WALTON COUNTY COASTAL DUNE LAKES WATER CHEMISTRY SUMMARY 2019

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April 15, 2020

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Overview Northwest Florida Coastal Dune Lakes

Lakes, located along coastlines across the globe, are frequently referred to as coastal dune lakes. Coastal dune lakes, however, are rare as they are found only in select areas of the globe, such as Australia, New Zealand, and the pacific northwest of the United States. Northwest Florida is home to numerous coastal dune lakes with the Walton County Dune Lake Advisory Board identifying 18 named coastal dune lakes in Walton County, Florida. This report also includes monitoring data on Tresca Lake, bringing the total count to 19 lakes. Due to the global scarcity, Northwest Florida's coastal dune lakes have been listed as imperiled by the Florida Natural Areas Inventory.

Northwest Florida coastal dune lakes are located within two miles of the coastline with intermittent hydrologic connection to the Gulf of Mexico. These hydrologic connections are known as outlets, or outfalls. When lake level reach flood stage, its waters breach through the sand dunes and flow into the Gulf of Mexico. Typically, lake levels and subsequent outlet openings are dependent on precipitation, runoff, and groundwater conditions. However, strong winds, tides or storms can cause the outlet to open and saltwater inflow or overwash from the Gulf of Mexico to occur.

Coastal dune lakes of Northwest Florida reside within the geomorphological province of the Gulf Coastal Lowlands, where undifferentiated siliciclastic sediments occur in significant thickness (less than 6.1 meters). Walton County southern coastline is made up of Holocene sediments consisting of quartz sand, carbonate sands and muds, and organics. This area of Florida resides in the Coastal Strip division of the Apalachicola Delta District, built by sediments deposited by the Apalachicola River. Sediments are composed of medium fine sand, silty sand, silt, and clay representing estuarine facies of the Biloxi Formation. Geologic characteristics may influence the shape of the waterbody basin and, also, contribute to chemical characteristics and trophic state composition of the waterbody (Canfield and Hoyer 1986).

Differences in chemical composition of lakes in Florida are furthered explained by lake regions designations specific for the State of Florida. Lake regions of Florida include physical, chemical, and ecological components outlining regions with homogeneity among lake characteristics. Northwest Florida's coastal dune lakes occur in the Gulf Coast Lowlands Lake Region within the East Gulf Coastal Plain Ecoregion. Majority of lakes within these regions are acidic, softwater lakes containing high concentrations of dissolved organic carbons and low to moderate nutrients, comparatively. Coastal dune lakes have higher sulfate, sodium, and chloride levels than inland lakes, and can quickly decrease or increase in salt content depending on shifts in rainfall, saltwater input, or salt spray (Griffith et al. 1997).

Majority of Northwest Florida's coastal dune lake watersheds include water flow through forested and wetland areas, increasing the contribution of dissolved organic carbons and tannic acids to the lake water. Dissolved organic carbons and tannic acids derive from slowly decomposing organic matter, which results in more colored, darker water with an acidic, pH condition.

Total phosphorus (TP) and total nitrogen (TN) zones were developed to broadly highlight differences in lake nutrient concentrations associated with natural influences like geology. Northwest Florida's coastal dune lakes fall within TP Zone 3 and TN Zone 3. Geometric mean total phosphorus concentration for lakes with TP Zone 3 is 19 µg/L with the 95% range of values

being 4 to 39 µg/L. Geometric mean total nitrogen concentration for lakes with TN Zone 3 is 611 µg/L with the 95% range of values being 200 to 1030 µg/L (Bachmann et al. 2012).

Methods of Water Sample and Variable Collection

A combination of physical and chemical variables were collected at each water quality monitoring station. Open water surface samples were collected in the field and analyzed for nutrients, chlorophyll, color and conductivity at University of Florida's Institute of Food and Agricultural Sciences/SFRC Fisheries and Aquatic Sciences LAKEWATCH National Environmental Laboratory Accredited Certified (NELAC) laboratory. Secchi disk vanishing measurements were recorded and submitted to LAKEWATCH laboratory. In addition, multiparameter datasonde equipment collected surface and bottom water chemistry variables.

Water Samples

- One, 250-mL, acid-cleaned, triple-rinsed Nalgene bottle is used to collect a water sample that is analyzed for total phosphorus (µg/L), total nitrogen (µg/L) and analyze color (Pt-Co Units) and conductivity (µS/cm).
- One, 1000-mL, Nalgene bottle is used to collect a water sample for total chlorophyll analysis. Water is filtered through Gelman 47mm Type A-E glass fiber filter.
-

Secchi Disk — measures the attenuation of light within the water column, or transparency, in meters.

Nutrient Concentration Estimation

- **Total Phosphorous (µg/L)** — Sum of all phosphorus compounds in the water column, organic and inorganic, at the time of collection. Phosphorous is an essential nutrient for alga and plant growth.
- **Total Nitrogen (µg/L) —** Sum of the all nitrogen compounds in the water column, organic and inorganic, at the time of collection. Nitrogen is an essential nutrient for alga and plant growth.

Algal Concentration Estimation

- **Total Chlorophyll (µg/L) —** Sum of all chlorophyll (common pigment found in alga frequently used as a proxy for aquatic flora abundance) in the water column at the time of sampling.

Color

- **True Color—** Measurement of the color of the water after particles have been filtered out (Platinum-Cobalt Units). Based on the Alpha-Hazen color scale.

Conductivity

- **Specific Conductance (µS/cm) —** Measurement of the ability of water to conduct electricity. Values reported in micro-Siemens per centimeter at 25˚ Celsius.

Trophic State Index (TSI)

- The trophic state index is a classification system that is used to estimate the biological productivity of a waterbody based on concentrations of nutrients, chlorophyll and secchi disk.

Multiparameter Datasonde—Hydrolab Quanta multiparameter datasonde unit was used to measure physical and chemical variables including temperature (C), specific conductivity (µS/cm), dissolved oxygen (mg/L), pH, salinity (PPS), and turbidity (NTU).

- ***Temperature (˚C)—***Temperature of the waterbody in degrees Celsius.
- ***Dissolved oxygen (mg/L) —*** Concentration of dissolved oxygen in water
- ***pH—*** Measurement of hydrogen ions within the water, which determine how acidic or basic a waterbody is based on a logarithmic scale.
- ***Salinity (PSS) —*** Measurement of dissolved sodium chloride content in the water. Measurements recorded in Practical Salinity Scale
- ***Turbidity (NTU) —*** Measurement of water clarity within the water column. Turbidity is an optical characteristic of water is measured by the amount of light scattered by material in the water. The higher intensity of scattered light, the higher the turbidity.

Walton County Coastal Dune Lakes Morphometry Table

Catchment area, surface area, average depth, max depth and volume for each coastal dune lake as determined by Choctawhatchee Basin Alliance, Mattie M. Kelly Environmental Institute and Florida LAKEWATCH.

Morphometry

Catchment Area (hectare) — Area in which all surface water runoff drains to single point.

Surface Area (hectare) — Sum of waterbody face area.

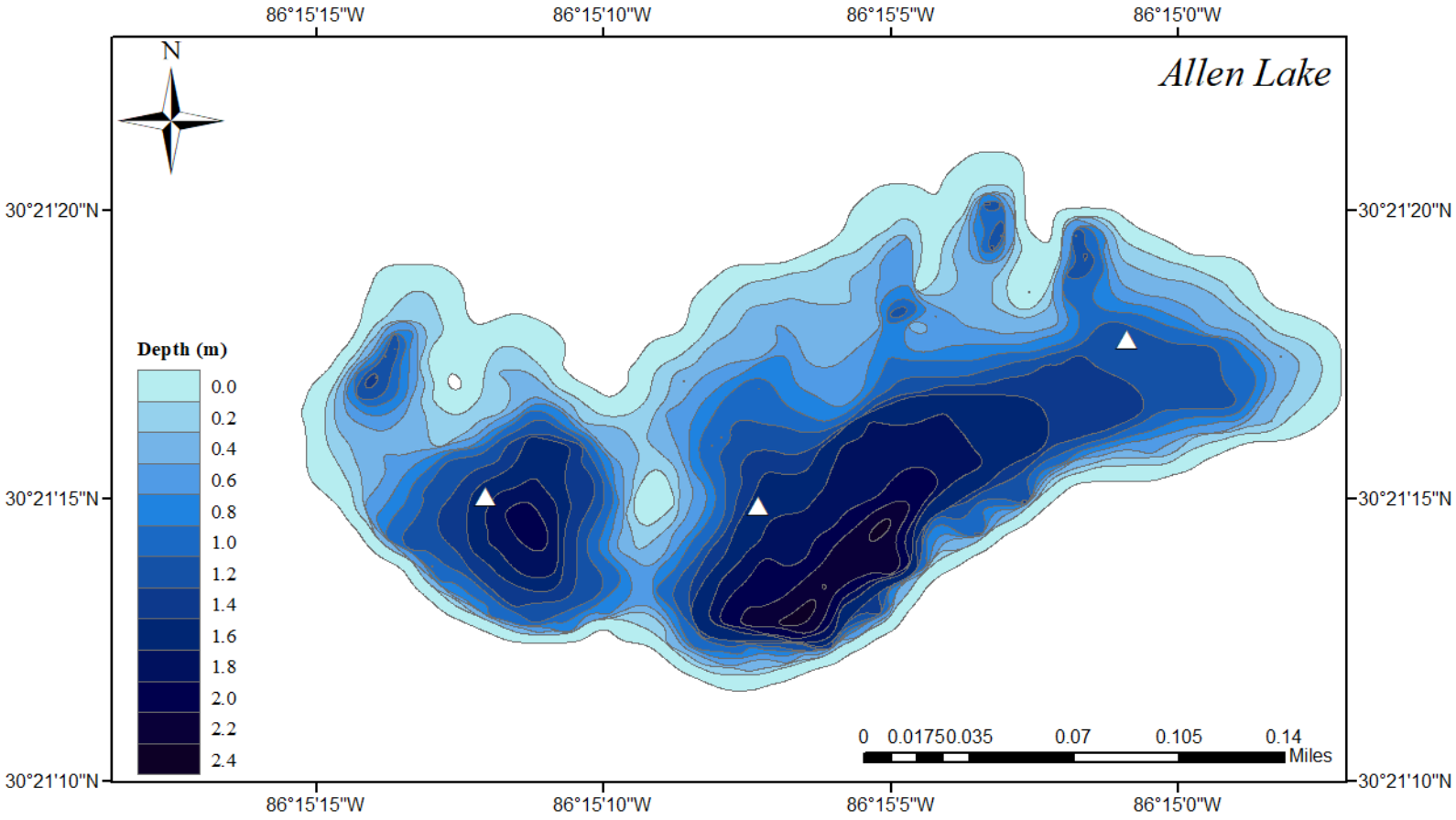
Average Depth (meter) — Mean depth of water column.

Max Depth (meter) — Maximum depth of waterbody.

Volume (cubic meter) —Measurement of the amount of space occupied by waterbody.

Lake	Catchment Area	Surface Area (ha)	Average depth (m)	Max depth (m)	Volume (m^3)	Perimeter (km)	Stations
Allen Lake	71	7.57	1.28	2.53	71000	1.8	3
Alligator Lake	38	5.45	0.94	2.33	42000	2.4	3
Big Red Fish Lake	119	12.40	1.12	1.81	130000	2.7	3
Camp Creek Lake	213	25.58	1.39	2.07	310000	5.1	3
Campbell Lake	NA	44.5	3.14	4.93	1300000	3.8	3
Deer Lake	127	16.9	1.49	2.43	180000	2.7	3
Draper Lake	193	16.32	1.79	3.01	280000	3.6	3
Eastern South Lobe (Eastern Lake)	43	20.56	1.77	2.88	360000	3.3	3
Eastern North Lobe (Eastern Lake)	154	8.50	1.77	2.88	150000	1.7	3
Fuller Lake	43	20.76	1.74	2.84	300000	2.2	3
Grayton Lobe (Western Lake)	275	22.93	1.42	4.45	33000	4.9	3
Little Red Fish Lake	NA	5.02	0.9	1.93	48000	1.4	3
Morris Lake	87	34.67	2.8	4.68	900000	3.1	3
Oyster Lake	56	10.56	1.38	2.16	140000	1.5	3
Powell Lake	730	287.13	2.54	4.98	6600000	21	9
Stallworth Lake	86	5.97	1.44	2.95	81000	1.6	4
Western Bowl Lobe (Western Lake)	275	45.91	1.58	4.78	73000	4.5	3
Western Northeast Lobe (Western Lake)	275	30.00	1.67	2.47	50000	4.4	3

Allen Lake, Walton County



Lake Description

Allen Lake is a primarily isolated, freshwater (0.08 ppt) system laying approximately 200m from the Gulf of Mexico. Among the population of coastal dune lakes, the system is relatively small; with a surface area of 8 hectares (80,000 m^2) and average volume of approximately 71,000 m^3. Long-term water chemistry monitoring for Allen Lake occurs at three stations denoted as white triangles on the map above. Currently, Allen Lake is one of several systems which do not possess a direct connection with the Gulf of Mexico. Although at one time Allen Lake was able to connect to the gulf via an outfall, this characteristic was lost as a direct result of the paving of Highway 30A, which created a barrier between the lake and the gulf. The system is thought to have retained a small measure of connectivity through a culvert connecting to Oyster Lake (Hoyer & Canfield, 2008). However, long-term salinity results suggest that this connection likely does not play a significant role in lake water chemistry.

Water Chemistry Data- 2019

Summary statistics include mean, maximum (Max), minimum (Min), median, and standard error (Std Error) calculated for both surface and bottom measurements for temperature, dissolved oxygen (DO), pH, and salinity, as well as surface measurements total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), secchi depth, as well as. These statistics represent 2019 water chemistry data.

2019 Summary Statistics

	min	mean	max	Std.Error
Temperature top	14.13	24.08	31.44	2
Temperature bottom	13.54	23.13	30.14	2.01
DO (mg/L) top	5.1	6.89	8.5	0.37
DO (mg/L) bottom	2.77	6.12	10.72	0.74
pH top	5.26	5.81	6.15	0.09
pH bottom	4.96	5.5	6.3	0.13
Salinity (ppt) top	0.04	0.04	0.05	0
Salinity (ppt) bottom	0.04	0.04	0.05	0
TP (micrograms/L)	12.56	14.58	17.31	0.58
TN (micrograms/L)	449.33	508.99	564.41	12.24
CHL (micrograms/L)	1.26	3.42	6.65	0.5

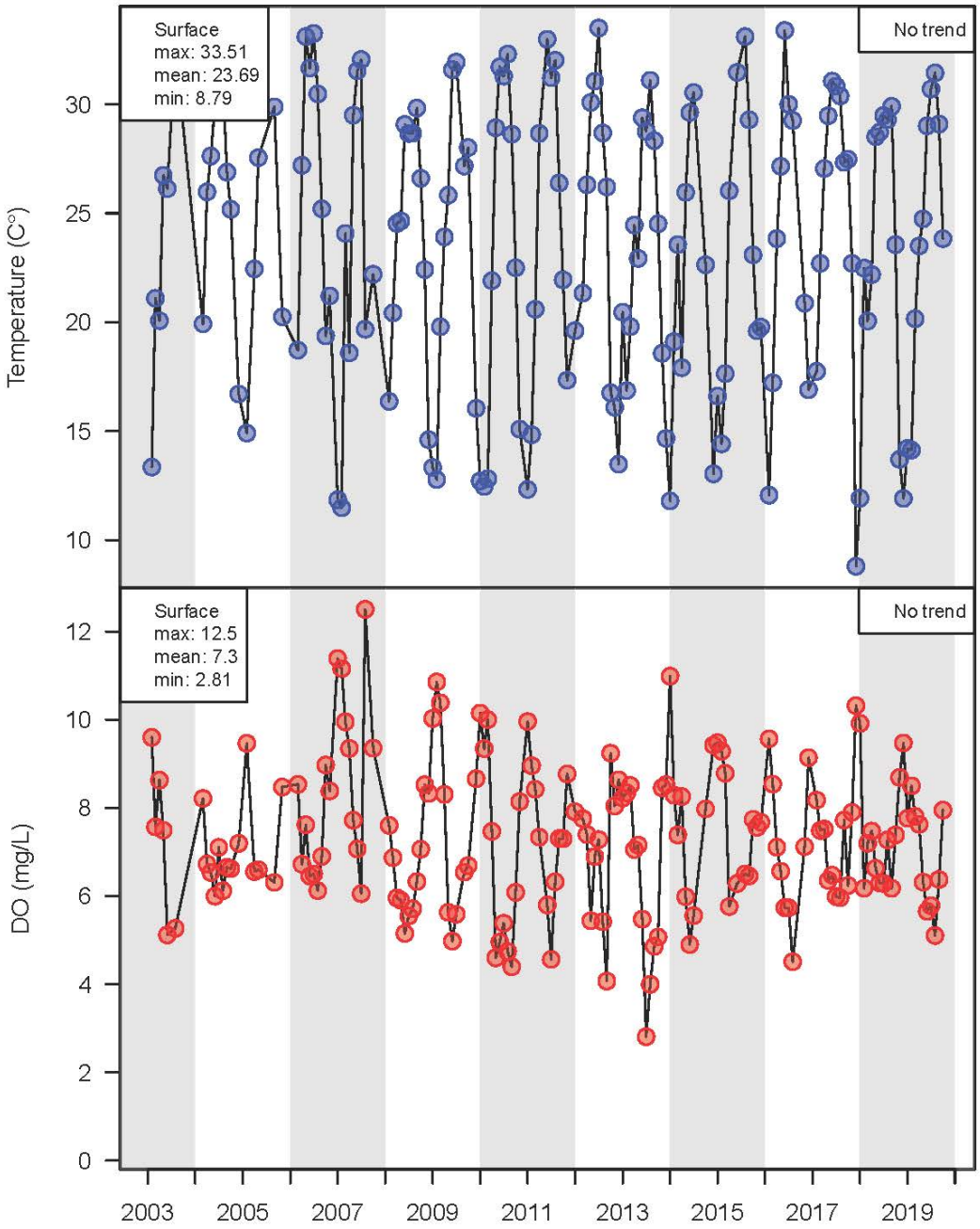
Water Chemistry Data- 2003 through 2019

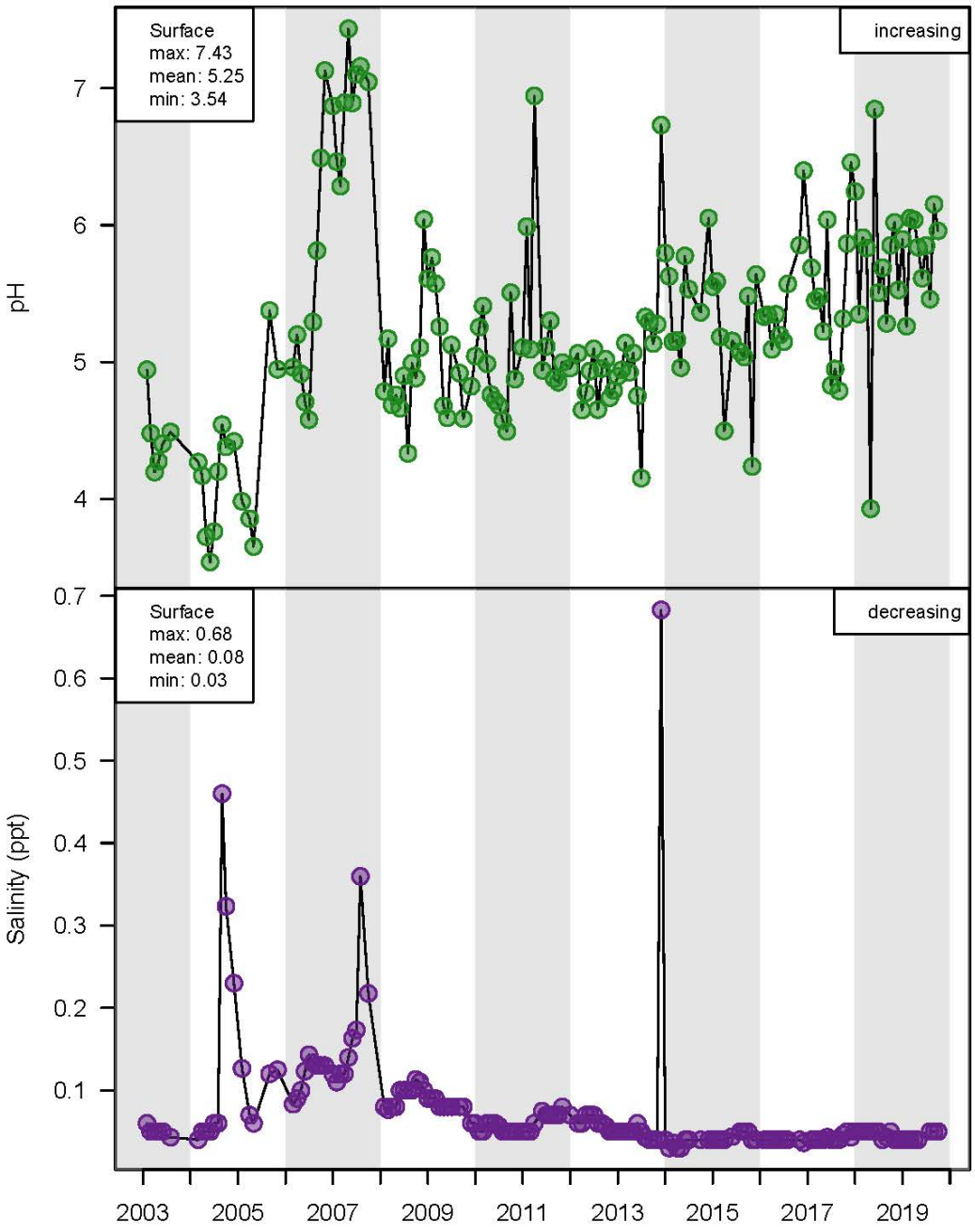
Summary statistics include mean, maximum (max), and minimum (min) summary statistics calculated on an annual basis using monthly data for hydrolab data variables; temperature, dissolved oxygen (DO), pH, and salinity as well as nutrient data variables total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), and secchi depth,. Summary statistics and trends represent results from long-term analyses among annual means from 2003 through 2019.

Times series plots display the inter-annual (monthly variability within the year - circles) and intra-annual variance (variability among years - triangles). Columns delineate three year time intervals.

Kendall-Tau trend analysis results are shown for each water chemistry variable on the top-left of each plot. *No trend* indicates there was no significant trend found among the years examined (2003 through 2019). *Increasing* indicates a significant, positive trend was found over time. *Decreasing* indicates a significant, negative trend was found among the years examined. *Insufficient data* indicates insufficient annual data (year averages) were available for trend analysis.

Hydrolab Trend Analyses

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pH
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Salinity (ppt)
0.7
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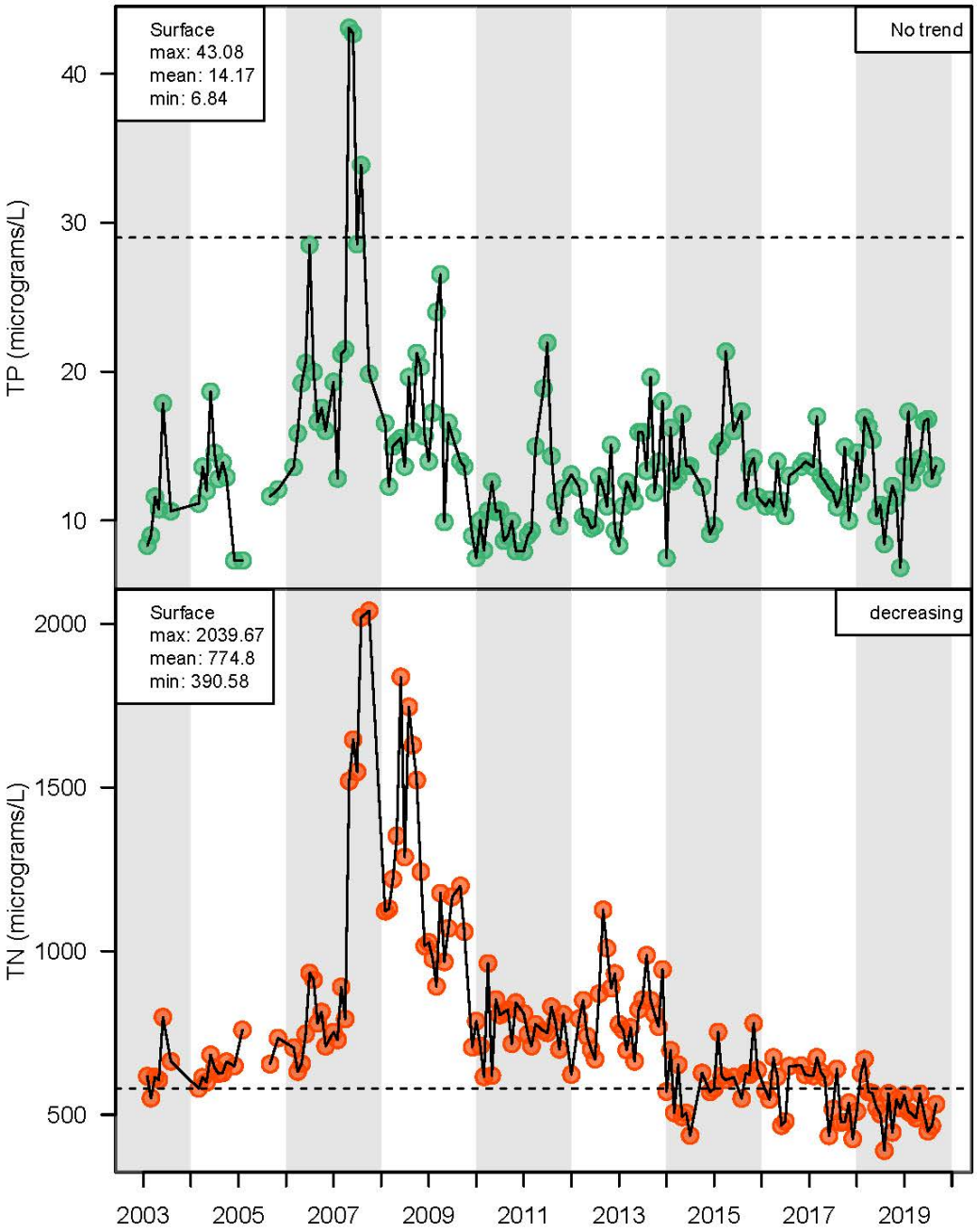
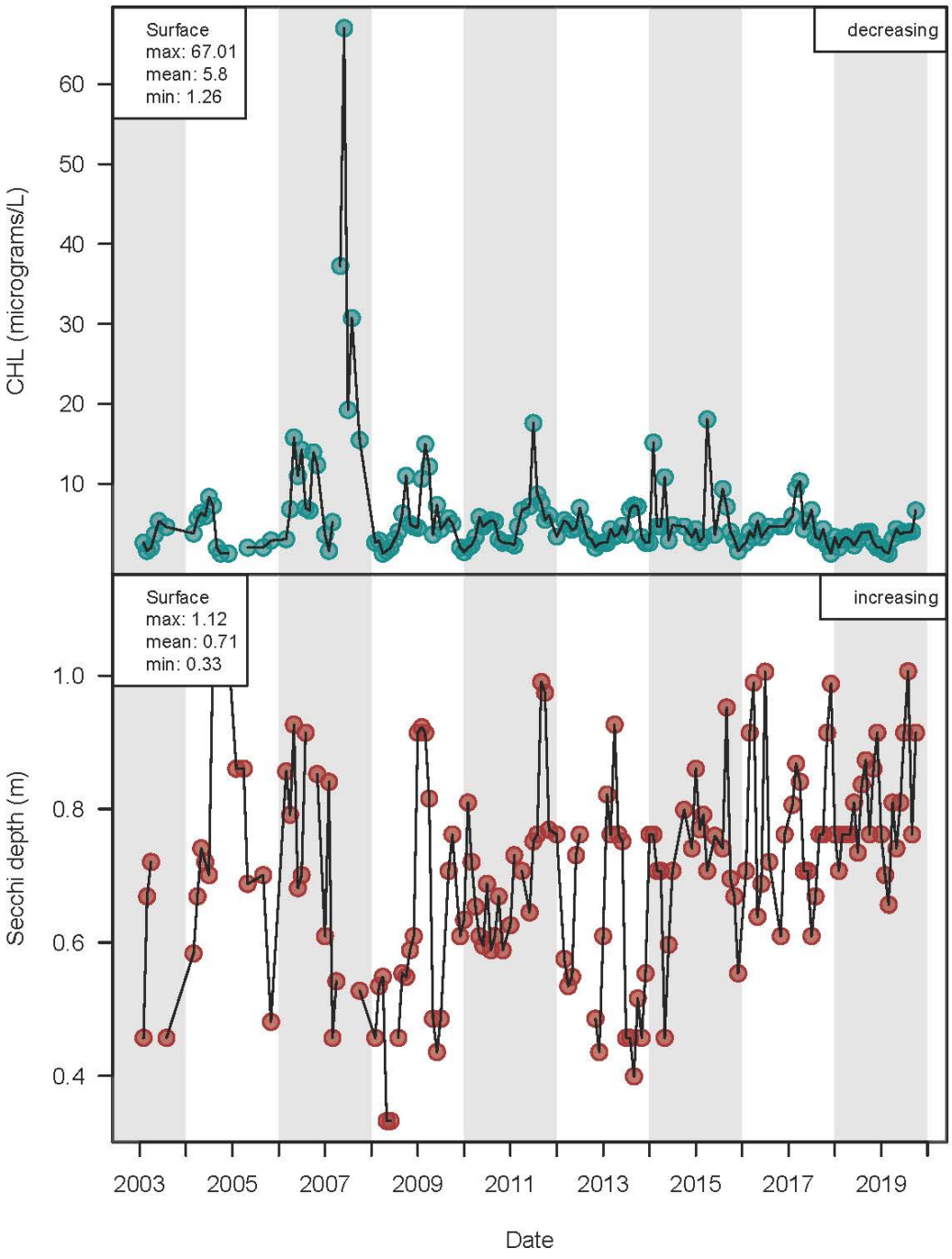
Nutrient Trend Analyses

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CHL (micrograms/L)
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40
30
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Surface
max: 1.12
mean: 0.71
min: 0.33
increasing
Secchi depth (m)
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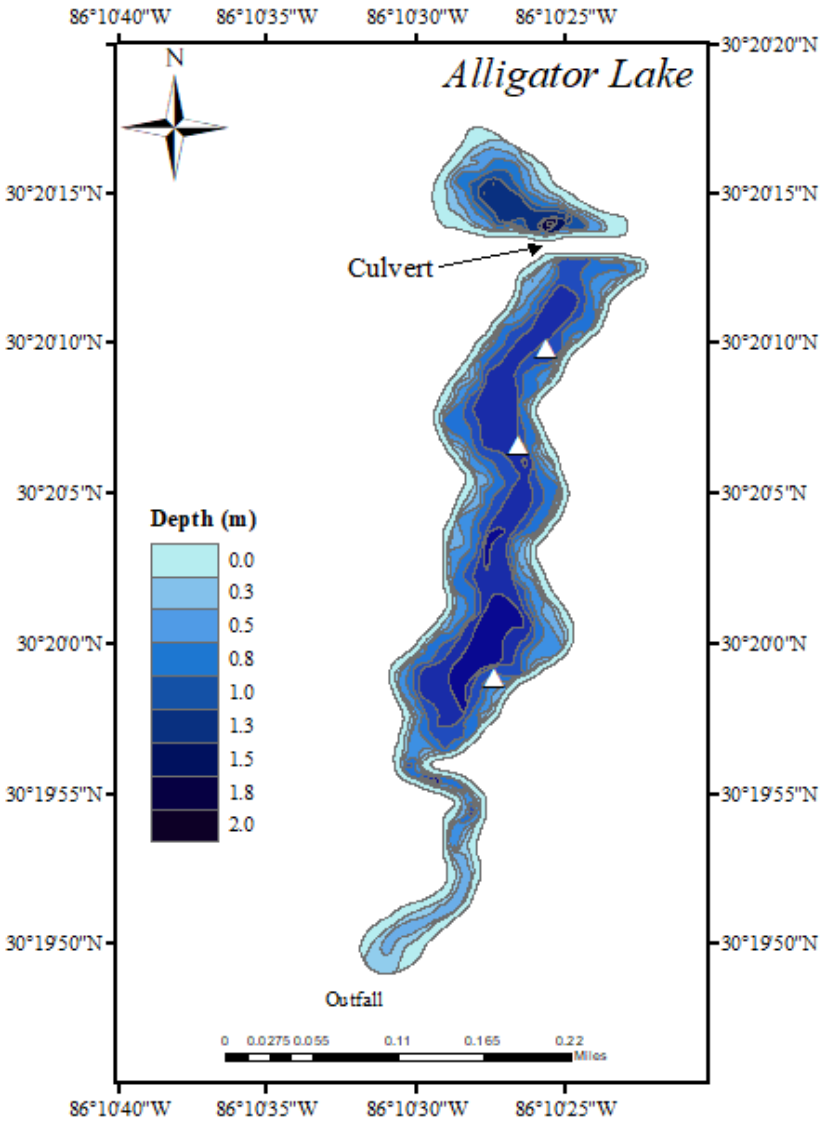
Alligator Lake, Walton County



Lake Description

Alligator Lake is a long, narrow system of intermediate salinity (3.3 ppt) located approximately 260 meters from the Gulf of Mexico. Alligator Lake is among the smallest systems in the population of coastal dune lakes, with a surface area of 5.5 hectares (50,000 m^2) and an average volume of 42,000 m^3. The system is divided by Highway 30A into northern and southern sections. Connection between the two sections was formerly facilitated via a culvert extending under the highway, though has now been upgraded to a bridge (project completed March 2020). Long-term water chemistry monitoring for Alligator Lake occurs at three stations denoted as white triangles on the map above. One new station has been added to the north side of the lake for continued monitoring. Alligator Lake possesses an outfall which intermittently connects to the Gulf, enabling substantial fluctuations in water chemistry values. Although no significant trends in water

chemistry were found within the 15 year timeframe analyzed, a potentially concerning trend of increasing salinity since 2014 is evident from hydrolab time series plots.

Water Chemistry Data- 2019

Summary statistics include mean, maximum (Max), minimum (Min), median, and standard error (Std Error) calculated for both surface and bottom measurements for temperature, dissolved oxygen (DO), pH, and salinity, as well as surface measurements total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), secchi depth, as well as. These statistics represent 2019 water chemistry data.

2019 Summary Statistics

	min	mean	max	Std Error
Temperature top	17.16	27.82	34.51	1.98
Temperature bottom	17.06	27.03	31.7	1.54
DO (mg/L) top	3.72	5.5	7.48	0.36
DO (mg/L) bottom	0.68	2.68	5.29	0.5
pH top	6.62	7.46	8.6	0.2
pH bottom	6.76	7.46	8.75	0.23
Salinity (ppt) top	7.5	14.66	27.74	2.56
Salinity (ppt) bottom	9.32	21.04	28.52	2.29
TP (micrograms/L)	10.32	15.49	30.93	2.11
TN (micrograms/L)	295.12	395.41	572.59	34.91
CHL (micrograms/L)	3.63	6.03	12.49	1.05

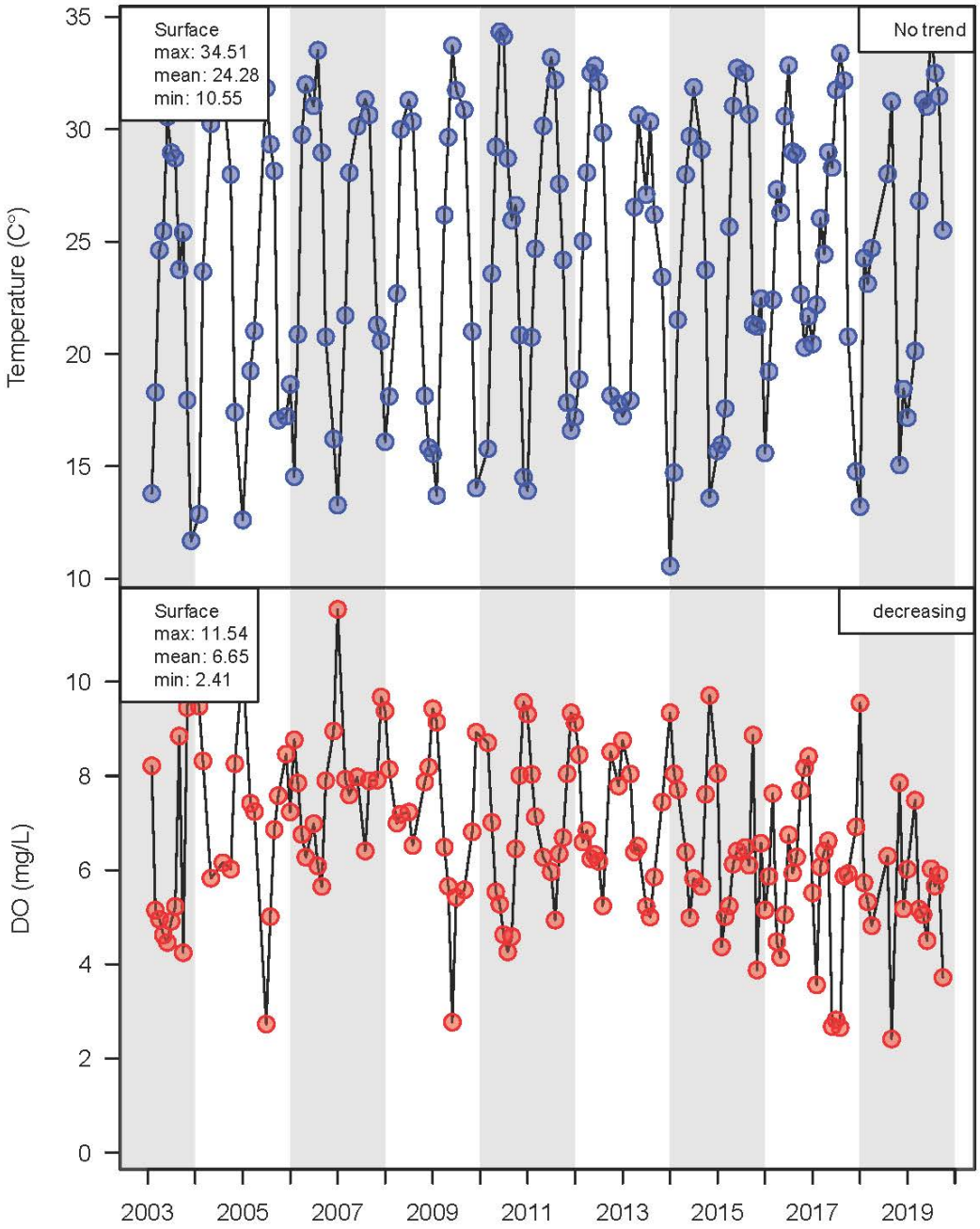
Water Chemistry Data- 2003 through 2019

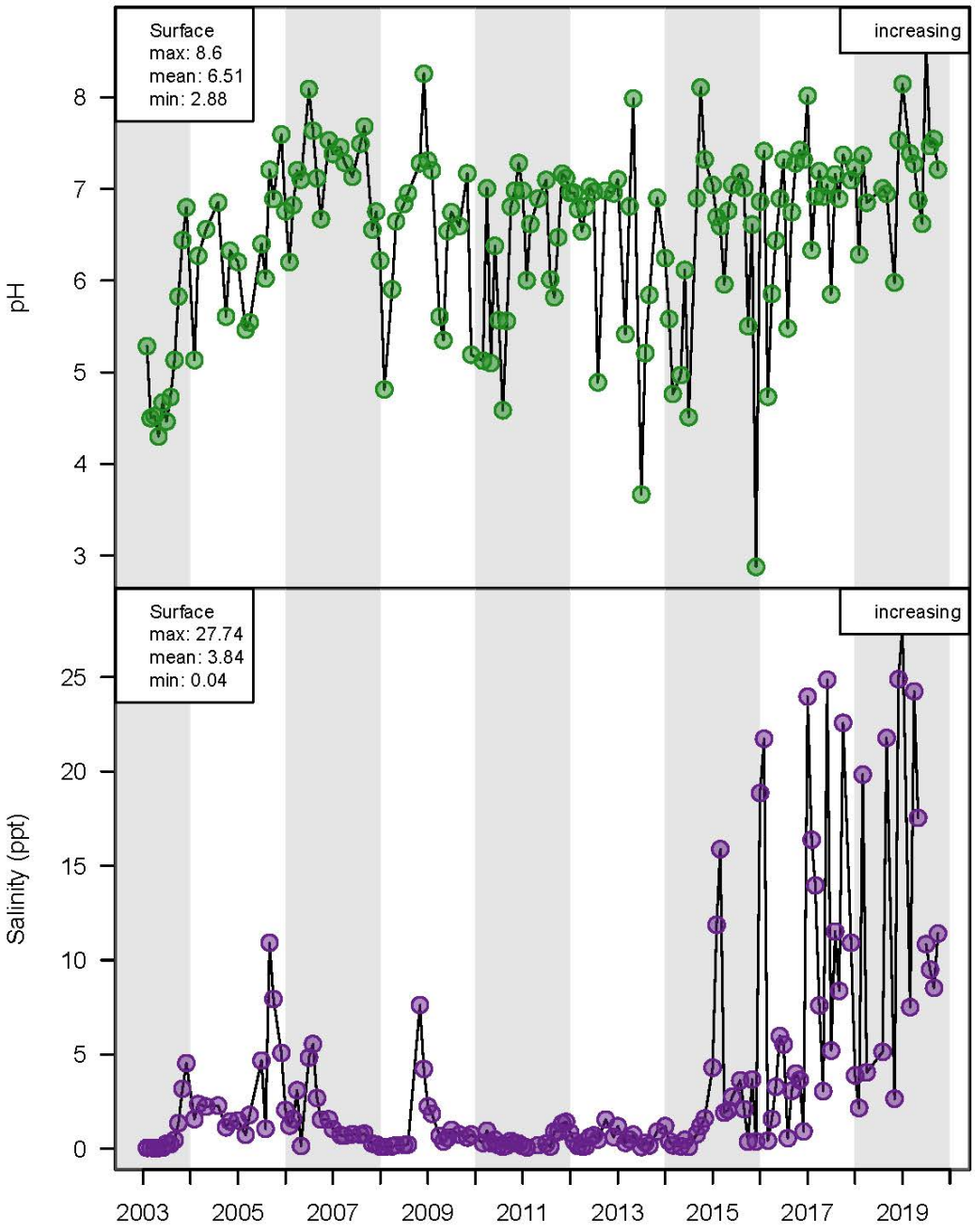
Summary statistics include mean, maximum (max), and minimum (min) summary statistics calculated on an annual basis using monthly data for hydrolab data variables; temperature, dissolved oxygen (DO), pH, and salinity as well as nutrient data variables total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), and secchi depth,. Summary statistics and trends represent results from long-term analyses among annual means from 2003 through 2019.

Times series plots display the inter-annual (monthly variability within the year - circles) and intra-annual variance (variability among years - triangles). Columns denote three year time intervals.

Kendall-Tau trend analysis results are shown for each water chemistry variable on the top-left of each plot. *No trend* indicates there was no significant trend found among the years examined (2003 through 2019). *Increasing* indicates a significant, positive trend was found over time. *Decreasing* indicates a significant, negative trend was found among the years examined. *Insufficient data* indicates insufficient annual data (year averages) were available for trend analysis.

