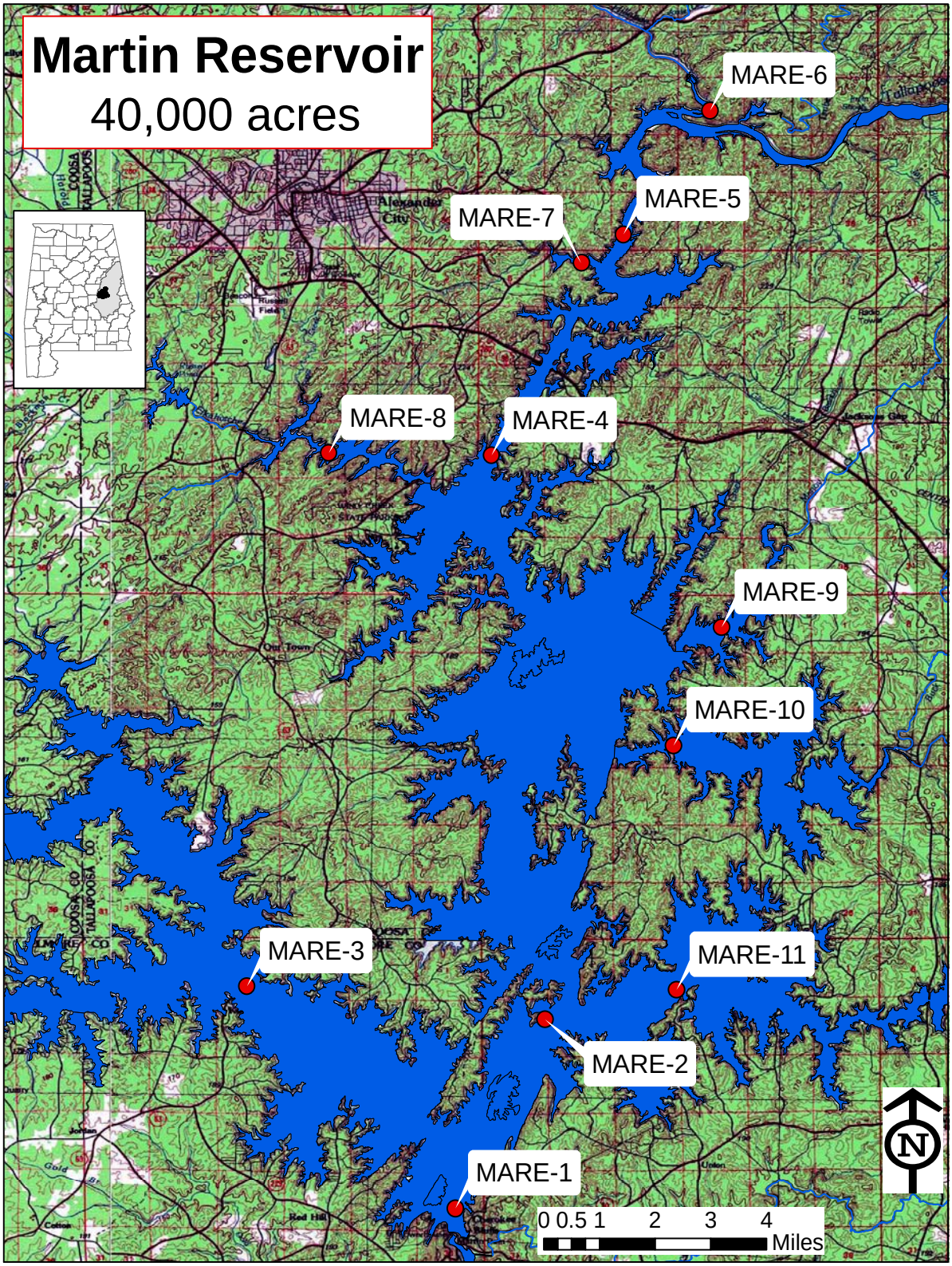


Figure 1. Martin Reservoir with 2005 sampling locations. A description of each sampling location is provided in Table 1.

Table 1. Descriptions of the 2005 monitoring stations in Martin Reservoir.

Martin Reservoir								
Sub-watershed	**County**	**Station Number**	**Report Designation**	**Waterbody Name**	**Station Description**	**Chl *a* Criteria**	**Latitude**	**Longitude**
Middle Tallapoosa (0315-0109)								
220	Elmore	MARE-1*	Lower	Tallapoosa R	Lower reservoir. Deepest point, main river channel, dam forebay .	5 μg/L	32.6865	-85.9107
220	Elmore	MARE-2*	Mid	Tallapoosa R	Mid reservoir. Deepest point, main river channel, immed. upstream of Blue Creek embayment.	5 μg/L	32.7344	-85.8874
220	Elmore	MARE-3*	Kowaliga	Kowaliga Cr	Kowaliga. Deepest point, main creek channel, immed. upstream of Alabama Hwy 63 bridge.	5 μg/L	32.7428	-85.9649
190	Tallapoosa	MARE-4	Upper	Tallapoosa R	Upper reservoir. Deepest point, main river channel, upstream of Wind Creek State Park.		32.8775	-85.9013
190	Tallapoosa	MARE-5	Upstream 280	Tallapoosa R	Upstream 280. Deepest point, main river channel, approx. 0.5 miles upstream of Coley Creek embayment.		32.9336	-85.8669
170	Tallapoosa	MARE-6	Hillabee Cr	Hillabee Cr	Deepest point, main creek channel, Hillabee Creek embayment, approx. 0.5 miles upstream of lake confluence.		32.9650	-85.8444
190	Tallapoosa	MARE-7	Coley Cr	Coley Cr	Deepest point, main creek channel, Coley Creek embayment, approx. 0.5 miles upstream of lake confluence.		32.9264	-85.8778
190	Tallapoosa	MARE-8	Elkahatchee Cr	Elkahatchee Cr	Deepest point, main creek channel, Elkahatchee Creek embayment, approx. 0.5 miles downstream of Elkahatchee/Sugar Creek confluence.		32.8781	-85.9436
180	Tallapoosa	MARE-9	Manoy Cr	Manoy Cr	Deepest point, main creek channel, Manoy Creek embayment, approx. 1.0 mile upstream of lake confluence.		32.8339	-85.8414
200	Tallapoosa	MARE-10	Sandy Cr	Sandy Cr	Deepest point, main creek channel, Sandy Creek embayment, approx. 1.0 mile upstream of lake confluence.		32.8039	-85.8539
210	Tallapoosa	MARE-11	Blue Cr	Blue Cr	Deepest point, main creek channel, Blue Creek embayment, approx. 2.0 miles upstream of lake confluence.		32.7419	-85.8531

*Growing season mean chl. *a* criteria implemented at the station in 2002

RESULTS

Summary statistics of the 2005 data are presented in Appendix Table 1. The table contains the min, max, median, average, and standard deviation of each parameter analyzed. Seasonal mean concentrations of TN, TP, chl *a*, and TSS are presented in Fig. 2. Monthly concentrations of these parameters are also presented for the Upstream 280 (Fig. 3), Upper (Fig. 4), Mid (Fig. 5), Kowaliga (Fig. 6), and Lower (Fig. 7) stations. Fig. 8 compares mean concentrations of chl *a* at the mainstem stations, 1997-2005.

Mainstem Stations: The highest seasonal mean TN concentration was measured at the Upstream 280 station in both 2000 and 2005 (Fig. 2; ADEM 2003). Monthly TN concentrations at Upstream 280 station, from June-September, were at the top of historic means (Fig. 3). Other mainstem stations were highest in Jun or September and lowest in October (Fig. 4, 5, 6 & 7) Mean TP concentrations were similar across the reservoir (Fig. 2). While the other mainstem stations monthly TP concentrations were variable throughout the season, the Lower station remained below historic monthly means for 6 of the 7 months (Fig. 7). Comparison of the 2000 and 2005 seasonal means of chl *a* and TSS concentrations showed most values were slightly higher in 2005 (Fig. 2; ADEM 2003). The mid, Kowaliga, and lower stations monthly chl *a* concentrations were generally higher than historic means (Fig. 5). Seasonal mean chl *a* concentrations at the downstream mainstem locations were among the highest measured from 1997-2005 (Fig. 8). In addition, the Mid station seasonal chl *a* mean exceeded established criteria in 2003 and 2005 (Fig. 8).

AGPT results indicated all but the Upper station were phosphorous limited, similar to the 2000 results (Table 2). The Upper station was nitrogen/phosphorus co-limited in 2005, and nitrogen limited in 2000. Mean standing crop (MSC) values for all stations were below 5 mg/l, the value considered protective in reservoir and lakes (Raschke and Schultz 1987). Values were slightly higher than those from the 2000 sampling season.

Dissolved oxygen concentrations were stratified at all mainstem stations except the Upstream 280 station, which is more riverine than the other stations (Fig. 9). Warmest water temperatures were reached in August and September (Fig. 9). Dissolved oxygen concentrations were above the ADEM Water Criteria (ADEM Admin. Code R. 335-6-10-.09) limit of 5.0 mg/l

for all stations in all months. Monthly TSI values were calculated using chl *a* and the Carlson's TSI. The upper station was mostly eutrophic while the remaining mainstem stations were mostly mesotrophic throughout the season (Fig. 11). August TSI values over the past 20 years indicate a slight upward trend (Fig. 12).

Tributary Stations: The highest mean TN and chl *a* concentrations were found in the Coley Creek tributary in the upper part of the reservoir. The mean TN and chl *a* were more than double the concentration at most other stations (Fig. 2). Mean TP was highest in Sandy Creek, with Coley Creek second highest. The tributary with the lowest TP and chl *a* parameters was Blue Creek (Fig. 2). Mean TSS was highest in Hillabee Creek, located in the upper portion of the reservoir, while the lower tributaries exhibited much lower mean concentrations (Fig. 2). Dissolved oxygen concentrations remained above the ADEM Water Quality Criteria (ADEM Admin. Code R. 335-6-10-.09) limit of 5.0 mg/l for all stations in all months (Fig. 10). TSI values tended to be in the middle to upper eutrophic range in Coley and Elkahatchee Creeks while Manoy and Sandy Creeks were in the lower eutrophic range. Blue and Hillabee Creeks were mostly mesotrophic (Fig. 11).

Figure 2. Mean total nitrogen (TN), mean total phosphorus (TP), mean chlorophyll *a* (chl *a*), and mean total suspended solids (TSS) of all stations in Martin Reservoir, April-October 2005. Bar graphs consist of multiple stations, illustrated from upstream to downstream as the graph is read from left to right. The blue bars represent mainstem stations; tributary stations are in green.

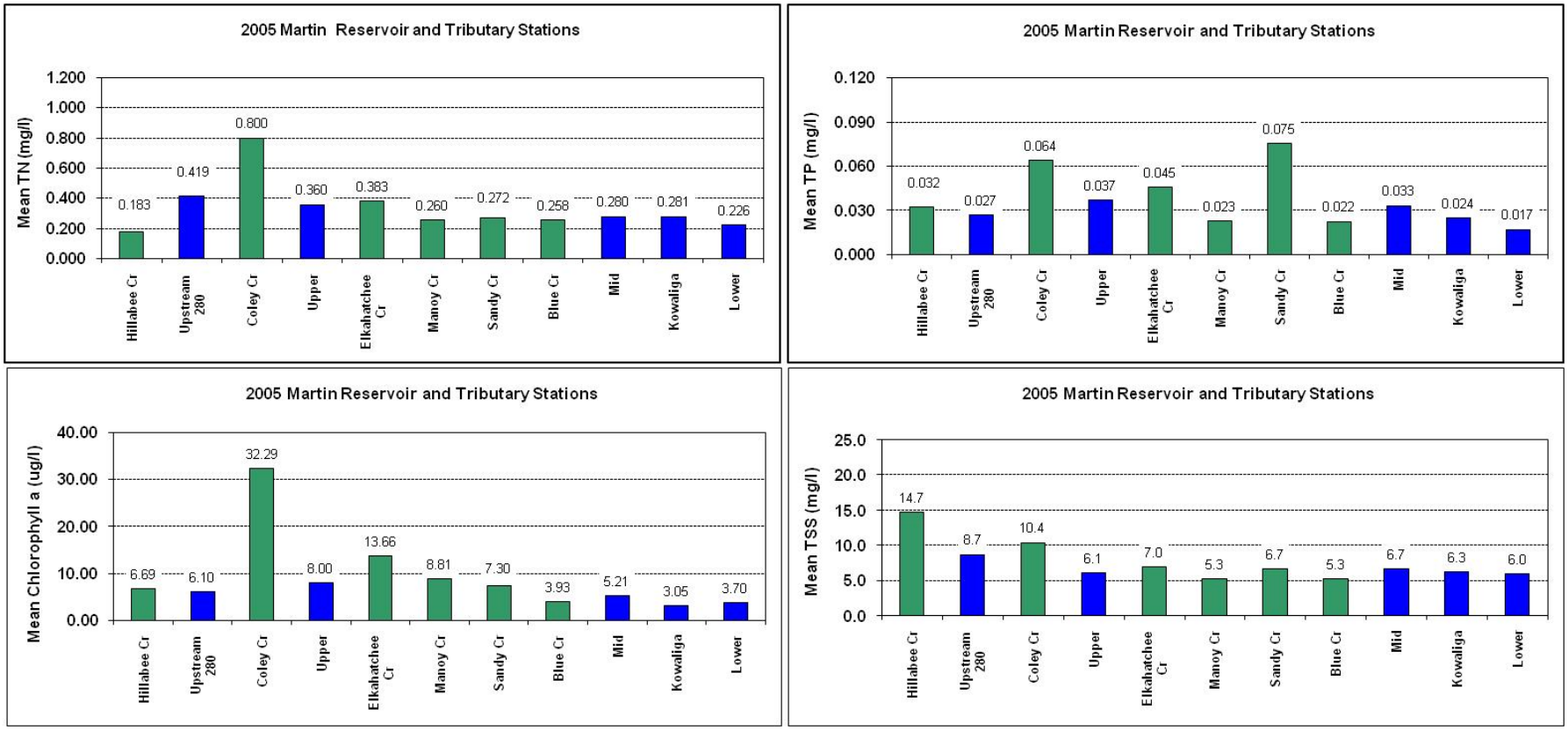
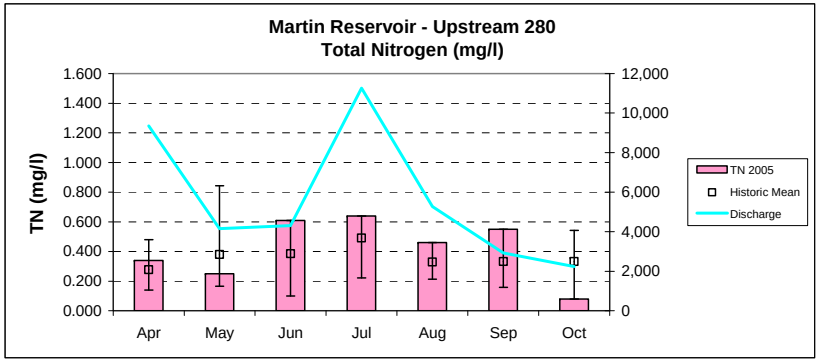
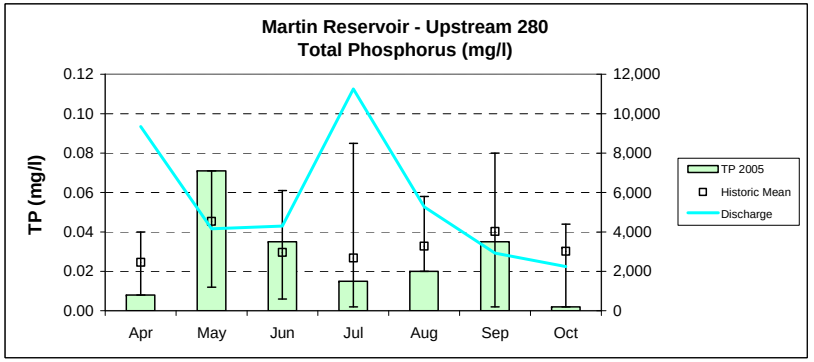
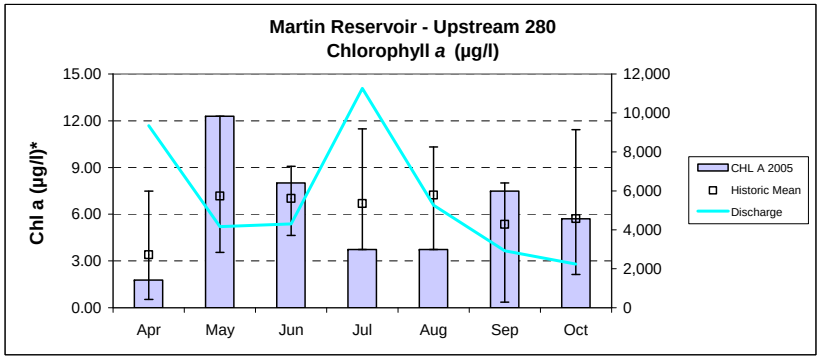


Figure 3. Total nitrogen (TN), total phosphorus (TP), chlorophyll *a* (chl *a*), and total suspended solids (TSS) of the Upstream 280 station, April-October 2005. Monthly bar graphs for the Upstream 280 station depict changes in the variables, with the historic mean and min/max range displayed for comparison. Nutrients and TSS were plotted vs. discharge (Martin Dam discharge data).