Hydrolab Trend Analyses

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pH
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3
Surface
max: 27.74
mean: 3.84
min: 0.04
increasing
Salinity (ppt)
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15
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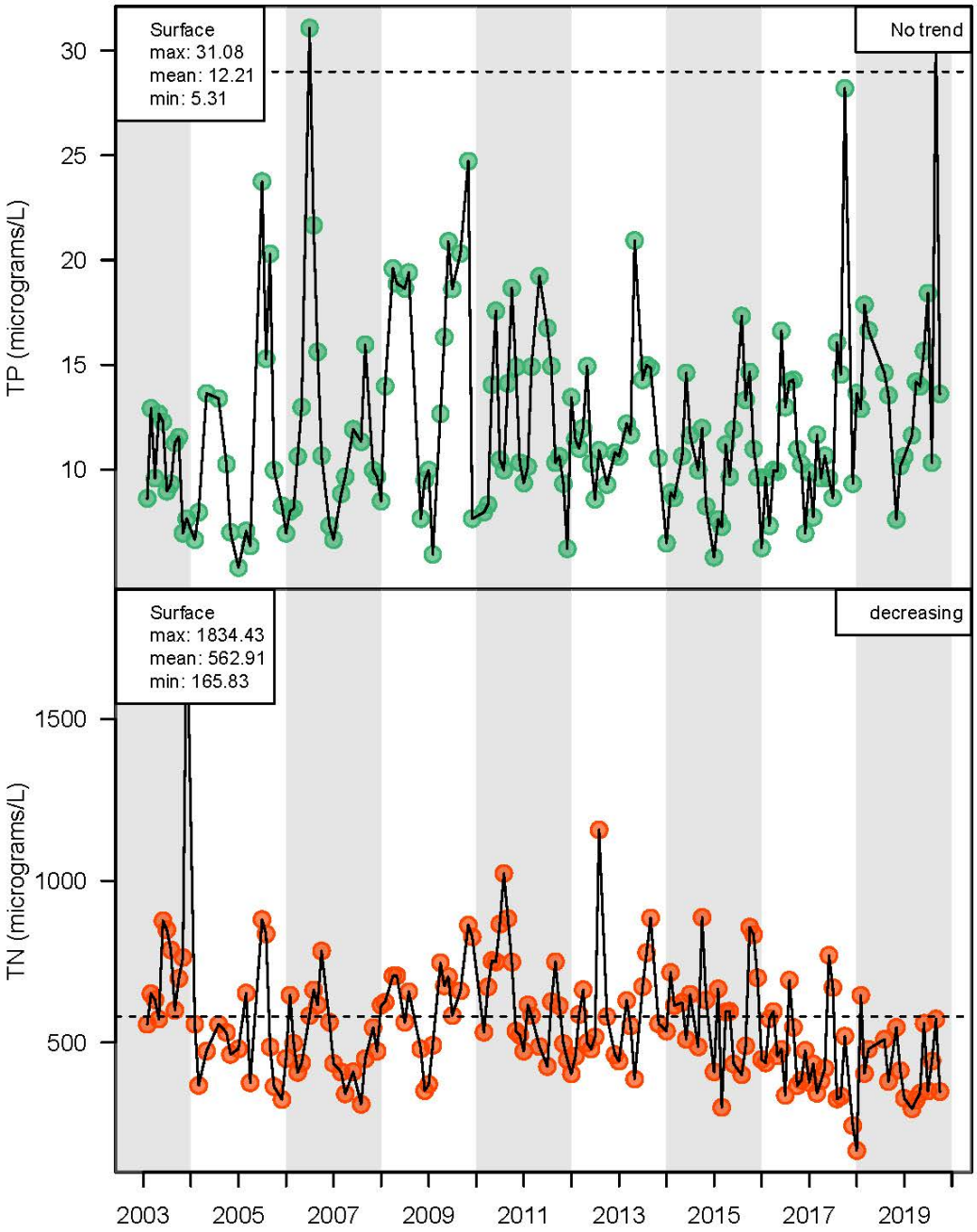
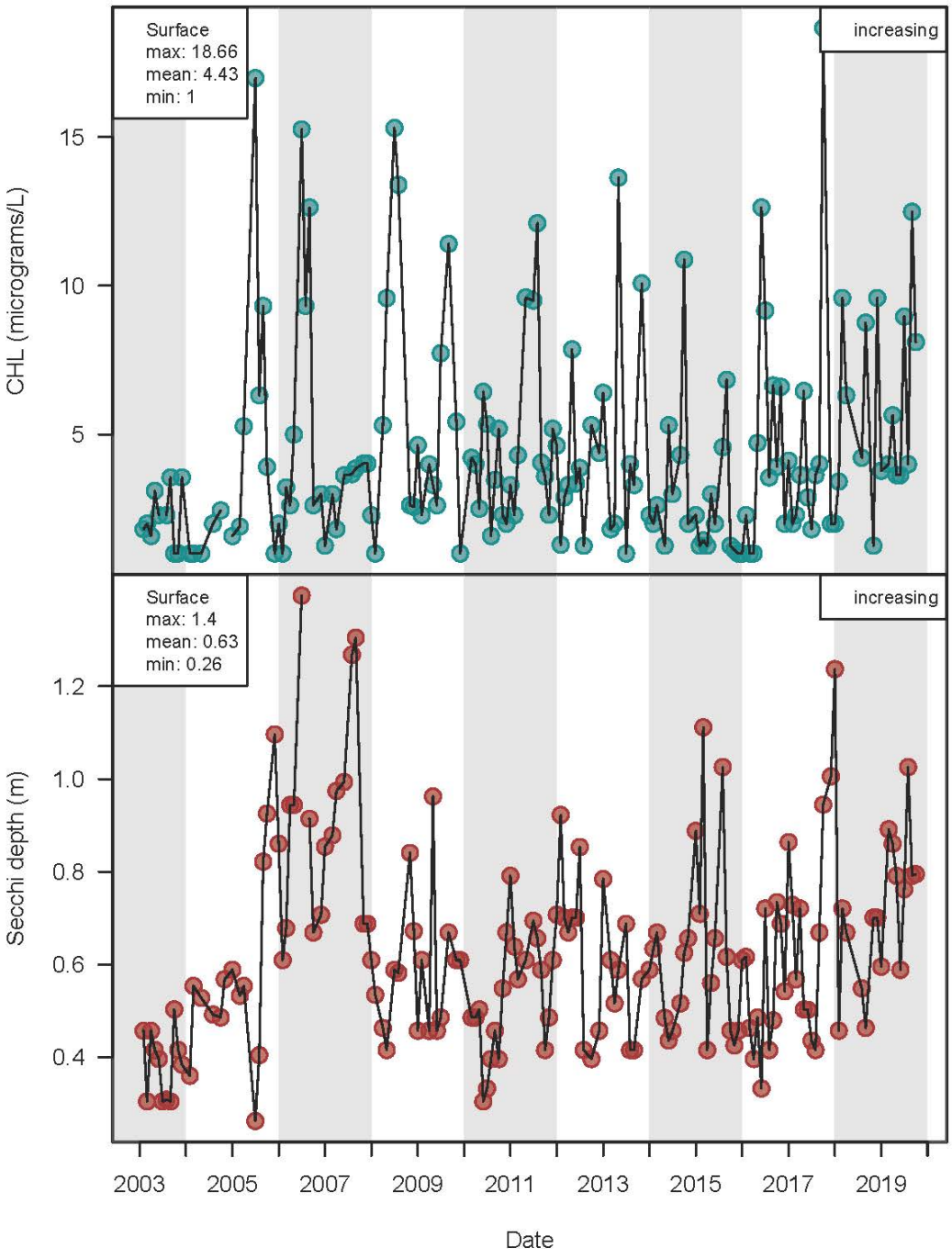
2003
2005
2007
2009
2011
2013
2015
2017
2019

Nutrient Trend Analyses




Surface
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mean: 4.43
min: 1
increasing
CHL (micrograms/L)
15
10
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Surface
max: 1.4
mean: 0.63
min: 0.26
increasing
Secchi depth (m)
1.2
1.0
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2003
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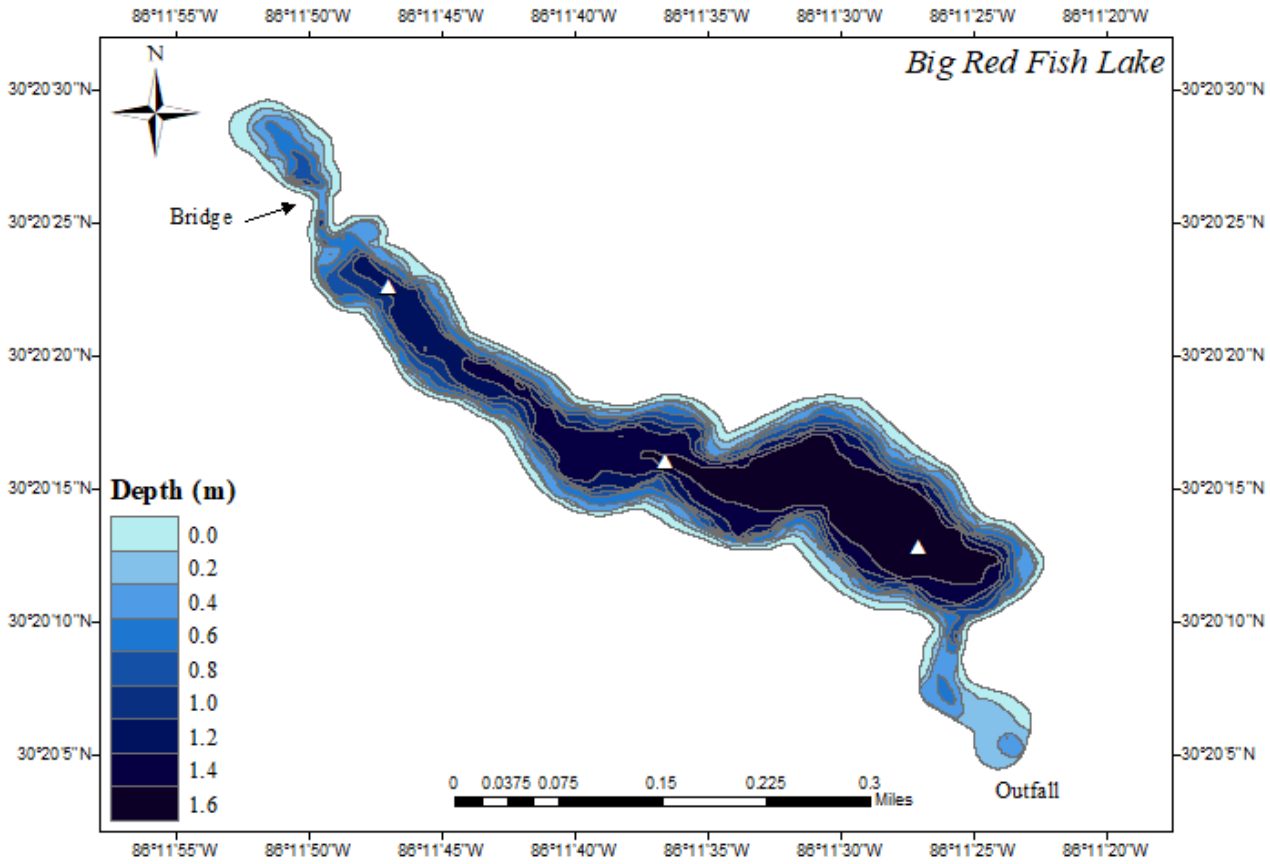
Big Red Fish Lake, Walton County



Lake Description

Big Red Fish Lake is elongated system approximately 200 meters from the Gulf of Mexico. The system is non-uniformly shaped; narrow at the northern end and widening into a larger, deeper southern section at the base. Big Red Fish Lake is an intermediate-sized coastal dune lake with a surface area of 12 hectares (120,000 m^2) and an approximate volume of 130,000 m^3. The system is divided by Highway 30A into a smaller northern section and a larger southern section. Connectivity between the two sections is maintained by a bridge. Long-term water chemistry monitoring for Big Red Fish Lake occurs at three stations denoted as white triangles on the map above. The system contains an outfall which regularly connects to the gulf. As a result, Big Red Fish Lake is one of the more brackish systems (8.7 ppt).

Water Chemistry Data- 2019

Summary statistics include mean, maximum (Max), minimum (Min), median, and standard error (Std Error) calculated for both surface and bottom measurements for temperature, dissolved oxygen (DO), pH, and salinity, as well as surface measurements total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), secchi depth, as well as. These statistics represent 2019 water chemistry data.

2019 Summary Statistics

	min	mean	max	Std Error
Temperature top	19.31	26.59	33.28	1.75
Temperature bottom	20.14	26.48	32.46	1.55
DO (mg/L) top	3.16	5.18	7.18	0.44
DO (mg/L) bottom	0.45	2.84	4.33	0.42
pH top	7.13	7.5	8.04	0.11
pH bottom	6.98	7.47	7.74	0.09
Salinity (ppt) top	5.44	16.7	27.05	1.8
Salinity (ppt) bottom	16.26	22.94	28.2	1.51
TP (micrograms/L)	8.66	22.08	35.17	2.76
TN (micrograms/L)	281.37	395.06	479.52	22.63
CHL (micrograms/L)	1.59	11	30.26	2.83

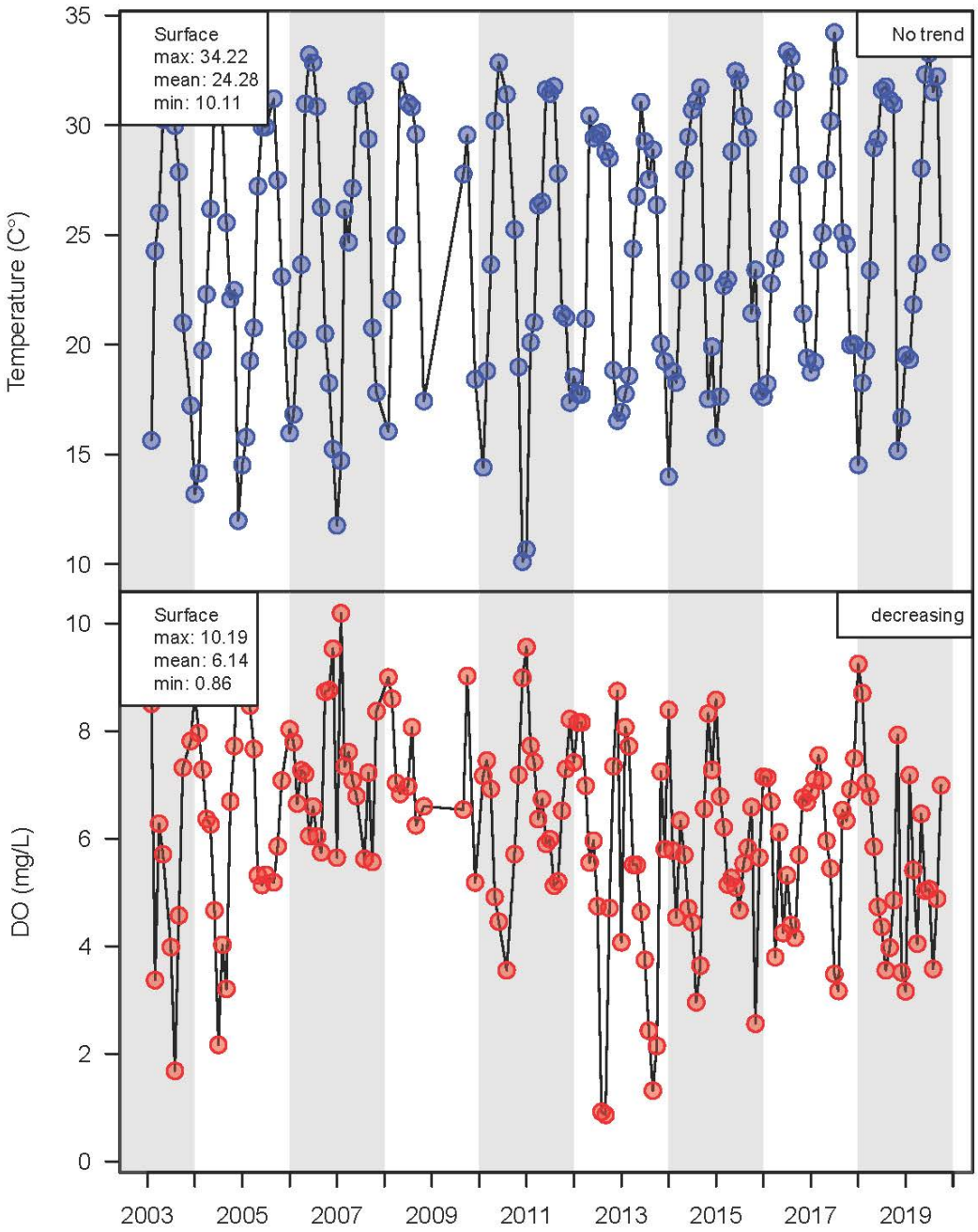
Water Chemistry Data- 2003 through 2019

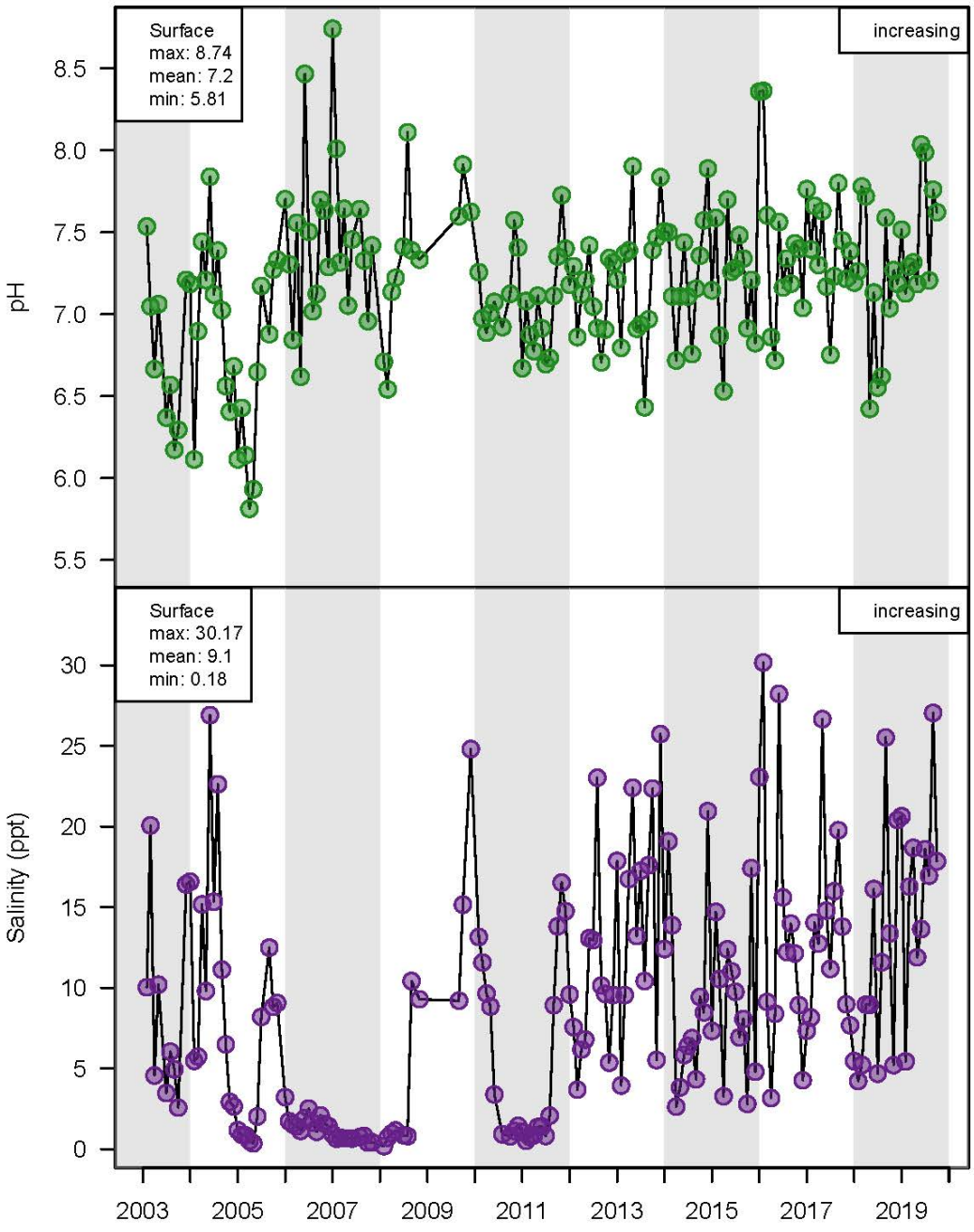
Summary statistics include mean, maximum (max), and minimum (min) summary statistics calculated on an annual basis using monthly data for hydrolab data variables; temperature, dissolved oxygen (DO), pH, and salinity as well as nutrient data variables total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), and secchi depth,. Summary statistics and trends represent results from long-term analyses among annual means from 2003 through 2019.

Times series plots display the inter-annual (monthly variability within the year - circles) and intra-annual variance (variability among years - triangles). Columns denote three year time intervals.

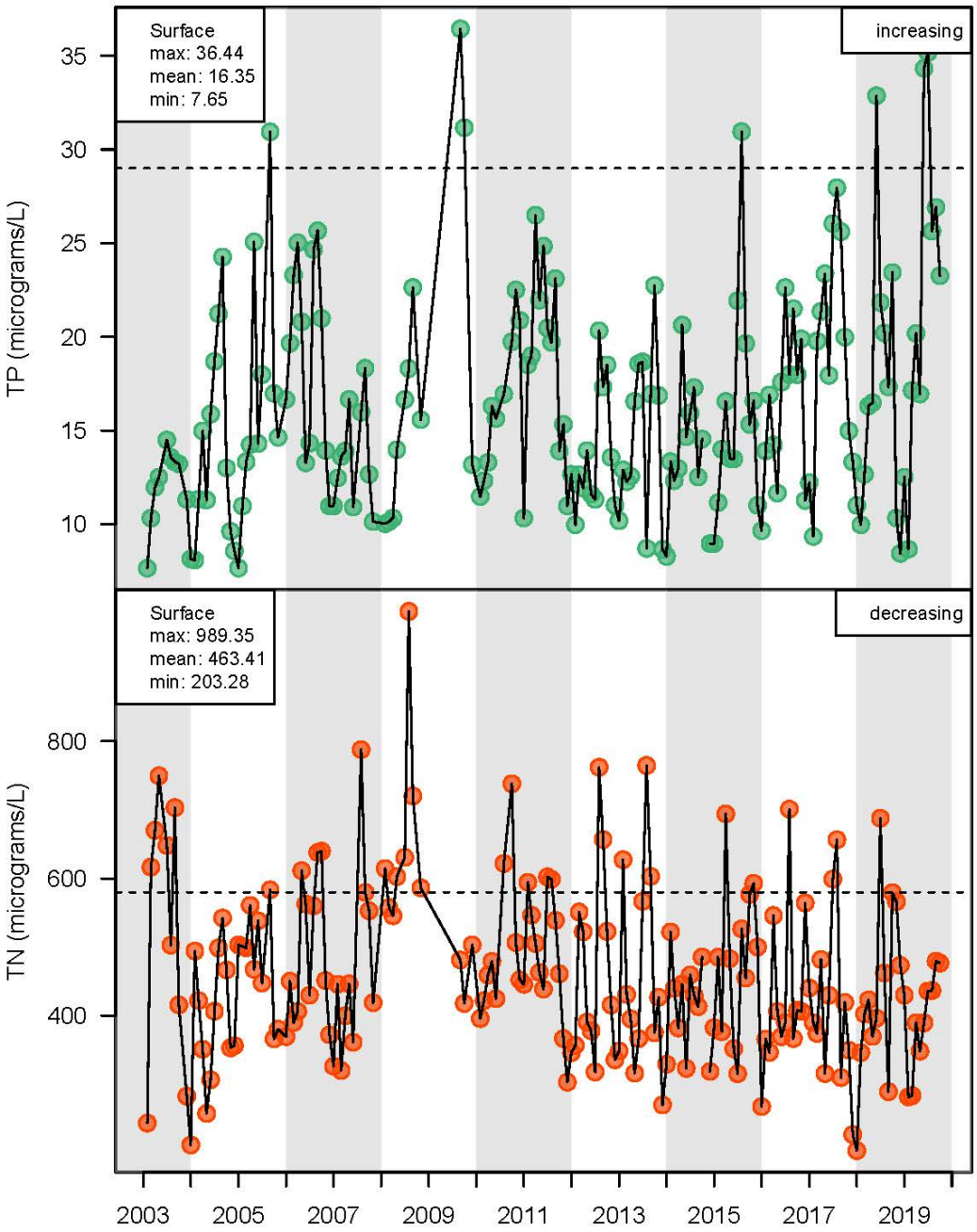
Kendall-Tau trend analysis results are shown for each water chemistry variable on the top-left of each plot. *No trend* indicates there was no significant trend found among the years examined (2003 through 2019). *Increasing* indicates a significant, positive trend was found over time. *Decreasing* indicates a significant, negative trend was found among the years examined. *Insufficient data* indicates insufficient annual data (year averages) were available for trend analysis.

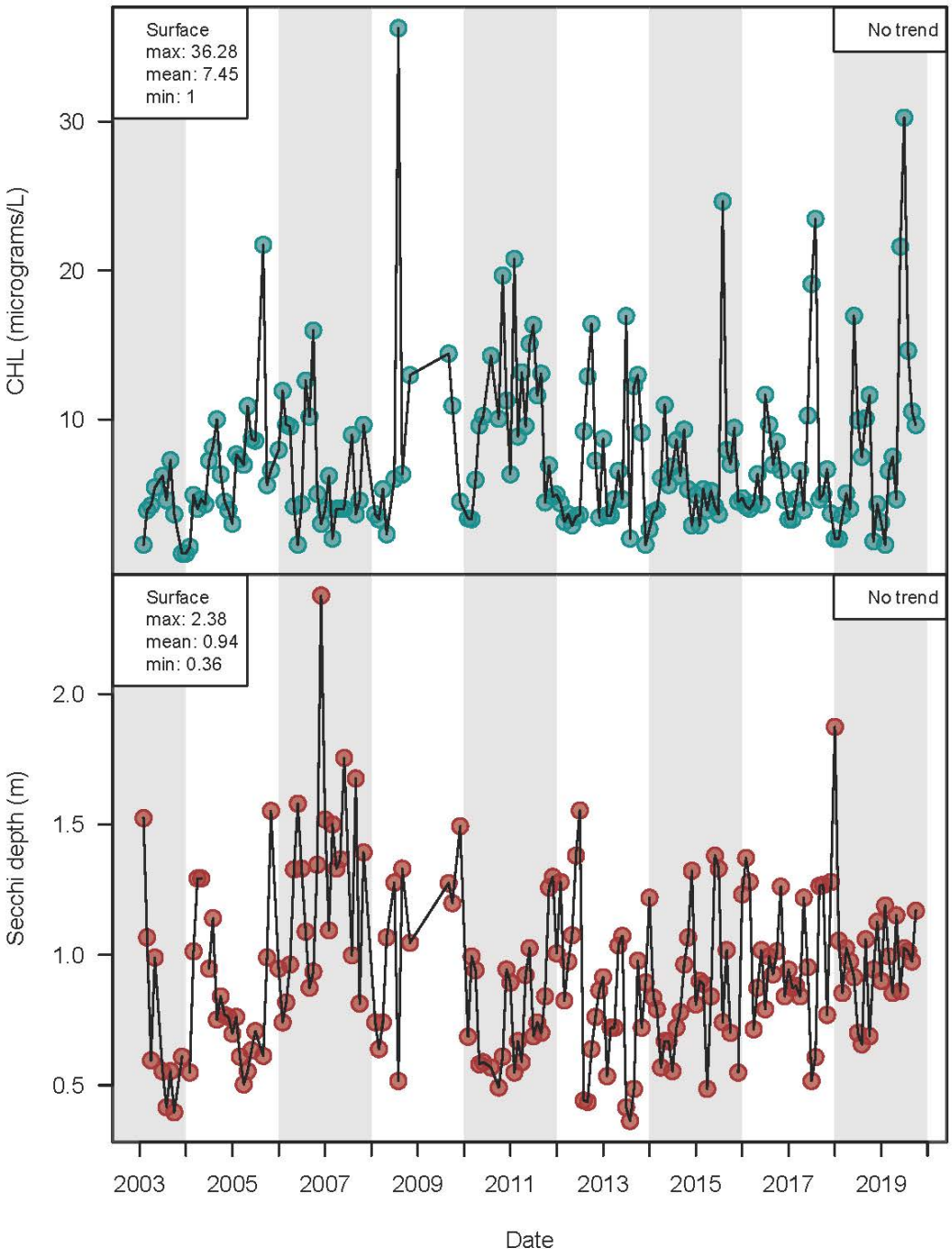
Hydrolab Trend Analyses



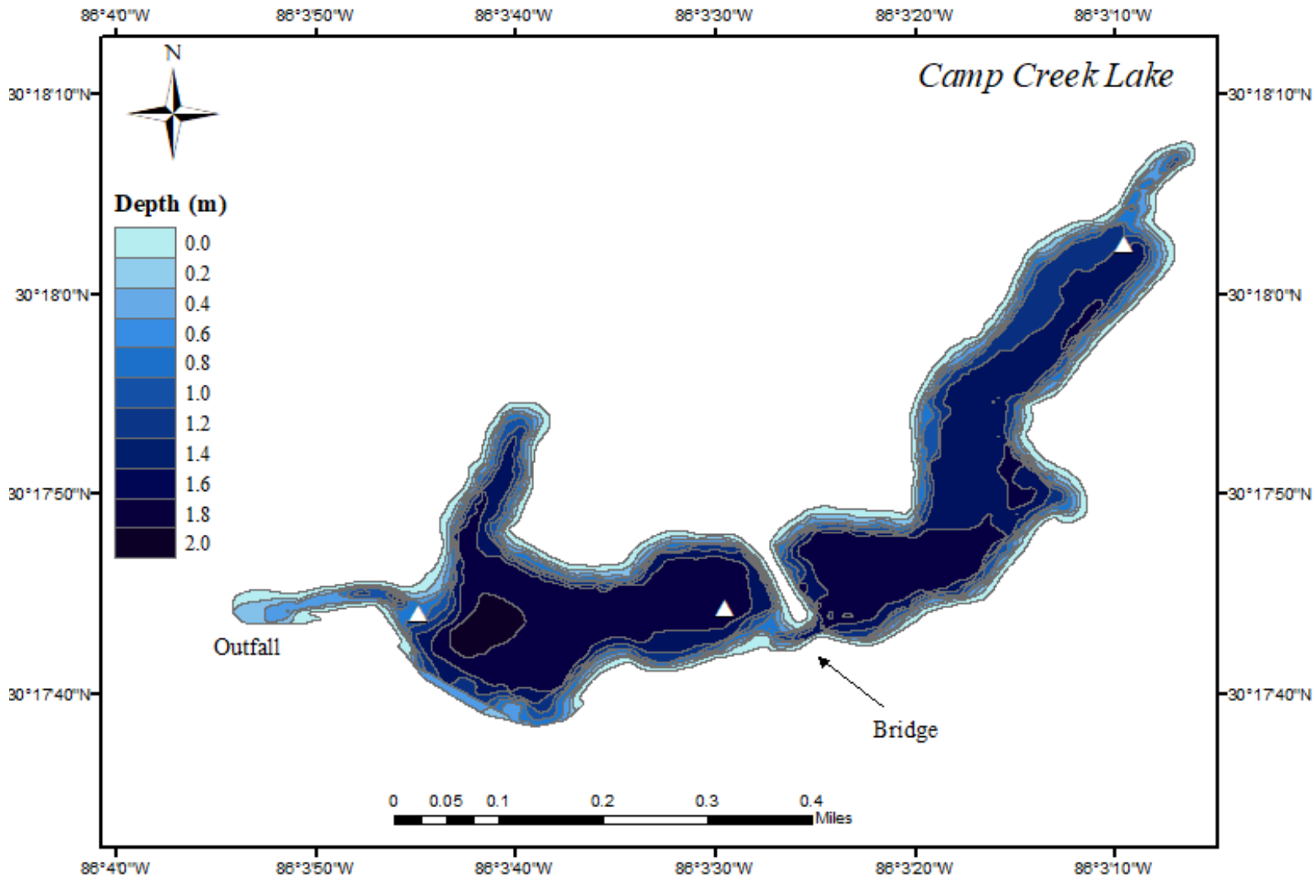

Surface
max: 8.74
mean: 7.2
min: 5.81
increasing
pH
8.5
8.0
7.5
7.0
6.5
6.0
5.5
Surface
max: 30.17
mean: 9.1
min: 0.18
increasing
Salinity (ppt)
30
25
20
15
10
5
0
2003
2005
2007
2009
2011
2013
2015
2017
2019

Nutrient Trend Analyses




Surface
max: 36.28
mean: 7.45
min: 1
No trend
CHL (micrograms/L)
30
20
10
Surface
max: 2.38
mean: 0.94
min: 0.36
No trend
Secchi depth (m)
2.0
1.5
1.0
0.5
2003
2005
2007
2009
2011
2013
2015
2017
2019
Date

Camp Creek Lake, Walton County



Lake Description

Camp Creek Lake is an elongated system approximately 130 meters from the Gulf of Mexico. The system is divided into a northern and a southern section by Highway 30A. Connectivity between the two sections is preserved via a bridge. Camp Creek Lake is among the larger coastal dune lakes with a surface area of 26 hectares (260,000 m^2) and an approximate volume of 310,000 m^3. Long-term water chemistry monitoring for Camp Creek Lake occurs at three stations denoted as white triangles on the map above. Camp Creek Lake contains an outfall which intermittently connects to the Gulf. The system's average water chemistry stays relatively fresh (1.5 ppt).

Water Chemistry Data- 2019

Summary statistics include mean, maximum (Max), minimum (Min), median, and standard error (Std Error) calculated for both surface and bottom measurements for temperature, dissolved oxygen (DO), pH, and salinity, as well as surface measurements total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), secchi depth, as well as. These statistics represent 2019 water chemistry data.

2019 Summary Statistics

	min	mean	max	Std.Error
Temperature top	15.81	25.26	32.46	1.96
Temperature bottom	15.67	24.24	31.19	1.92
DO (mg/L) top	6.18	7.32	8.8	0.3
DO (mg/L) bottom	4.49	6.66	8.69	0.42
pH top	4.8	5.04	5.45	0.07
pH bottom	4.67	5.03	5.42	0.09
Salinity (ppt) top	0.04	0.04	0.05	0
Salinity (ppt) bottom	0.04	0.04	0.05	0
TP (micrograms/L)	6.46	8.09	10.8	0.36
TN (micrograms/L)	179.81	252.84	326.53	15.37
CHL (micrograms/L)	1.59	2.56	3.56	0.22

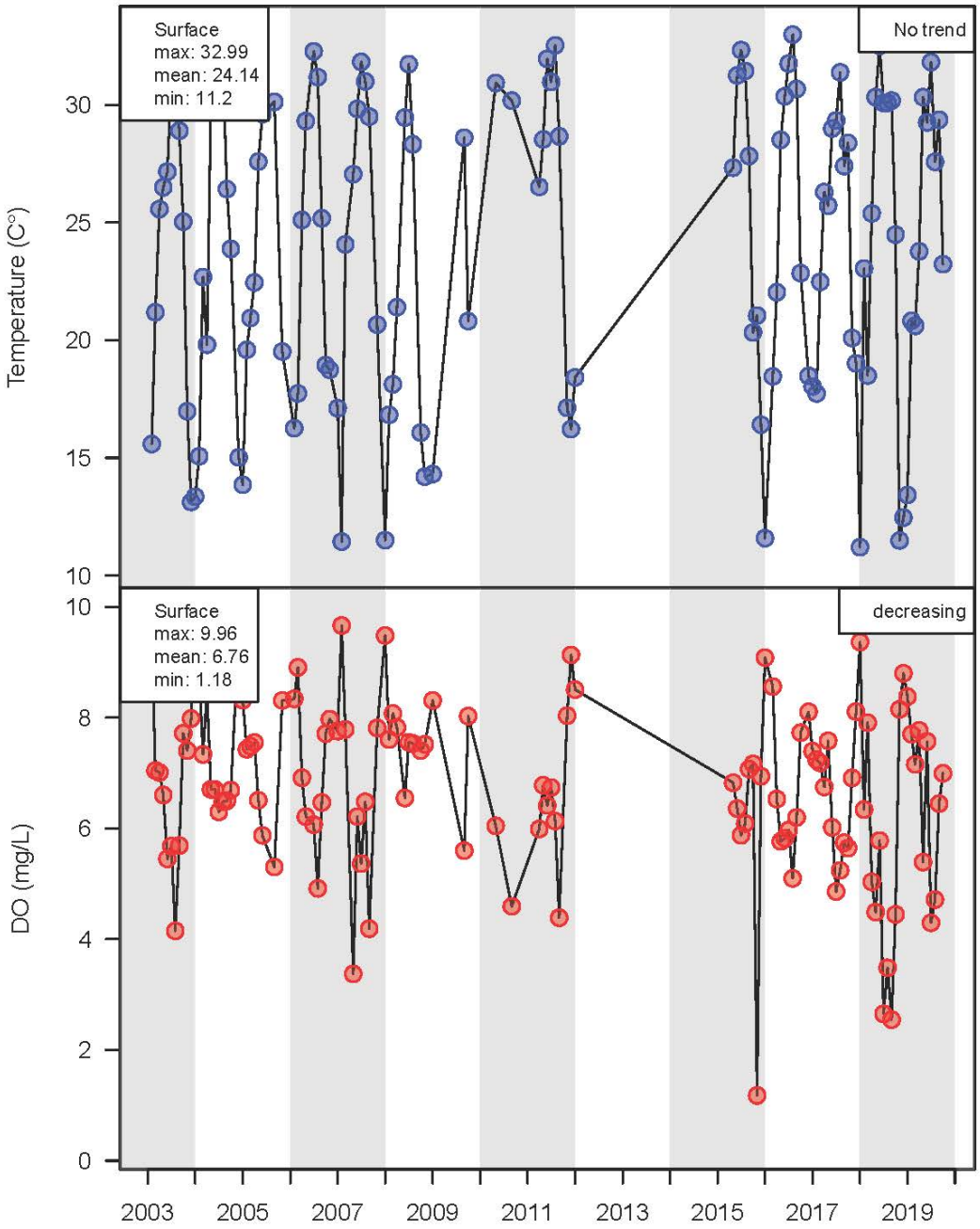
Water Chemistry Data- 2003 through 2019

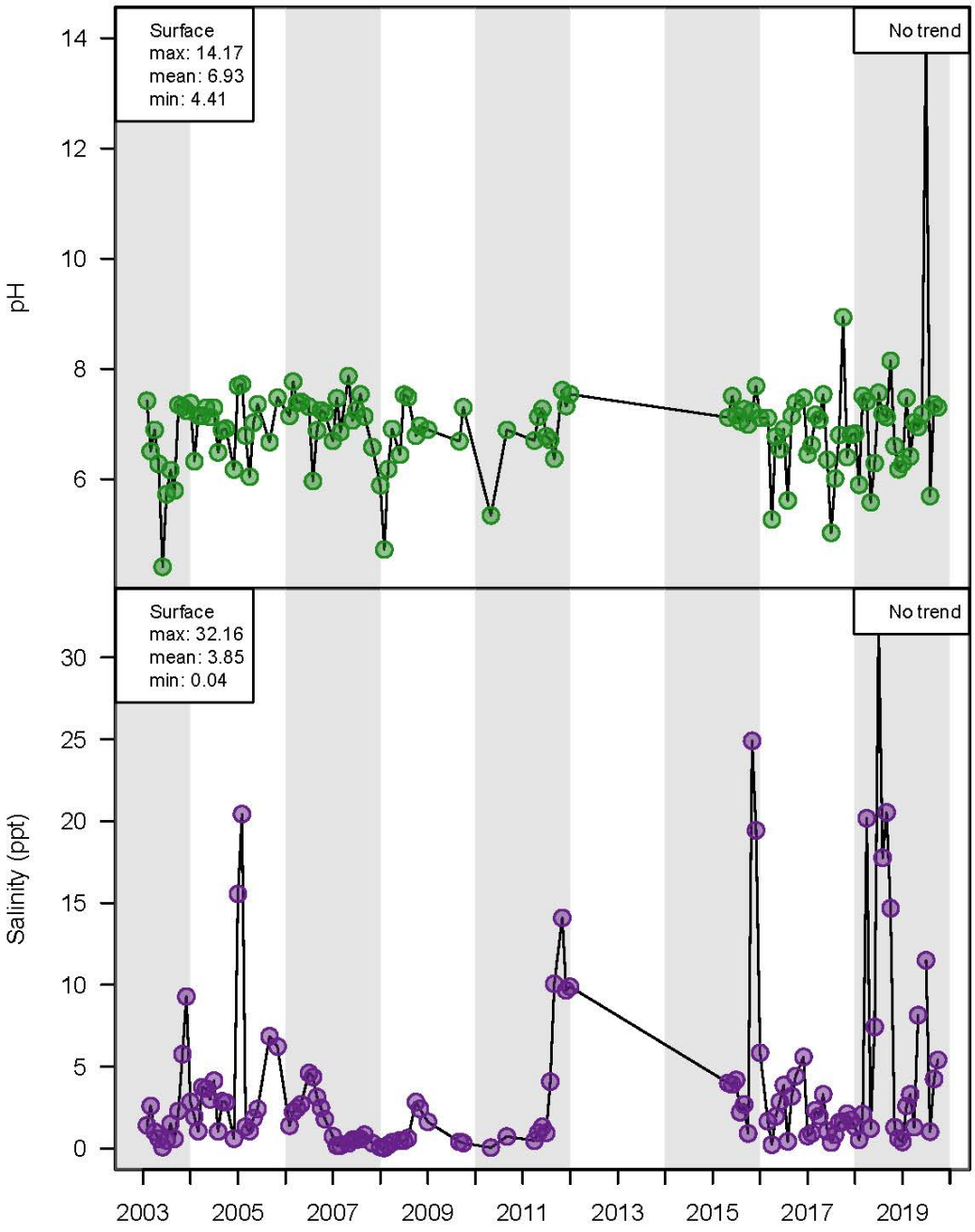
Summary statistics include mean, maximum (max), and minimum (min) summary statistics calculated on an annual basis using monthly data for hydrolab data variables; temperature, dissolved oxygen (DO), pH, and salinity as well as nutrient data variables total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), and secchi depth,. Summary statistics and trends represent results from long-term analyses among annual means from 2003 through 2019.

Times series plots display the inter-annual (monthly variability within the year - circles) and intra-annual variance (variability among years - triangles). Columns delineate three year time intervals.

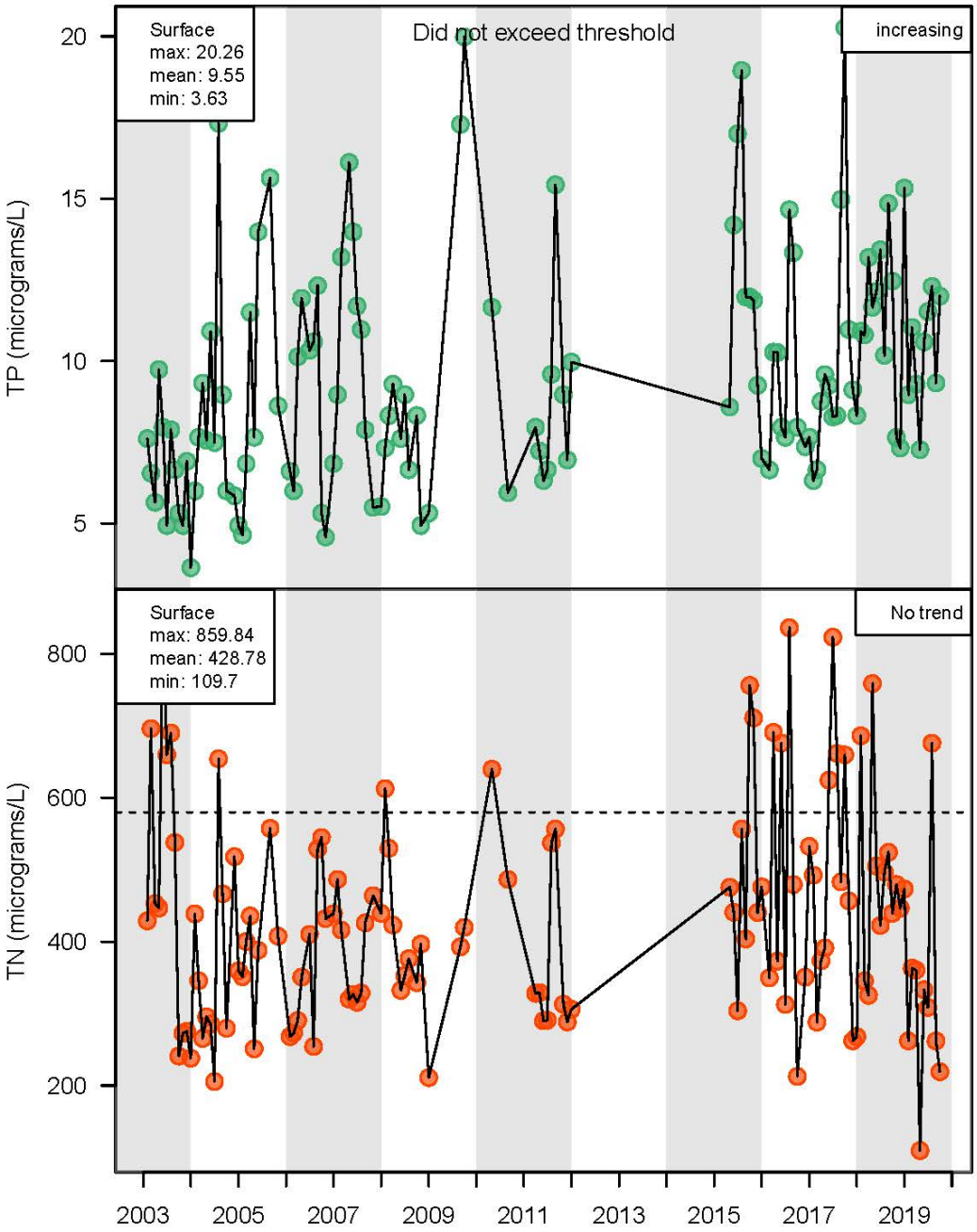
Kendall-Tau trend analysis results are shown for each water chemistry variable on the top-left of each plot. *No trend* indicates there was no significant trend found among the years examined (2003 through 2019). *Increasing* indicates a significant, positive trend was found over time. *Decreasing* indicates a significant, negative trend was found among the years examined. *Insufficient data* indicates insufficient annual data (year averages) were available for trend analysis.