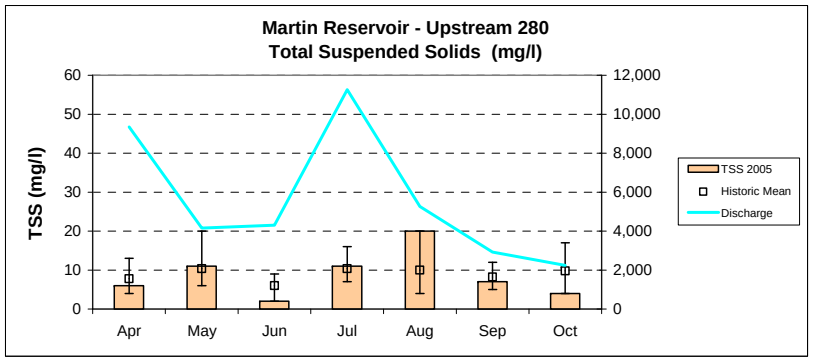
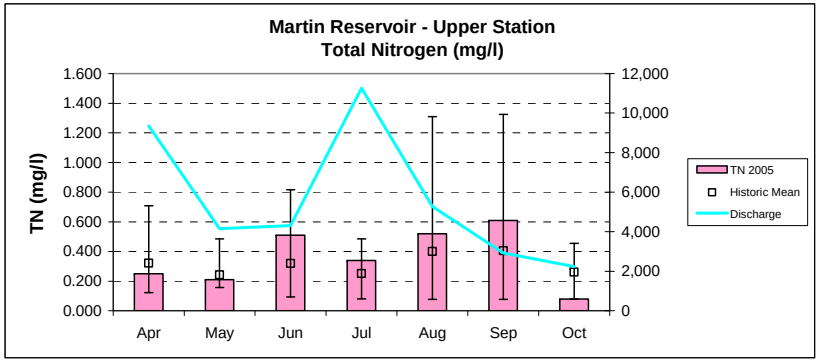
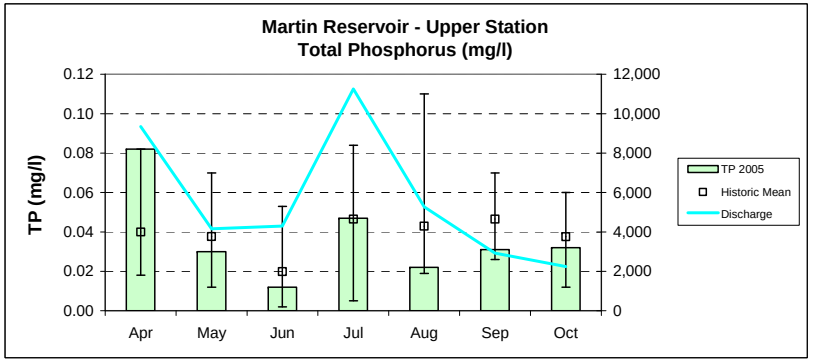
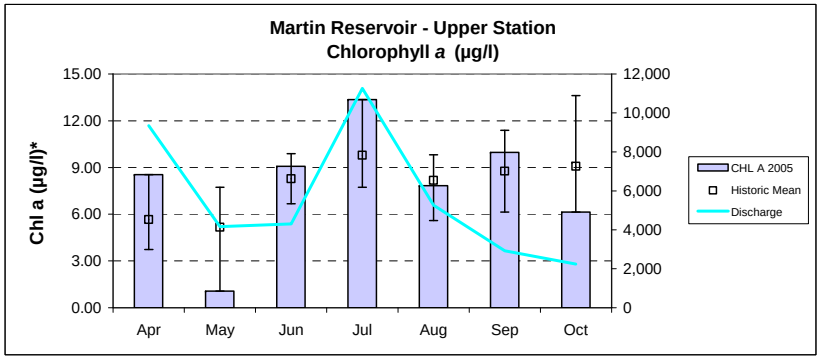


Figure 4. Total nitrogen (TN), total phosphorus (TP), chlorophyll *a* (chl *a*), and total suspended solids (TSS) of the Upper station, April-October 2005. Monthly bar graphs for the Upper station depict changes in the variables, with the historic mean and min/max range displayed for comparison. Nutrients and TSS were plotted vs. discharge (Martin Dam discharge data).







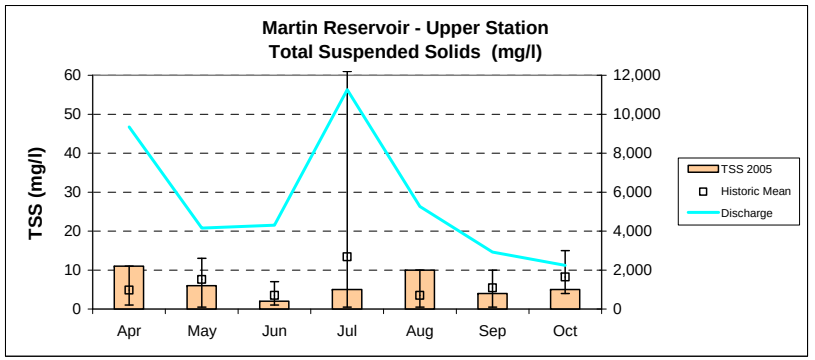


Figure 5. Total nitrogen (TN), total phosphorus (TP), chlorophyll *a* (chl *a*), and total suspended solids (TSS) of the Mid station, April-October 2005. Monthly bar graphs for the Mid station depict changes in the variables, with the historic mean and min/max range displayed for comparison. Nutrients and TSS were plotted vs. discharge (Martin Dam discharge data).

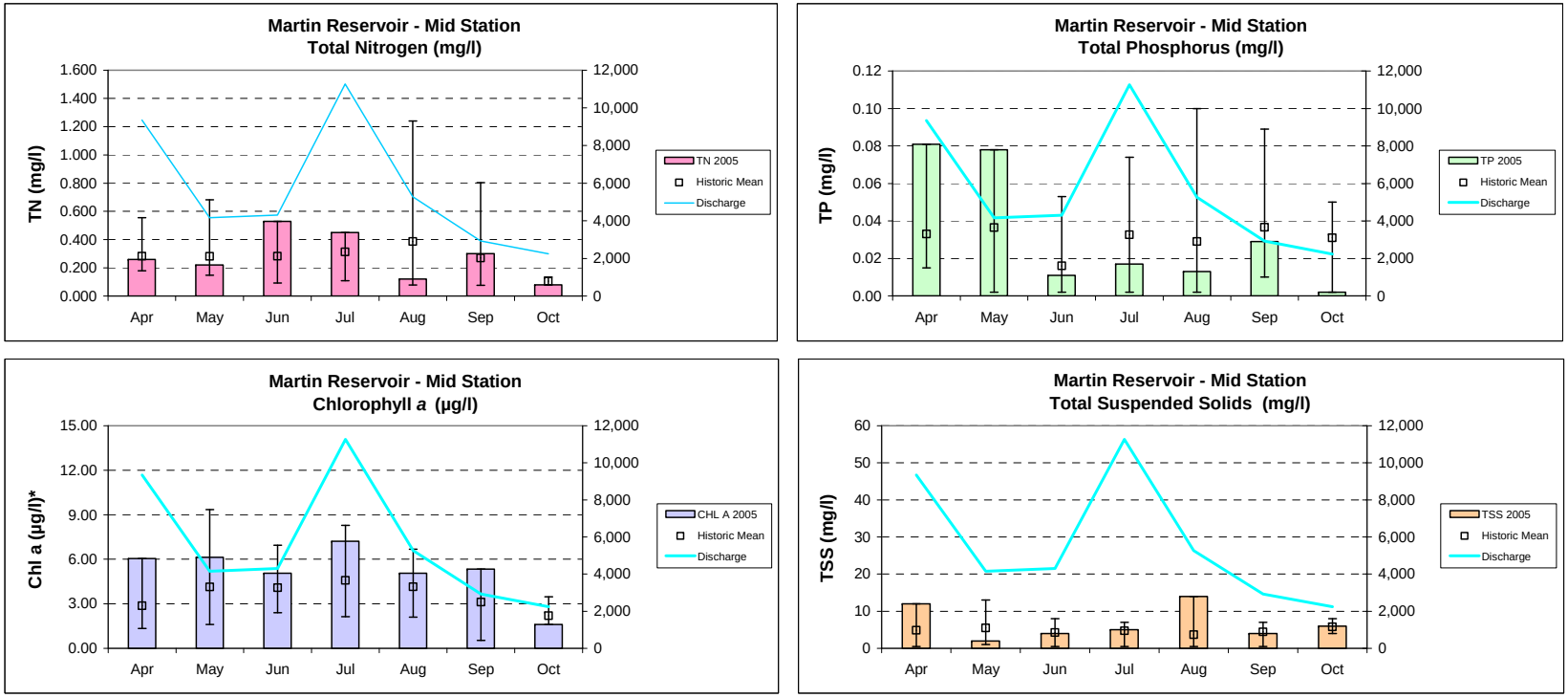
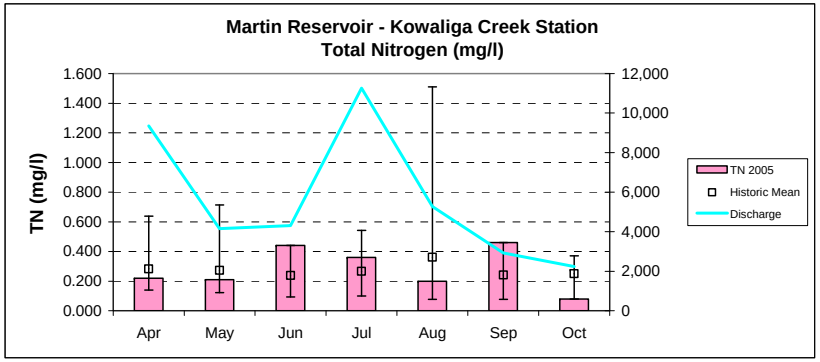
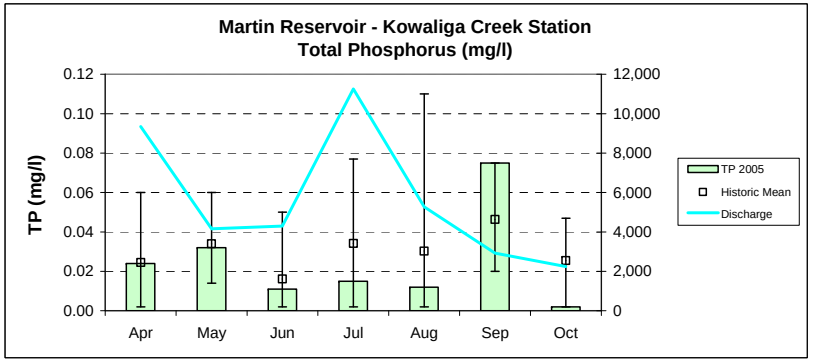
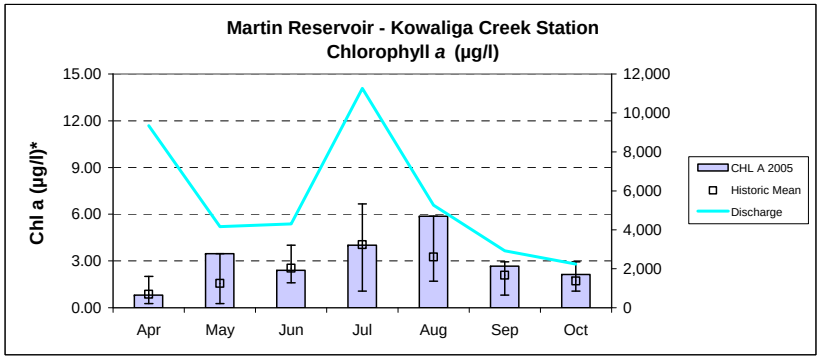


Figure 6. Total nitrogen (TN), total phosphorus (TP), chlorophyll *a* (chl *a*), and total suspended solids (TSS) of the Kowaliga station, April-October 2005. Monthly bar graphs for the Kowaliga station depict changes in the variables, with the historic mean and min/max range displayed for comparison. Nutrients and TSS were plotted vs. discharge (Martin Dam discharge data).







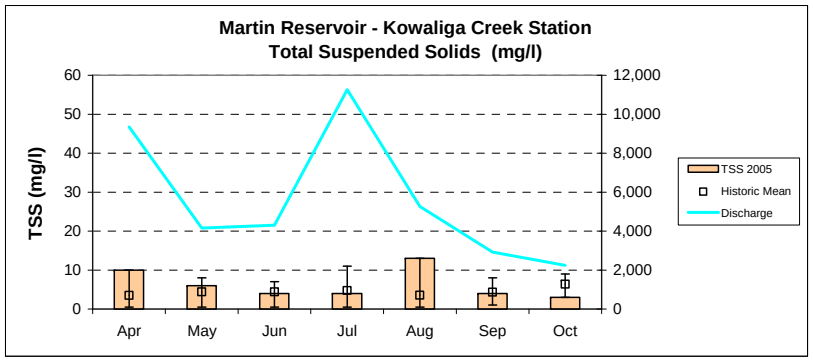
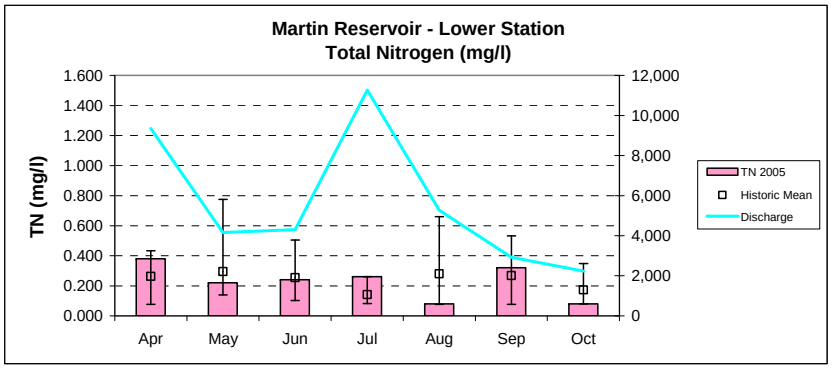
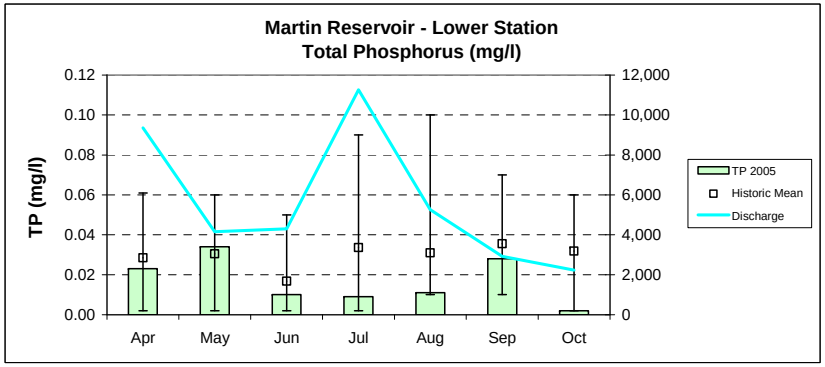
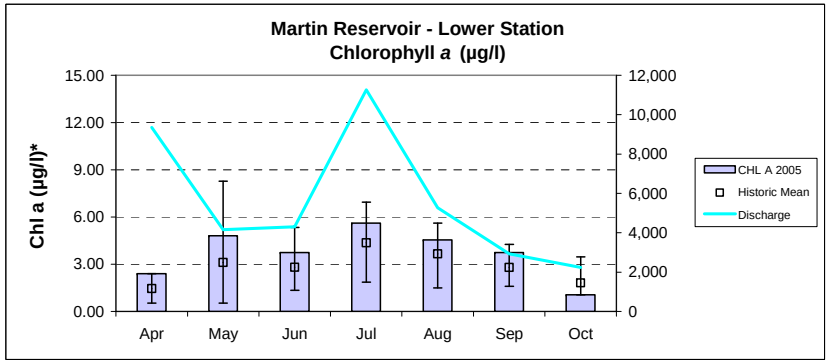


Figure 7. Total nitrogen (TN), total phosphorus (TP), chlorophyll *a* (chl *a*), and total suspended solids (TSS) of the dam forebay station, April-October 2005. Monthly bar graphs for the Lower station depict changes in the variables, with the historic mean and min/max range displayed for comparison. Nutrients and TSS were plotted vs. discharge (Martin Dam discharge data).