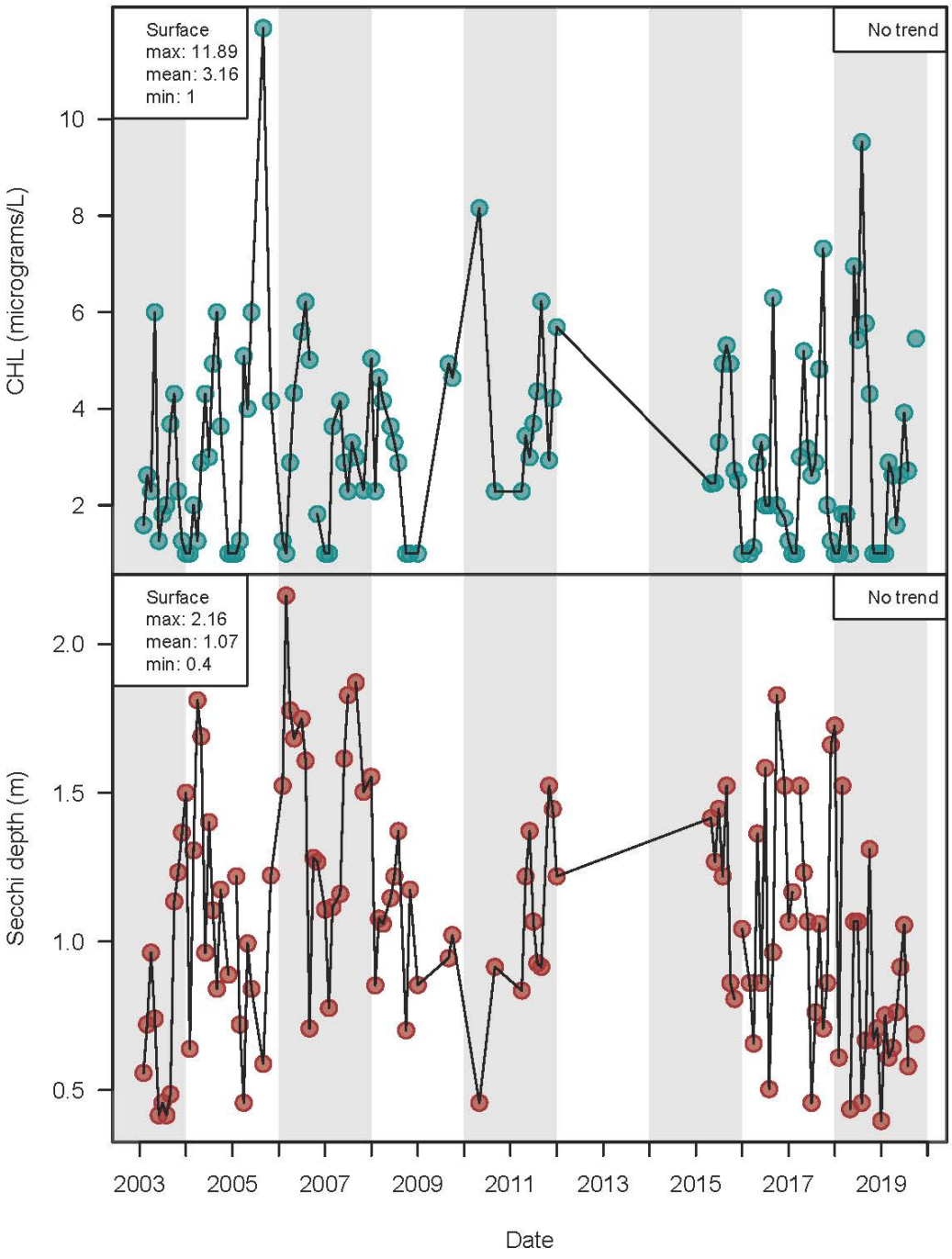
Hydrolab Trend Analyses



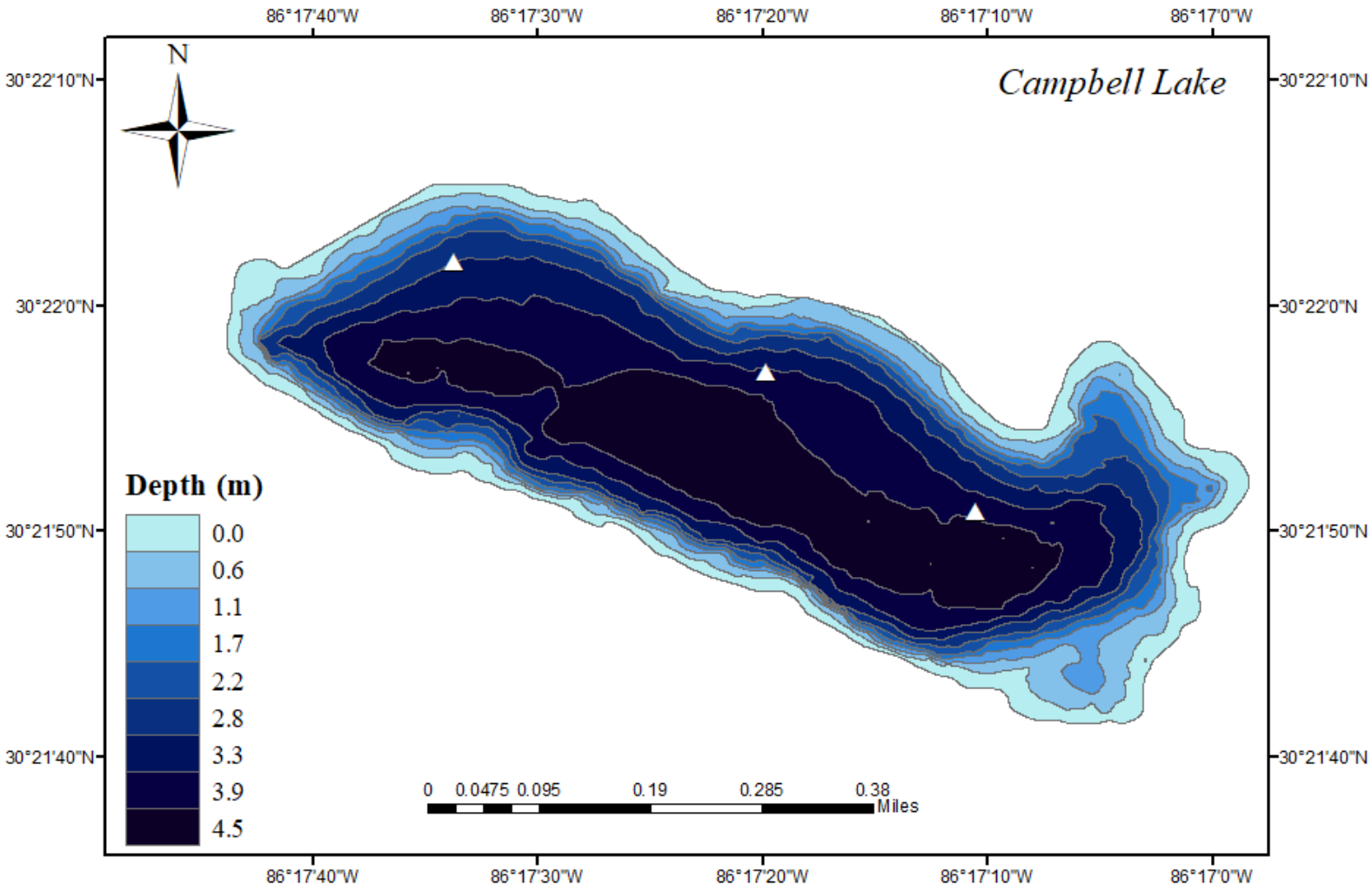

Surface
max: 14.17
mean: 6.93
min: 4.41
No trend
pH
14
12
10
8
6
Surface
max: 32.16
mean: 3.85
min: 0.04
No trend
Salinity (ppt)
30
25
20
15
10
5
0
2003
2005
2007
2009
2011
2013
2015
2017
2019

Nutrient Trend Analyses




Surface
max: 11.89
mean: 3.16
min: 1
No trend
CHL (micrograms/L)
10
8
6
4
2
Surface
max: 2.16
mean: 1.07
min: 0.4
No trend
Secchi depth (m)
2.0
1.5
1.0
0.5
2003
2005
2007
2009
2011
2013
2015
2017
2019
Date

Campbell Lake, Walton County



Lake Description

Campbell Lake is an irregularly-ellipse shaped system approximately 200 meters from the Gulf of Mexico. The system is among the larger coastal dune lakes, with a surface area of 45 hectares (450,000 m^2) and an approximate volume of 1,300,000 m^3. The system is one of two lakes laying within Topsail State Park, which offers a degree of protection form the adverse effects of coastal development. Long-term water chemistry monitoring for Campbell Lake occurs at three stations denoted as white triangles on the map above. While the system does contain an outfall, Campbell Lake seldom connects to the gulf. As a result the system is primarily freshwater (0.06 ppt).

Water Chemistry Data- 2019

Summary statistics include mean, maximum (Max), minimum (Min), median, and standard error (Std Error) calculated for both surface and bottom measurements for temperature, dissolved oxygen (DO), pH, and salinity, as well as surface measurements total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), secchi depth, as well as. These statistics represent 2019 water chemistry data.

2019 Summary Statistics

	min	mean	Max	Std.Error
Temperature top	15.81	25.26	32.46	1.96
Temperature bottom	15.67	24.24	31.19	1.92
DO (mg/L) top	6.18	7.32	8.8	0.3
DO (mg/L) bottom	4.49	6.66	8.69	0.42
pH top	4.8	5.04	5.45	0.07
pH bottom	4.67	5.03	5.42	0.09
Salinity (ppt) top	0.04	0.04	0.05	0
Salinity (ppt) bottom	0.04	0.04	0.05	0
TP (micrograms/L)	6.46	8.09	10.8	0.36
TN (micrograms/L)	179.81	252.84	326.53	15.37
CHL (micrograms/L)	1.59	2.56	3.56	0.22

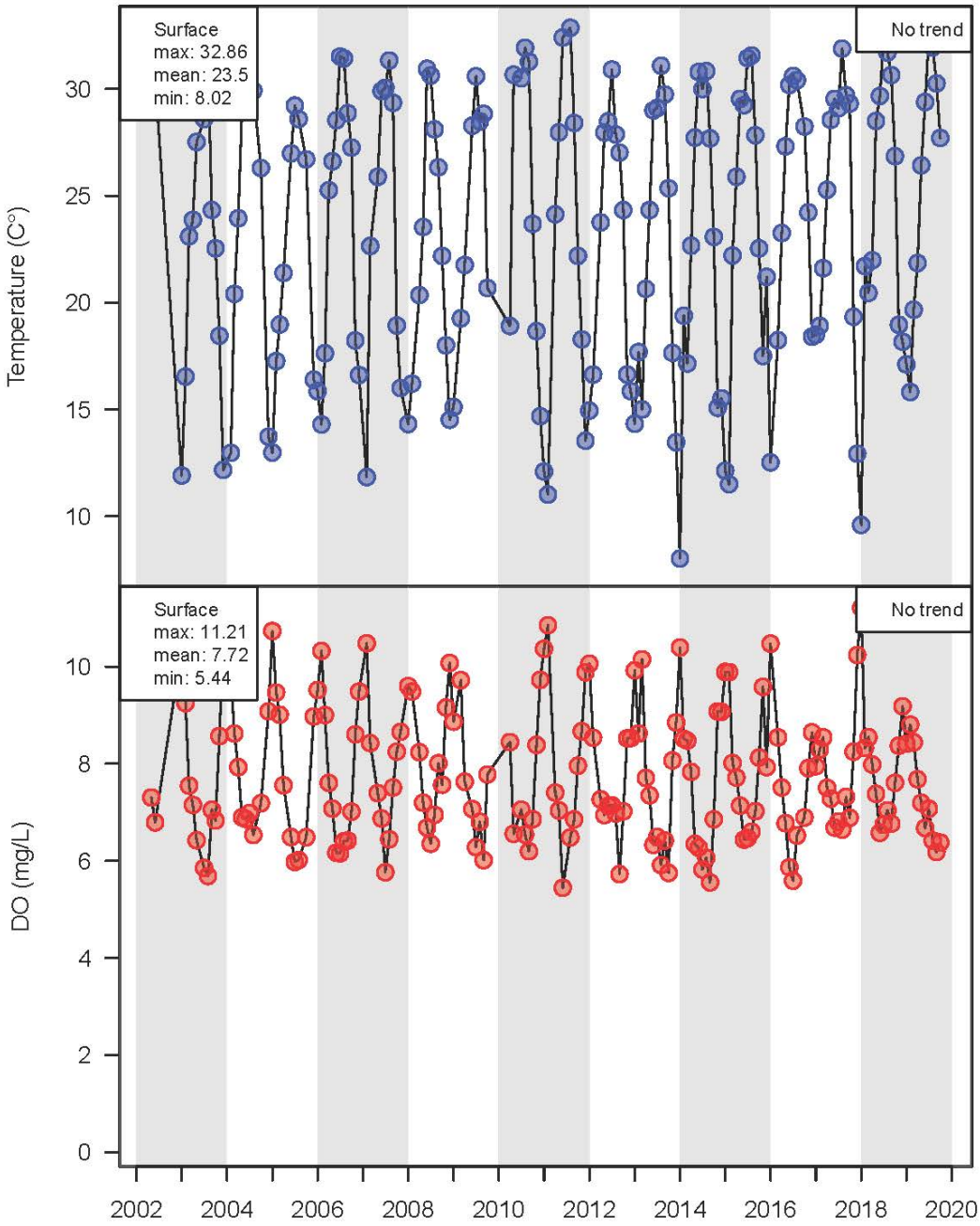
Water Chemistry Data- 2003 through 2019

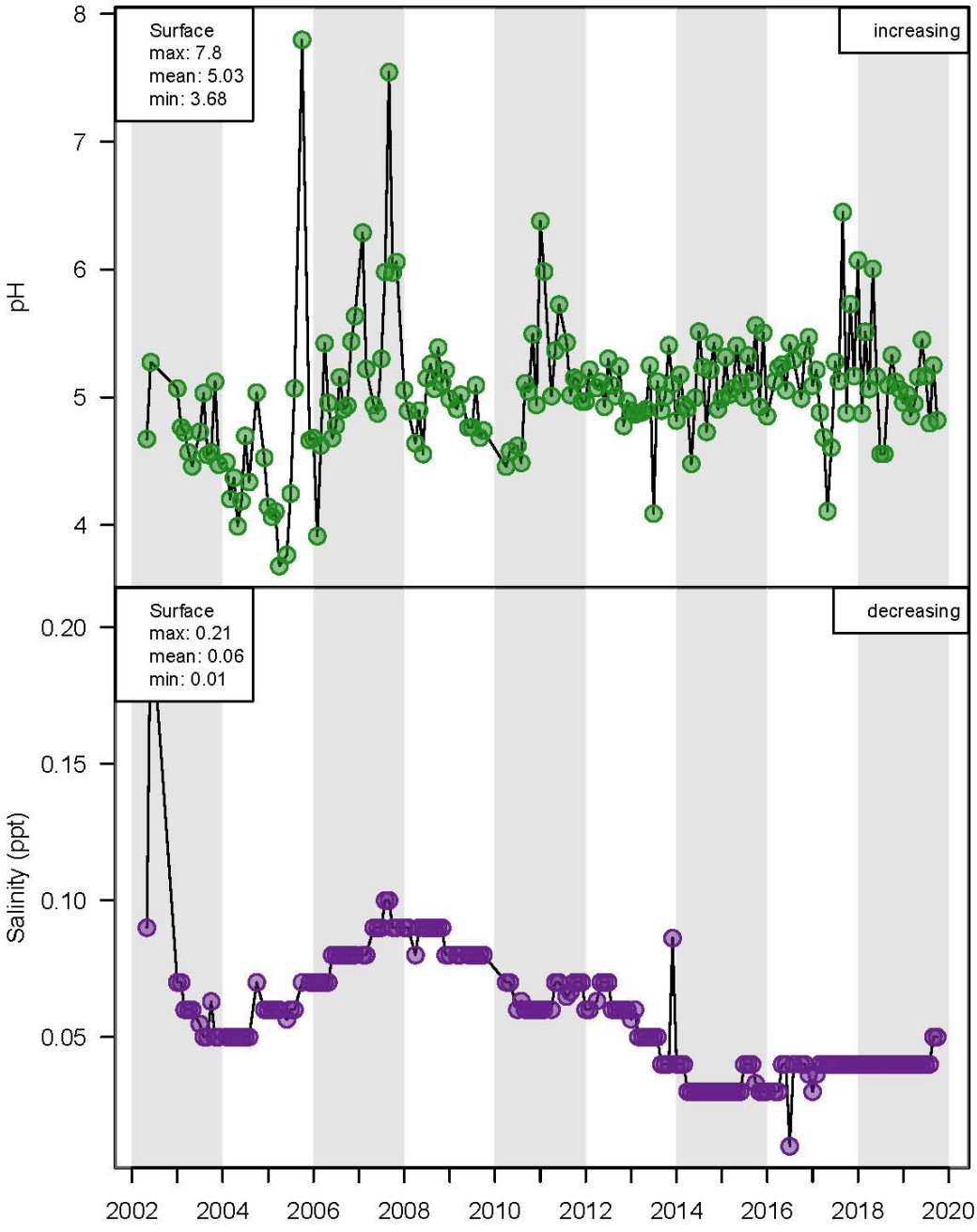
Summary statistics include mean, maximum (max), and minimum (min) summary statistics calculated on an annual basis using monthly data for hydrolab data variables; temperature, dissolved oxygen (DO), pH, and salinity as well as nutrient data variables total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), and secchi depth,. Summary statistics and trends represent results from long-term analyses among annual means from 2003 through 2019.

Times series plots display the inter-annual (monthly variability within the year - circles) and intra-annual variance (variability among years - triangles). Columns delineate three year time intervals.

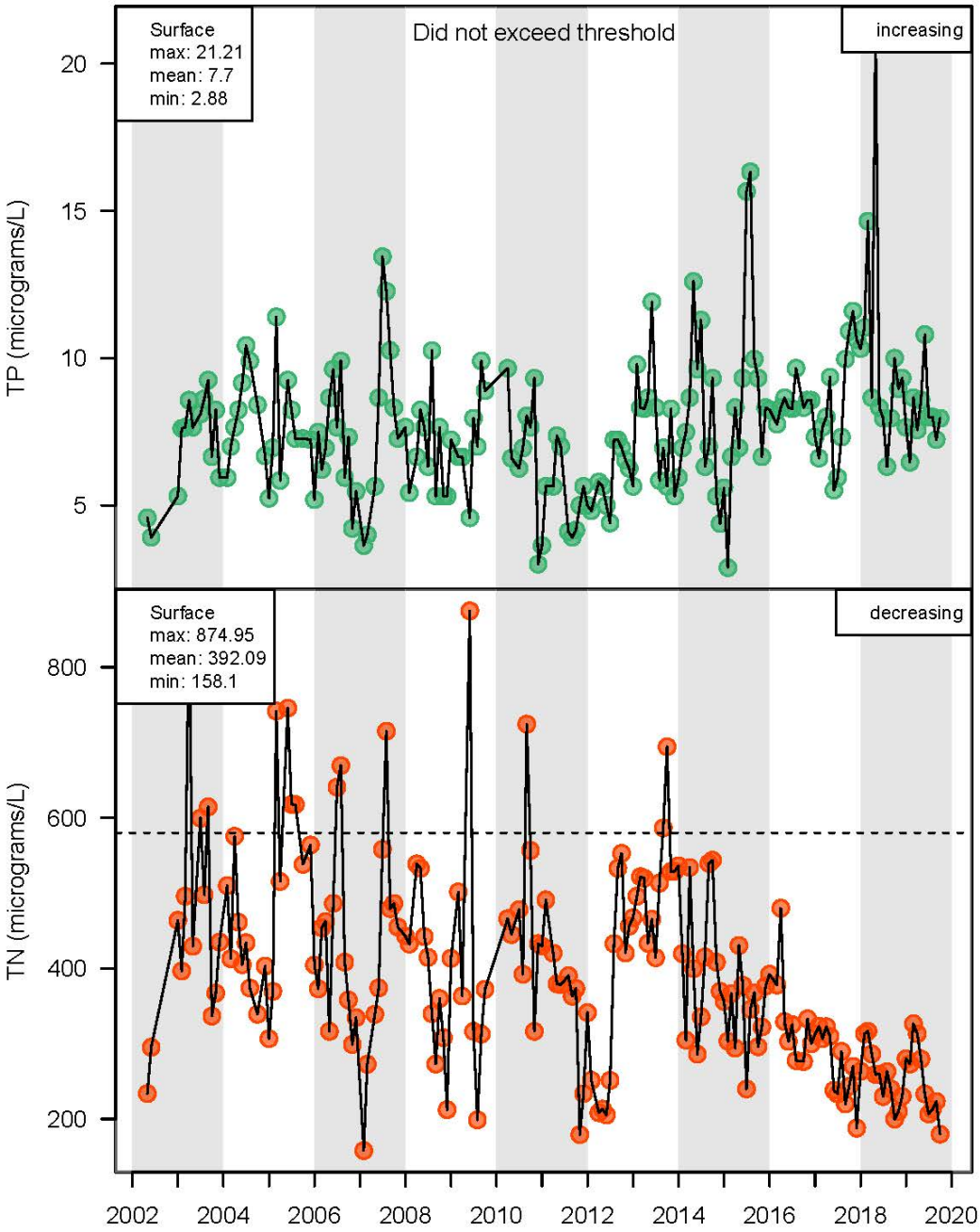
Kendall-Tau trend analysis results are shown for each water chemistry variable on the top-left of each plot. *No trend* indicates there was no significant trend found among the years examined (2003 through 2019). *Increasing* indicates a significant, positive trend was found over time. *Decreasing* indicates a significant, negative trend was found among the years examined. *Insufficient data* indicates insufficient annual data (year averages) were available for trend analysis.

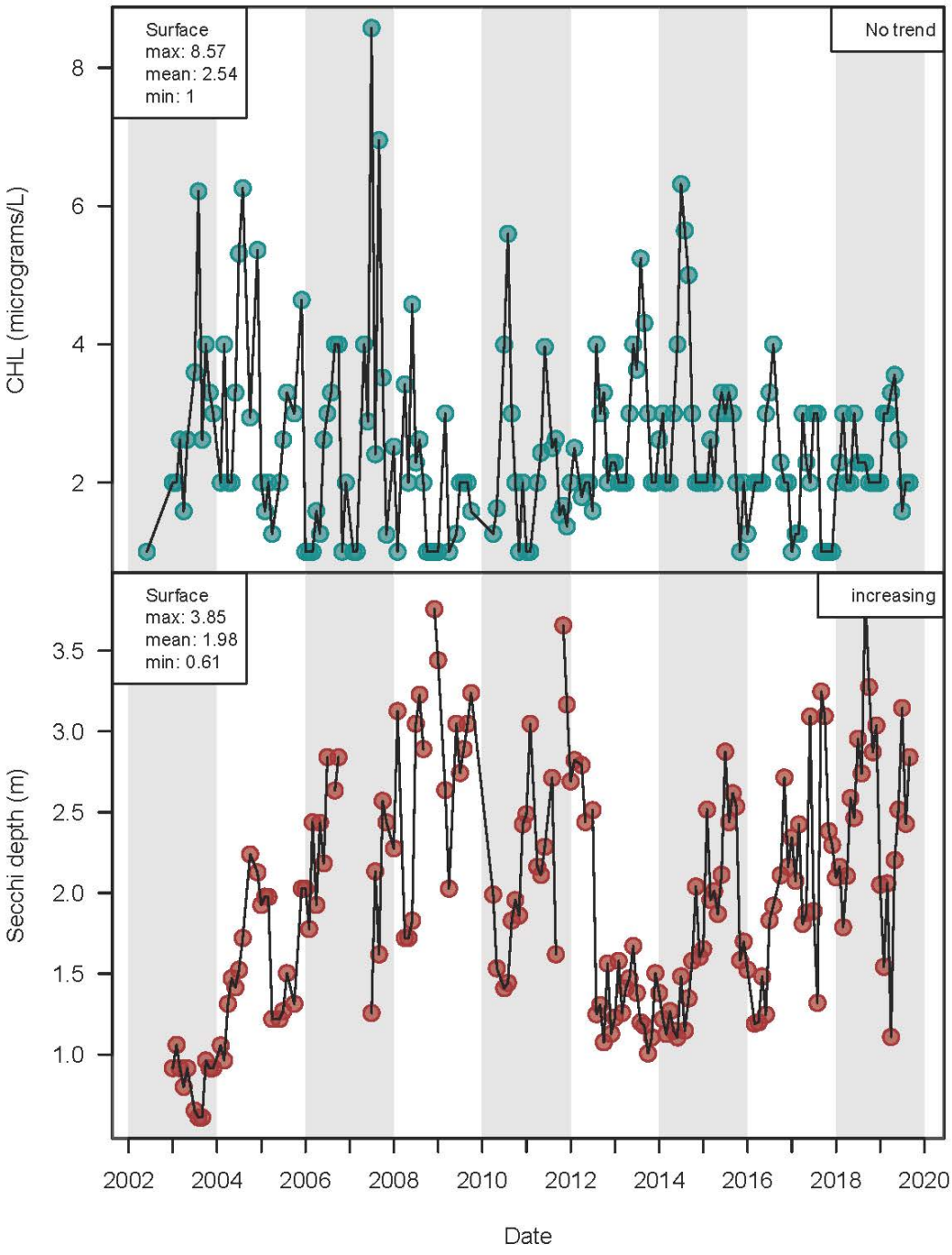
Hydrolab Trend Analyses



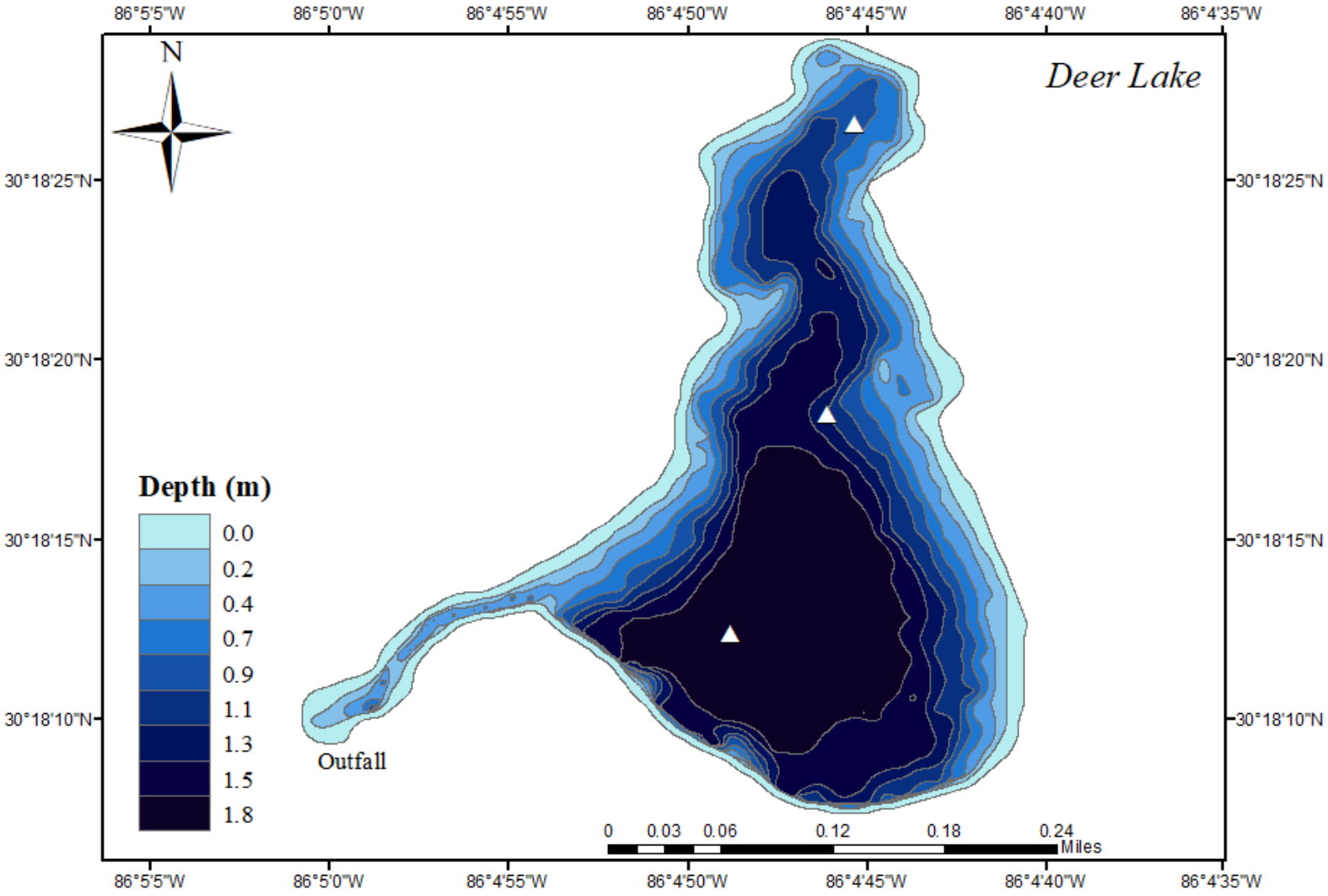

Surface
max: 7.8
mean: 5.03
min: 3.68
increasing
pH
8
7
6
5
4
Surface
max: 0.21
mean: 0.06
min: 0.01
decreasing
Salinity (ppt)
0.20
0.15
0.10
0.05
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

Nutrient Trend Analyses




Surface
max: 8.57
mean: 2.54
min: 1
No trend
CHL (micrograms/L)
8
6
4
2
Surface
max: 3.85
mean: 1.98
min: 0.61
increasing
Secchi depth (m)
3.5
3.0
2.5
2.0
1.5
1.0
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Date

Deer Lake, Walton County



Lake Description

Deer Lake is a teardrop-shaped system approximately 250 meters away from the Gulf of Mexico. Deer Lake is an intermediate-sized coastal dune lake with a surface area of 17 hectares (170,000 m2) and an approximate volume of 250,000 m3. The system lays within Deer Lake State Park, which offers a degree of protection form the adverse effects of coastal development. Long-term water chemistry monitoring for Deer Lake occurs at three stations denoted as white triangles on the map above. The system contains an outfall which intermittently connects to the gulf. Trend analysis of water chemistry variables in Deer Lake indicate significantly increasing salinity and total phosphorous, as well as significantly decreasing dissolved oxygen concentration.

Water Chemistry Data- 2019

Summary statistics include mean, maximum (Max), minimum (Min), median, and standard error (Std Error) calculated for both surface and bottom measurements for temperature, dissolved oxygen (DO), pH, and salinity, as well as surface measurements total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), secchi depth, as well as. These statistics represent 2019 water chemistry data.

2019 Summary Statistics

	min	mean	Max	Std.Error
Temperature top	16.72	27.37	33.31	2
Temperature bottom	17.37	26.79	32.02	1.85
DO (mg/L) top	4.8	6.59	8.57	0.47
DO (mg/L) bottom	0.39	3.27	6.87	0.76
pH top	7.12	7.68	8.16	0.13
pH bottom	7	7.59	8.46	0.16
Salinity (ppt) top	4.71	18.54	27.56	2.61
Salinity (ppt) bottom	3.78	20.35	28.48	2.59
TP (micrograms/L)	10.56	15.81	31.7	2.25
TN (micrograms/L)	241.47	317.54	477.98	23.49
CHL (micrograms/L)	2.88	4.81	10.77	0.85

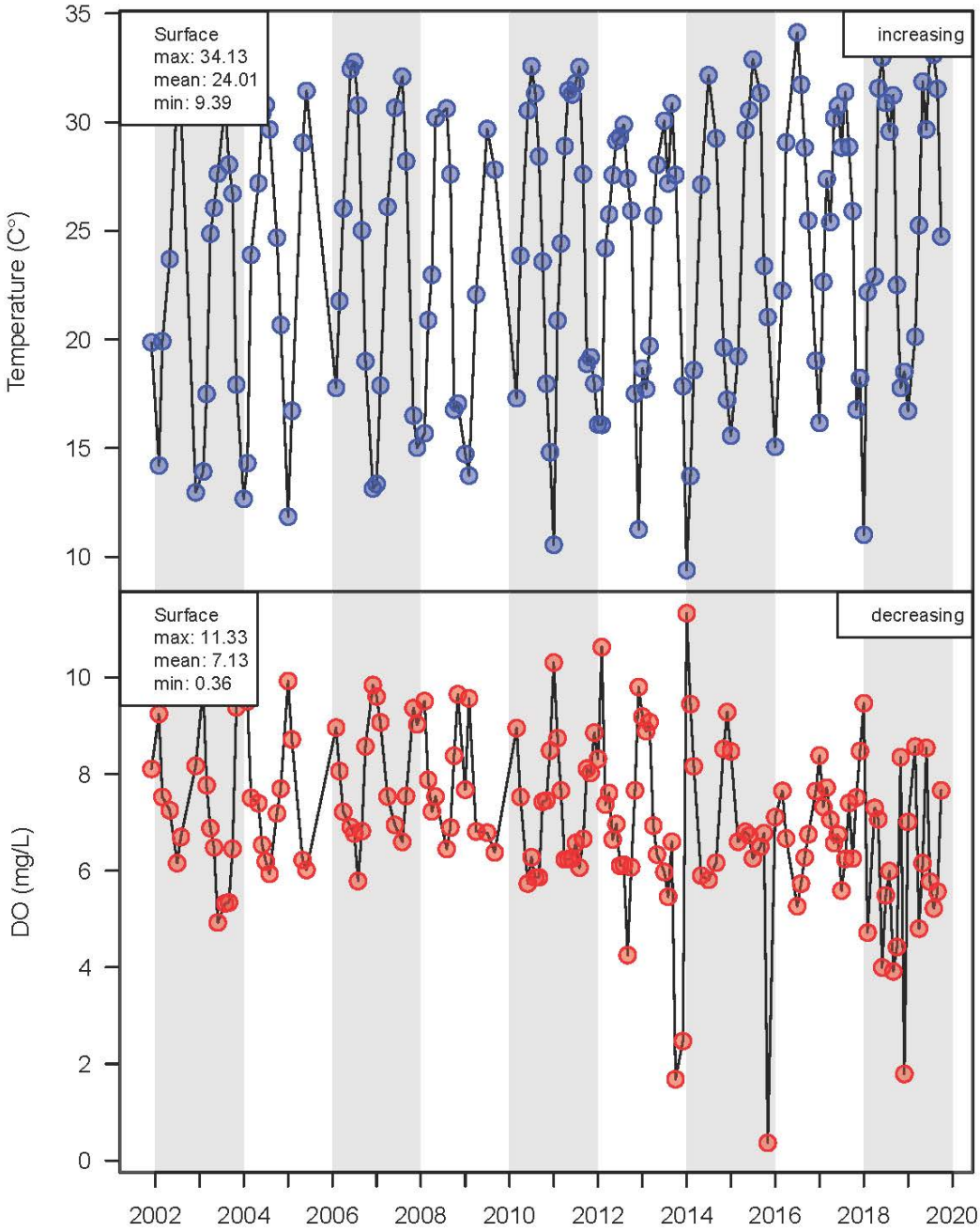
Water Chemistry Data- 2003 through 2019

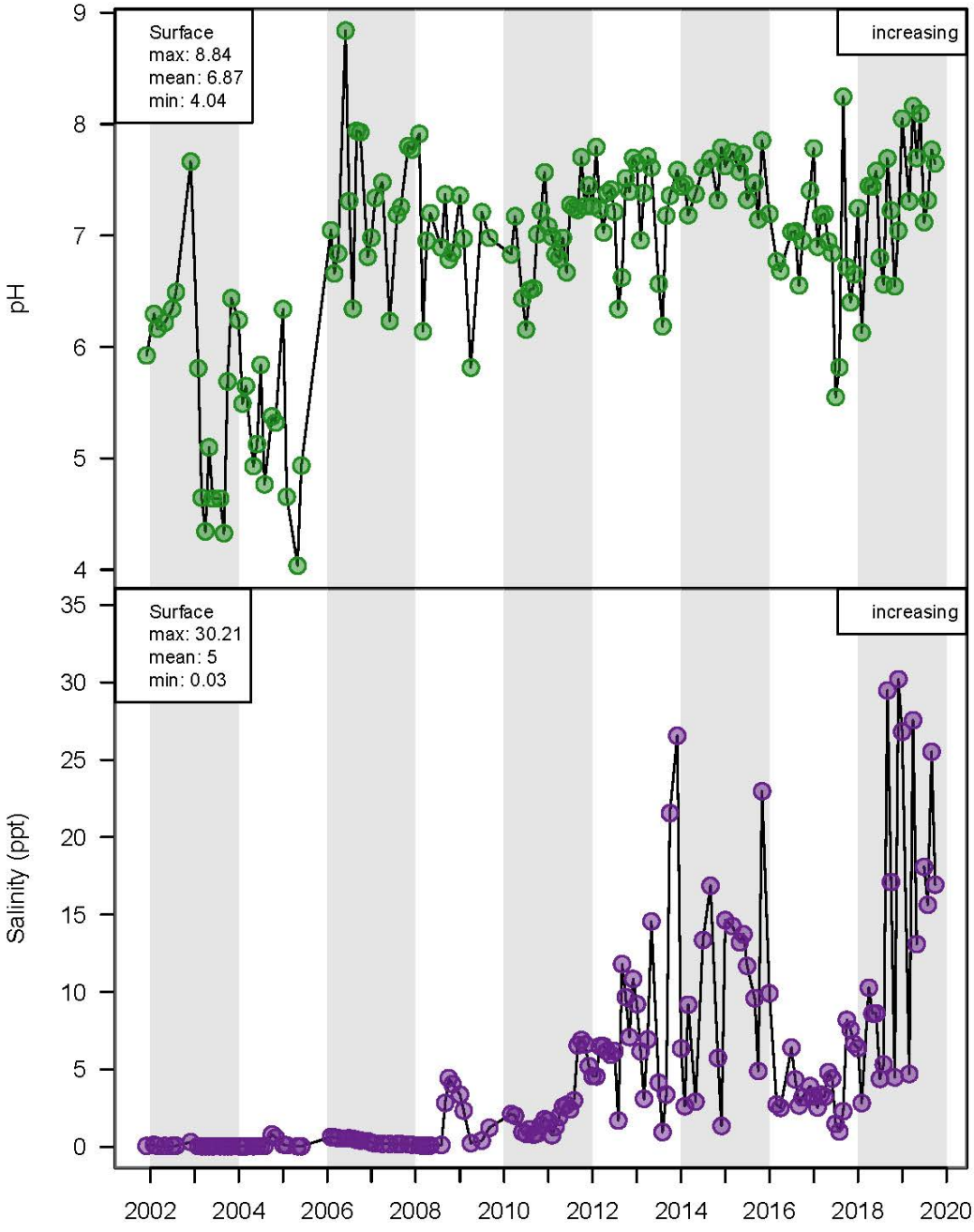
Summary statistics include mean, maximum (max), and minimum (min) summary statistics calculated on an annual basis using monthly data for hydrolab data variables; temperature, dissolved oxygen (DO), pH, and salinity as well as nutrient data variables total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), and secchi depth,. Summary statistics and trends represent results from long-term analyses among annual means from 2003 through 2019.

Times series plots display the inter-annual (monthly variability within the year - circles) and intra-annual variance (variability among years - triangles). Columns delineate three year time intervals.