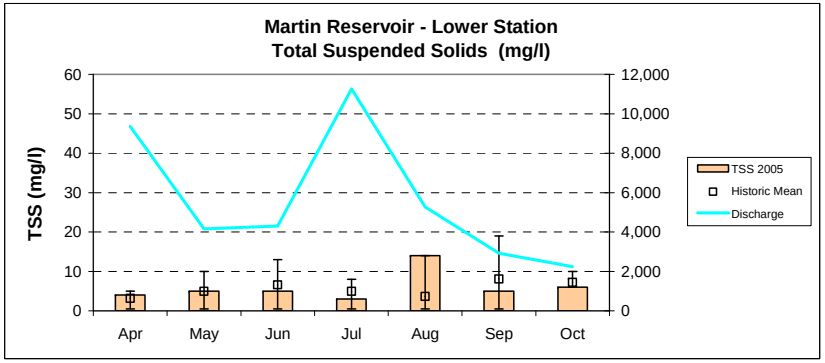
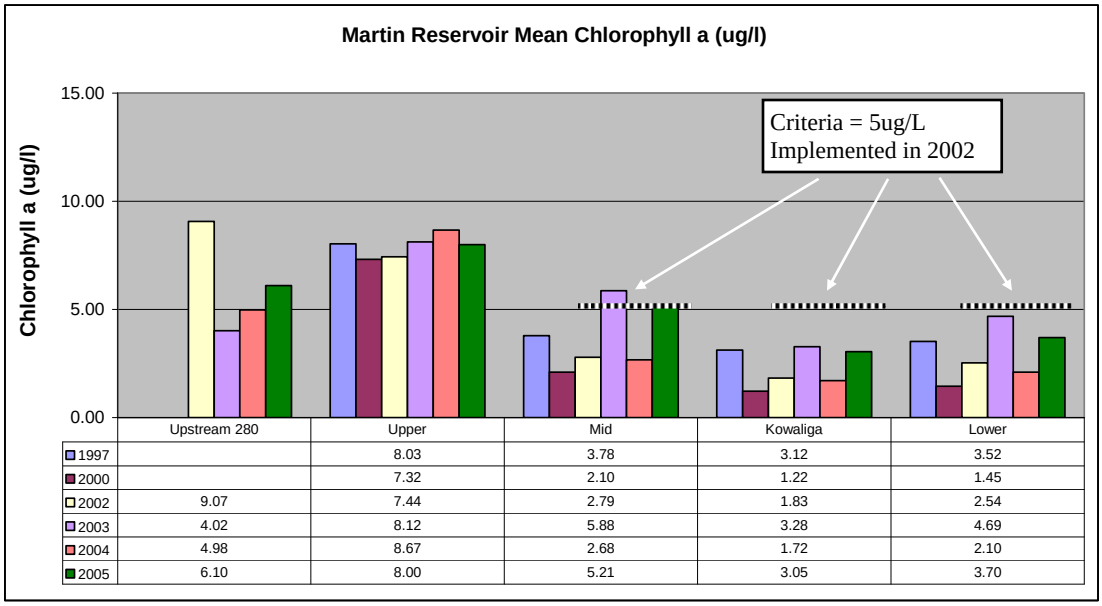


Figure 8. Mean chl *a* concentrations of mainstem Martin Reservoir, 1997 through 2005. Chlorophyll *a* criteria applies to the growing season mean of the Mid, Kowaliga and Lower stations only.



	Upstream 280	Upper	Mid	Kowaliga	Lower
1997		8.03	3.78	3.12	3.52
2000		7.32	2.10	1.22	1.45
2002	9.07	7.44	2.79	1.83	2.54
2003	4.02	8.12	5.88	3.28	4.69
2004	4.98	8.67	2.68	1.72	2.10
2005	6.10	8.00	5.21	3.05	3.70

Table 2. Algal growth potential test results (expressed as mean Maximum Standing Crop (MSC) dry weights of Selenastrum capricornutum in mg/L) and limiting nutrient status. Mean standing crop (MSC) values below 5 mg/l are considered to be protective in reservoirs and lakes (Raschke and Schultz 1987).

Station	2000 Control mean MSC	2000 Limiting Nutrient	2005 Control mean MSC	2005 Limiting Nutrient
Upstream 280	3.20	Phosphorus	4.26	Phosphorus
Upper	3.01	Nitrogen	3.50	Co-Limiting
Kowaliga	1.63	Phosphorus	2.78	Phosphorus
Mid	*	*	2.89	Phosphorus
Lower	1.73	Phosphorus	2.99	Phosphorus

*Lost/damaged sample

Figure 9. Depth profiles of dissolved oxygen (DO) and temperature (temp) in Martin Reservoir, June-September 2005. Although profiles were meaured April-October, these select months were chosen as they represent the warmest water temperatures and most stratified dissolved oxygen concentrations. ADEM Water Quality Criteria pertaining to non-wadeable river and reservoir waters require a DO concentration of 5.0 mg/l at 5.0ft (1.5m)(ADEM Admin. Code R. 335-6-10-.09). Under extreme natural conditions such as drought, the DO concentration may be as low as 4.0 mg/l.

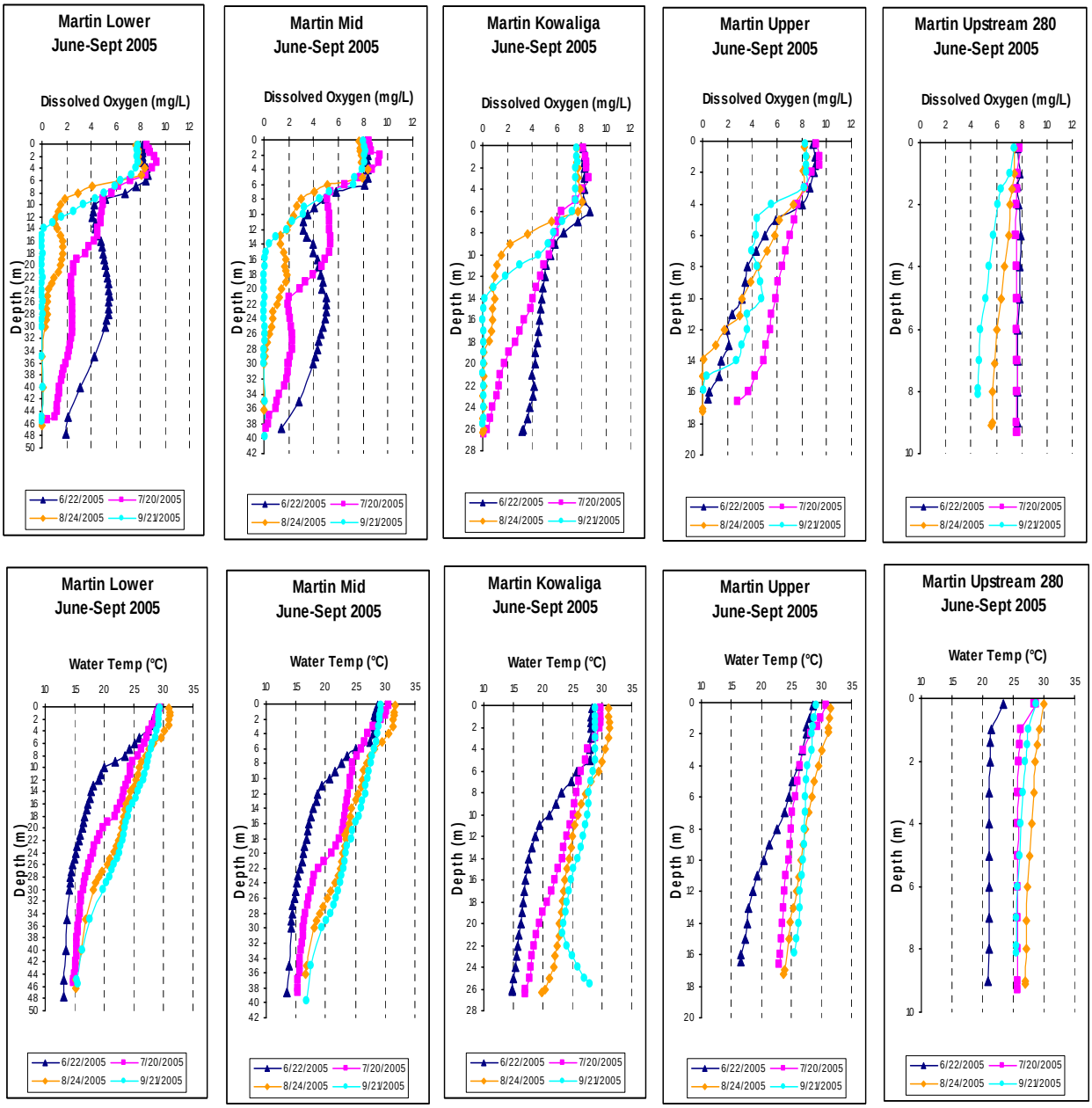


Figure 10. DO concentrations at 5 ft (1.5m) for Martin Reservoir tributaries collected April-October 2005. For tributary embayments, which are typically not as deep as mainstem stations and usually maintain a mixed water column throughout the season, profiles were collected but only the monthly DO concentrations at a depth of 5ft (1.5m) are graphed. ADEM Water Quality Criteria pertaining to reservoir waters require a DO concentration of 5.0 mg/l at this depth (ADEM 2005).

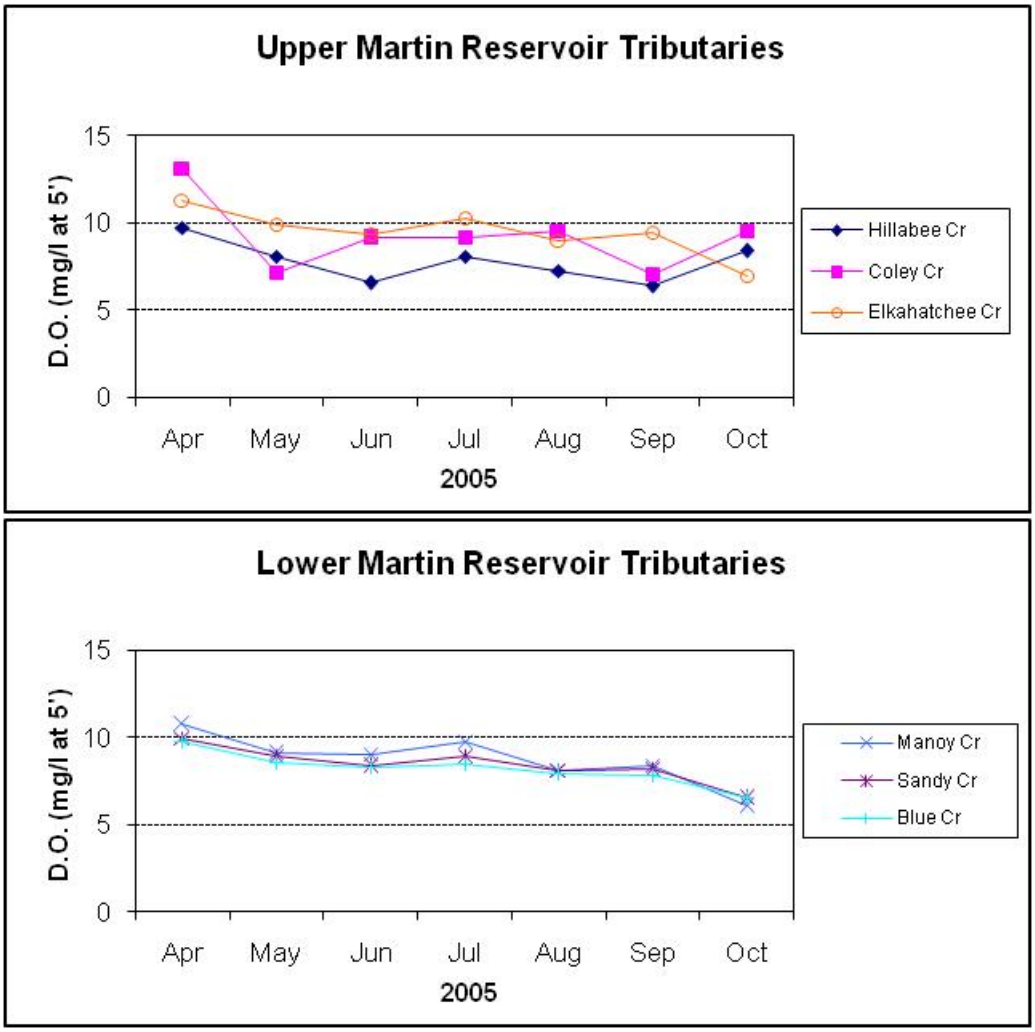
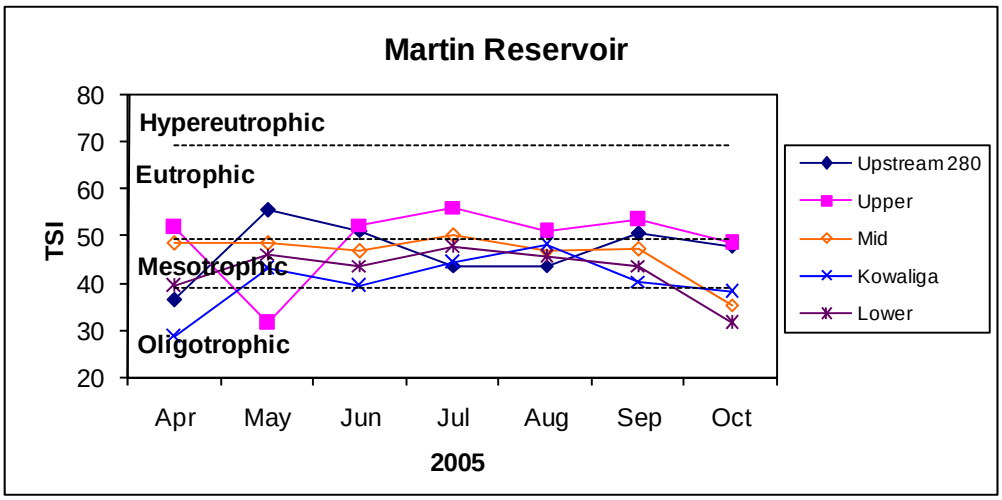
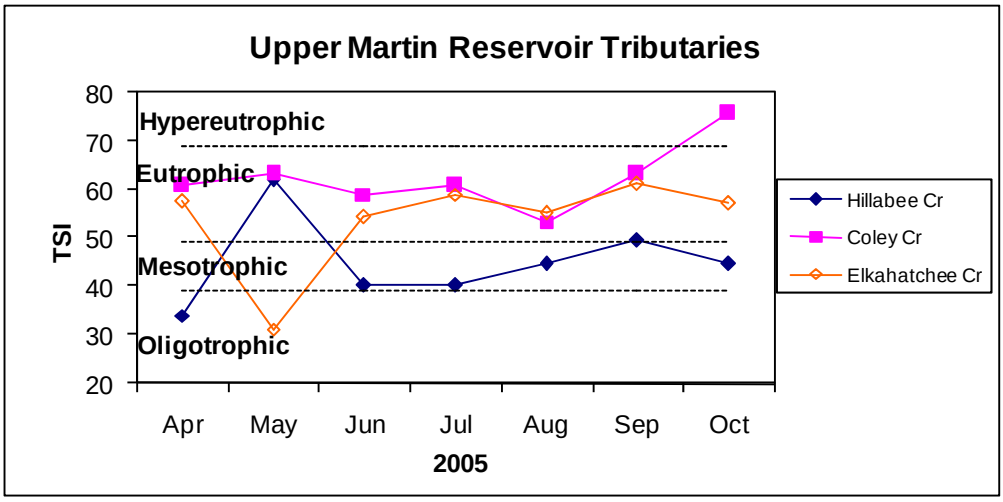


Figure 11. Monthly Trophic State Index (TSI) values for mainstem and tributary stations using chlorophyll *a* concentrations and the Carlson's Trophic State Index calculation, April-October 2005.