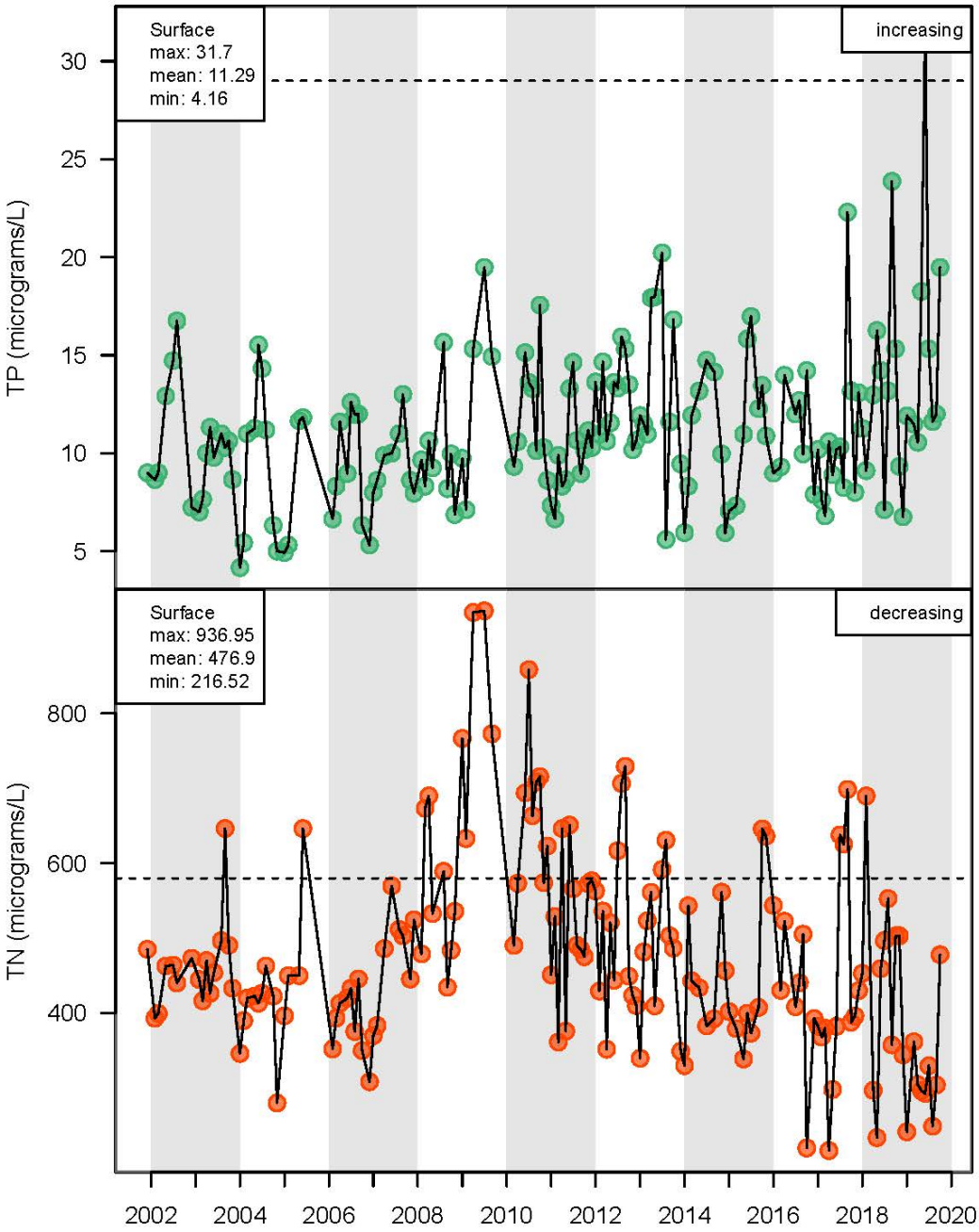
Kendall-Tau trend analysis results are shown for each water chemistry variable on the top-left of each plot. *No trend* indicates there was no significant trend found among the years examined (2003 through 2019). *Increasing* indicates a significant, positive trend was found over time. *Decreasing* indicates a significant, negative trend was found among the years examined. *Insufficient data* indicates insufficient annual data (year averages) were available for trend analysis

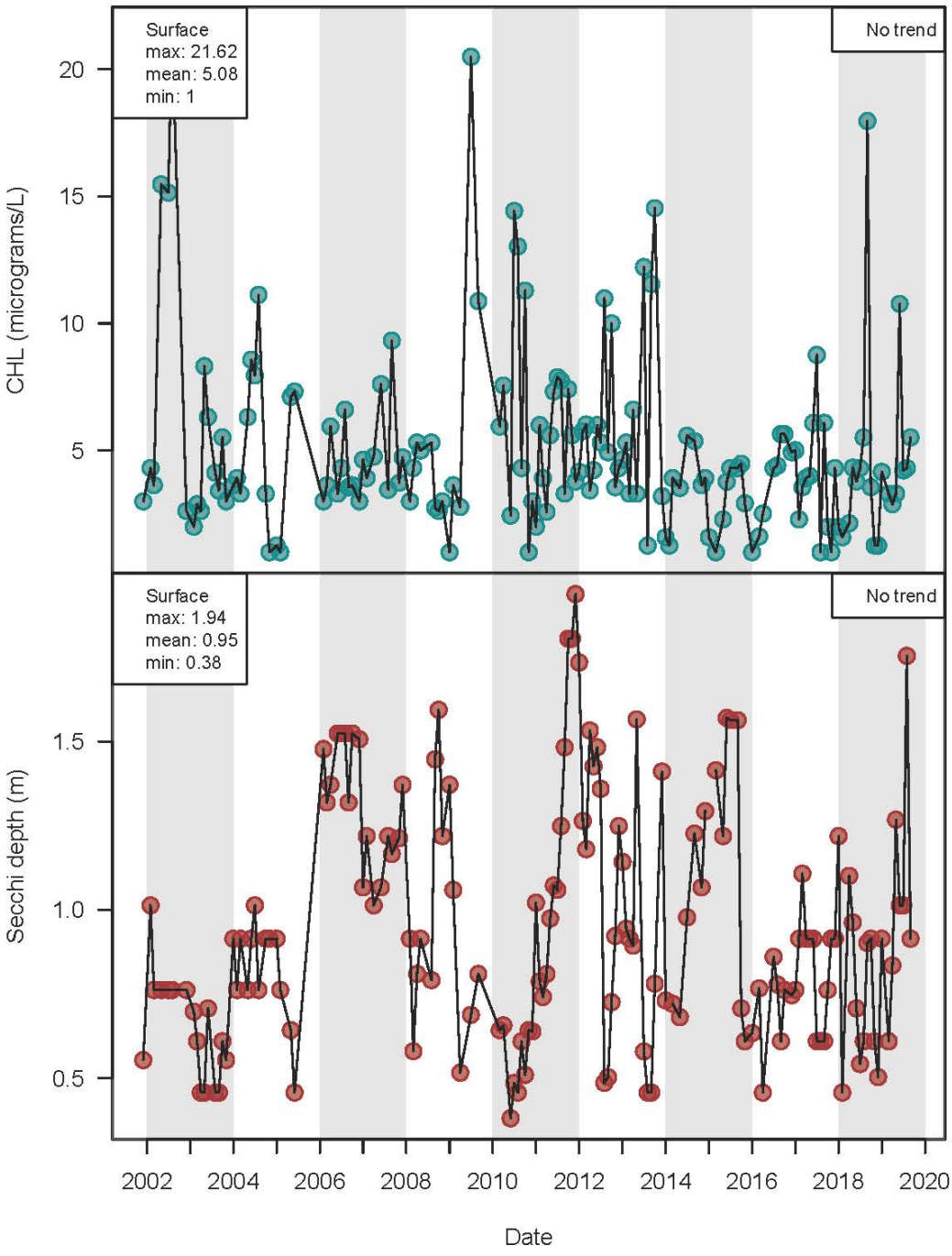
Hydrolab Trend Analyses



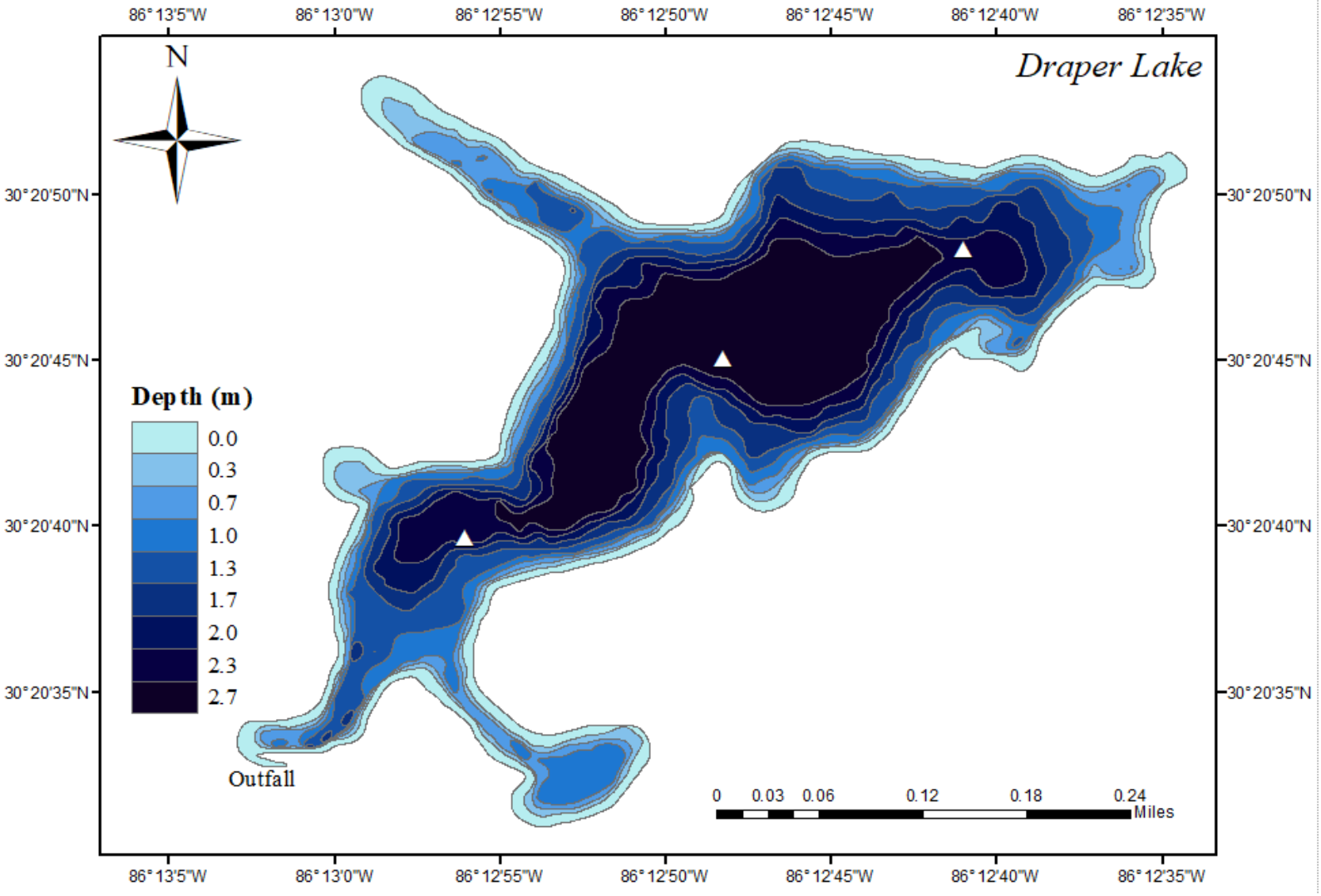

Surface
max: 8.84
mean: 6.87
min: 4.04
increasing
pH
Surface
max: 30.21
mean: 5
min: 0.03
increasing
Salinity (ppt)
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

Nutrient Trend Analyses




Surface
max: 21.62
mean: 5.08
min: 1
No trend
CHL (micrograms/L)
20
15
10
5
Surface
max: 1.94
mean: 0.95
min: 0.38
No trend
Secchi depth (m)
1.5
1.0
0.5
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Date

Draper Lake, Walton County



Lake Description

Draper Lake is an irregularly- shaped system approximately 200 meters from the Gulf of Mexico. The system is an intermediate-sized coastal dune lake, with a surface area of 16 hectares (160,000 m^2) and an approximate volume of 280,000 m^3. Long-term water chemistry monitoring for Draper Lake occurs at three stations denoted as white triangles on the map above. The system contains an outfall which regularly connects with the gulf. As a result, Draper Lake is a brackish system (6.1 ppt).

Water Chemistry Data- 2019

Summary statistics include mean, maximum (Max), minimum (Min), median, and standard error (Std Error) calculated for both surface and bottom measurements for temperature, dissolved oxygen (DO), pH, and salinity, as well as surface measurements total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), secchi depth, as well as. These statistics represent 2019 water chemistry data.

2019 Summary Statistics

	min	mean	Max	Std.Error
Temperature top	13.39	24.8	32.48	2.25
Temperature bottom	17.87	26.84	32.76	1.73
DO (mg/L) top	4.81	6.65	8.56	0.43
DO (mg/L) bottom	1.27	3.89	5.95	0.47
pH top	6.82	7.42	8.56	0.15
pH bottom	6.7	7.32	7.76	0.11
Salinity (ppt) top	0.04	9.61	14.65	1.33
Salinity (ppt) bottom	0.04	17.34	28.01	2.81
TP (micrograms/L)	9.89	12.23	17.7	0.72
TN (micrograms/L)	176.09	226.92	304.34	13.67
CHL (micrograms/L)	1	2.4	3.91	0.33

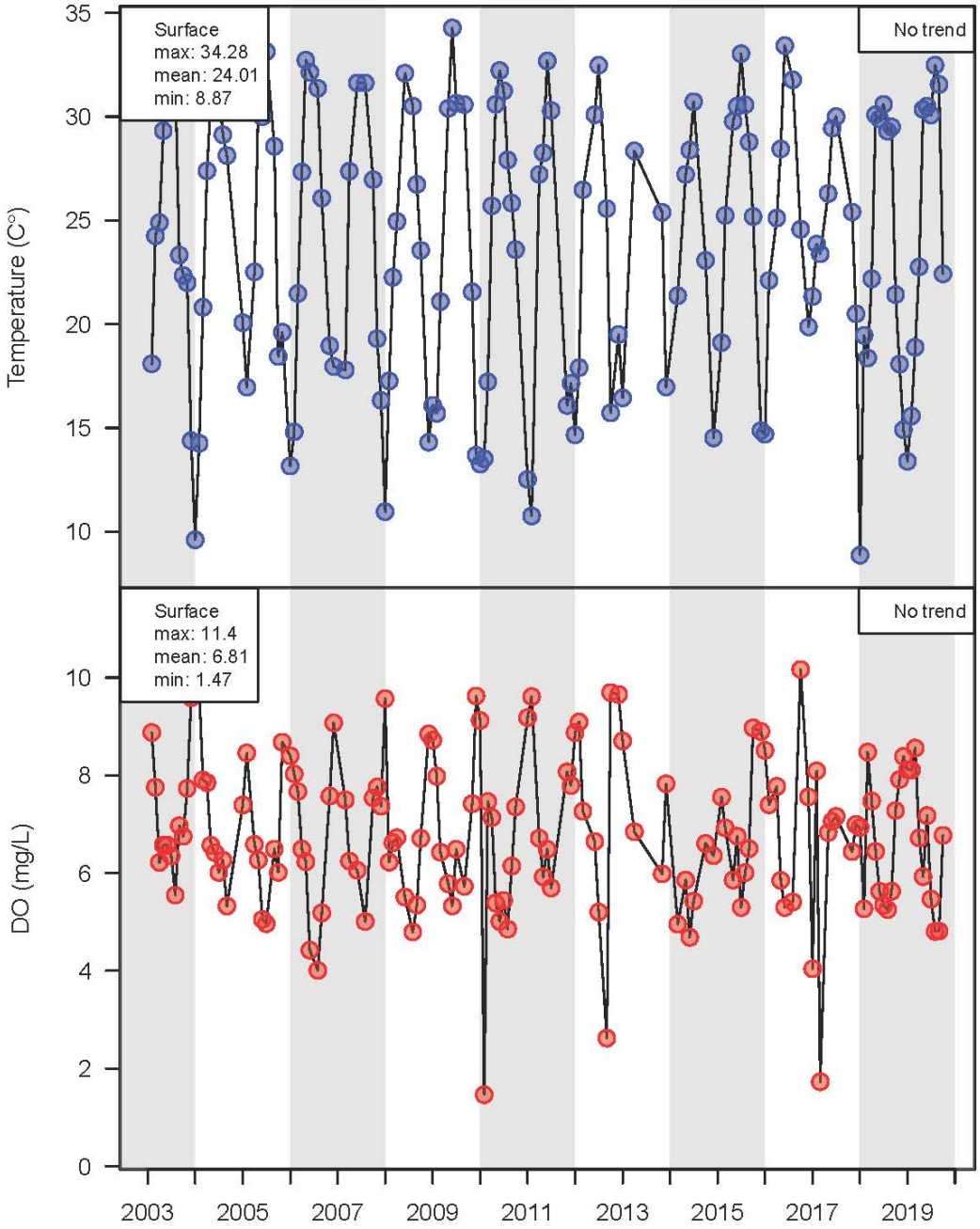
Water Chemistry Data- 2003 through 2019

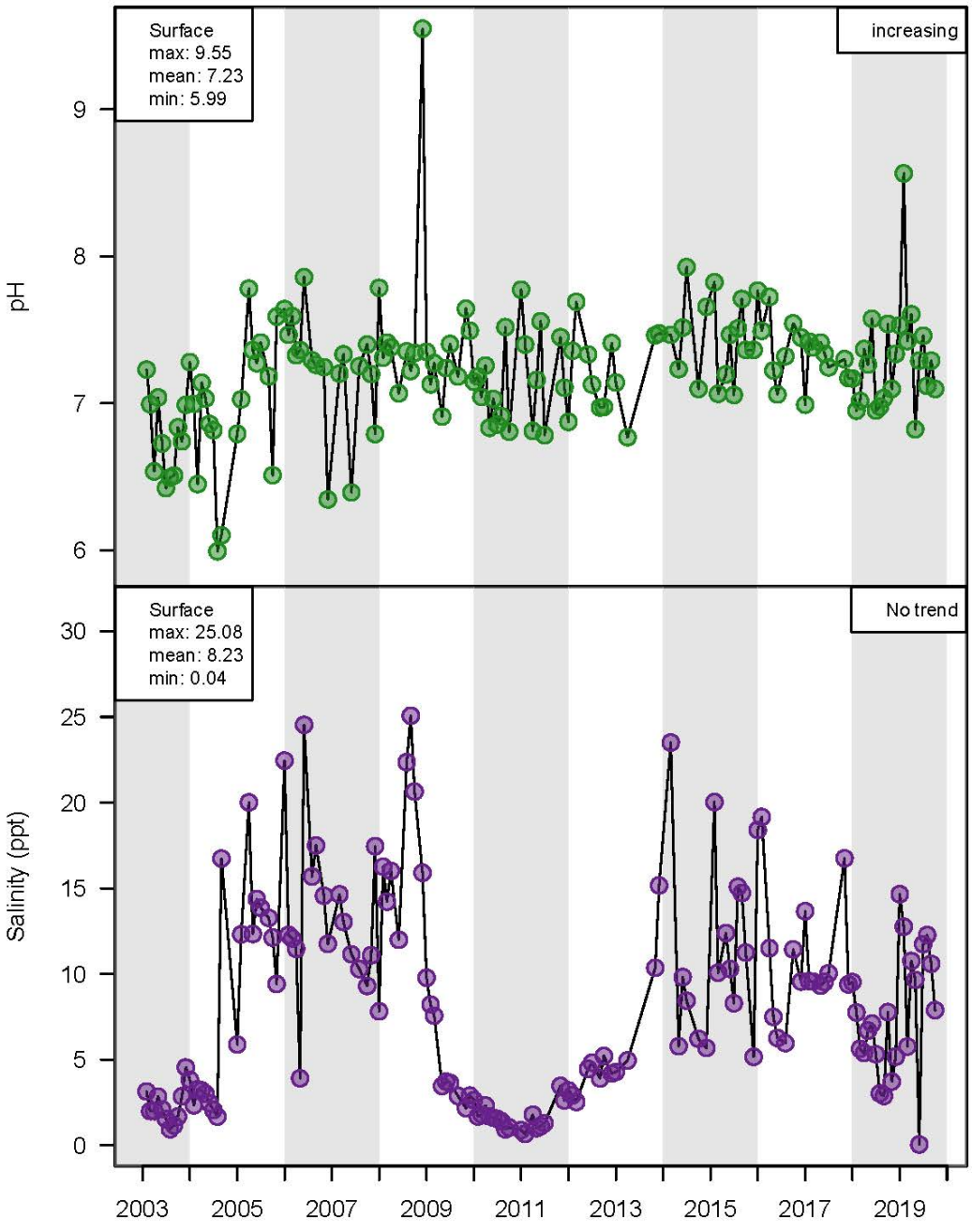
Summary statistics include mean, maximum (max), and minimum (min) summary statistics calculated on an annual basis using monthly data for hydrolab data variables; temperature, dissolved oxygen (DO), pH, and salinity as well as nutrient data variables total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), and secchi depth,. Summary statistics and trends represent results from long-term analyses among annual means from 2003 through 2019.

Times series plots display the inter-annual (monthly variability within the year - circles) and intra-annual variance (variability among years - triangles). Columns delineate three year time intervals.

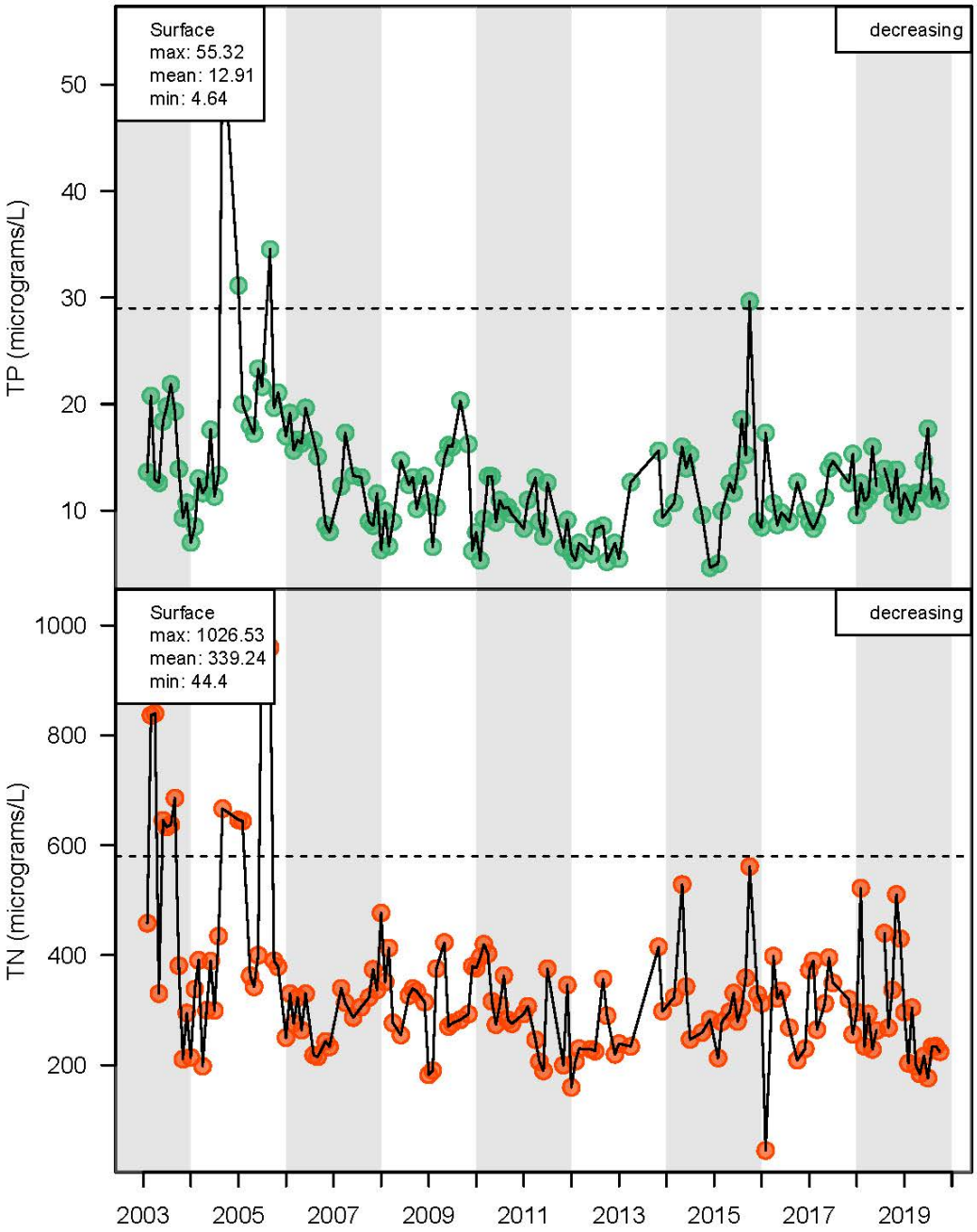
Kendall-Tau trend analysis results are shown for each water chemistry variable on the top-left of each plot. *No trend* indicates there was no significant trend found among the years examined (2003 through 2019). *Increasing* indicates a significant, positive trend was found over time. *Decreasing* indicates a significant, negative trend was found among the years examined. *Insufficient data* indicates insufficient annual data (year averages) were available for trend analysis.

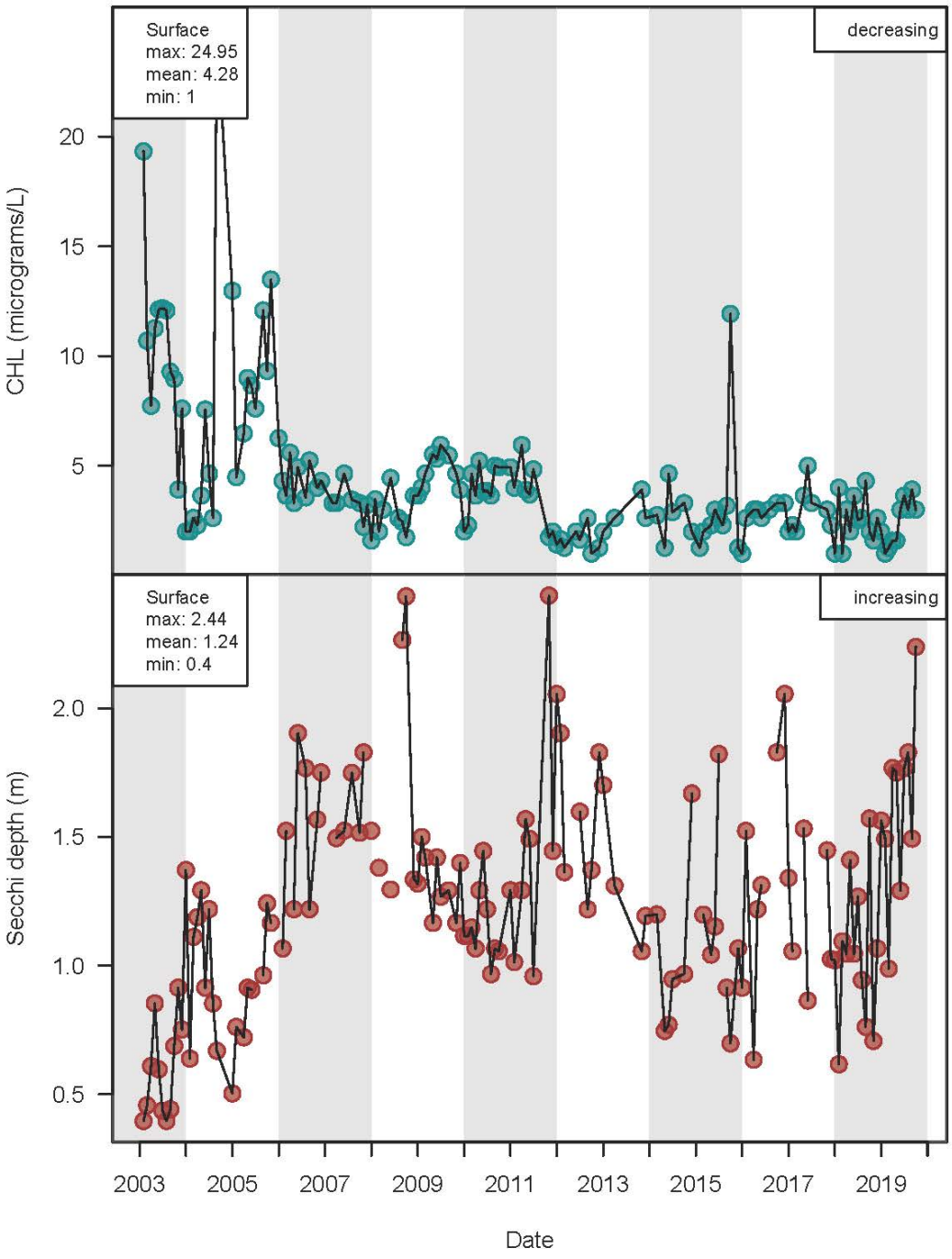
Hydrolab Trend Analyses



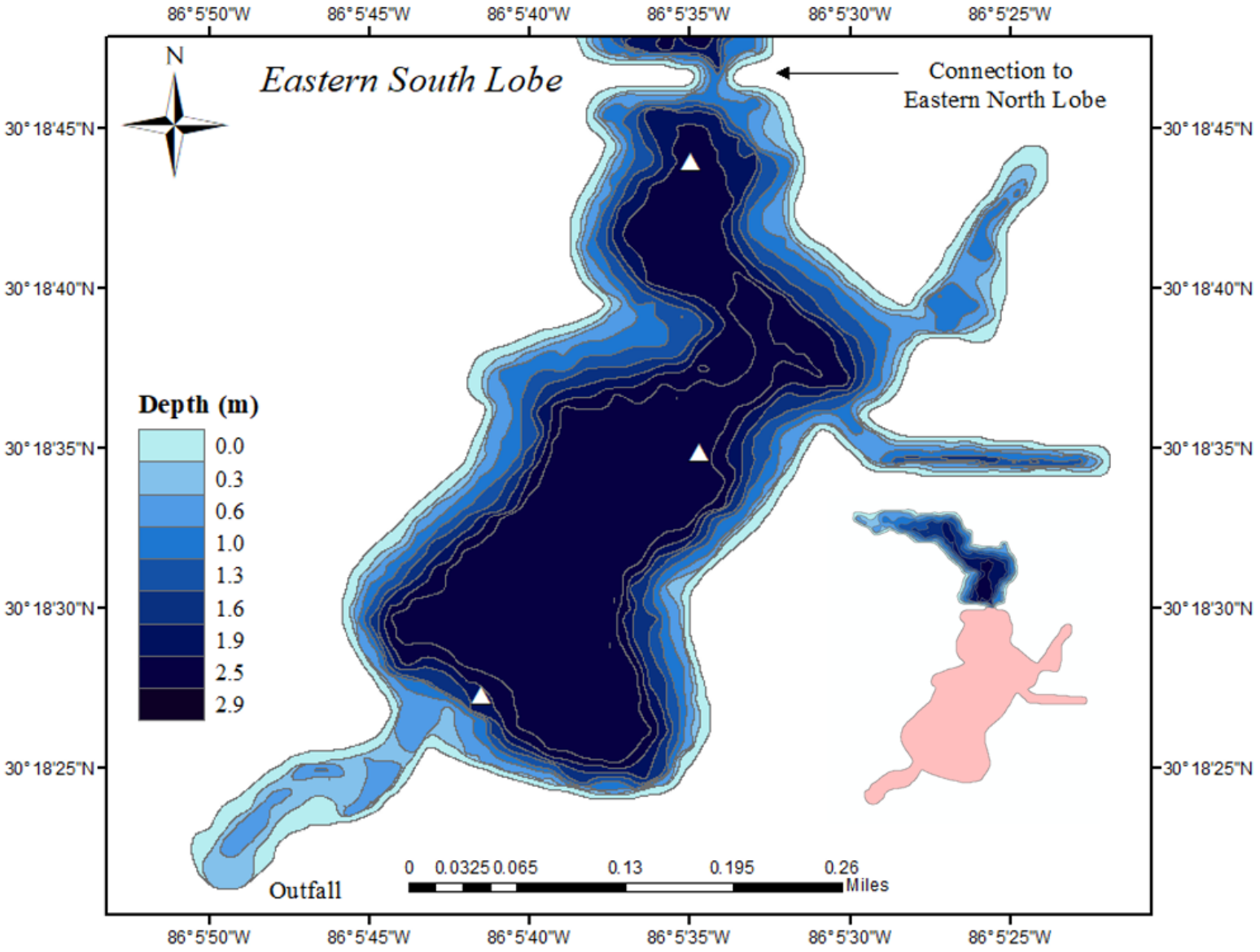

Surface
max: 9.55
mean: 7.23
min: 5.99
increasing
pH
9
8
7
6
Surface
max: 25.08
mean: 8.23
min: 0.04
No trend
Salinity (ppt)
30
25
20
15
10
5
0
2003
2005
2007
2009
2011
2013
2015
2017
2019

Nutrient Trend Analyses




Surface
max: 24.95
mean: 4.28
min: 1
decreasing
CHL (micrograms/L)
20
15
10
5
Surface
max: 2.44
mean: 1.24
min: 0.4
increasing
Secchi depth (m)
2.0
1.5
1.0
0.5
2003
2005
2007
2009
2011
2013
2015
2017
2019
Date

Eastern South Lake Lobe, Walton County



Lake Description

Eastern Lake is a large, elongated system approximately 200 meters from the Gul of Mexico. The system is among the larger coastal dune lakes, with a total surface area of 30 hectares (300,000 m2) and an approximate volume of 530,000 m3. The system is divided by Highway 30A into a northern and a southern lobe. Connectivity between the two lobes is maintained by a bridge. Eastern South Lobe refers to the southern lobe of Eastern Lake. Long-term water chemistry monitoring for Eastern South Lobe occurs at three stations denoted as white triangles on the map above. The system contains an outfall which frequently connects to the gulf. As a result Eastern South Lobe and Eastern North Lobe are among the most saline coastal dune lake systems (11 ppt and 10 ppt respectively).

Water Chemistry Data- 2019

Summary statistics include mean, maximum (Max), minimum (Min), median, and standard error (Std Error) calculated for both surface and bottom measurements for temperature, dissolved oxygen (DO), pH, and salinity, as well as surface measurements total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), secchi depth, as well as. These statistics represent 2019 water chemistry data.

2019 Summary Statistics

	min	mean	max	Std.Error
Temperature top	18.71	27.75	32.17	1.99
Temperature bottom	19.17	27.38	32.3	1.66
DO (mg/L) top	4.84	6.35	8.66	0.49
DO (mg/L) bottom	0.96	5.02	6.99	0.74
pH top	7.24	7.96	8.73	0.21
pH bottom	7.32	8.07	8.75	0.21
Salinity (ppt) top	0.04	14.3	25.16	3.09
Salinity (ppt) bottom	0.04	20.51	27.01	3.65
TP (micrograms/L)	13.29	19.58	28.92	2.09
TN (micrograms/L)	209.84	320.14	439.92	28.3
CHL (micrograms/L)	3	4.97	7.61	0.58

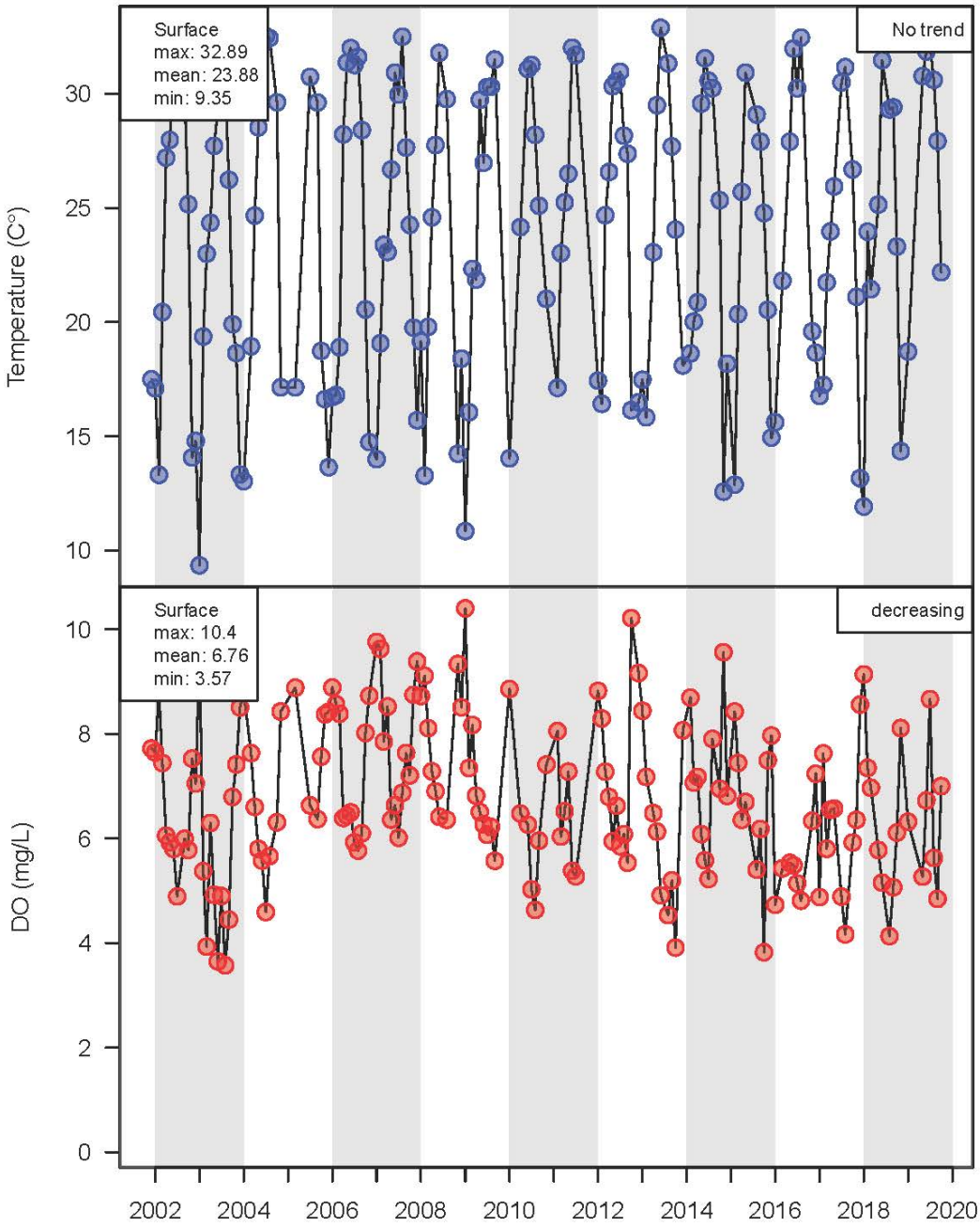
Water Chemistry Data- 2003 through 2019

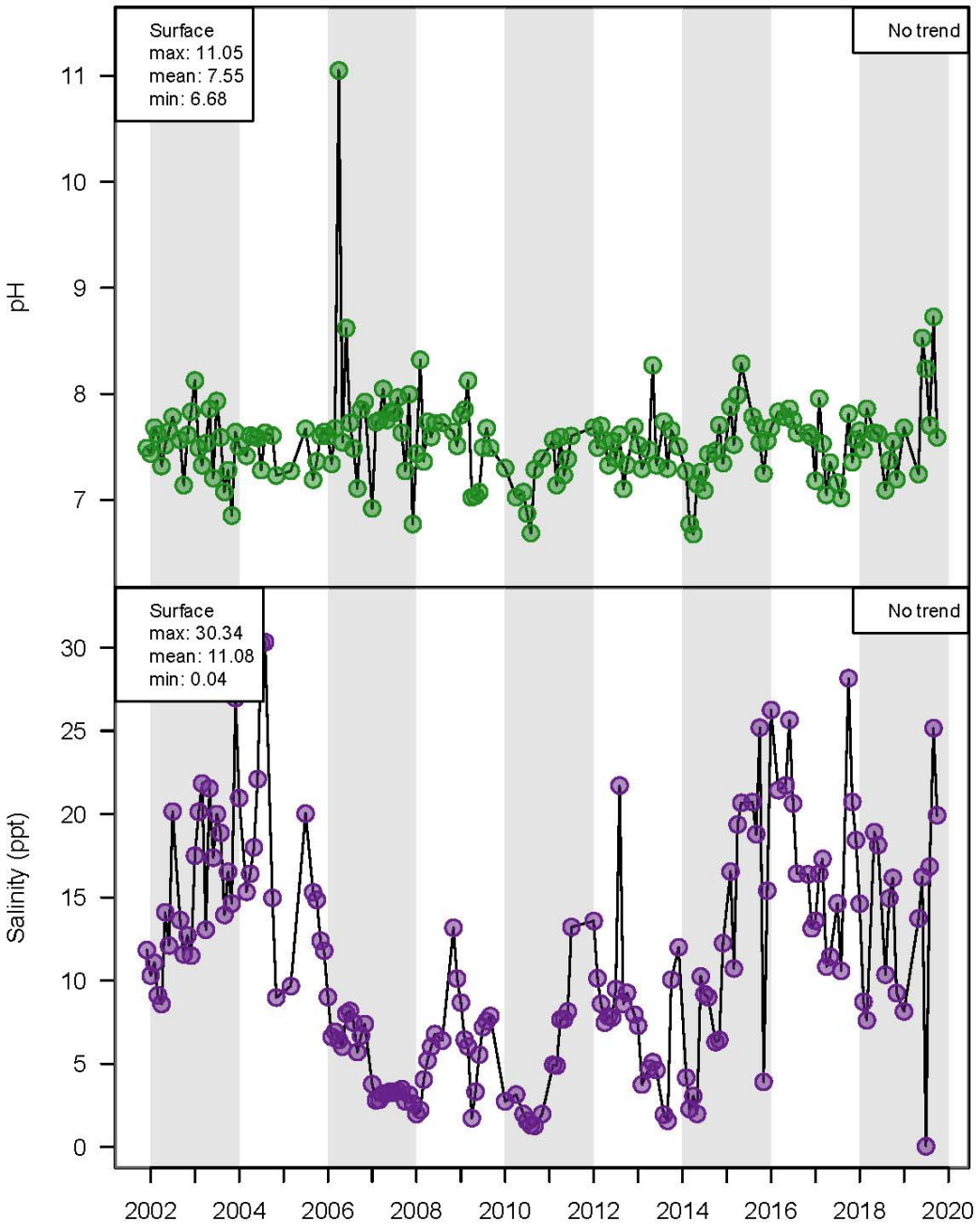
Summary statistics include mean, maximum (max), and minimum (min) summary statistics calculated on an annual basis using monthly data for hydrolab data variables; temperature, dissolved oxygen (DO), pH, and salinity as well as nutrient data variables total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), and secchi depth,. Summary statistics and trends represent results from long-term analyses among annual means from 2003 through 2019.

Times series plots display the inter-annual (monthly variability within the year - circles) and intra-annual variance (variability among years - triangles). Columns delineate three year time intervals.

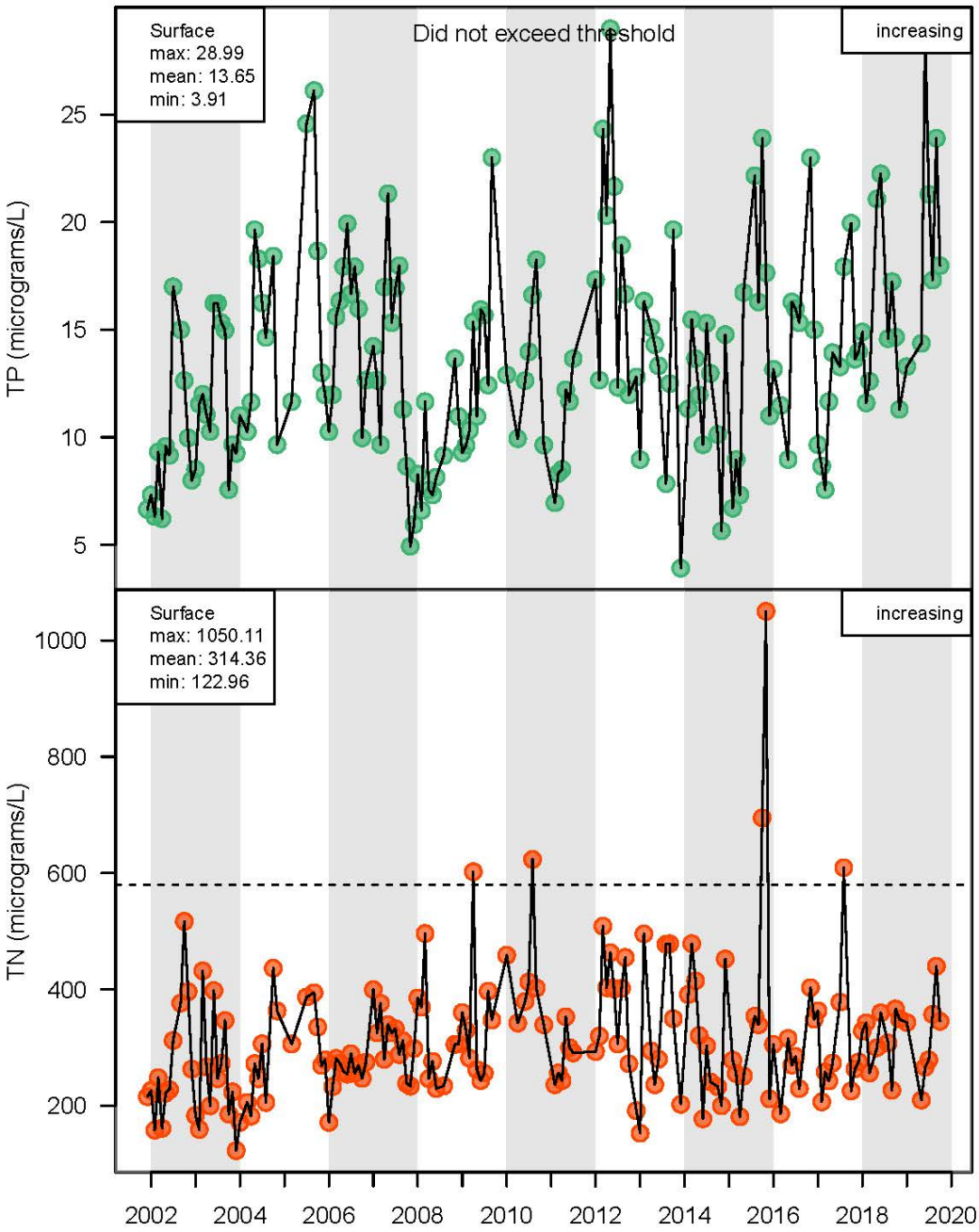
Kendall-Tau trend analysis results are shown for each water chemistry variable on the top-left of each plot. *No trend* indicates there was no significant trend found among the years examined (2003 through 2019). *Increasing* indicates a significant, positive trend was found over time. *Decreasing* indicates a significant, negative trend was found among the years examined. *Insufficient data* indicates insufficient annual data (year averages) were available for trend analysis.