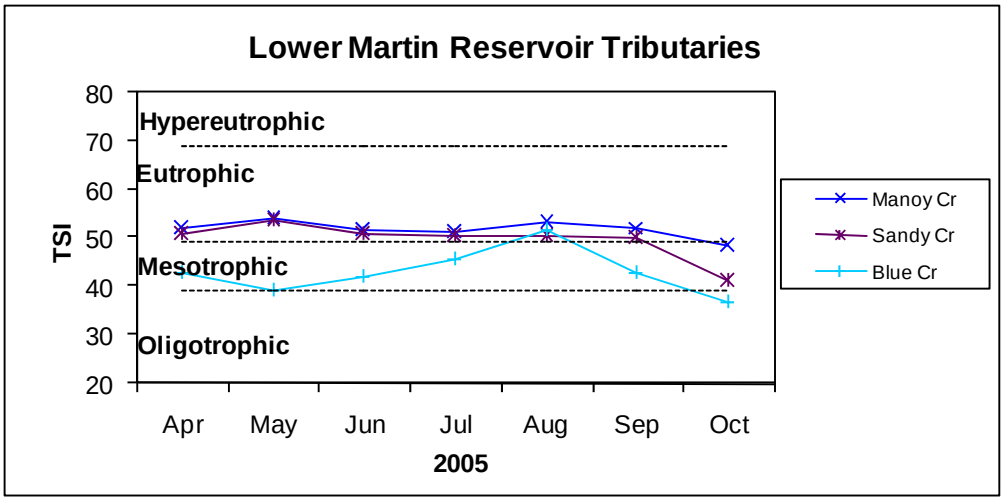
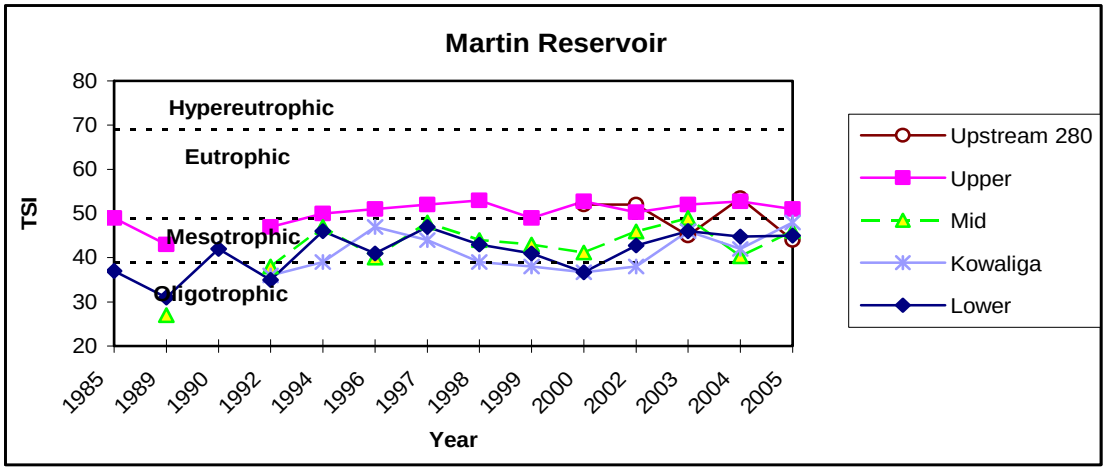


Figure 12. TSI values from critical period sampling (August sampling only) from 1985 to 2005.



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APPENDIX

Appendix Table 1. Summary of water quality data collected April-October, 2005. Minimum (Min) and maximum (Max) values calculated using minimum detection limits (MDL) when results were less than this value. Median (Med), average (Ave), and standard deviations (SD) values were calculated by multiplying the MDL by 0.5 when results were less than this value.

Station	Parameter	N	Min	Max	Median	Avg	SD
MARE-1	Alkalinity (mg/L)	7	9.7	28.2	10.3	12.8	6.8
	Hardness (mg/L)	4	9.0	10.6	10.5	10.1	0.7
	Total Dissolved Solids (mg/L)	7	4.0	51.0	45.0	38.6	16.5
	Total Suspended Solids (mg/L)	7	3	14	5	6	4
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.030	0.008	0.013	0.010
	Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.003	0.200	0.011	0.055	0.082
	Total Kjeldahl Nitrogen (mg/L)	7	< 0.150	0.308	0.180	0.169	0.096
	Total Nitrogen (mg/L)	7	< 0.080	0.380	0.240	0.226	0.113
	Total Phosphorus (mg/L)	7	< 0.004	0.034	0.011	0.017	0.012
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.012	0.007	0.007	0.005
	Chlorophyll *a* (mg/L)[J]	7	1.07	5.61	3.74	3.70	1.54
	Turbidity (NTU)	7	1	4	2	2	1
	Secchi (m)	7	2.29	4.77	3.51	3.62	0.83
	Fecal Coliform (col/100 mL)	1	---	---	---	1	---
MARE-2	Alkalinity (mg/L)	7	8.8	23.7	10.4	12.1	5.2
	Hardness (mg/L)	3	9.5	10.2	9.9	9.9	0.4
	Total Dissolved Solids (mg/L)	7	18.0	51.0	45.0	39.7	12.0
	Total Suspended Solids (mg/L)	7	2	14	5	7	4
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.027	0.008	0.013	0.009
	Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.003	0.189	0.043	0.070	0.073
	Total Kjeldahl Nitrogen (mg/L)	7	< 0.150	0.450	0.075	0.210	0.174
	Total Nitrogen (mg/L)	7	< 0.080	0.530	0.260	0.280	0.164
	Total Phosphorus (mg/L)	7	< 0.004	0.081	0.017	0.033	0.033
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.011	0.008	0.007	0.005
	Chlorophyll *a* (mg/L)[J]	7	1.60	7.21	5.34	5.21	1.76
	Turbidity (NTU)	7	2	6	2	3	2
	Secchi (m)	7	1.42	4.46	3.63	3.42	1.04
	Fecal Coliform (col/100 mL)	1	---	---	---	1	---
MARE-3	Alkalinity (mg/L)	7	9.4	28.6	10.9	13.2	6.8
	Hardness (mg/L)	4	9.0	9.9	9.7	9.6	0.4
	Total Dissolved Solids (mg/L)	7	5.0	61.0	44.0	41.3	18.8
	Total Suspended Solids (mg/L)	7	3	13	4	6	4
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.018	0.008	0.010	0.005
	Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.003	0.141	0.018	0.046	0.062
	Total Kjeldahl Nitrogen (mg/L)	7	< 0.150	0.456	0.198	0.233	0.167
	Total Nitrogen (mg/L)	7	< 0.080	0.460	0.220	0.281	0.141
	Total Phosphorus (mg/L)	7	< 0.004	0.075	0.015	0.024	0.024
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.014	0.004	0.006	0.005
	Chlorophyll *a* (mg/L)[J]	7	0.80	5.87	2.67	3.05	1.61
	Turbidity (NTU)	7	1	3	2	2	1
	Secchi (m)	7	3.24	5.16	3.71	3.86	0.65
	Fecal Coliform (col/100 mL)	1	---	---	---	1	---