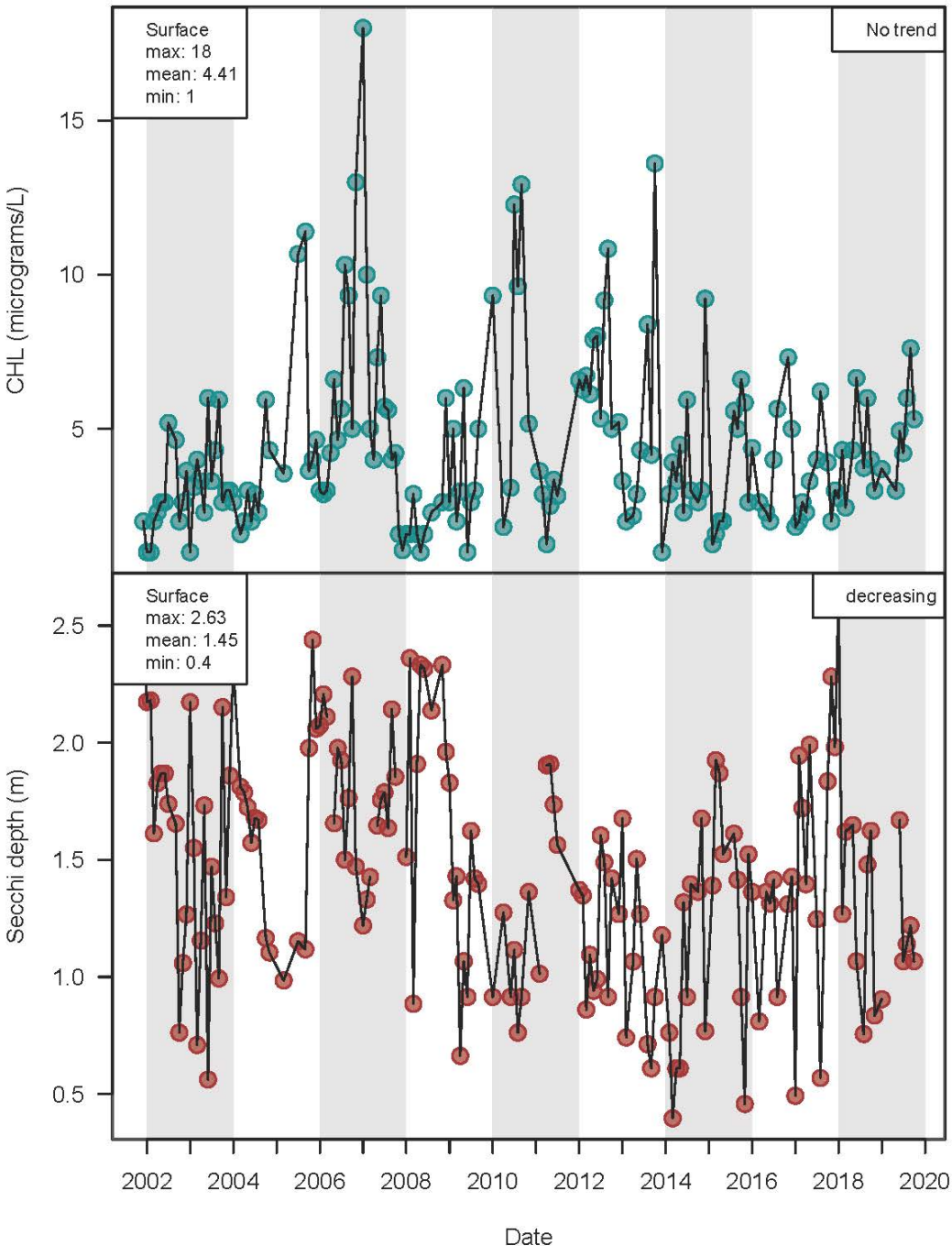
Hydrolab Data Analyses



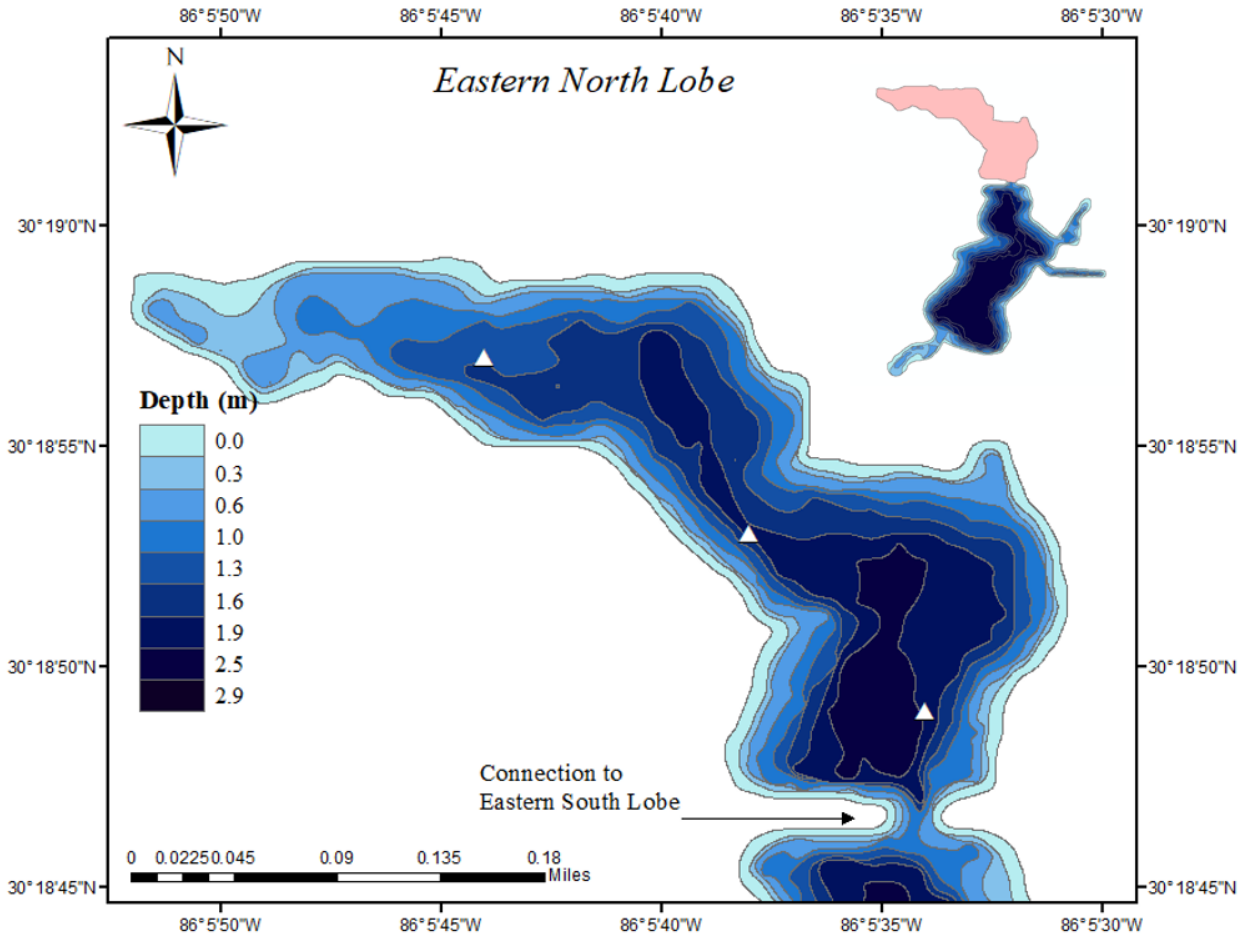

Surface
max: 11.05
mean: 7.55
min: 6.68
No trend
pH
11
10
9
8
7
Surface
max: 30.34
mean: 11.08
min: 0.04
No trend
Salinity (ppt)
30
25
20
15
10
5
0
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

Nutrient Trend Analyses




Surface
max: 18
mean: 4.41
min: 1
No trend
CHL (micrograms/L)
15
10
5
Surface
max: 2.63
mean: 1.45
min: 0.4
decreasing
Secchi depth (m)
2.5
2.0
1.5
1.0
0.5
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Date

Eastern North Lake Lobe, Walton County



Lake Description

Eastern Lake is a large, elongated system approximately 200 meters from the Gul of Mexico. The system is among the larger coastal dune lakes, with a total surface area of 30 hectares (300,000 m2) and an approximate volume of 530,000 m3. The system is divided by Highway 30A into a northern and a southern lobe. Connectivity between the two lobes is maintained by a bridge. Eastern North Lobe refers to the Northern lobe of Eastern Lake. Long-term water chemistry monitoring for Eastern North Lobe occurs at three stations denoted as white triangles on the map above. Although Eastern North does not contain an outfall, it indirectly interacts with the gulf through its connection to Eastern South Lobe; which frequently connects to the gulf. As a result Eastern South Lobe and Eastern North Lobe are among the most saline coastal dune lake systems (11 ppt and 10 ppt respectively).

Water Chemistry Data- 2019

Summary statistics include mean, maximum (Max), minimum (Min), median, and standard error (Std Error) calculated for both surface and bottom measurements for temperature, dissolved oxygen (DO), pH, and salinity, as well as surface measurements total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), secchi depth, as well as. These statistics represent 2019 water chemistry data.

2019 Summary Statistics

	min	mean	max	Std.Error
Temperature top	15.42	25.85	31.81	2.1
Temperature bottom	19.16	27.08	33.07	1.67
DO (mg/L) top	4.81	5.87	7.12	0.26
DO (mg/L) bottom	0.31	4.2	7.09	0.63
pH top	6.85	7.47	8.8	0.17
pH bottom	6.76	7.59	8.74	0.18
Salinity (ppt) top	3.54	17.1	24.09	2
Salinity (ppt) bottom	15.61	23.16	30.01	1.62
TP (micrograms/L)	12.1	18.9	37.34	2.27
TN (micrograms/L)	193.28	314.45	482.9	33.46
CHL (micrograms/L)	3	5.12	9.32	0.72

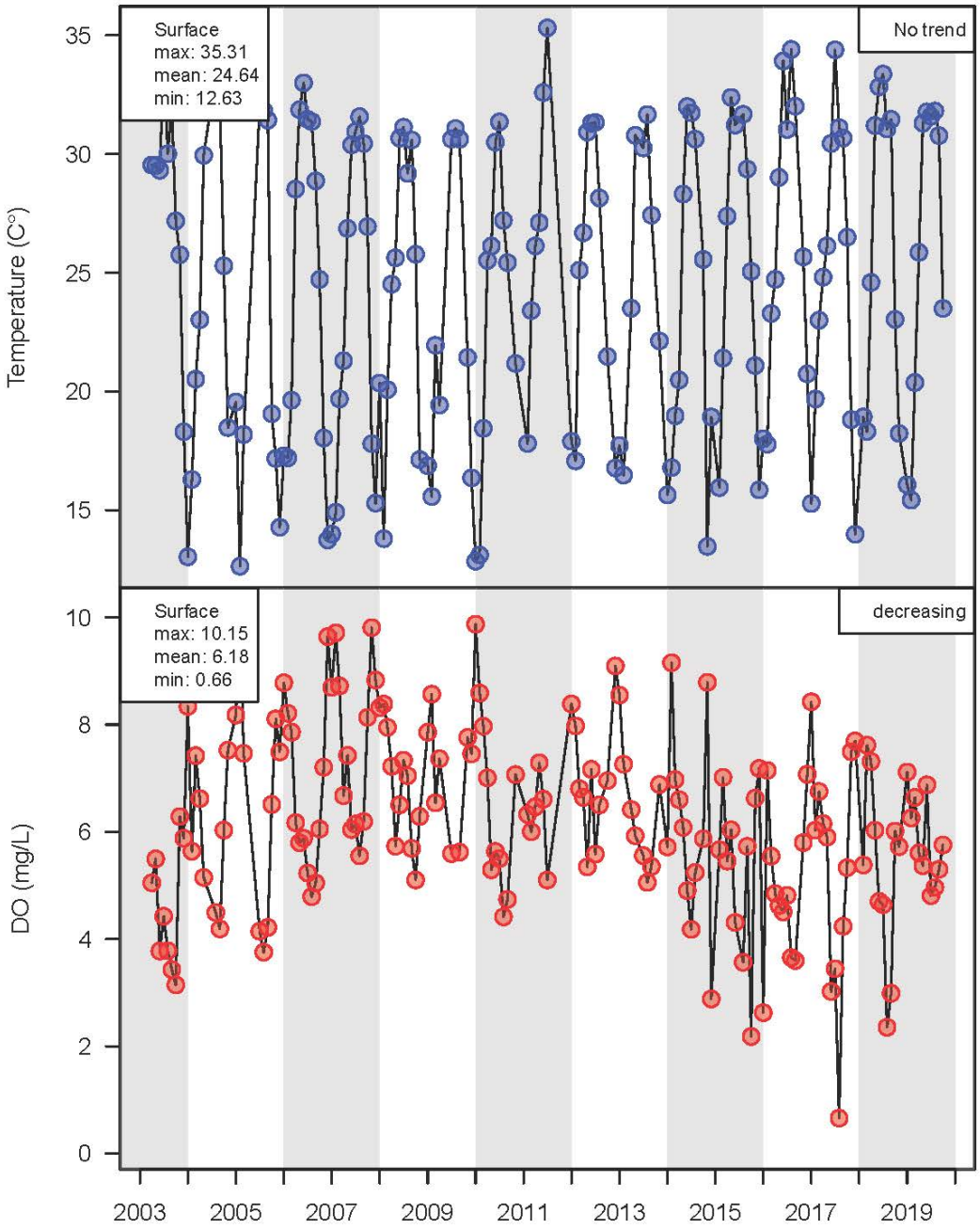
Water Chemistry Data- 2003 through 2019

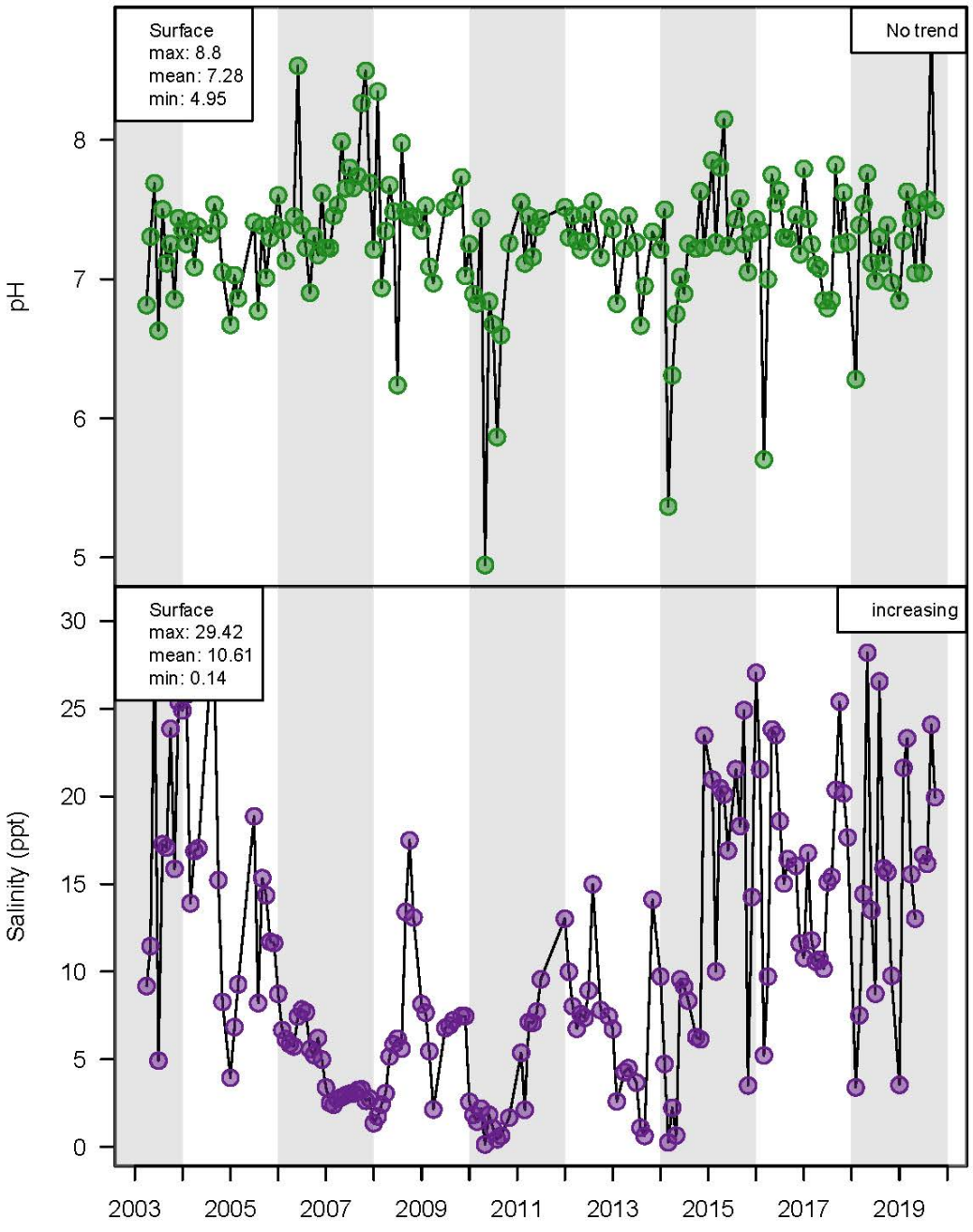
Summary statistics include mean, maximum (max), and minimum (min) summary statistics calculated on an annual basis using monthly data for hydrolab data variables; temperature, dissolved oxygen (DO), pH, and salinity as well as nutrient data variables total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), and secchi depth,. Summary statistics and trends represent results from long-term analyses among annual means from 2003 through 2019.

Times series plots display the inter-annual (monthly variability within the year - circles) and intra-annual variance (variability among years - triangles). Columns delineate three year time intervals.

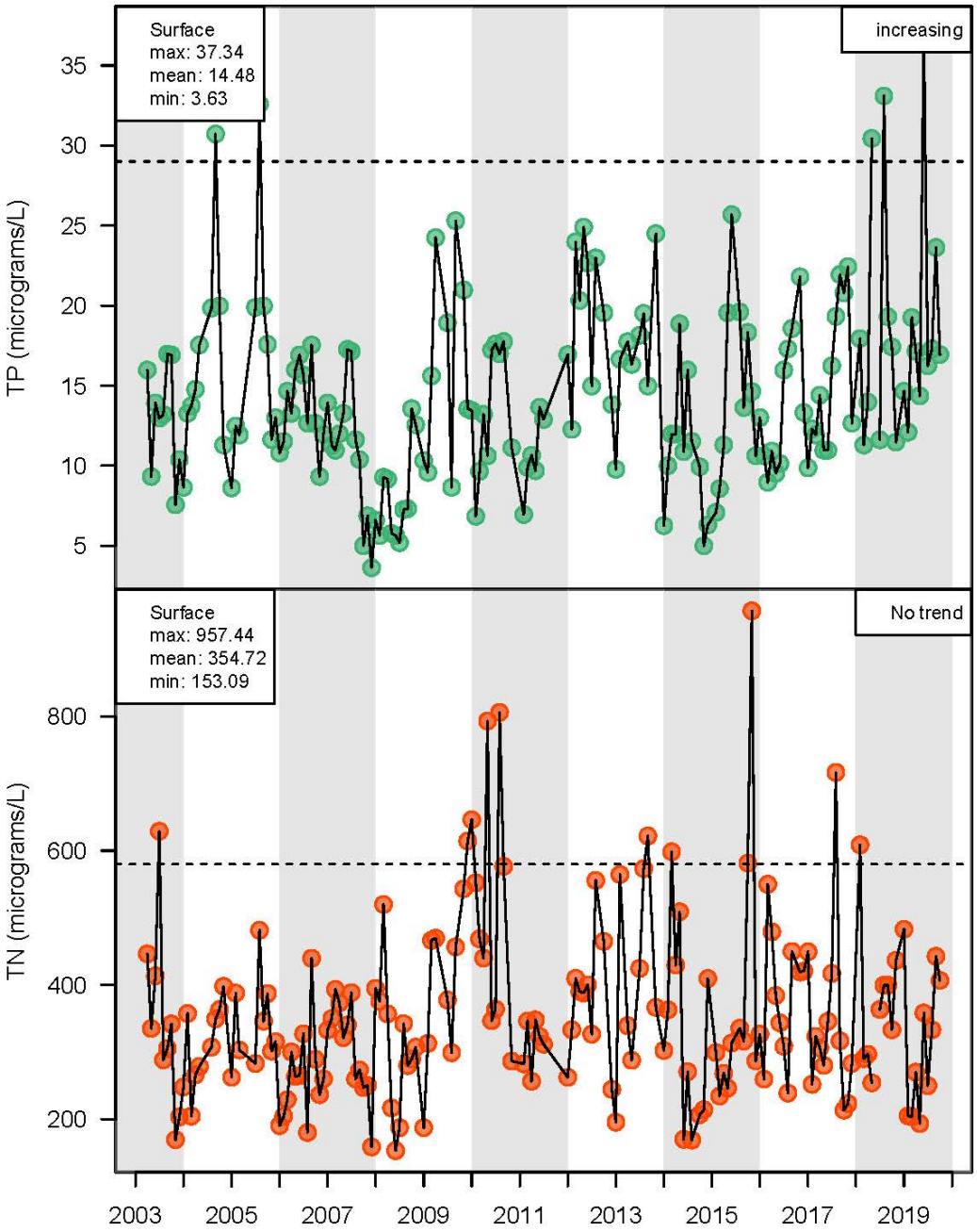
Kendall-Tau trend analysis results are shown for each water chemistry variable on the top-left of each plot. No trend indicates there was no significant trend found among the years examined (2003 through 2019). Increasing indicates a significant, positive trend was found over time. Decreasing indicates a significant, negative trend was found among the years examined. Insufficient data indicates insufficient annual data (year averages) were available for trend analysis.

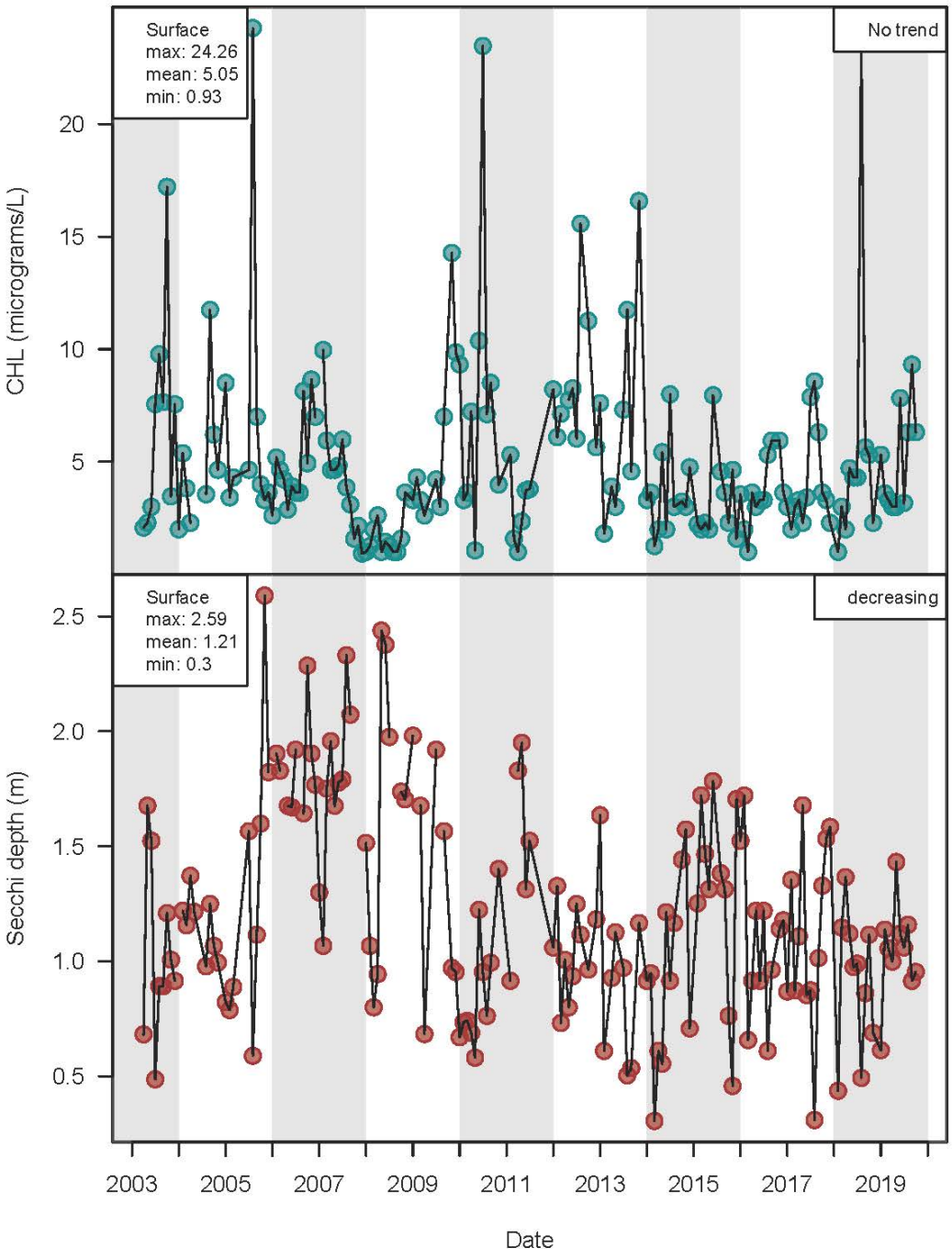
Hydrolab Trend Analyses



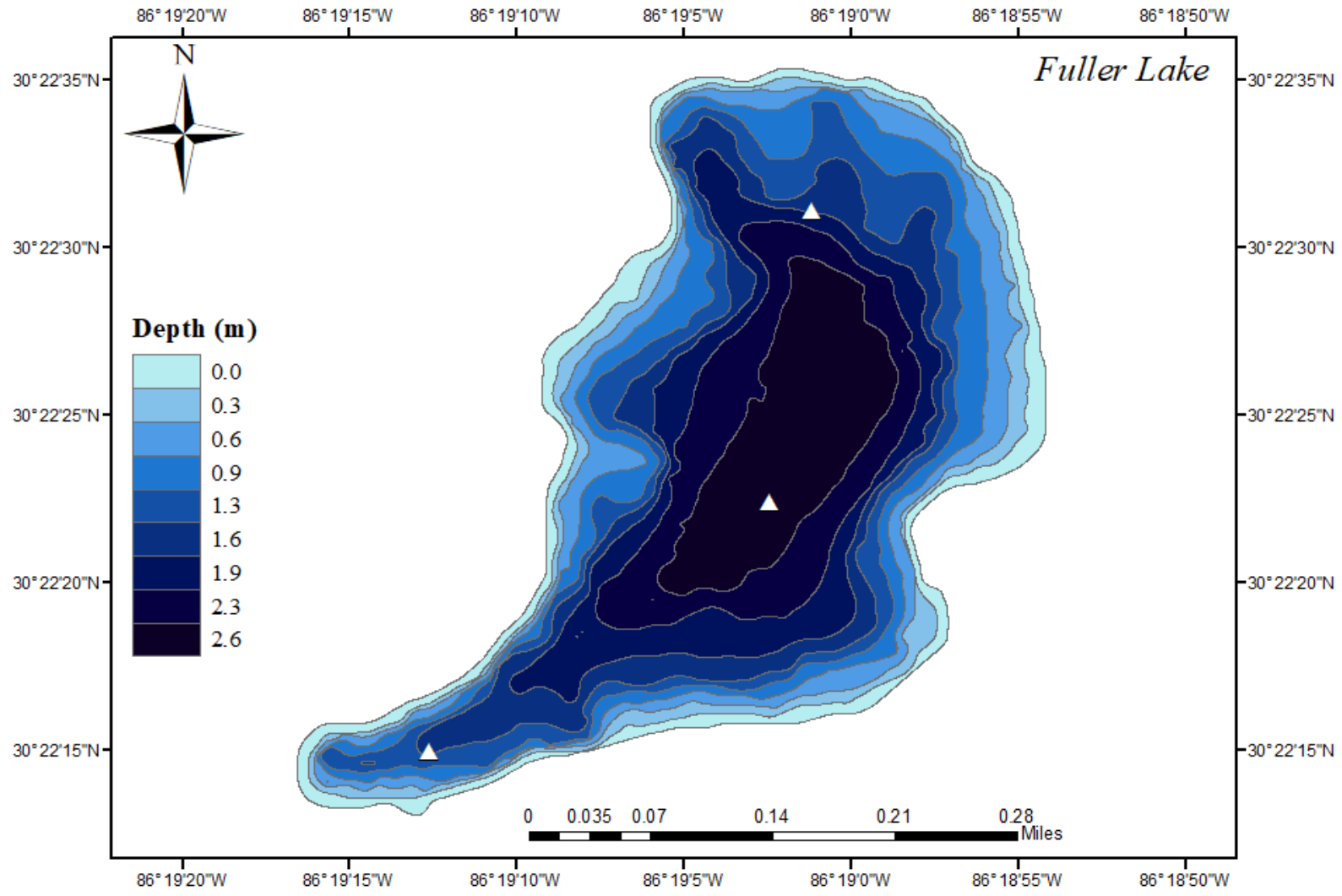

Surface
max: 8.8
mean: 7.28
min: 4.95
No trend
pH
8
7
6
5
Surface
max: 29.42
mean: 10.61
min: 0.14
increasing
Salinity (ppt)
30
25
20
15
10
5
0
2003
2005
2007
2009
2011
2013
2015
2017
2019

Nutrient Trend Analyses




Surface
max: 24.26
mean: 5.05
min: 0.93
No trend
CHL (micrograms/L)
20
15
10
5
Surface
max: 2.59
mean: 1.21
min: 0.3
decreasing
Secchi depth (m)
2.5
2.0
1.5
1.0
0.5
2003
2005
2007
2009
2011
2013
2015
2017
2019
Date

Fuller Lake, Walton County



Lake Description

Fuller Lake is a primarily isolated, freshwater (0.11 ppt) system laying approximately 400m from the Gulf of Mexico. The system is an intermediate-sized coastal dune lake; with a surface area of 21 hectares (210,000 m^2) and average volume of approximately 300,000 m^3. Long-term water chemistry monitoring for Fuller Lake occurs at three stations denoted as white triangles on the map above. Fuller Lake is one of several systems which do not possess a direct connection with the Gulf of Mexico. The system is retains indirect connectivity through a connection to Morris Lake (Hoyer & Canfield, 2008). However, long-term salinity results suggest that this connection likely does not play a significant role in lake water chemistry.

Water Chemistry Data- 2019

Summary statistics include mean, maximum (Max), minimum (Min), median, and standard error (Std Error) calculated for both surface and bottom measurements for temperature, dissolved oxygen (DO), pH, and salinity, as well as surface measurements total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), secchi depth, as well as. These statistics represent 2019 water chemistry data.

2019 Summary Statistics

	min	mean	max	Std.Error
Temperature top	12.42	26.96	31.84	2.5
Temperature bottom	11.66	25.54	30.74	2.42
DO (mg/L) top	5.7	6.64	8.74	0.36
DO (mg/L) bottom	3.2	5.85	8.26	0.54
pH top	4.82	5.1	5.51	0.09
pH bottom	4.89	5.09	5.39	0.07
Salinity (ppt) top	0.04	0.05	0.05	0
Salinity (ppt) bottom	0.04	0.05	0.05	0
TP (micrograms/L)	10.54	13.69	16.33	0.65
TN (micrograms/L)	503.31	608.6	733.05	28.05
CHL (micrograms/L)	1.59	5.69	11.77	1.25

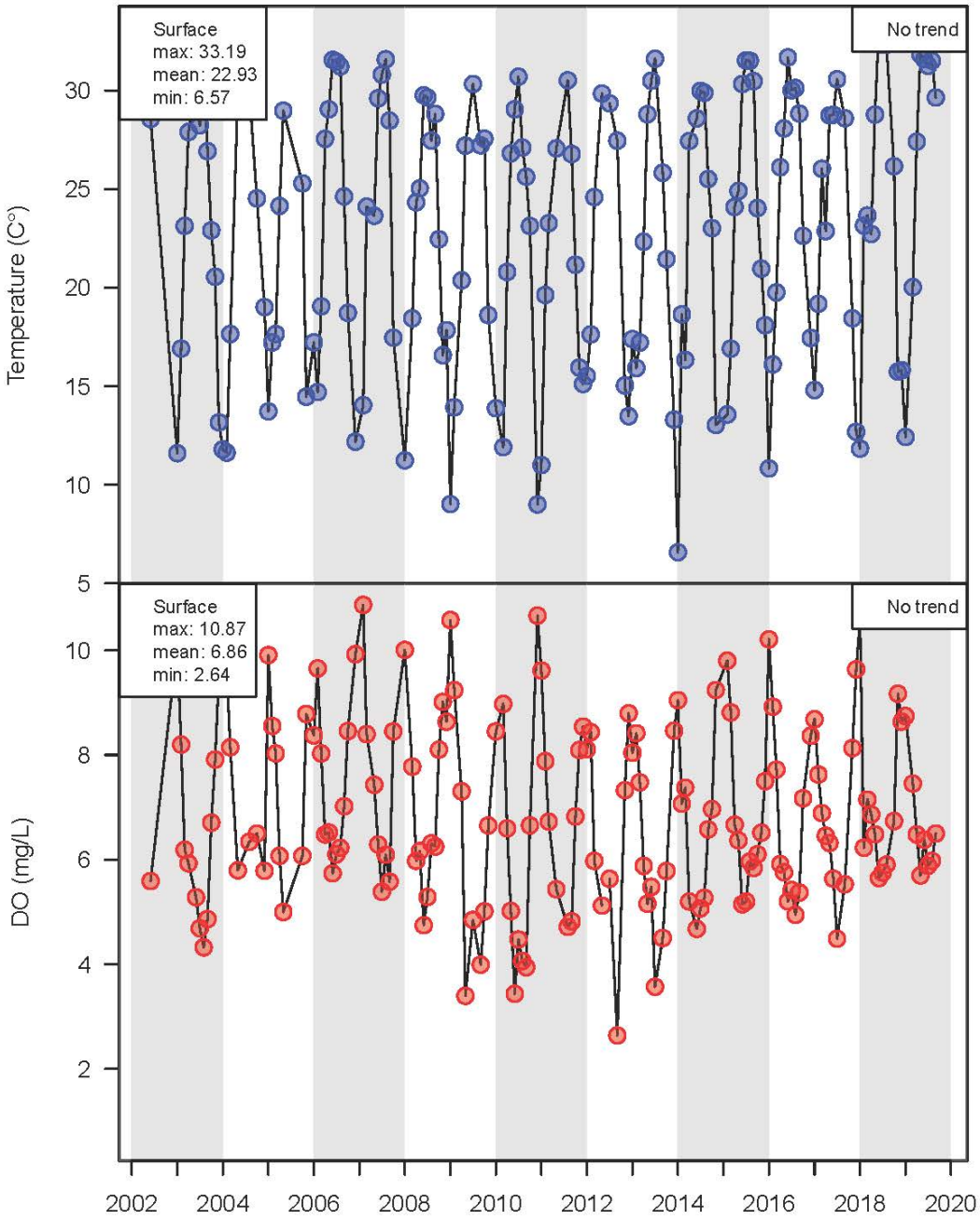
Water Chemistry Data- 2003 through 2019

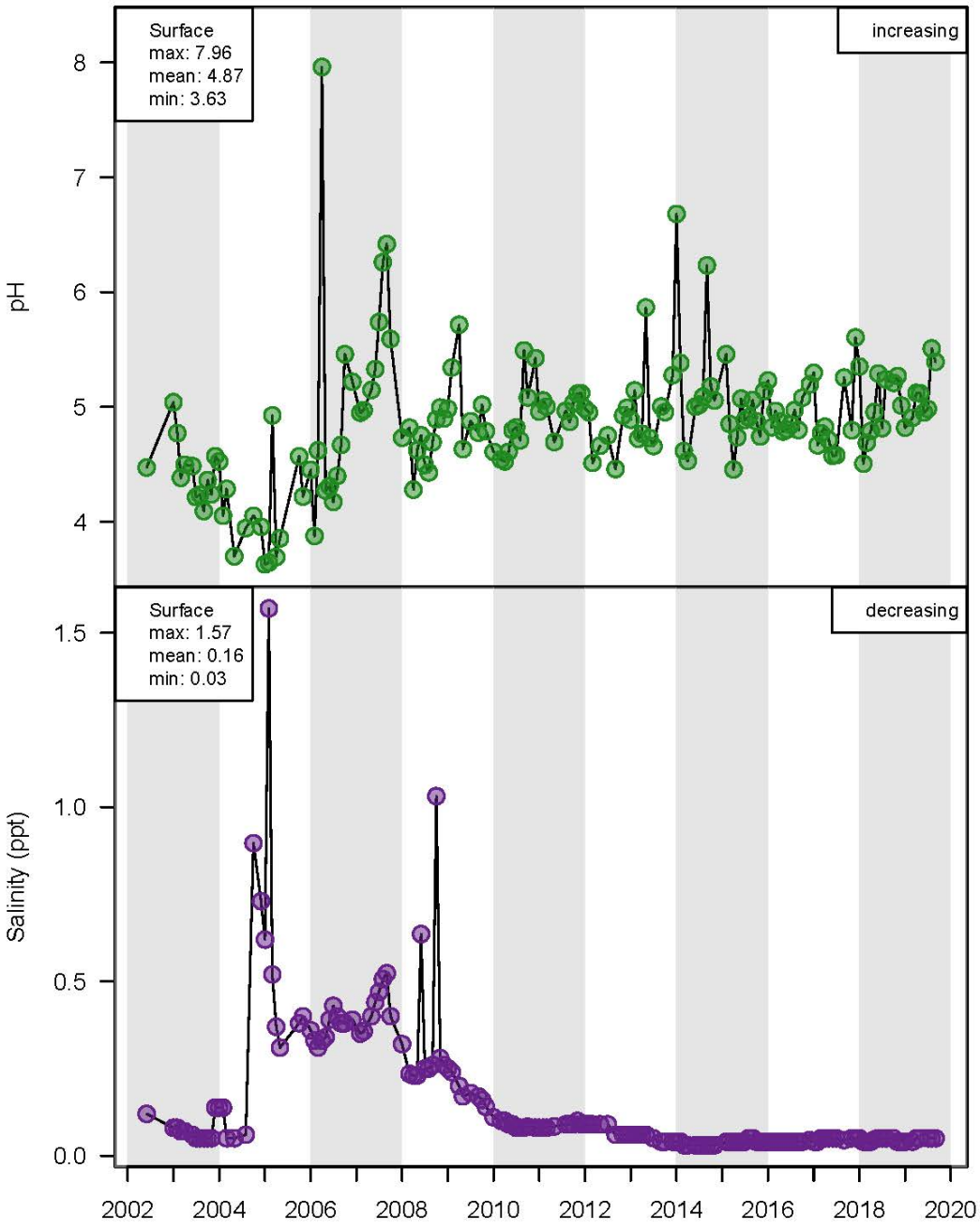
Summary statistics include mean, maximum (max), and minimum (min) summary statistics calculated on an annual basis using monthly data for hydrolab data variables; temperature, dissolved oxygen (DO), pH, and salinity as well as nutrient data variables total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), and secchi depth,. Summary statistics and trends represent results from long-term analyses among annual means from 2003 through 2019.

Times series plots display the inter-annual (monthly variability within the year - circles) and intra-annual variance (variability among years - triangles). Columns delineate three year time intervals.

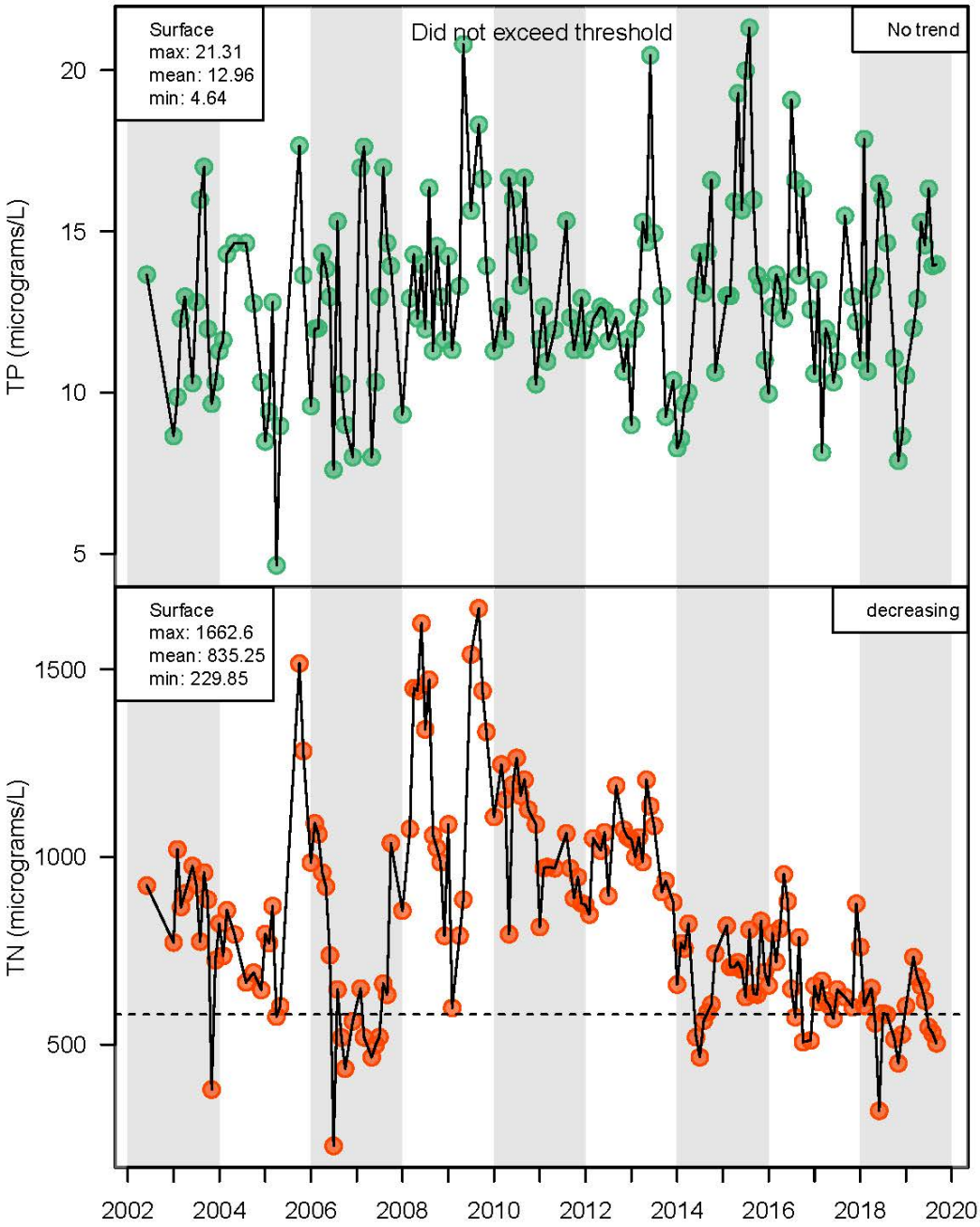
Kendall-Tau trend analysis results are shown for each water chemistry variable on the top-left of each plot. *No trend* indicates there was no significant trend found among the years examined (2003 through 2019). *Increasing* indicates a significant, positive trend was found over time. *Decreasing* indicates a significant, negative trend was found among the years examined. *Insufficient data* indicates insufficient annual data (year averages) were available for trend analysis.

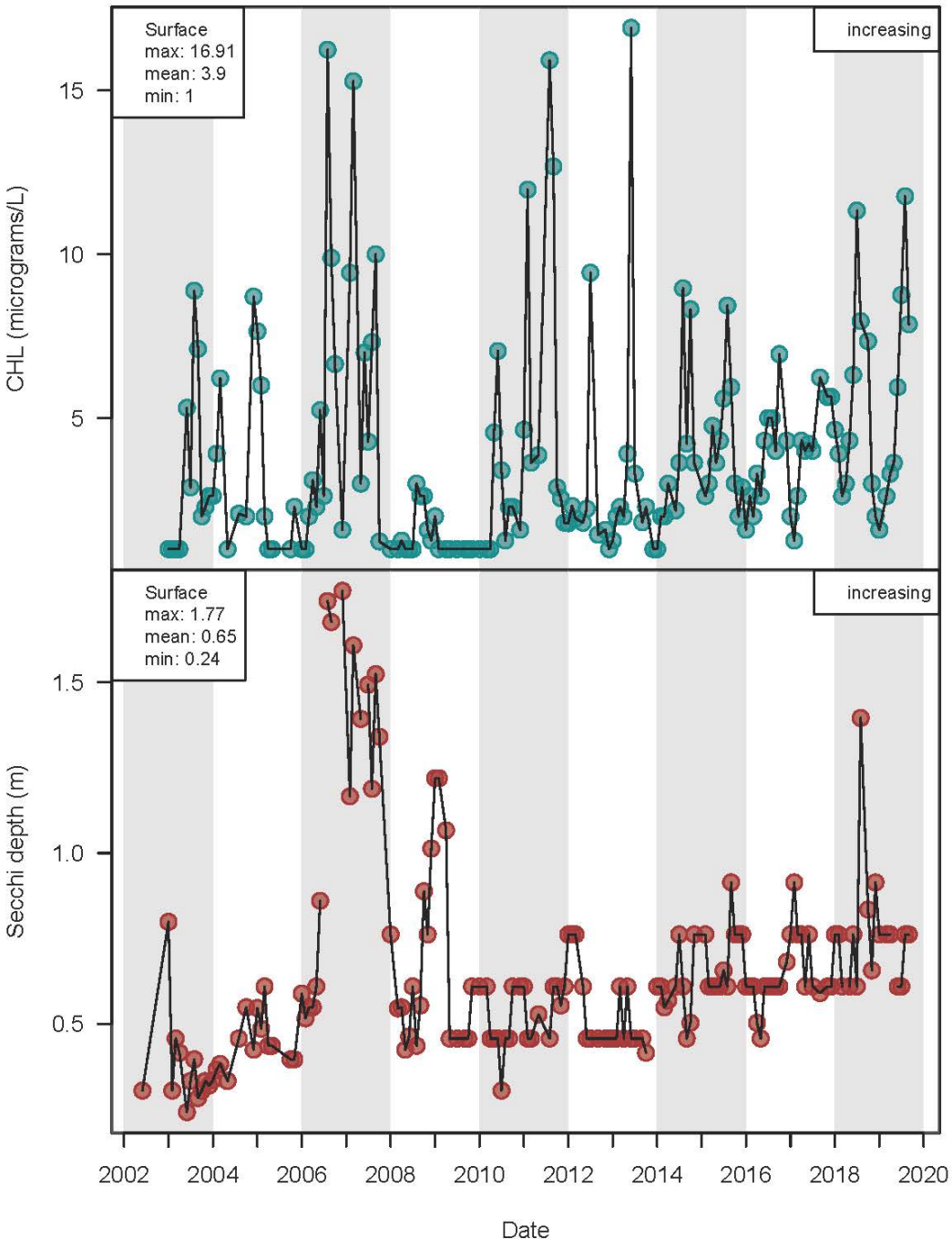
Hydrolab Trend Analyses



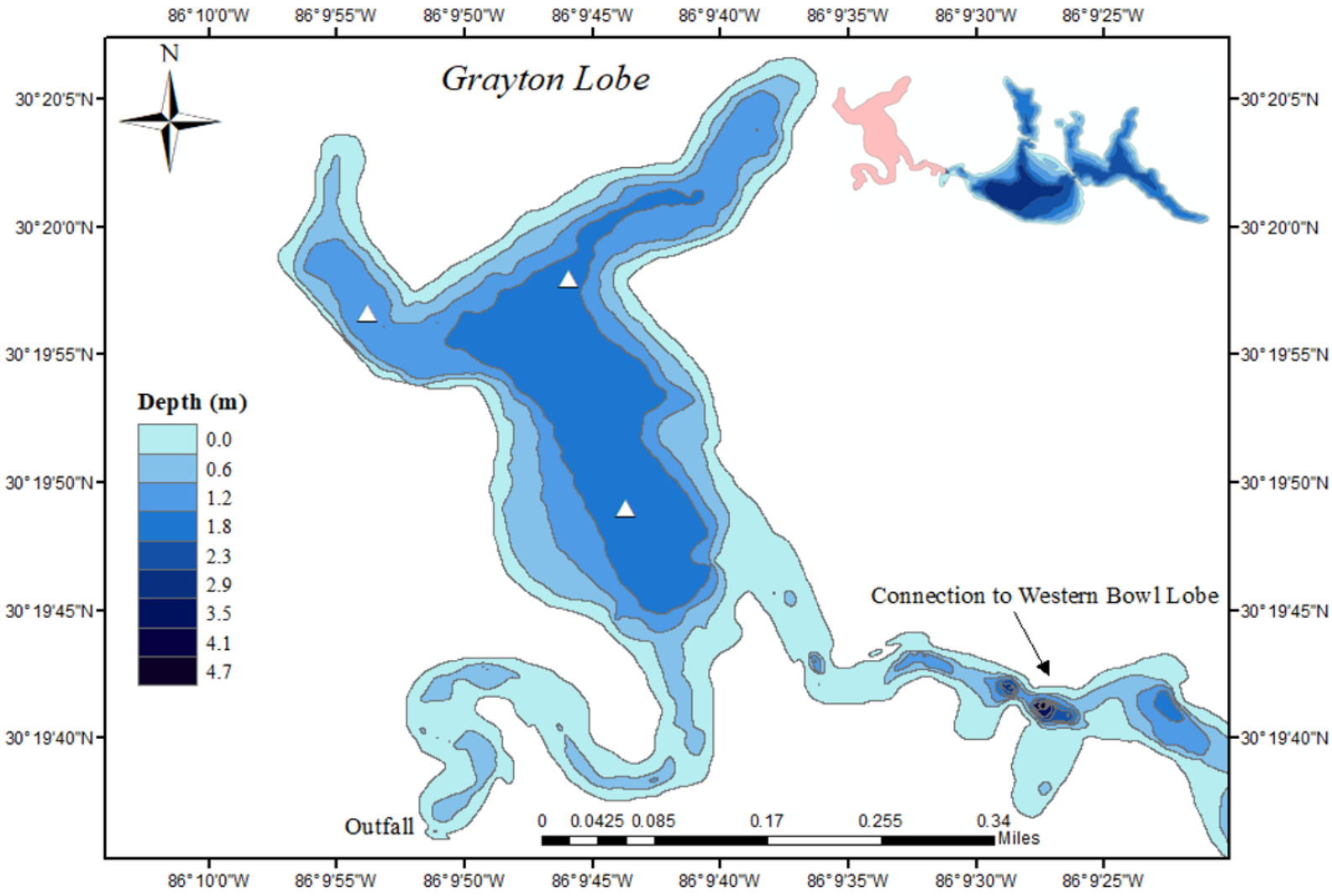

Surface
max: 7.96
mean: 4.87
min: 3.63
increasing
pH
8
7
6
5
4
Surface
max: 1.57
mean: 0.16
min: 0.03
decreasing
Salinity (ppt)
1.5
1.0
0.5
0.0
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

Nutrient Trend Analyses




Surface
max: 16.91
mean: 3.9
min: 1
increasing
CHL (micrograms/L)
15
10
5
Surface
max: 1.77
mean: 0.65
min: 0.24
increasing
Secchi depth (m)
1.5
1.0
0.5
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Date

Grayton Lake Lobe, Walton County



Lake Description

The Western Lake system is an irregularly-shaped lake system approximately 300 meters from the Gul of Mexico. The system is the second largest coastal dune lake system, with a total surface area of 98 hectares (980,000 m^2) and an approximate volume of 1,590,000 m^3. The system is divided first by a shallow, narrow channel into western and eastern lobes, and then again by Highway 30A into an eastern and northeastern lobe. Connectivity between the three lobes is maintained by two bridges. Grayton Lobe refers to the western lobe of Western Lake. It is an intermediate-sized system with a surface area of 23 hectares (230,000 m^2) and an approximate volume of 330,000 m^3. Long-term water chemistry monitoring for Grayton Lobe occurs at three stations denoted as white triangles on the map above. Grayton Lobe contains an outfall which frequently connects to the gulf. As a result Grayton Lobe is among the most saline coastal dune lake systems (11 ppt). However, the long, narrow channel separating Grayton Lobe from the other two lobes in the system acts as a bottleneck for seawater inflows, and as a result Western Bowl lobe and Western Northeast Lobes have markedly different salinity regimes (5 ppt each).

Water Chemistry Data- 2019

Summary statistics include mean, maximum (Max), minimum (Min), median, and standard error (Std Error) calculated for both surface and bottom measurements for temperature, dissolved oxygen (DO), pH, and salinity, as well as surface measurements total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), secchi depth, as well as. These statistics represent 2019 water chemistry data.

2019 Summary Statistics

	min	mean	max	Std.Error
Temperature top	12.16	26.05	33.59	2.16
Temperature bottom	17.76	27.08	33.31	1.71
DO (mg/L) top	4.45	6.23	9.2	0.44
DO (mg/L) bottom	2.57	4.52	6.01	0.37
pH top	7.48	7.74	8.84	0.13
pH bottom	7.13	7.85	8.81	0.14
Salinity (ppt) top	9.73	17.37	26.13	1.59
Salinity (ppt) bottom	13.25	25	32.28	2.54
TP (micrograms/L)	12.27	16.96	22.47	1.31
TN (micrograms/L)	212.63	330.19	452.19	24.31
CHL (micrograms/L)	1.26	5.17	12	1.06

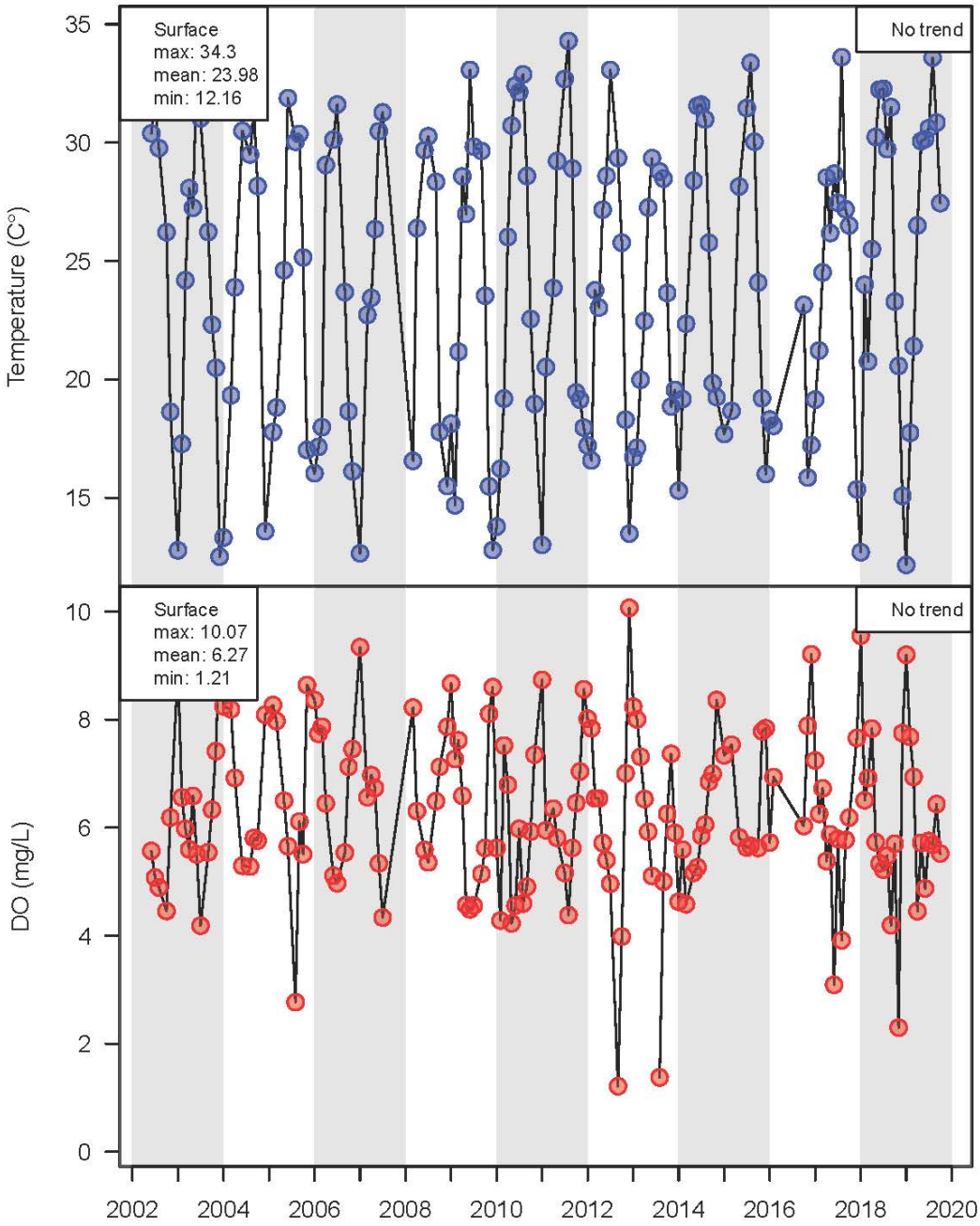
Water Chemistry Data- 2003 through 2019

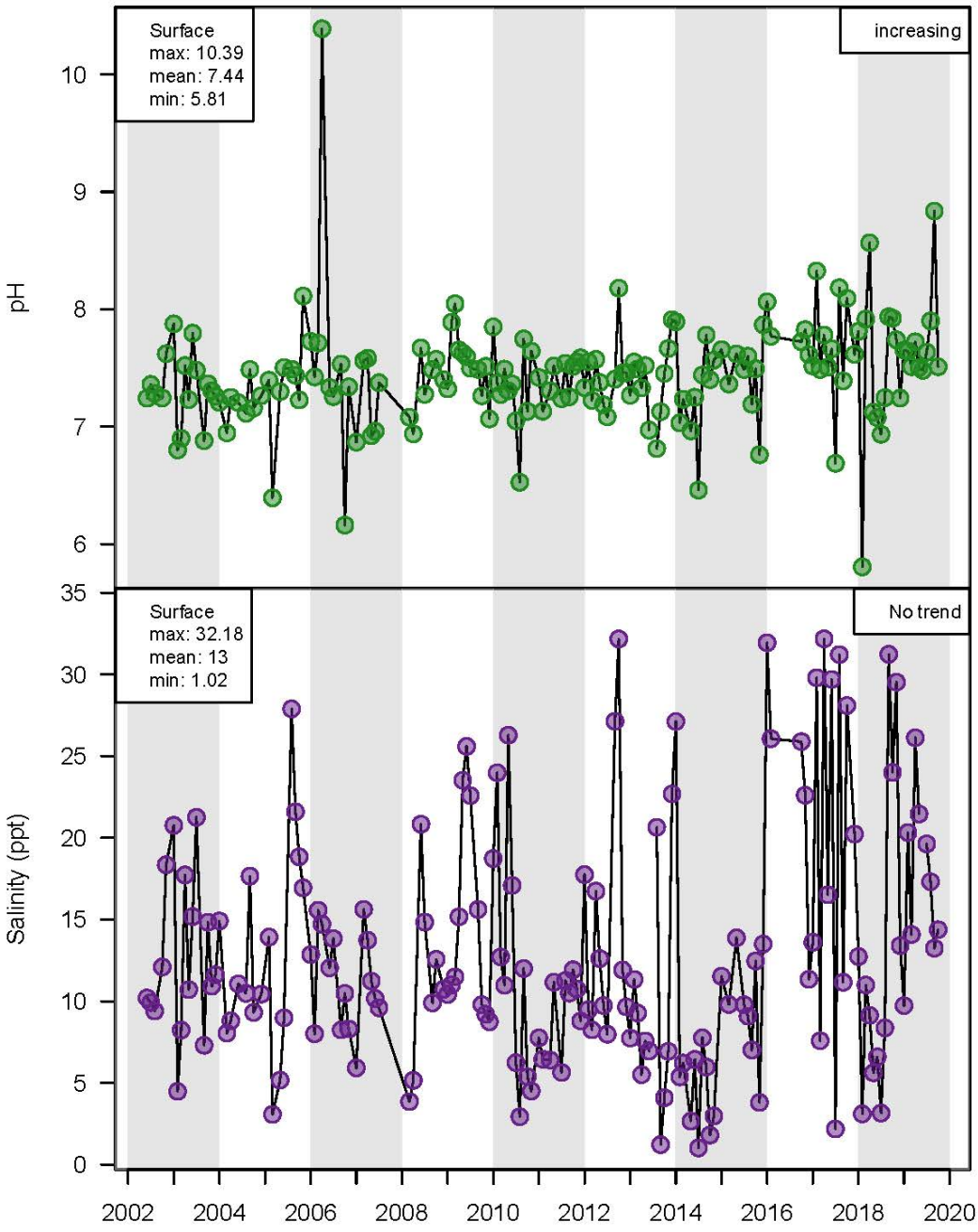
Summary statistics include mean, maximum (max), and minimum (min) summary statistics calculated on an annual basis using monthly data for hydrolab data variables; temperature, dissolved oxygen (DO), pH, and salinity as well as nutrient data variables total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), and secchi depth,. Summary statistics and trends represent results from long-term analyses among annual means from 2003 through 2019.

Times series plots display the inter-annual (monthly variability within the year - circles) and intra-annual variance (variability among years - triangles). Columns delineate three year time intervals.

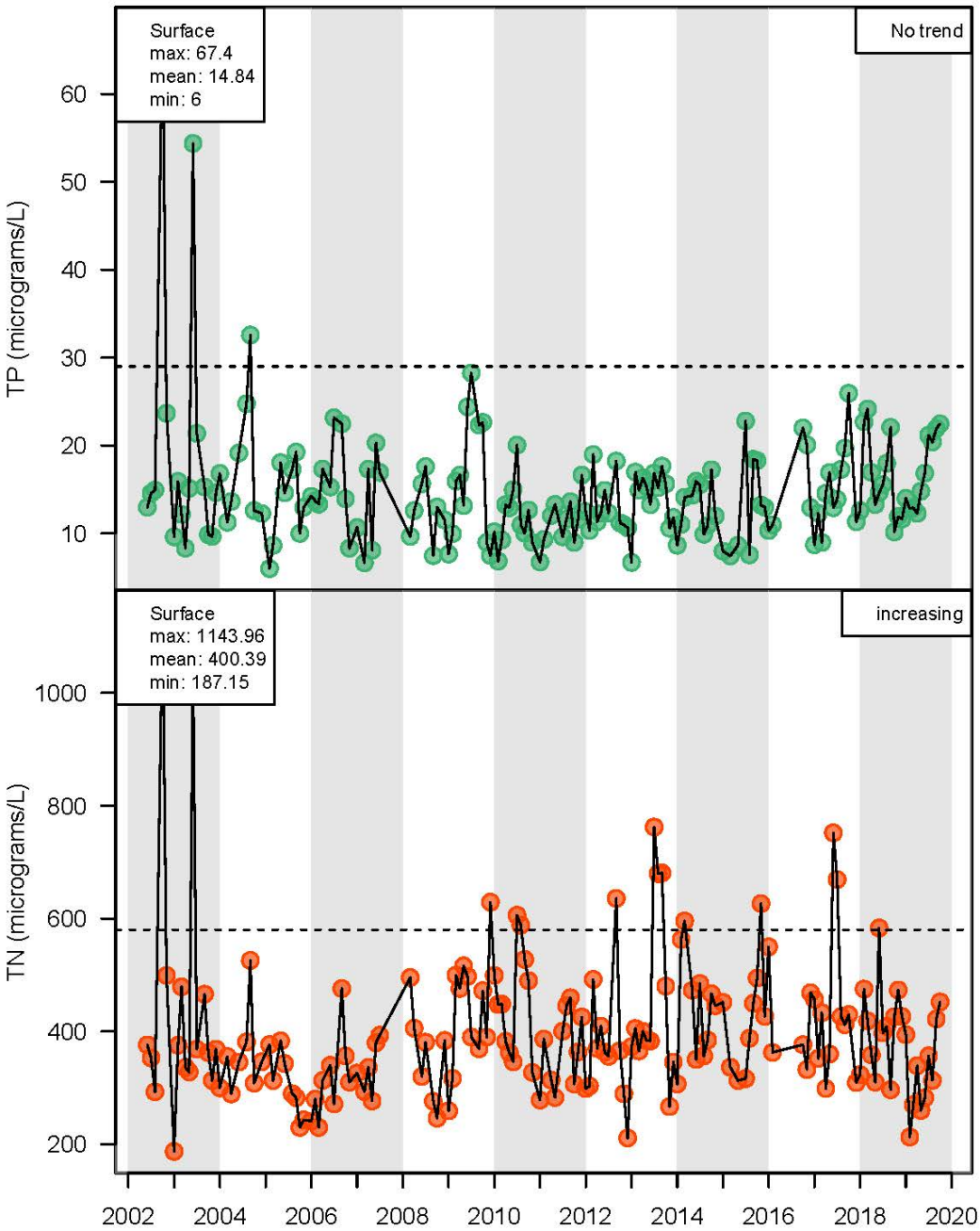
Kendall-Tau trend analysis results are shown for each water chemistry variable on the top-left of each plot. No trend indicates there was no significant trend found among the years examined (2003 through 2019). Increasing indicates a significant, positive trend was found over time. Decreasing indicates a significant, negative trend was found among the years examined. Insufficient data indicates insufficient annual data (year averages) were available for trend analysis.

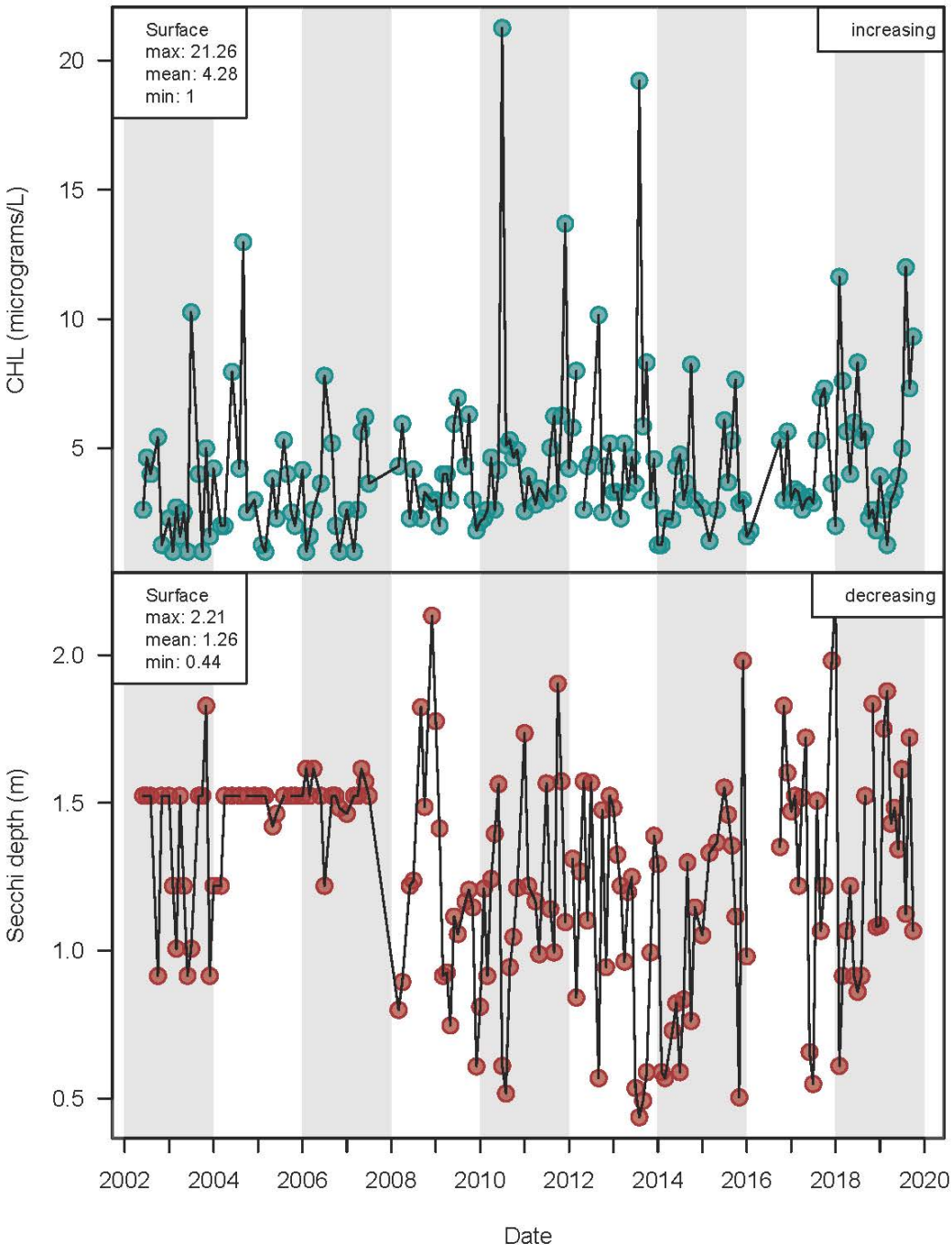
Hydrolab Trend Analyses



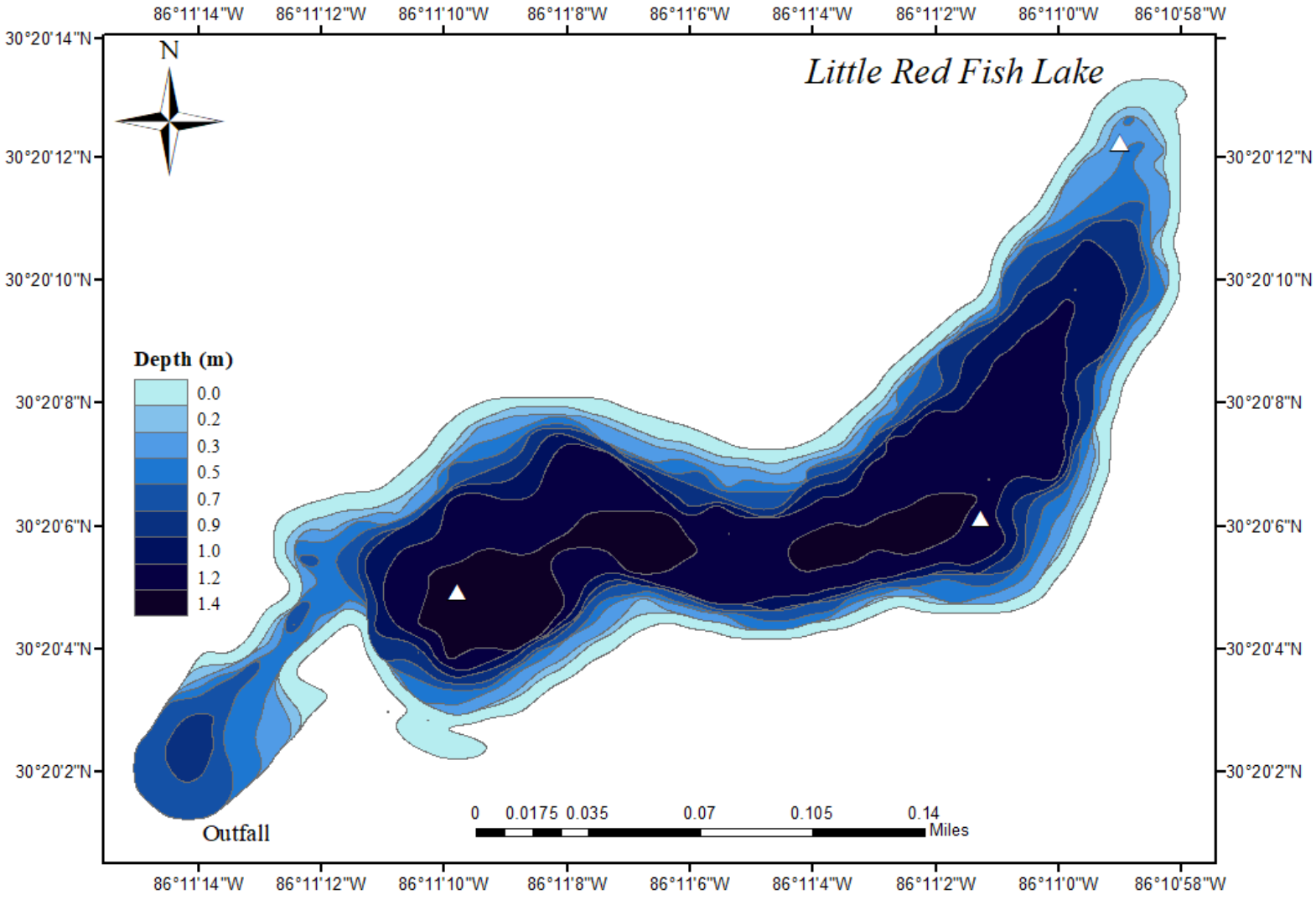

Surface
max: 10.39
mean: 7.44
min: 5.81
increasing
pH
10
9
8
7
6
Surface
max: 32.18
mean: 13
min: 1.02
No trend
Salinity (ppt)
35
30
25
20
15
10
5
0
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

Nutrient Trend Analyses




Surface
max: 21.26
mean: 4.28
min: 1
increasing
CHL (micrograms/L)
20
15
10
5
Surface
max: 2.21
mean: 1.26
min: 0.44
decreasing
Secchi depth (m)
2.0
1.5
1.0
0.5
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Date

Little Red Fish Lake, Walton County



Lake Description

Little Red Fish Lake is a narrow, elongated system approximately 100 meters from the Gulf of Mexico. Little Red Fish Lake is the smallest coastal dune lake, with a surface area of 5 hectares (50,000 m^2) and an approximate volume of 48,000 m^3. Long-term water chemistry monitoring for Little Red Fish Lake occurs at three stations denoted as white triangles on the map above. The system contains an outfall and frequently connects to the gulf. This, coupled with its small size, results in an intermediate average salinity value (3.5 ppt) with large fluctuations in water chemistry depending on rainfall and seawater connections.

Water Chemistry Data- 2019

Summary statistics include mean, maximum (Max), minimum (Min), median, and standard error (Std Error) calculated for both surface and bottom measurements for temperature, dissolved oxygen (DO), pH, and salinity, as well as surface measurements total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), secchi depth, as well as. These statistics represent 2019 water chemistry data.

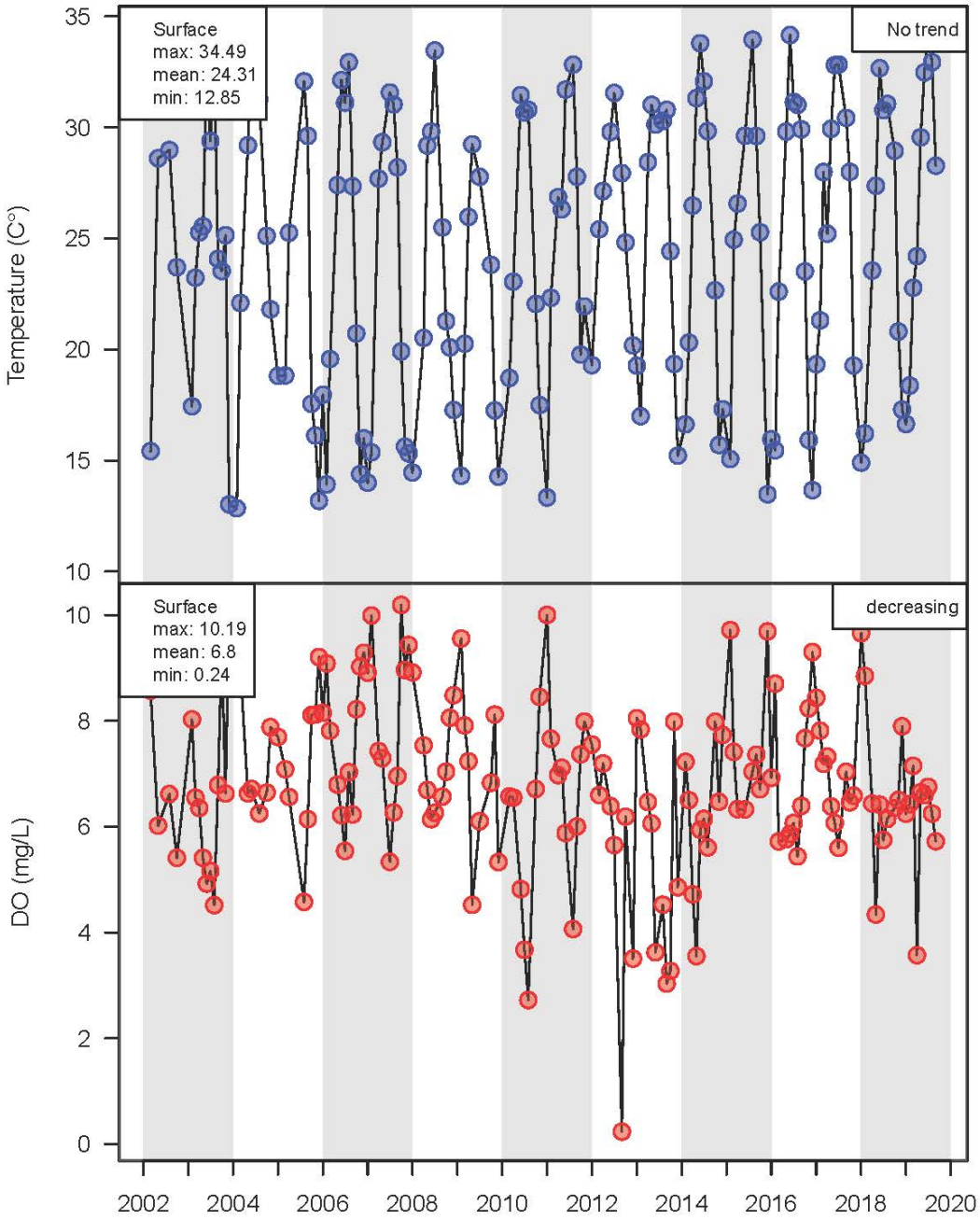
2019 Summary Statistics

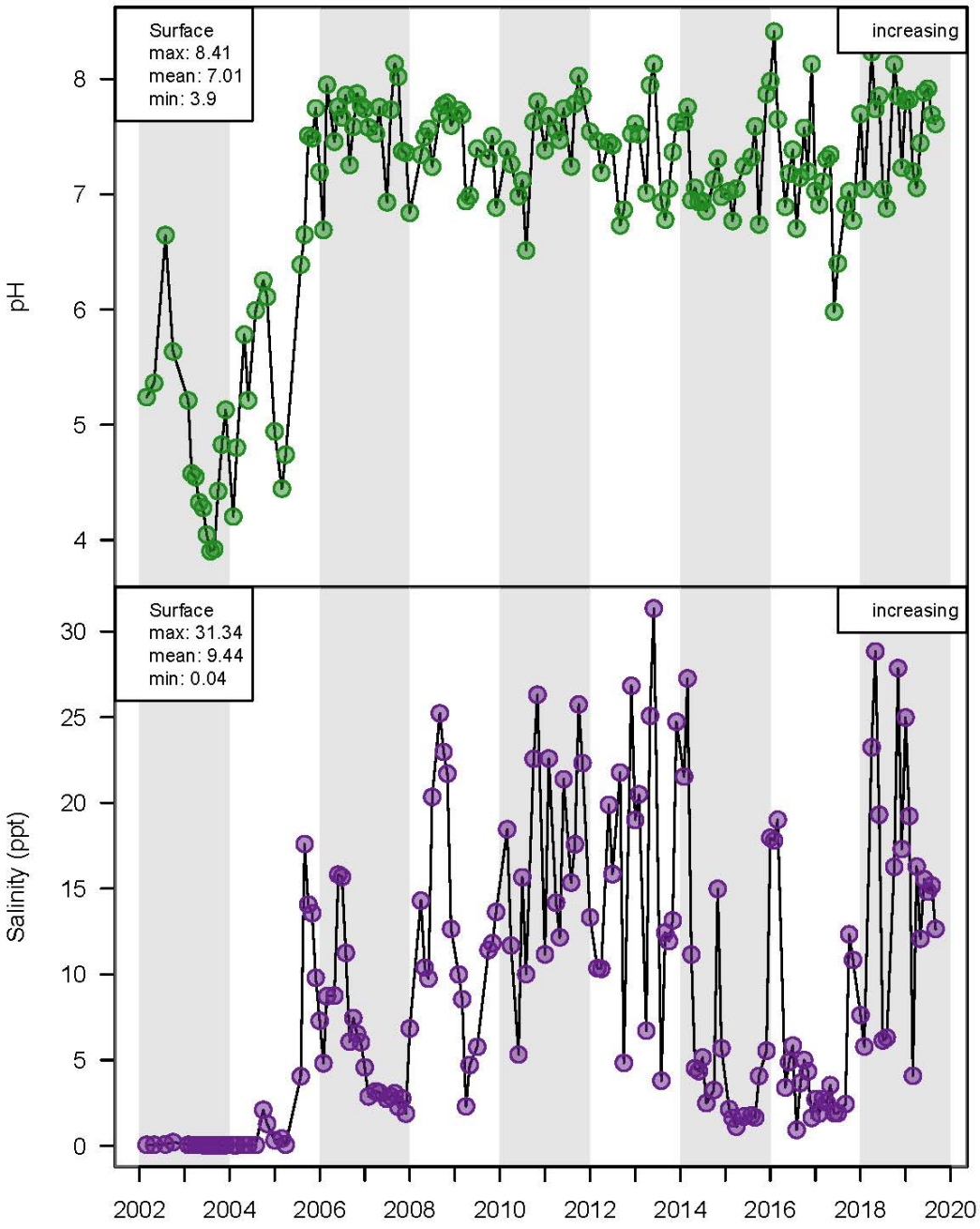
	min	mean	max	Std.Error
Temperature top	16.64	26.64	34.49	2.16
Temperature bottom	28.06	30.1	31.67	0.62
DO (mg/L) top	3.57	6.15	7.15	0.35
DO (mg/L) bottom	1.41	4.05	5.77	0.77
pH top	7.06	7.6	7.92	0.1
pH bottom	7.38	7.5	7.57	0.03
Salinity (ppt) top	4.08	14.99	24.98	1.87
Salinity (ppt) bottom	12.74	16.37	21.2	1.45
TP (micrograms/L)	9.25	21.62	42.05	3.26
TN (micrograms/L)	273.05	498.14	678.59	42.19
CHL (micrograms/L)	3.83	7.89	14.11	1.24

Water Chemistry Data- 2003 through 2019

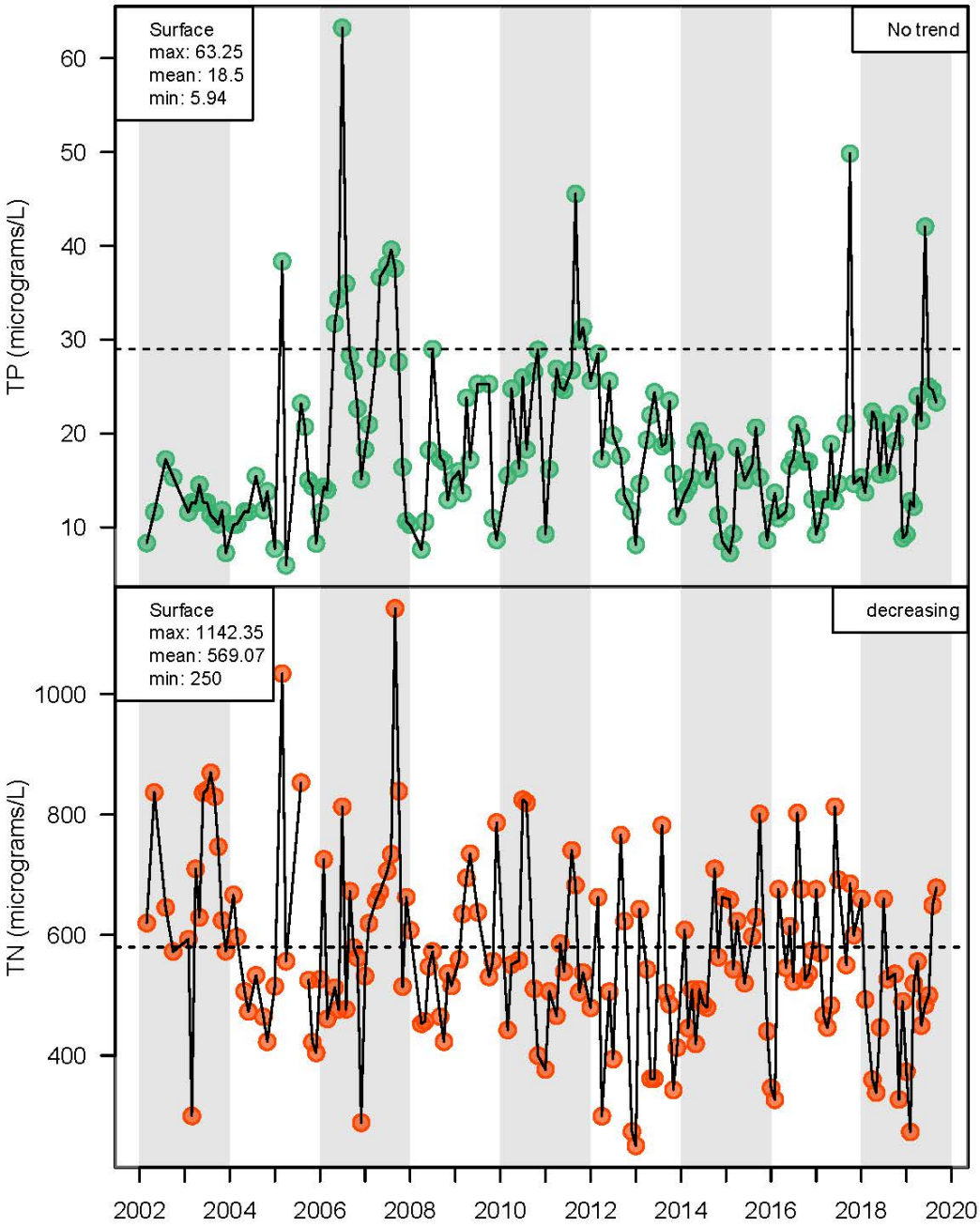
Summary statistics include mean, maximum (Max), minimum (Min), median, and standard error (Std Error) calculated for both surface and bottom measurements for temperature, dissolved oxygen (DO), pH, and salinity, as well as surface measurements total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), secchi depth, as well as. These statistics represent 2019 water chemistry data.