Station	Parameter	N	Min	Max	Median	Avg	SD
MARE-4	Alkalinity (mg/L)	7	9.2	26.8	10.5	14.5	7.4
	Hardness (mg/L)	4	8.0	10.4	9.7	9.4	1.2
	Total Dissolved Solids (mg/L)	7	29.0	72.0	46.0	45.4	13.5
	Total Suspended Solids (mg/L)	7	2	11	5	6	3
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.015	0.008	0.008	---
	Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.003	0.179	0.045	0.067	0.067
	Total Kjeldahl Nitrogen (mg/L)	7	< 0.150	0.608	0.271	0.293	0.226
	Total Nitrogen (mg/L)	7	< 0.080	0.610	0.340	0.360	0.193
	Total Phosphorus (mg/L)	7	0.012	0.082	0.031	0.037	0.023
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.014	0.011	0.009	0.005
	Chlorophyll *a* (mg/L)[J]	7	1.07	13.35	8.54	8.00	3.77
	Turbidity (NTU)	7	2	7	4	5	2
	Secchi (m)	7	1.38	2.54	1.62	1.79	0.42
	Fecal Coliform (col/100 mL)	1	---	---	---	1	---
MARE-5	Alkalinity (mg/L)	7	9.0	24.9	12.0	13.2	5.4
	Hardness (mg/L)	4	9.6	12.4	10.8	10.9	1.5
	Total Dissolved Solids (mg/L)	7	33.0	62.0	42.0	44.4	11.0
	Total Suspended Solids (mg/L)	7	2	20	7	9	6
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.342	0.008	0.055	0.126
	Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.003	0.187	0.148	0.118	0.068
	Total Kjeldahl Nitrogen (mg/L)	7	< 0.150	0.541	0.312	0.300	0.193
	Total Nitrogen (mg/L)	7	< 0.080	0.640	0.460	0.419	0.206
	Total Phosphorus (mg/L)	7	< 0.004	0.071	0.020	0.027	0.023
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.013	0.005	0.006	0.005
	Chlorophyll *a* (mg/L)[J]	7	1.78	12.28	5.70	6.10	3.50
	Turbidity (NTU)	7	7	15	13	12	3
	Secchi (m)	7	0.66	1.46	0.98	1.01	0.24
	Fecal Coliform (col/100 mL)	1	---	---	---	48	---
MARE-6	Alkalinity (mg/L)	7	9.3	27.7	12.0	14.0	6.2
	Hardness (mg/L)	4	6.8	11.1	10.1	9.5	1.9
	Total Dissolved Solids (mg/L)	7	22.0	51.0	40.0	38.3	10.6
	Total Suspended Solids (mg/L)	7	5	24	17	15	8
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.020	0.008	0.011	0.005
	Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.003	0.114	0.058	0.059	0.035
	Total Kjeldahl Nitrogen (mg/L)	7	< 0.150	0.268	0.075	0.124	0.084
	Total Nitrogen (mg/L)	7	< 0.080	0.320	0.160	0.183	0.091
	Total Phosphorus (mg/L)	7	< 0.004	0.069	0.032	0.032	0.021
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.013	0.006	0.006	0.005
	Chlorophyll *a* (mg/L)[J]	7	1.42	24.56	4.27	6.69	8.07
	Turbidity (NTU)	7	7	36	23	21	11
	Secchi (m)	7	0.51	1.56	0.77	0.86	0.37
	Fecal Coliform (col/100 mL)	1	---	---	---	72	---

Station	Parameter	N	Min	Max	Median	Avg	SD
MARE-7	Alkalinity (mg/L)	7	12.5	25.9	15.7	17.0	4.4
	Hardness (mg/L)	4	11.1	15.8	12.6	13.0	2.0
	Total Dissolved Solids (mg/L)	7	25.0	84.0	48.0	54.0	22.5
	Total Suspended Solids (mg/L)	7	5	21	9	10	6
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.015	0.008	0.008	---
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.147	0.634	0.371	0.346	0.170
	Total Kjeldahl Nitrogen (mg/L)	7	0.275	0.675	0.445	0.453	0.146
	Total Nitrogen (mg/L)	7	0.440	1.310	0.820	0.800	0.282
	Total Phosphorus (mg/L)	7	0.020	0.085	0.060	0.064	0.023
	Dissolved Reactive Phosphorus (mg/L)	7	0.005	0.024	0.015	0.015	0.007
	Chlorophyll *a* (mg/L)[J]	7	10.15	98.41	21.89	32.29	29.77
	Turbidity (NTU)	7	7	20	13	12	4
	Secchi (m)	7	0.75	1.52	0.96	1.01	0.28
	Fecal Coliform (col/100 mL)	1	---	---	---	5	---
MARE-8	Alkalinity (mg/L)	7	12.7	27.4	14.5	18.1	5.9
	Hardness (mg/L)	4	10.9	12.0	11.2	11.3	0.5
	Total Dissolved Solids (mg/L)	7	31.0	73.0	48.0	49.3	14.5
	Total Suspended Solids (mg/L)	7	2	15	7	7	4
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.015	0.008	0.008	---
	Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.003	0.049	0.002	0.014	0.018
	Total Kjeldahl Nitrogen (mg/L)	7	< 0.150	0.601	0.423	0.369	0.195
	Total Nitrogen (mg/L)	7	< 0.080	0.600	0.460	0.383	0.202
	Total Phosphorus (mg/L)	7	0.014	0.096	0.037	0.045	0.028
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.012	0.004	0.005	0.004
	Chlorophyll *a* (mg/L)[J]	7	1.07	22.43	14.95	13.66	6.69
	Turbidity (NTU)	7	2	7	4	4	2
	Secchi (m)	7	0.95	2.14	1.57	1.62	0.42
	Fecal Coliform (col/100 mL)	1	---	---	---	1	---
MARE-9	Alkalinity (mg/L)	7	9.9	12.9	11.3	11.3	1.1
	Hardness (mg/L)	4	8.7	12.2	10.5	10.4	1.4
	Total Dissolved Solids (mg/L)	7	31.0	99.0	36.0	47.6	24.7
	Total Suspended Solids (mg/L)	7	3	7	6	5	2
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.122	0.008	0.025	0.043
	Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.003	0.139	0.029	0.049	0.055
	Total Kjeldahl Nitrogen (mg/L)	6	< 0.150	0.405	0.189	0.208	0.133
	Total Nitrogen (mg/L)	6	< 0.080	0.410	0.270	0.260	0.116
	Total Phosphorus (mg/L)	7	< 0.004	0.038	0.024	0.022	0.013
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.026	0.009	0.010	0.009
	Chlorophyll *a* (mg/L)[J]	7	6.14	10.95	8.90	8.81	1.49
	Turbidity (NTU)	7	2	6	2	3	2
	Secchi (m)	7	1.24	3.23	2.10	2.25	0.67
	Fecal Coliform (col/100 mL)	1	---	---	---	1	---

Station	Parameter	N	Min	Max	Median	Avg	SD
MARE-10	Alkalinity (mg/L)	7	9.6	12.6	10.8	10.8	1.0
	Hardness (mg/L)	4	8.12	11.40	9.32	9.54	1.38
	Total Dissolved Solids (mg/L)	7	21.0	57.0	35.0	38.0	13.7
	Total Suspended Solids (mg/L)	7	4	11	7	7	3
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.048	0.008	0.017	0.015
	Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.003	0.168	0.05	0.071	0.065
	Total Kjeldahl Nitrogen (mg/L)	6	< 0.150	0.485	0.179	0.206	0.152
	Total Nitrogen (mg/L)	6	< 0.080	0.490	0.255	0.272	0.138
	Total Phosphorus (mg/L)	7	0.022	0.322	0.033	0.075	0.109
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.014	0.006	0.007	0.005
	Chlorophyll *a* (mg/L)[J]	7	2.94	10.41	7.48	7.30	2.21
	Turbidity (NTU)	7	1.74	16.30	2.11	4.34	5.30
	Secchi (m)	7	0.94	3.65	2.95	2.66	0.88
	Fecal Coliform (col/100 mL)	1	---	---	---	2	---
MARE-11	Alkalinity (mg/L)	7	10.1	16.8	10.9	11.6	2.3
	Hardness (mg/L)	4	8.07	11.10	9.33	9.46	1.34
	Total Dissolved Solids (mg/L)	7	29.0	105.0	40.0	50.1	25.6
	Total Suspended Solids (mg/L)	7	3	7	5	5	1
	Ammonia Nitrogen (mg/L)	7	< 0.015	0.024	0.008	0.012	0.007
	Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.003	0.191	0.052	0.073	0.074
	Total Kjeldahl Nitrogen (mg/L)	6	< 0.150	0.252	0.195	0.183	0.061
	Total Nitrogen (mg/L)	6	0.160	0.380	0.245	0.258	0.081
	Total Phosphorus (mg/L)	7	< 0.004	0.038	0.019	0.022	0.013
	Dissolved Reactive Phosphorus (mg/L)	7	< 0.004	0.007	0.004	0.004	0.002
	Chlorophyll *a* (mg/L)[J]	7	1.87	8.54	3.47	3.93	2.20
	Turbidity (NTU)	7	1.66	5.54	2.22	2.60	1.36
	Secchi (m)	7	2.07	3.63	3.50	3.14	0.59
	Fecal Coliform (col/100 mL)	1	---	---	---	1	---

J=one or more of the values provided are estimated; < = Actual value is less than the detection limit;