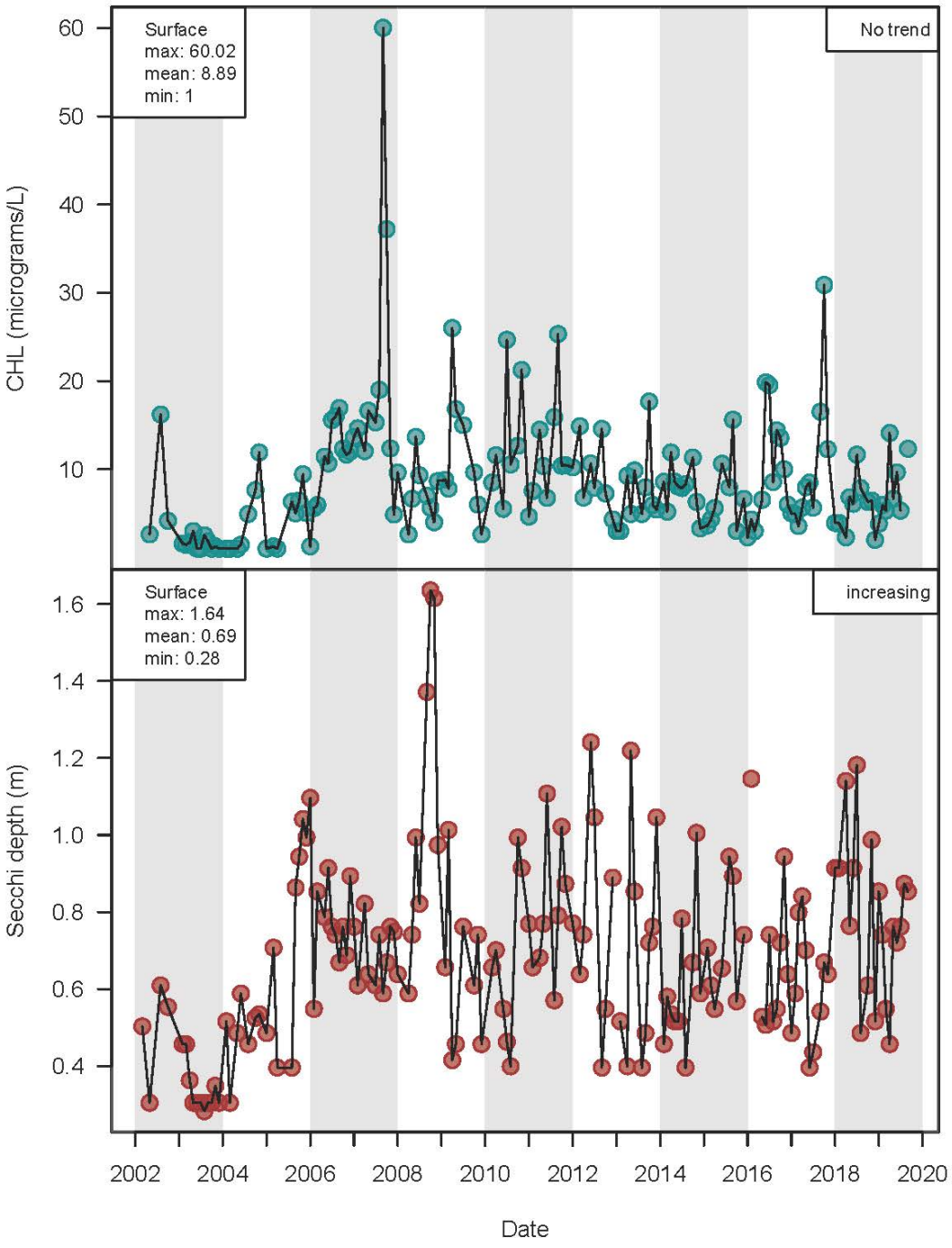
Hydrolab Trend Analyses



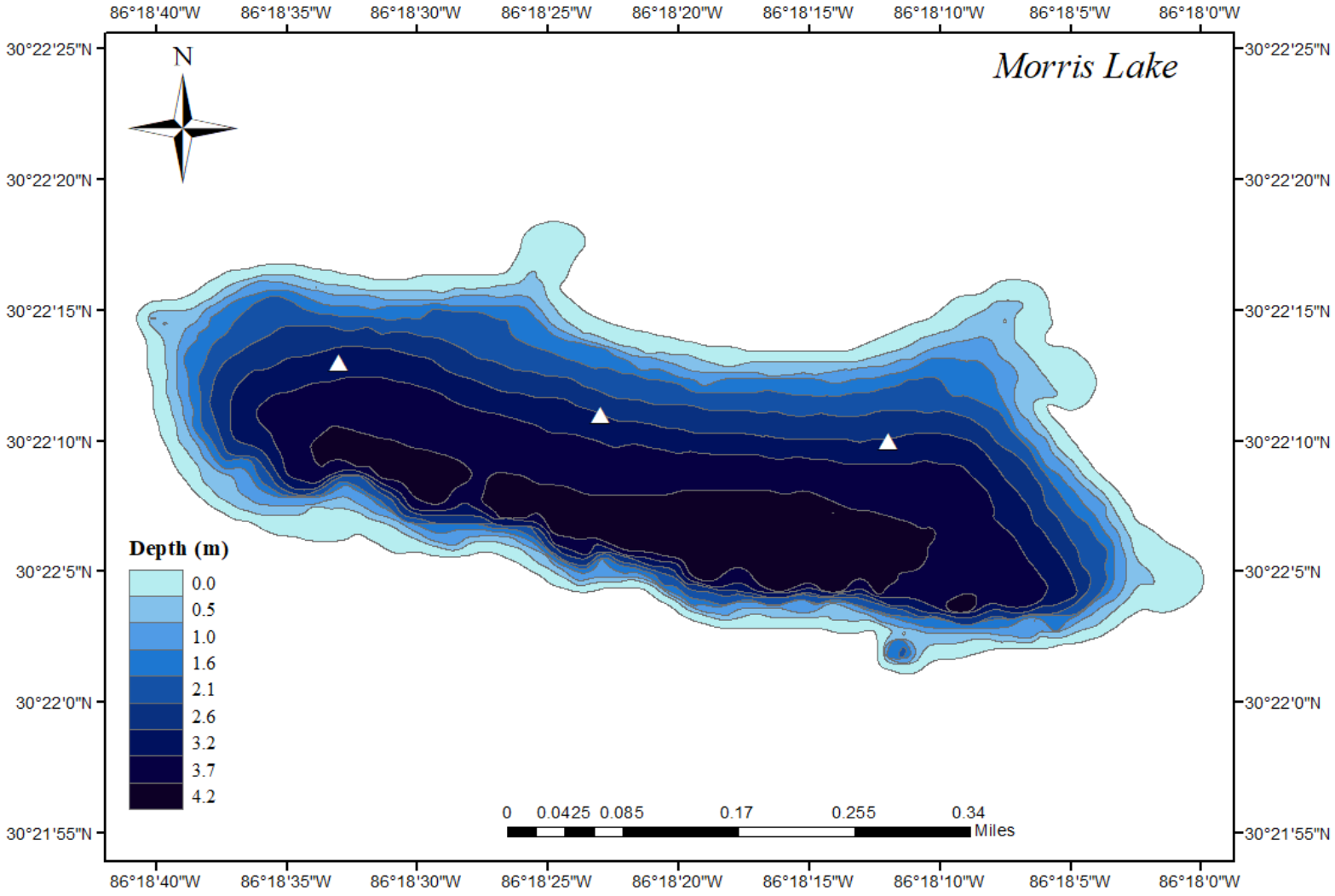

Surface
max: 8.41
mean: 7.01
min: 3.9
increasing
pH
8
7
6
5
4
Surface
max: 31.34
mean: 9.44
min: 0.04
increasing
Salinity (ppt)
30
25
20
15
10
5
0
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

Nutrient Trend Analyses




Surface
max: 60.02
mean: 8.89
min: 1
No trend
CHL (micrograms/L)
60
50
40
30
20
10
Surface
max: 1.64
mean: 0.69
min: 0.28
increasing
Secchi depth (m)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Date

Morris Lake, Walton County



Lake Description

Morris Lake is an irregularly-ellipse shaped system approximately 400 meters from the Gulf of Mexico. The system is among the larger coastal dune lakes, with a surface area of 35 hectares (350,000 m^2) and an approximate volume of 900,000 m^3. The system is one of two lakes laying within Topsail State Park, which offers a degree of protection form the adverse effects of coastal development. Long-term water chemistry monitoring for Morris Lake occurs at three stations denoted as white triangles on the map above. While the system does contain an outfall, Morris Lake seldom connects to the gulf. As a result the system is primarily freshwater (0.25 ppt).

Water Chemistry Data- 2019

Summary statistics include mean, maximum (Max), minimum (Min), median, and standard error (Std Error) calculated for both surface and bottom measurements for temperature, dissolved oxygen (DO), pH, and salinity, as well as surface measurements total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), secchi depth, as well as. These statistics represent 2019 water chemistry data.

2019 Summary Statistics

	min	mean	max	Std.Error
Temperature top	16.09	25.38	32.74	1.95
Temperature bottom	15.78	24.02	31.11	1.91
DO (mg/L) top	5.97	7.69	14.41	0.79
DO (mg/L) bottom	5.27	7.38	13.02	0.7
pH top	5.32	5.76	6.22	0.11
pH bottom	5.29	5.7	6.39	0.1
Salinity (ppt) top	0.06	0.08	0.09	0
Salinity (ppt) bottom	0.07	0.08	0.09	0
TP (micrograms/L)	7.32	10.71	13.98	0.73
TN (micrograms/L)	376.46	432.87	523.25	14.65
CHL (micrograms/L)	1.59	3.94	7.65	0.57

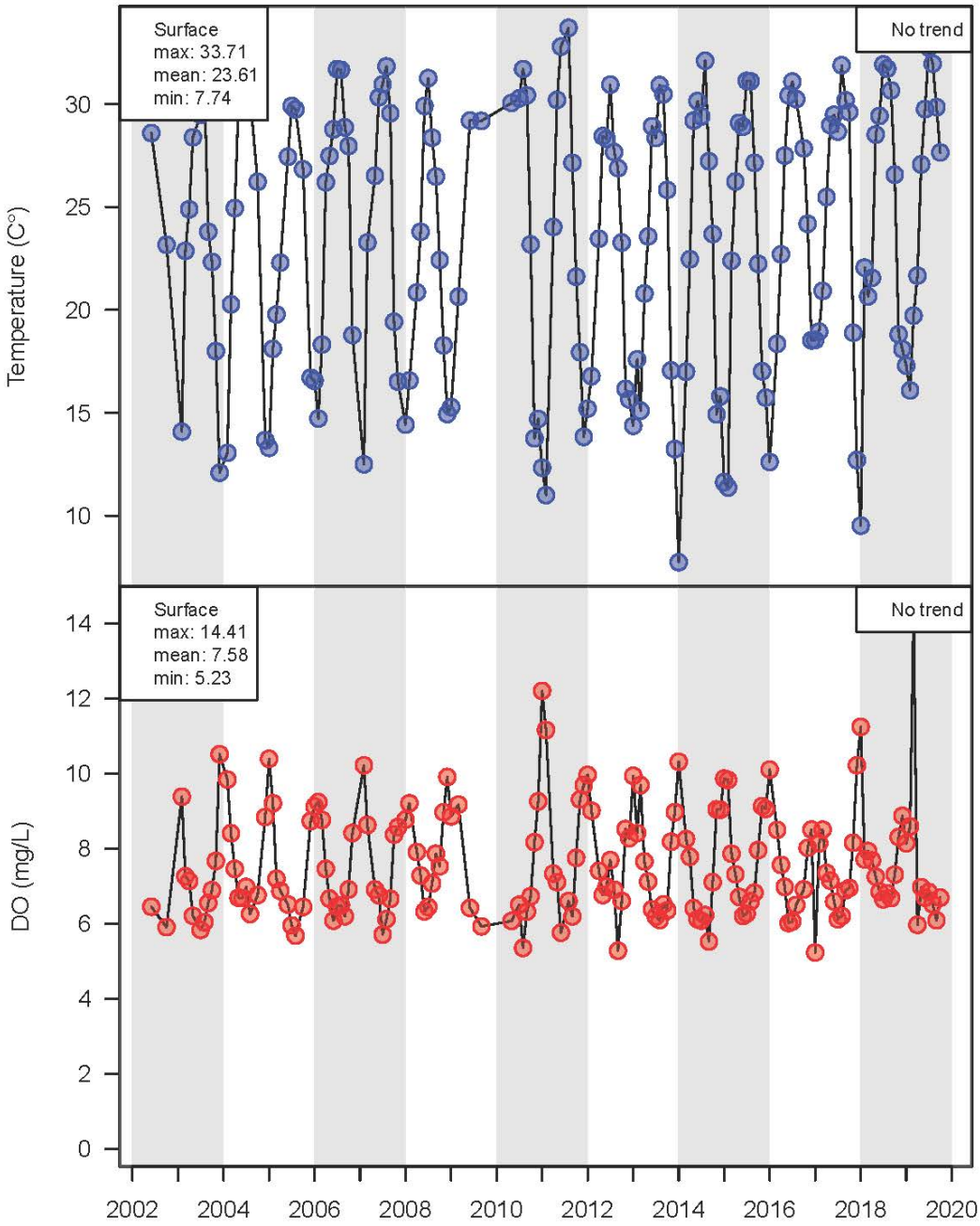
Water Chemistry Data- 2003 through 2019

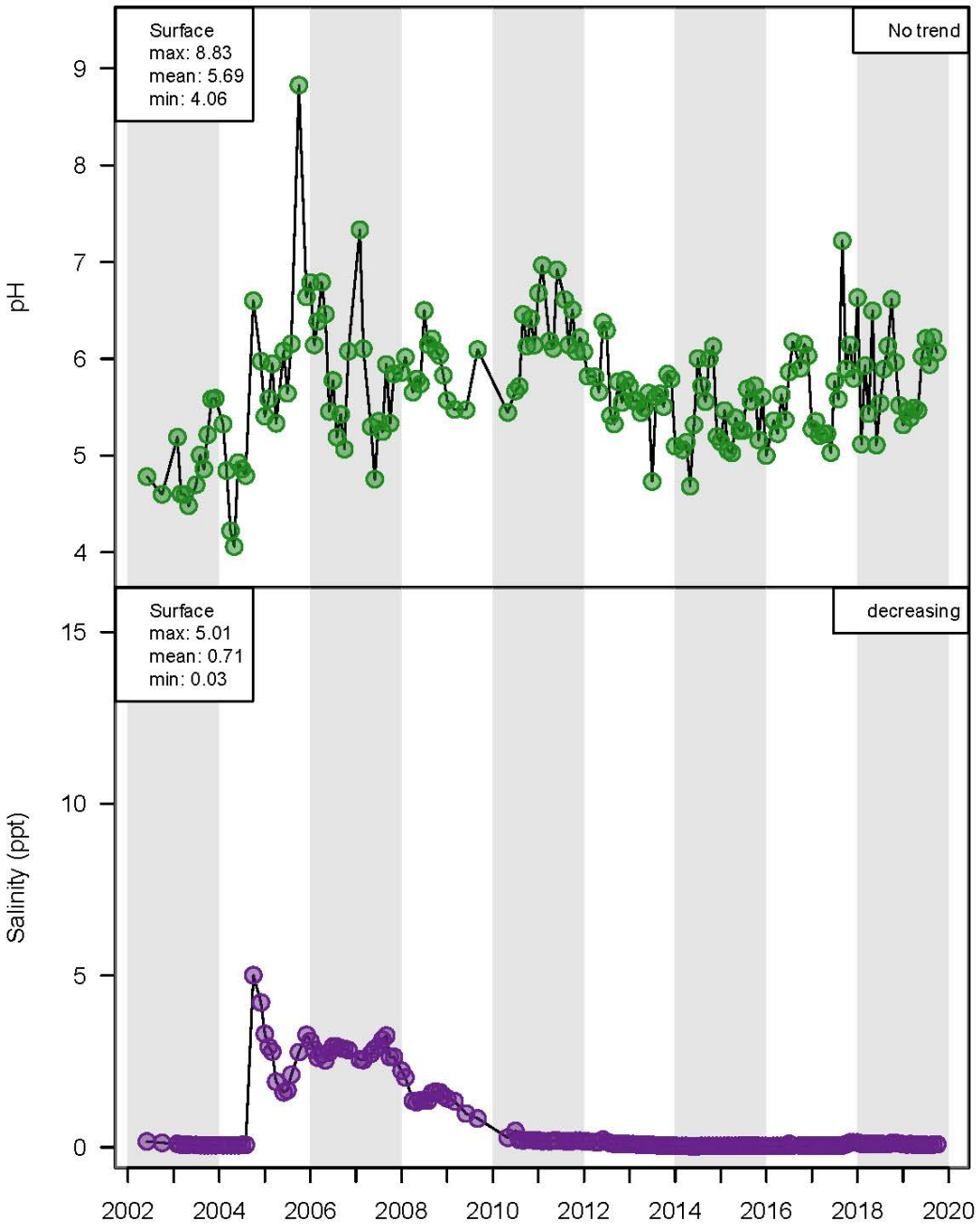
Summary statistics include mean, maximum (max), and minimum (min) summary statistics calculated on an annual basis using monthly data for hydrolab data variables; temperature, dissolved oxygen (DO), pH, and salinity as well as nutrient data variables total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), and secchi depth,. Summary statistics and trends represent results from long-term analyses among annual means from 2003 through 2019.

Times series plots display the inter-annual (monthly variability within the year - circles) and intra-annual variance (variability among years - triangles). Columns delineate three year time intervals.

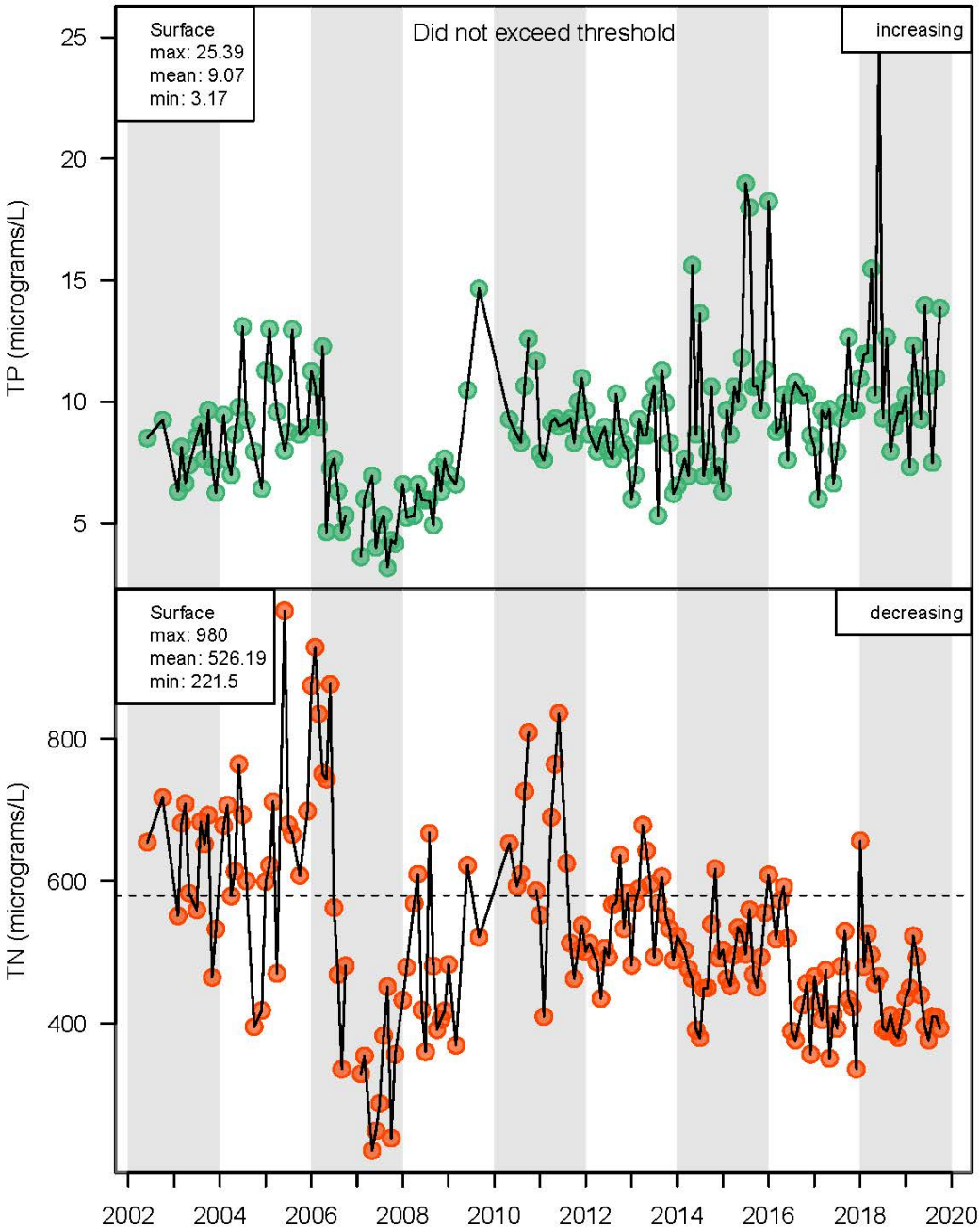
Kendall-Tau trend analysis results are shown for each water chemistry variable on the top-left of each plot. No trend indicates there was no significant trend found among the years examined (2003 through 2019). Increasing indicates a significant, positive trend was found over time. Decreasing indicates a significant, negative trend was found among the years examined. Insufficient data indicates insufficient annual data (year averages) were available for trend analysis.

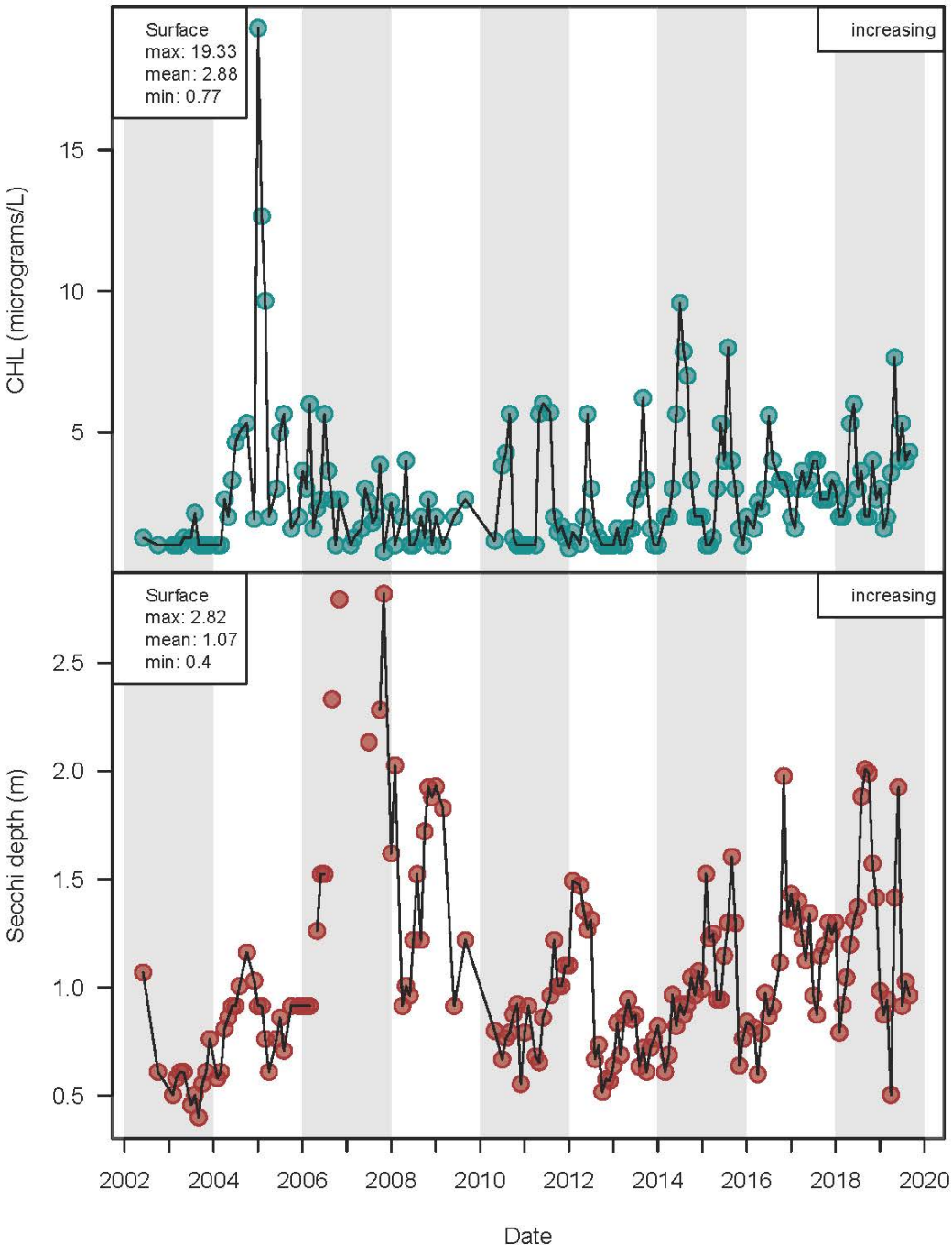
Hydrolab Trend Analyses



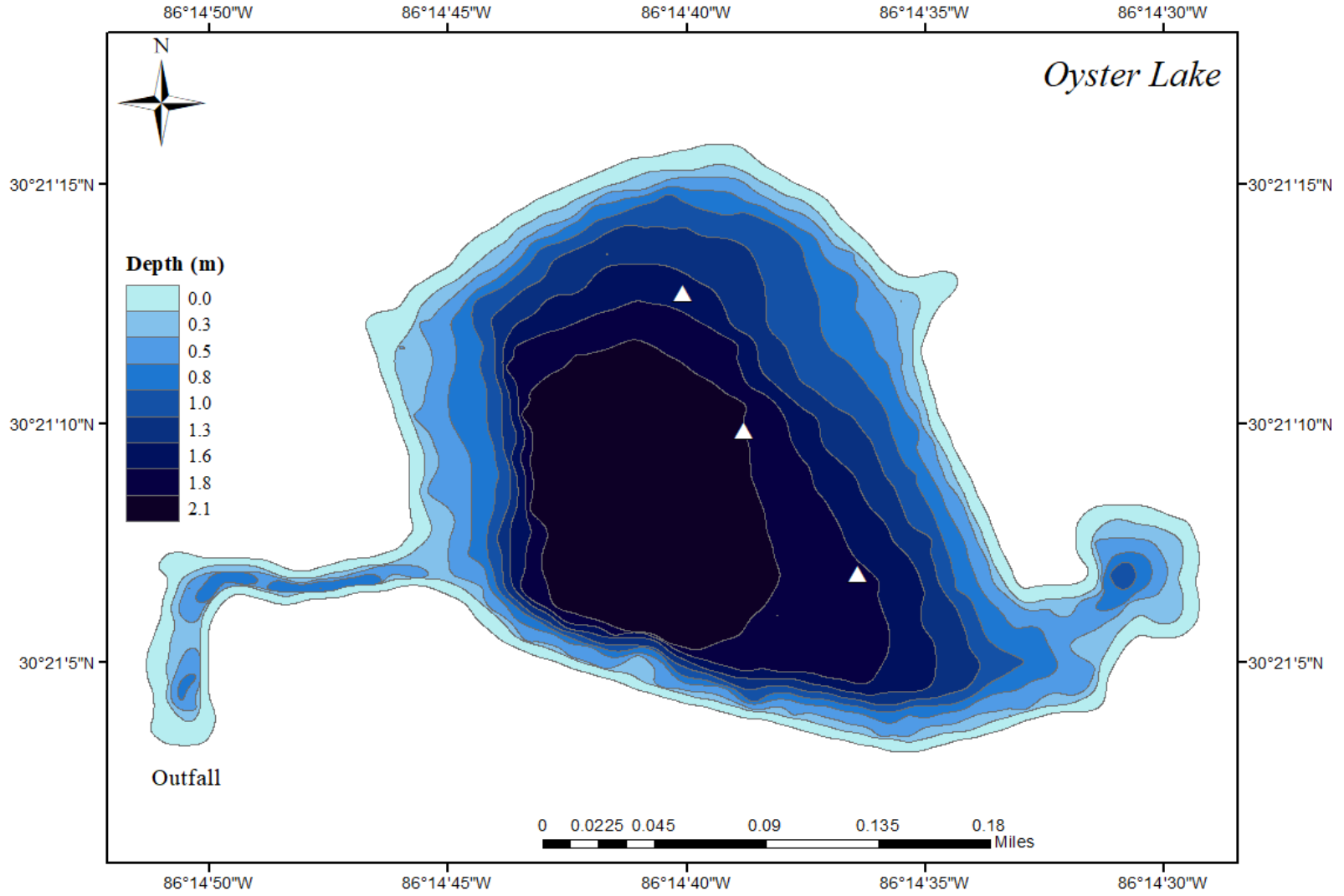

Surface
max: 8.83
mean: 5.69
min: 4.06
No trend
pH
9
8
7
6
5
4
Surface
max: 5.01
mean: 0.71
min: 0.03
decreasing
Salinity (ppt)
15
10
5
0
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

Nutrient Trend Analyses




Surface
max: 19.33
mean: 2.88
min: 0.77
increasing
CHL (micrograms/L)
15
10
5
Surface
max: 2.82
mean: 1.07
min: 0.4
increasing
Secchi depth (m)
2.5
2.0
1.5
1.0
0.5
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Date

Oyster Lake, Walton County



Lake Description

Oyster Lake is a teardrop-shaped system approximately 200 meters away from the Gulf of Mexico. Oyster Lake is relatively intermediate-sized coastal dune lake with a surface area of 11 hectares (110,000 m^2) and an approximate volume of 140,000 m^3. Despite being separated from the gulf by Highway 30A similar to Allen Lake, Oyster Lake retains connectivity to the gulf through a man-made culvert; allowing the system to intermittently connect Long-term water chemistry monitoring for Oyster Lake occurs at three stations denoted as white triangles on the map above. Trend analysis of water chemistry variables in Oyster Lake indicate significantly increasing salinity, although this trend began after the connectivity was reestablished between the system and the gulf, and likely reflects the restored hydrology.

Water Chemistry Data- 2019

Summary statistics include mean, maximum (Max), minimum (Min), median, and standard error (Std Error) calculated for both surface and bottom measurements for temperature, dissolved oxygen (DO), pH, and salinity, as well as surface measurements total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), secchi depth, as well as. These statistics represent 2019 water chemistry data..

2019 Summary Statistics

	min	mean	max	Std.Error
Temperature top	16.87	25.47	31.43	2.08
Temperature bottom	16.91	23.33	29.83	2.16
DO (mg/L) top	2.81	6.73	8.73	0.6
DO (mg/L) bottom	2.72	5.08	9.41	1.02
pH top	6.98	7.68	8.29	0.16
pH bottom	7.18	7.46	8	0.13
Salinity (ppt) top	7.02	14.46	24.02	1.6
Salinity (ppt) bottom	12.13	19.97	25.96	2.22
TP (micrograms/L)	31.53	53.51	92.22	7.42
TN (micrograms/L)	419.48	643.16	832.8	56.66
CHL (micrograms/L)	6	20.49	32.64	3.11

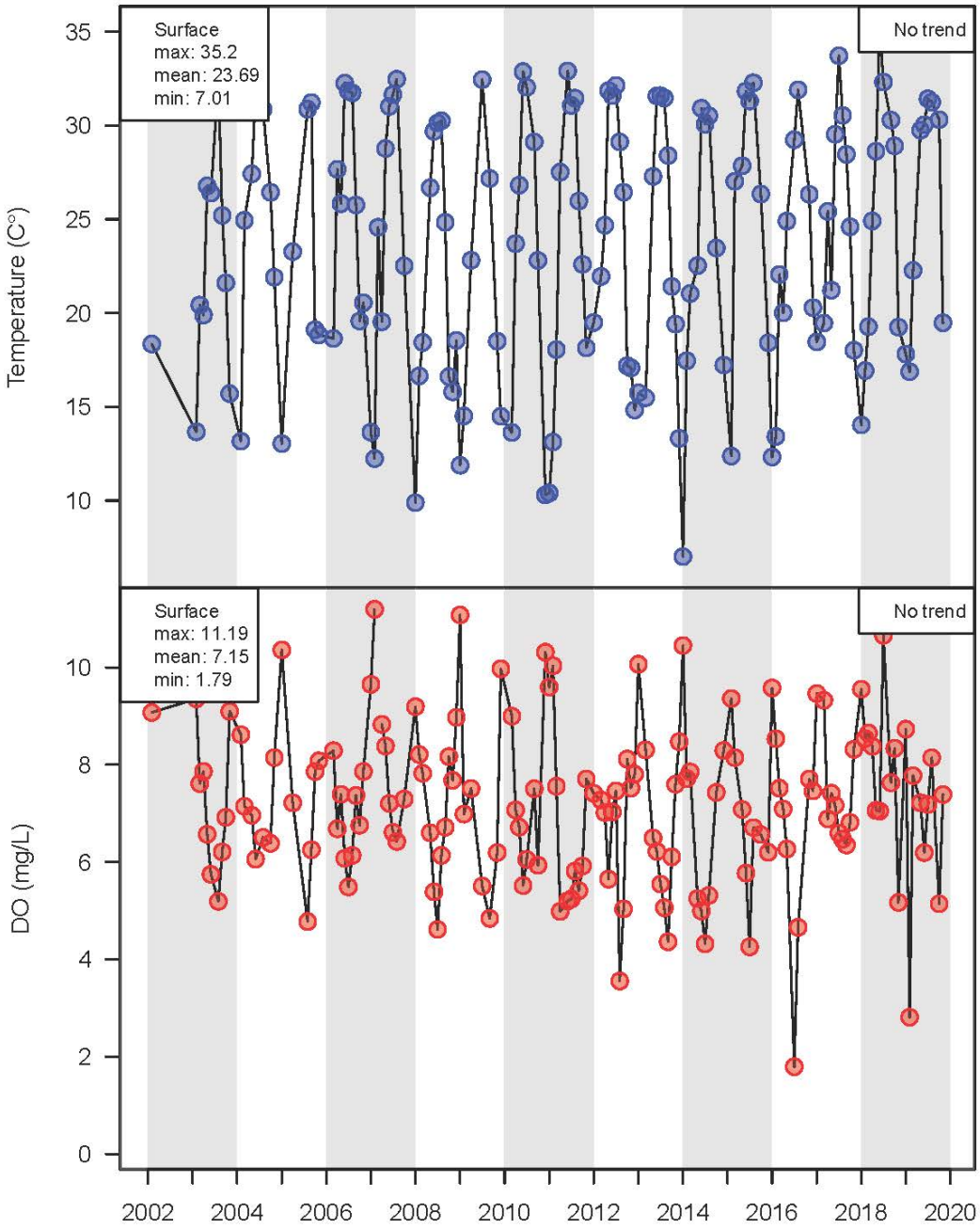
Water Chemistry Data- 2003 through 2019

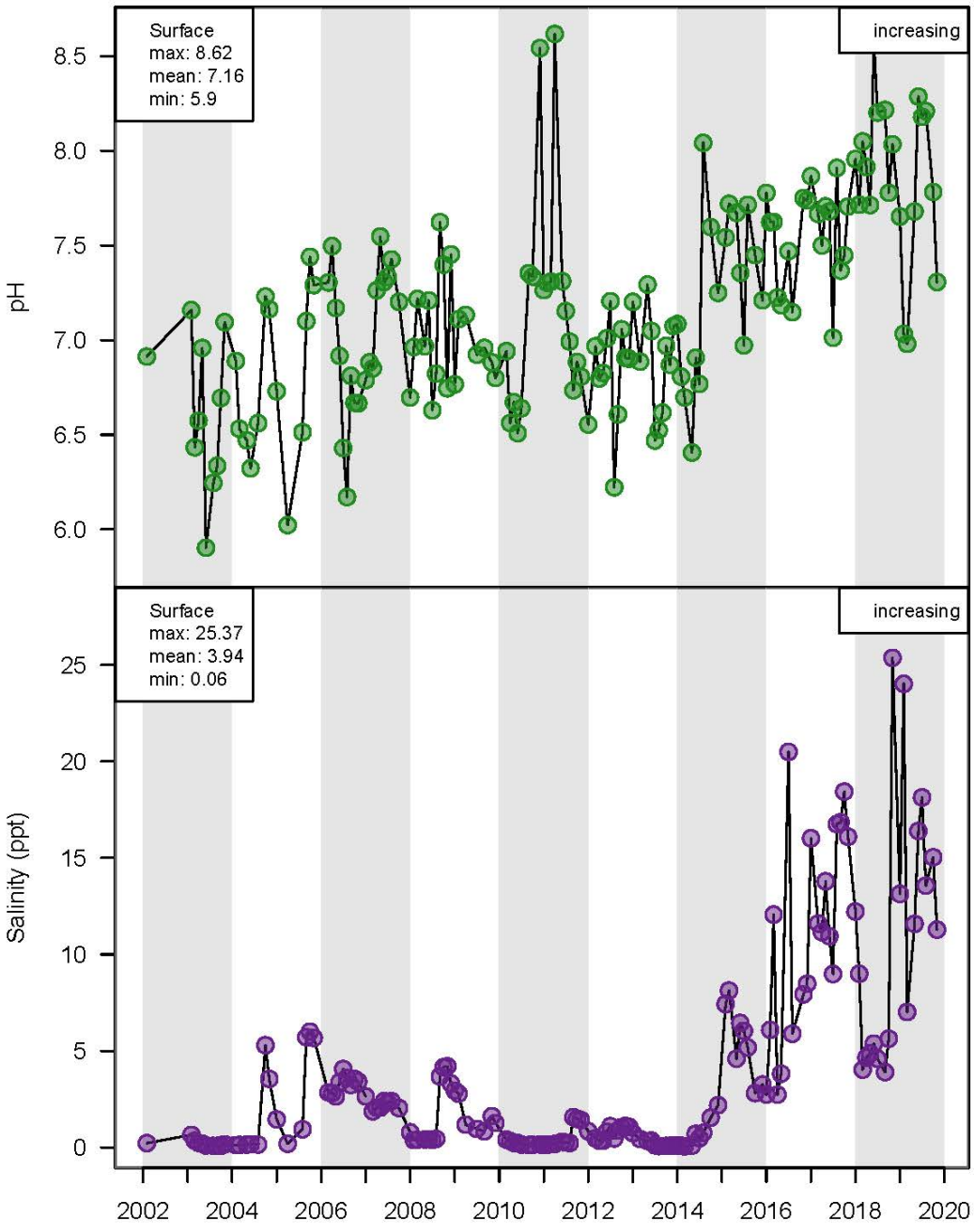
Summary statistics include mean, maximum (max), and minimum (min) summary statistics calculated on an annual basis using monthly data for hydrolab data variables; temperature, dissolved oxygen (DO), pH, and salinity as well as nutrient data variables total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), and secchi depth,. Summary statistics and trends represent results from long-term analyses among annual means from 2003 through 2019.

Times series plots display the inter-annual (monthly variability within the year - circles) and intra-annual variance (variability among years - triangles). Columns delineate three year time intervals.

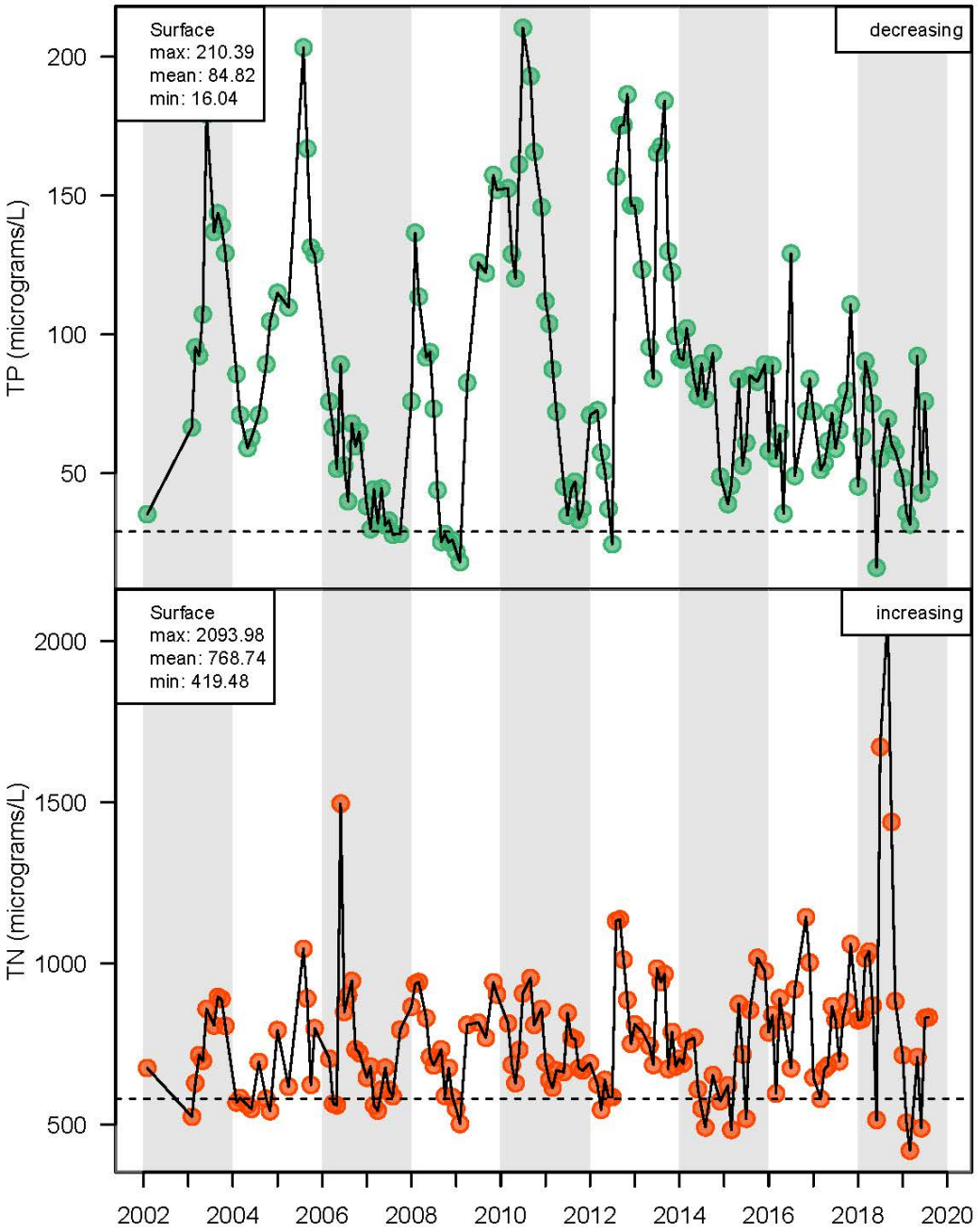
Kendall-Tau trend analysis results are shown for each water chemistry variable on the top-left of each plot. No trend indicates there was no significant trend found among the years examined (2003 through 2019). Increasing indicates a significant, positive trend was found over time. Decreasing indicates a significant, negative trend was found among the years examined. Insufficient data indicates insufficient annual data (year averages) were available for trend analysis.

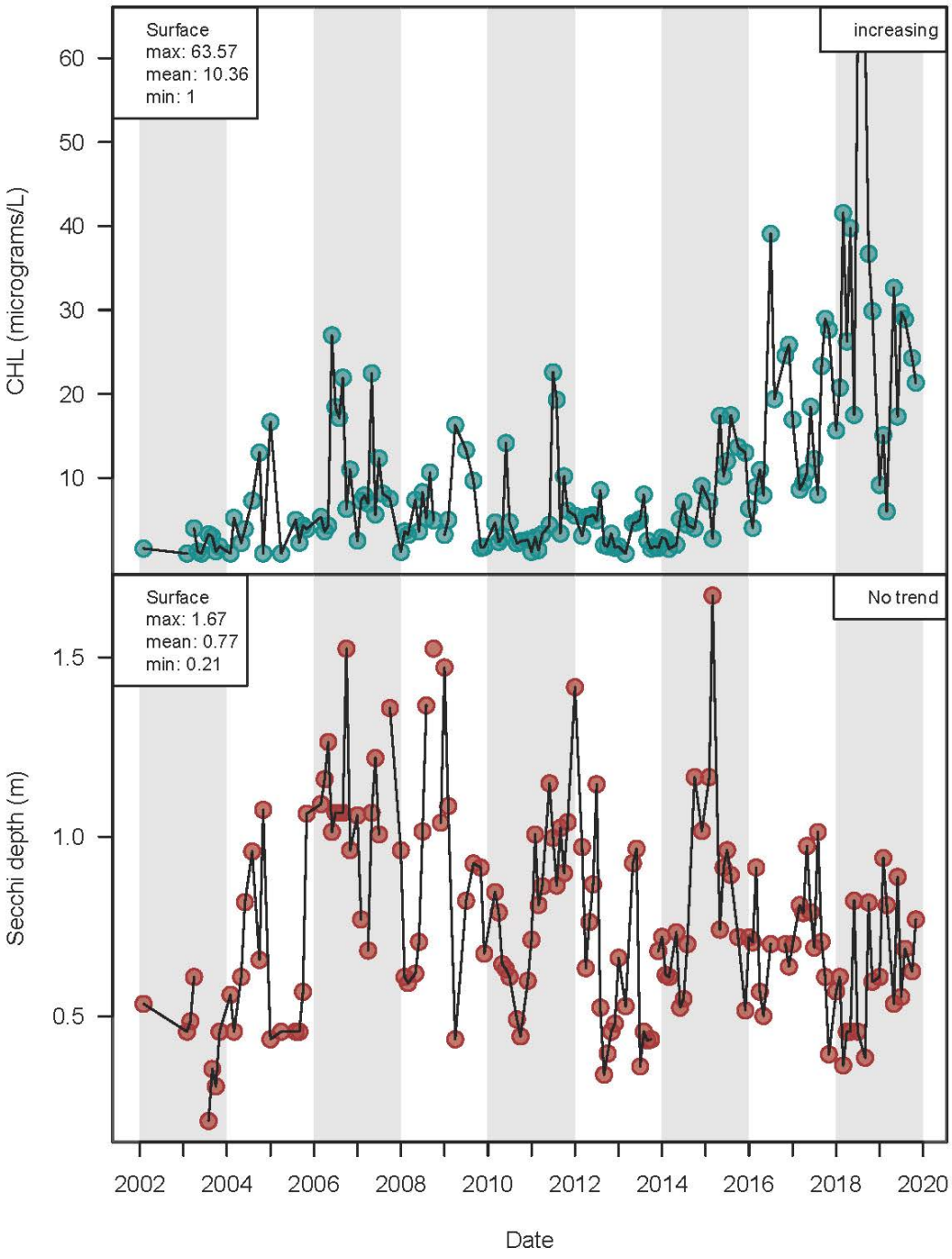
Hydrolab Trend Analyses



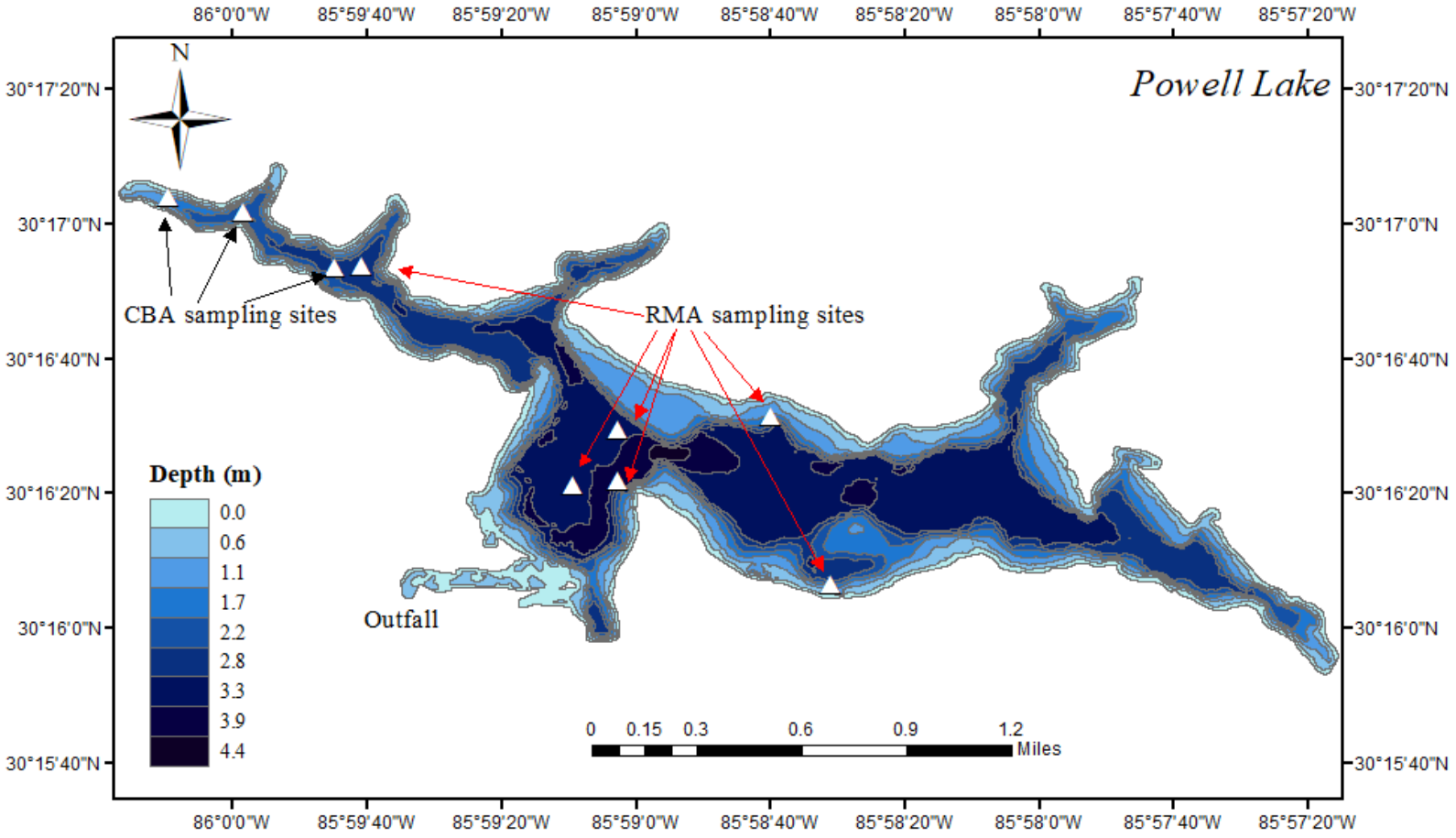

Surface
max: 8.62
mean: 7.16
min: 5.9
increasing
pH
8.5
8.0
7.5
7.0
6.5
6.0
Surface
max: 25.37
mean: 3.94
min: 0.06
increasing
Salinity (ppt)
25
20
15
10
5
0
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

Nutrient Trend Analyses




Surface
max: 63.57
mean: 10.36
min: 1
increasing
CHL (micrograms/L)
60
50
40
30
20
10
Surface
max: 1.67
mean: 0.77
min: 0.21
No trend
Secchi depth (m)
1.5
1.0
0.5
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Date

Powell Lake, Walton and Bay County



Lake Description

Powell Lake is an irregularly-shaped system approximately 300 meters away from the Gulf of Mexico. Powell Lake is the largest coastal dune lake system, with a surface area of 290 hectares (2,900,000 m^2) and an approximate volume of 6,600,000 m^3. Powell Lake is located along the border of Walton and Bay Counties. As a result, the system is sampled by both CBA in Walton County as well as St. Andrew's Bay Resource Management Association (RMA) in Bay County. Due to the efforts of both CBA and RMA, Powell Lake is consistently sampled at 9 sampling stations, providing a more accurate representation of water chemistry for the system. Sampling stations are depicted as white triangles in the map above. Powell Lake has an outfall which frequently connects to the gulf. As a result, Powell Lake has the highest inter-annual salinity of all the coastal dune lake systems (14 ppt).

Water Chemistry Data- 2019

Summary statistics include mean, maximum (Max), minimum (Min), median, and standard error (Std Error) calculated for both surface and bottom measurements for temperature, dissolved oxygen (DO), pH, and salinity, as well as surface measurements total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), secchi depth, as well as. These statistics represent 2019 water chemistry data.

2019 Summary Statistics

	min	mean	max	Std.Error
Temperature top	13.74	23.83	31.87	2.22
Temperature bottom	15.97	24.14	31.7	2.07
DO (mg/L) top	4.46	6.11	7.59	0.36
DO (mg/L) bottom	0.84	2.42	6.27	0.62
pH top	7.03	7.31	7.54	0.06
pH bottom	6.98	7.27	7.47	0.06
Salinity (ppt) top	2.45	7.72	12.65	1.14
Salinity (ppt) bottom	8.18	14.22	17.66	1.01
TP (micrograms/L)	11.32	14.89	23.99	1.24
TN (micrograms/L)	264.66	345.41	423.84	18.12
CHL (micrograms/L)	3.63	5.23	8.57	0.6

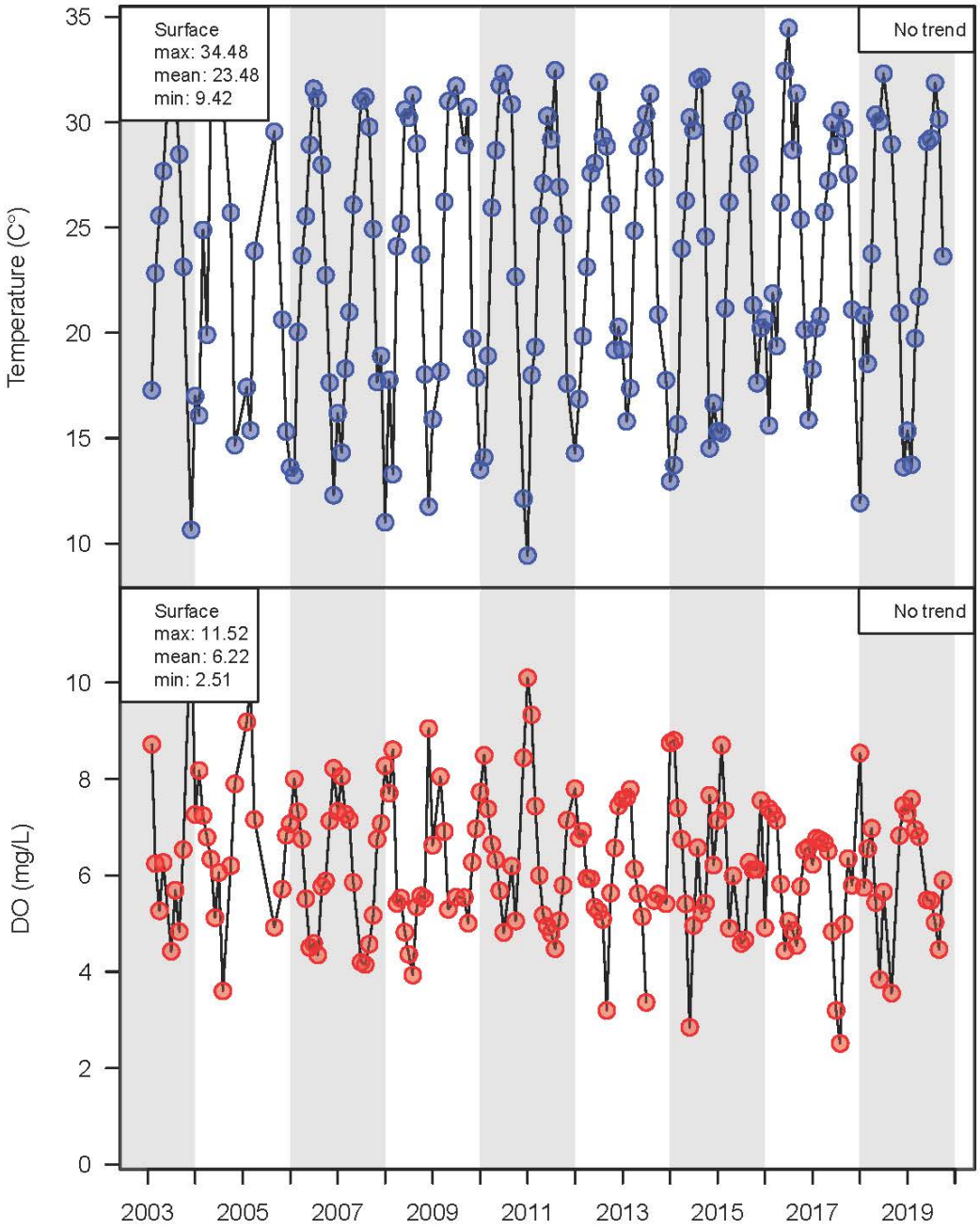
Water Chemistry Data- 2003 through 2019

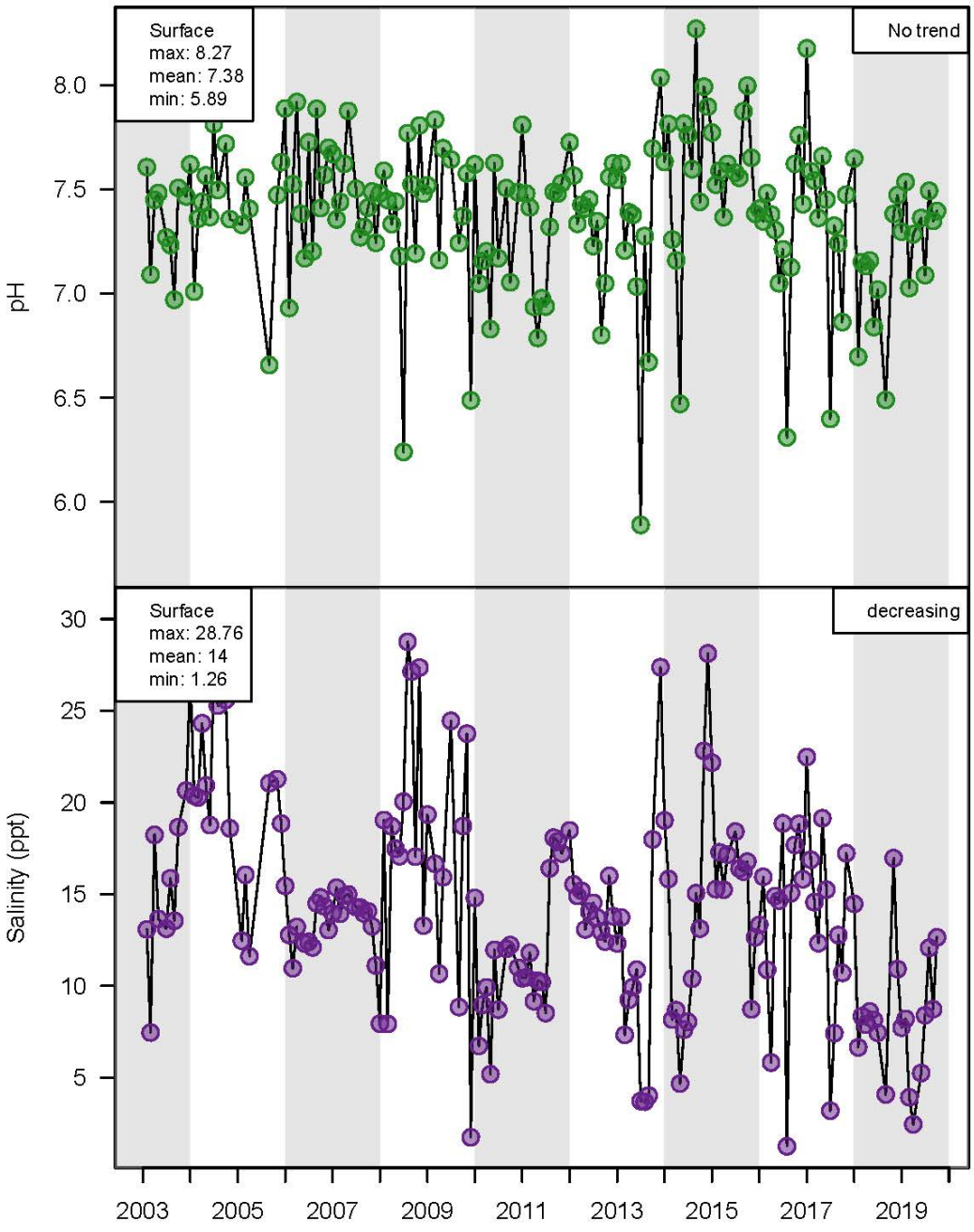
Summary statistics include mean, maximum (max), and minimum (min) summary statistics calculated on an annual basis using monthly data for hydrolab data variables; temperature, dissolved oxygen (DO), pH, and salinity as well as nutrient data variables total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), and secchi depth,. Summary statistics and trends represent results from long-term analyses among annual means from 2003 through 2019.

Times series plots display the inter-annual (monthly variability within the year - circles) and intra-annual variance (variability among years - triangles). Columns delineate three year time intervals.

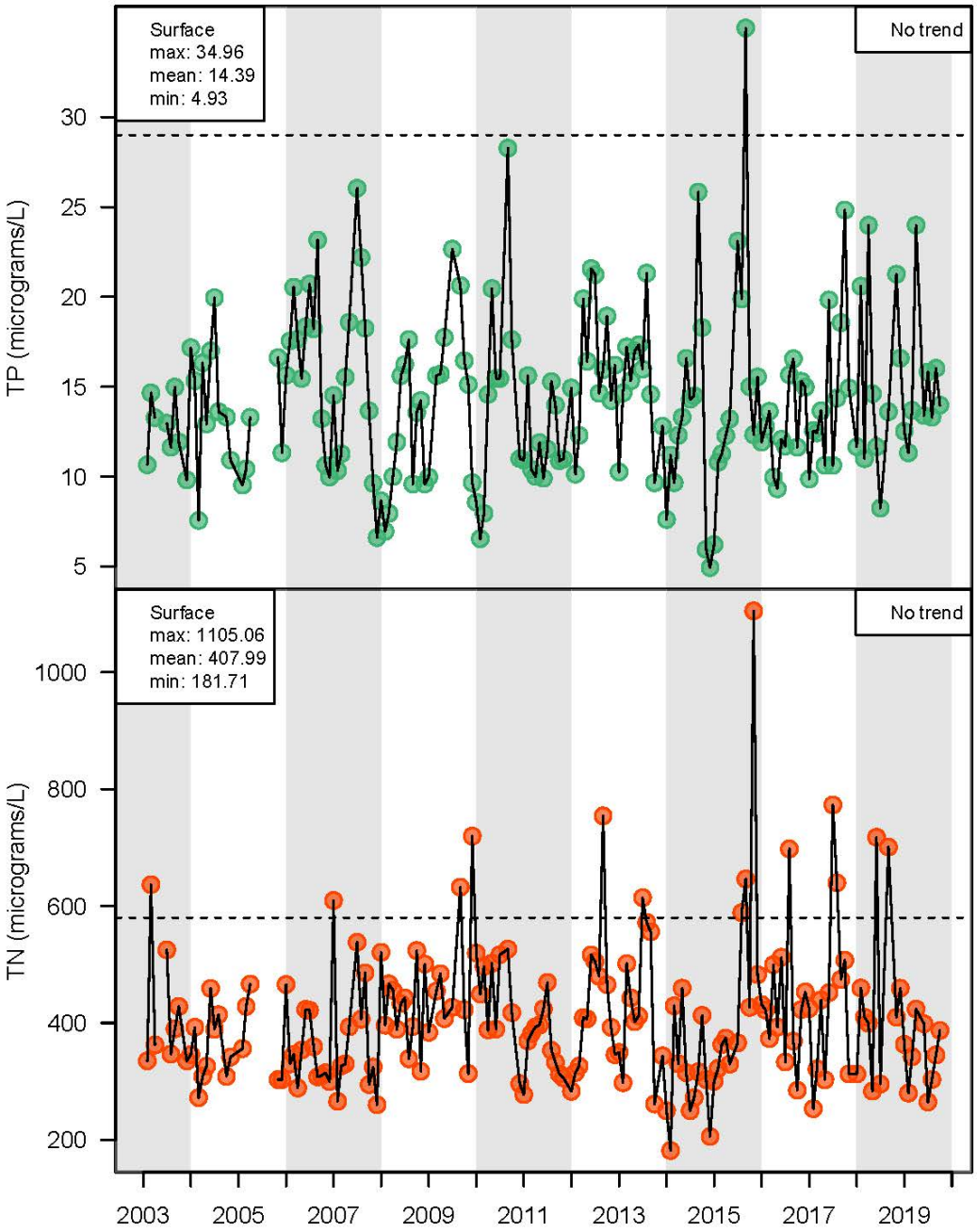
Kendall-Tau trend analysis results are shown for each water chemistry variable on the top-left of each plot. No trend indicates there was no significant trend found among the years examined (2003 through 2019). Increasing indicates a significant, positive trend was found over time. Decreasing indicates a significant, negative trend was found among the years examined. Insufficient data indicates insufficient annual data (year averages) were available for trend analysis.

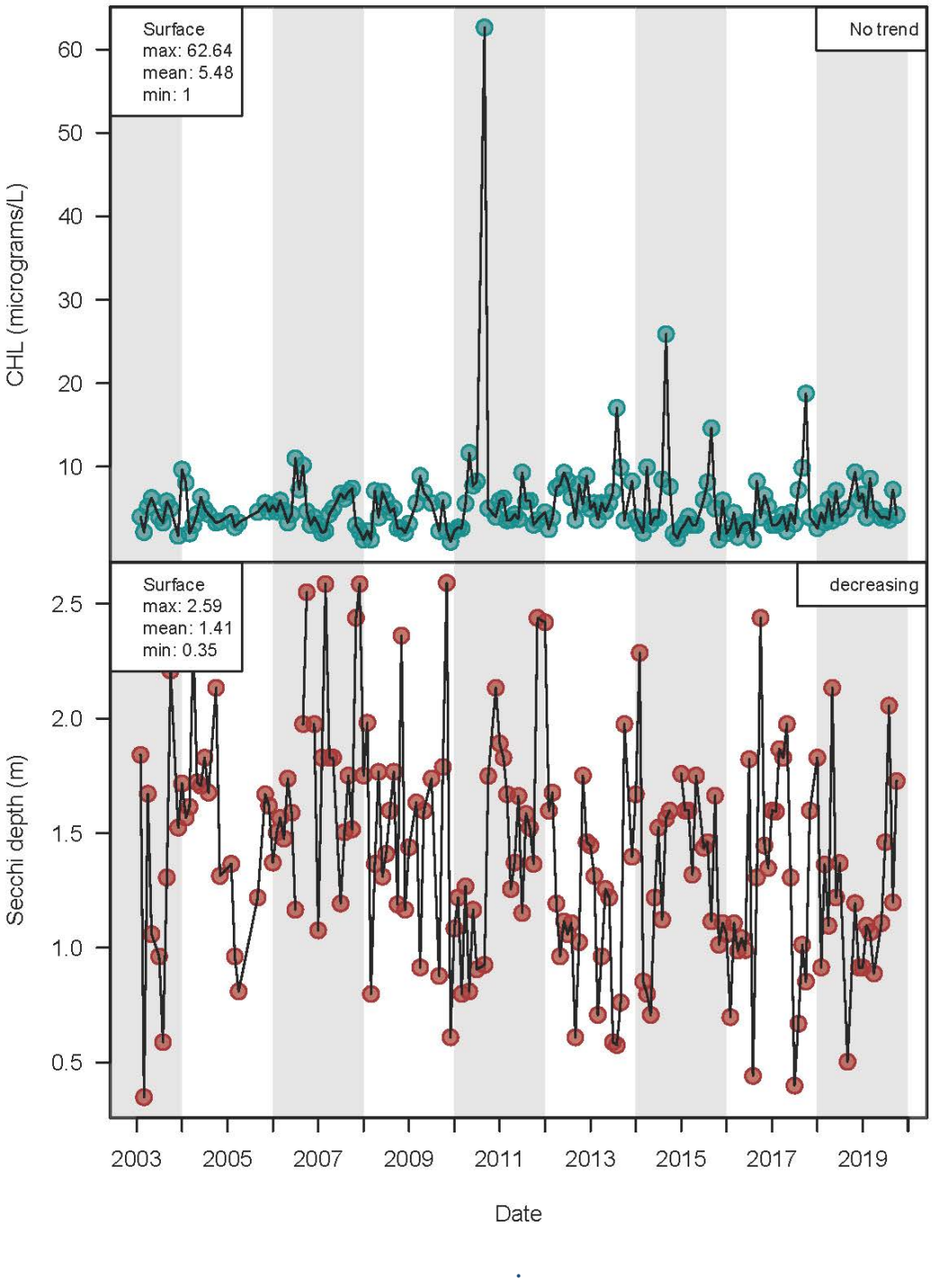
Hydrolab Trend Analyses



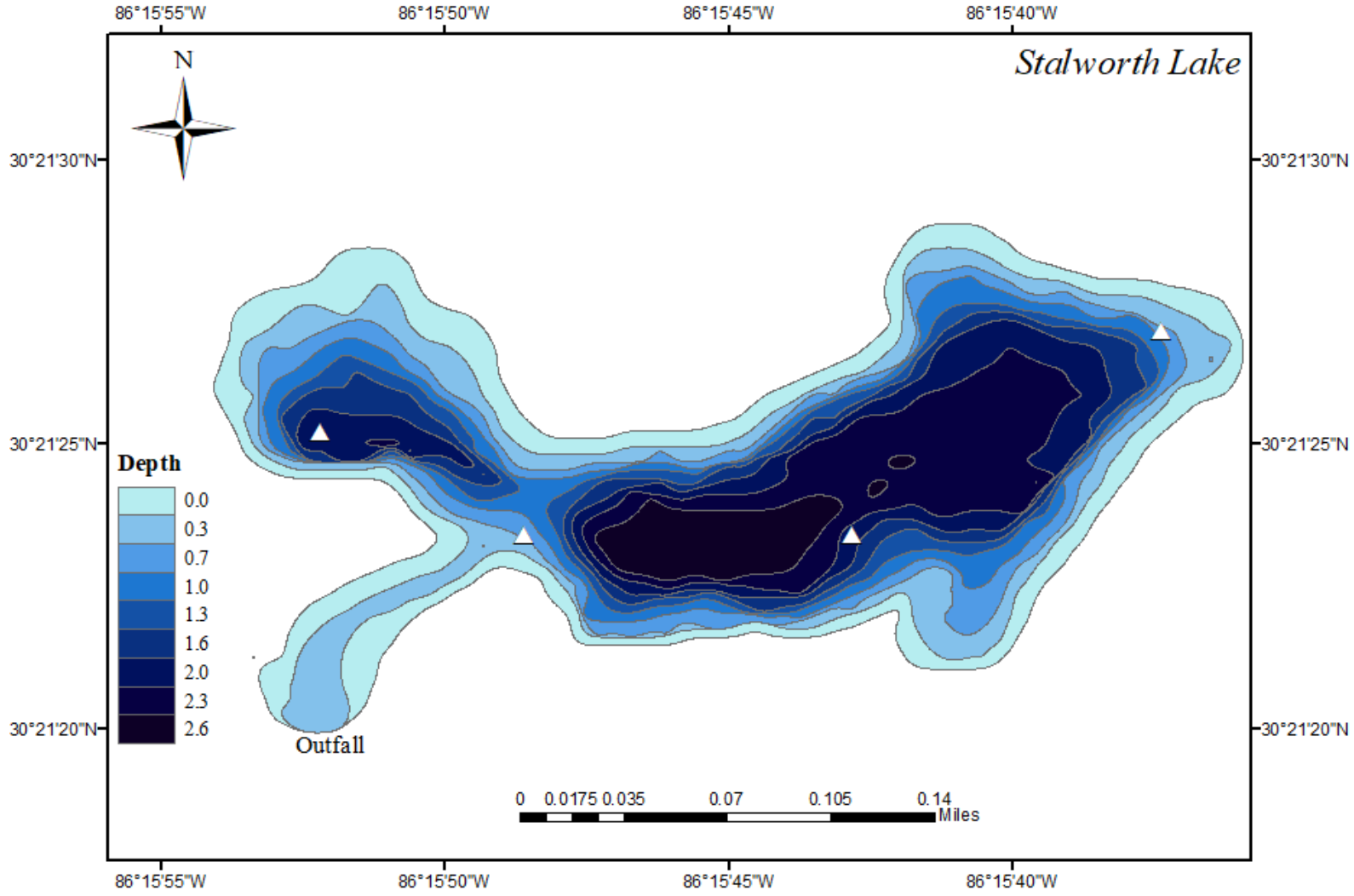

Surface
max: 8.27
mean: 7.38
min: 5.89
No trend
pH
8.0
7.5
7.0
6.5
6.0
Surface
max: 28.76
mean: 14
min: 1.26
decreasing
Salinity (ppt)
30
25
20
15
10
5
2003
2005
2007
2009
2011
2013
2015
2017
2019

Nutrient Trend Analyses




Surface
max: 62.64
mean: 5.48
min: 1
No trend
CHL (micrograms/L)
60
50
40
30
20
10
Surface
max: 2.59
mean: 1.41
min: 0.35
decreasing
Secchi depth (m)
2.5
2.0
1.5
1.0
0.5
2003
2005
2007
2009
2011
2013
2015
2017
2019
Date

Stallworth Lake, Walton County



Lake Description

Stallworth Lake is an irregularly-shaped system approximately 150 meters from the Gulf of Mexico. Stallworth is among the smallest coastal dune lakes, with a surface area of 5.2 hectares (52,000 m^2) and approximate volume of 81,000 m^3. Long-term water chemistry monitoring for Stallworth Lake occurs at four stations denoted as white triangles on the map above. Stallworth Lake has an outfall which infrequently connects to the gulf. As a result the system is primarily freshwater (0.77 ppt).

Water Chemistry Data- 2019

Summary statistics include mean, maximum (Max), minimum (Min), median, and standard error (Std Error) calculated for both surface and bottom measurements for temperature, dissolved oxygen (DO), pH, and salinity, as well as surface measurements total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), secchi depth, as well as. These statistics represent 2019 water chemistry data.

2019 Summary Statistics

	min	mean	max	Std.Error
Temperature top	14.09	23.63	31.08	2.25
Temperature bottom	20.31	26.48	32.84	1.79
DO (mg/L) top	5.3	7.18	9.42	0.52
DO (mg/L) bottom	2.77	4.02	6.47	0.46
pH top	6.65	7.25	7.73	0.17
pH bottom	6.57	7.12	7.7	0.18
Salinity (ppt) top	4.65	8.14	11.71	1.05
Salinity (ppt) bottom	7.74	15.92	25.05	2.04
TP (micrograms/L)	8.57	14.82	21.44	1.99
TN (micrograms/L)	198.04	334.66	468.12	38.43
CHL (micrograms/L)	1.19	4.16	7.22	0.89

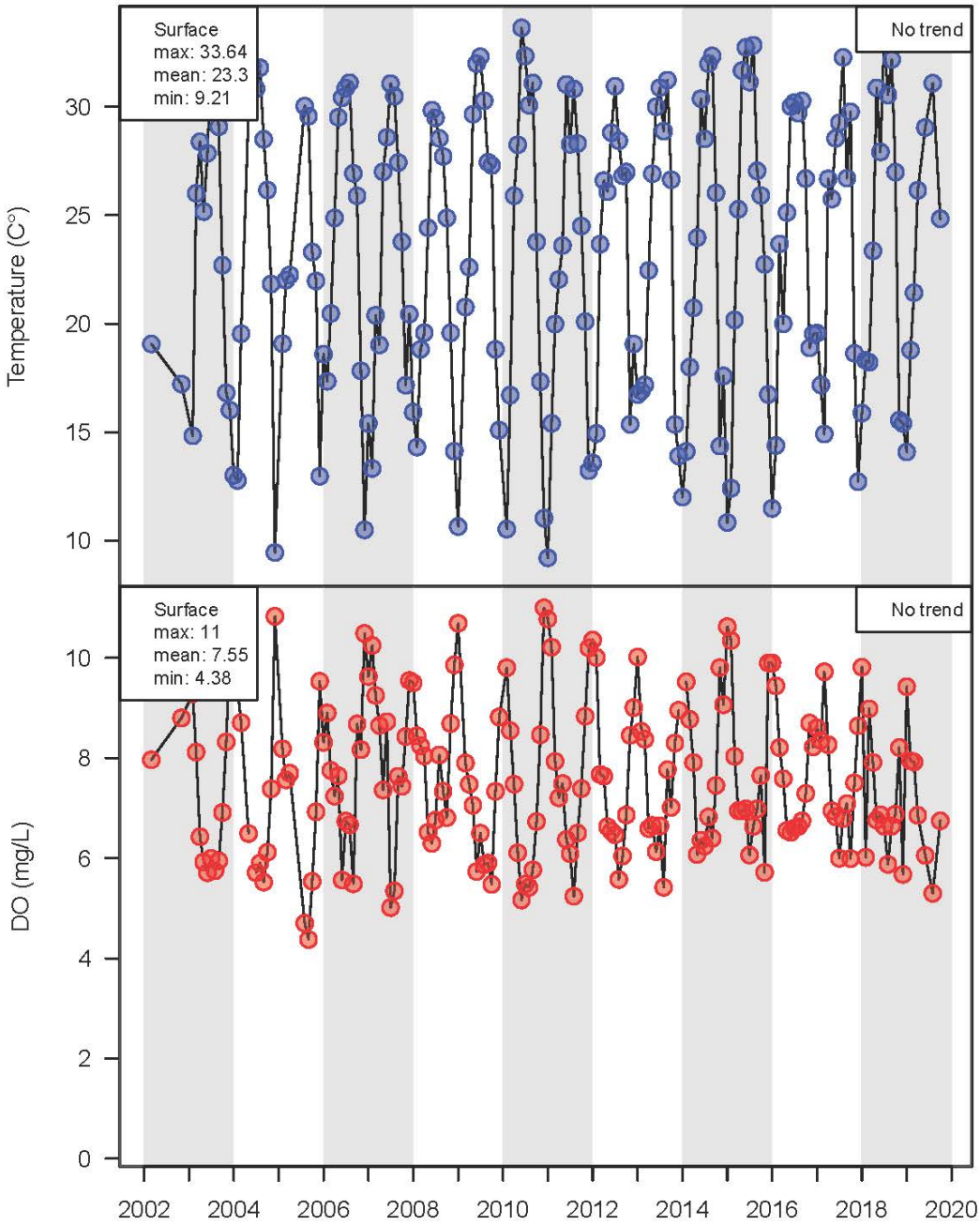
Water Chemistry Data- 2003 through 2019

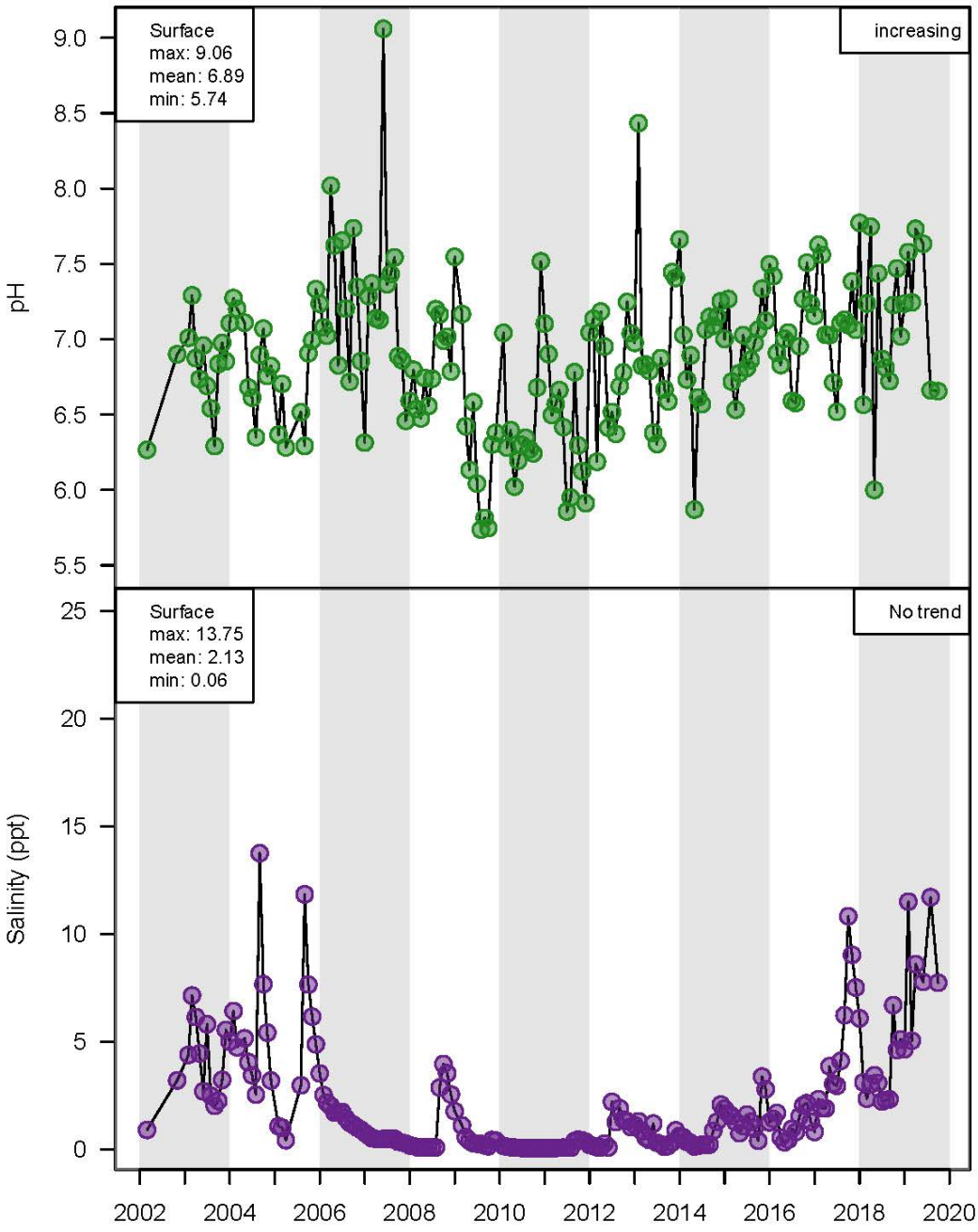
Summary statistics include mean, maximum (max), and minimum (min) summary statistics calculated on an annual basis using monthly data for hydrolab data variables; temperature, dissolved oxygen (DO), pH, and salinity as well as nutrient data variables total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), and secchi depth,. Summary statistics and trends represent results from long-term analyses among annual means from 2003 through 2019.

Times series plots display the inter-annual (monthly variability within the year - circles) and intra-annual variance (variability among years - triangles). Columns delineate three year time intervals.

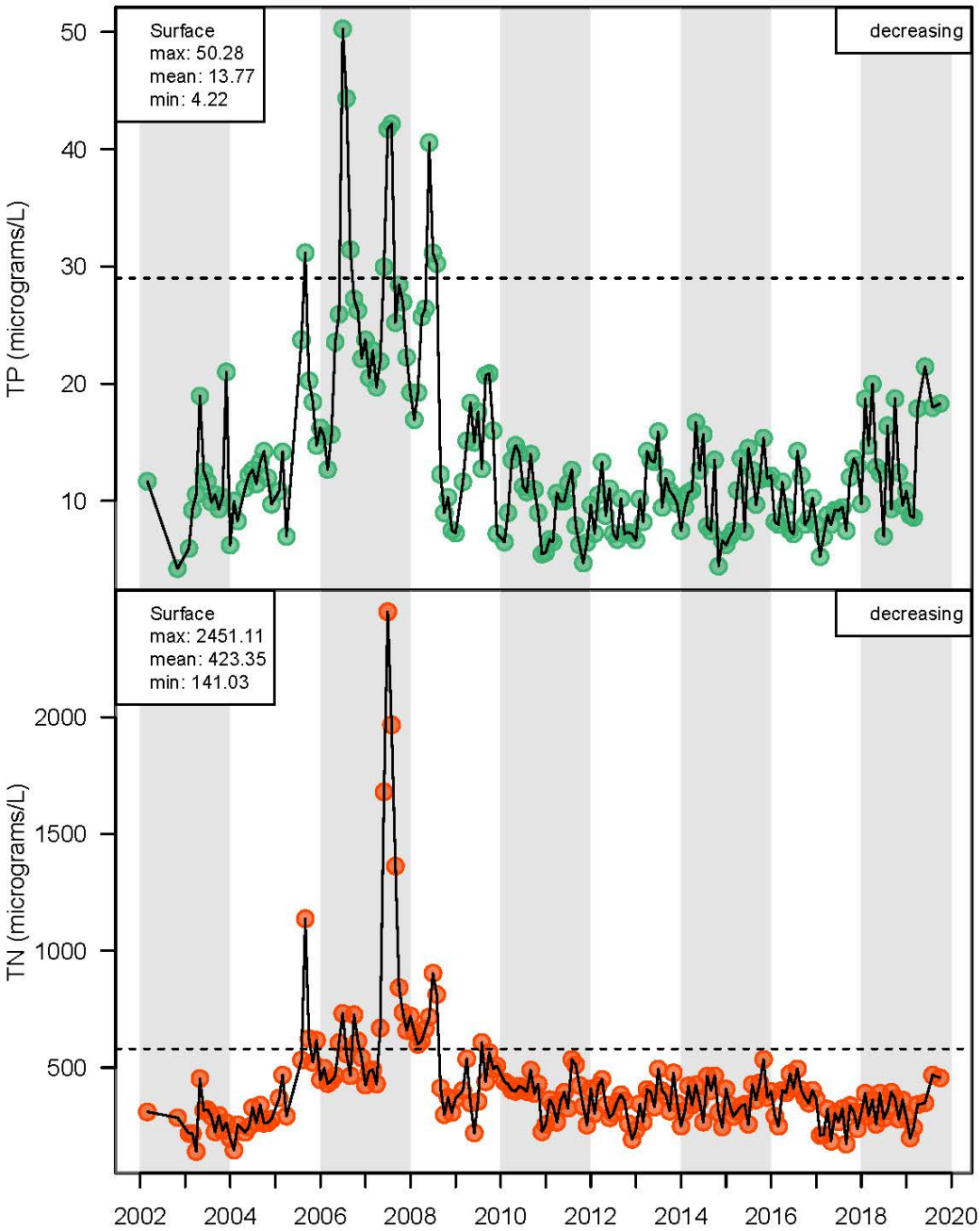
Kendall-Tau trend analysis results are shown for each water chemistry variable on the top-left of each plot. No trend indicates there was no significant trend found among the years examined (2003 through 2019). Increasing indicates a significant, positive trend was found over time. Decreasing indicates a significant, negative trend was found among the years examined. Insufficient data indicates insufficient annual data (year averages) were available for trend analysis.

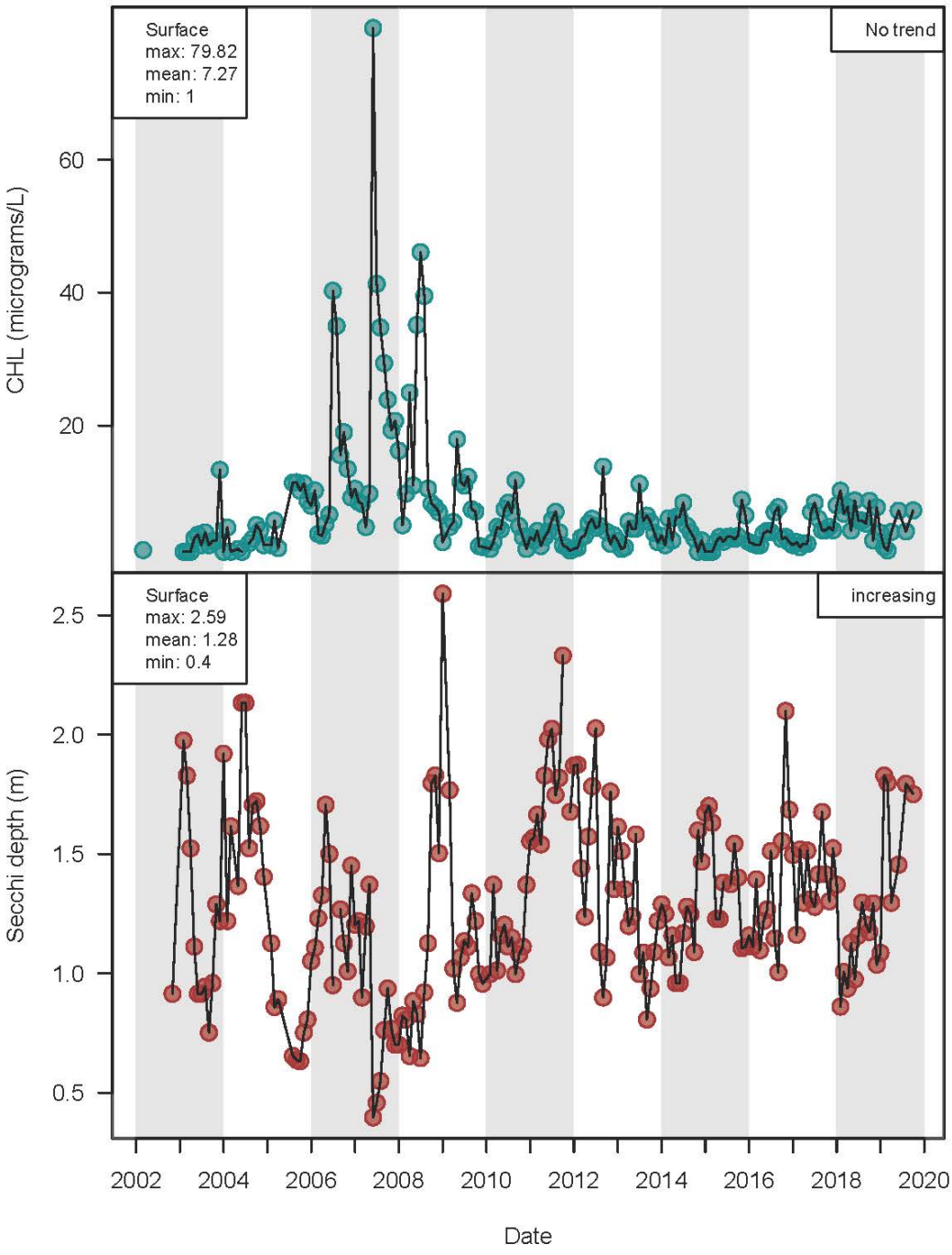
Hydrolab Trend Analyses



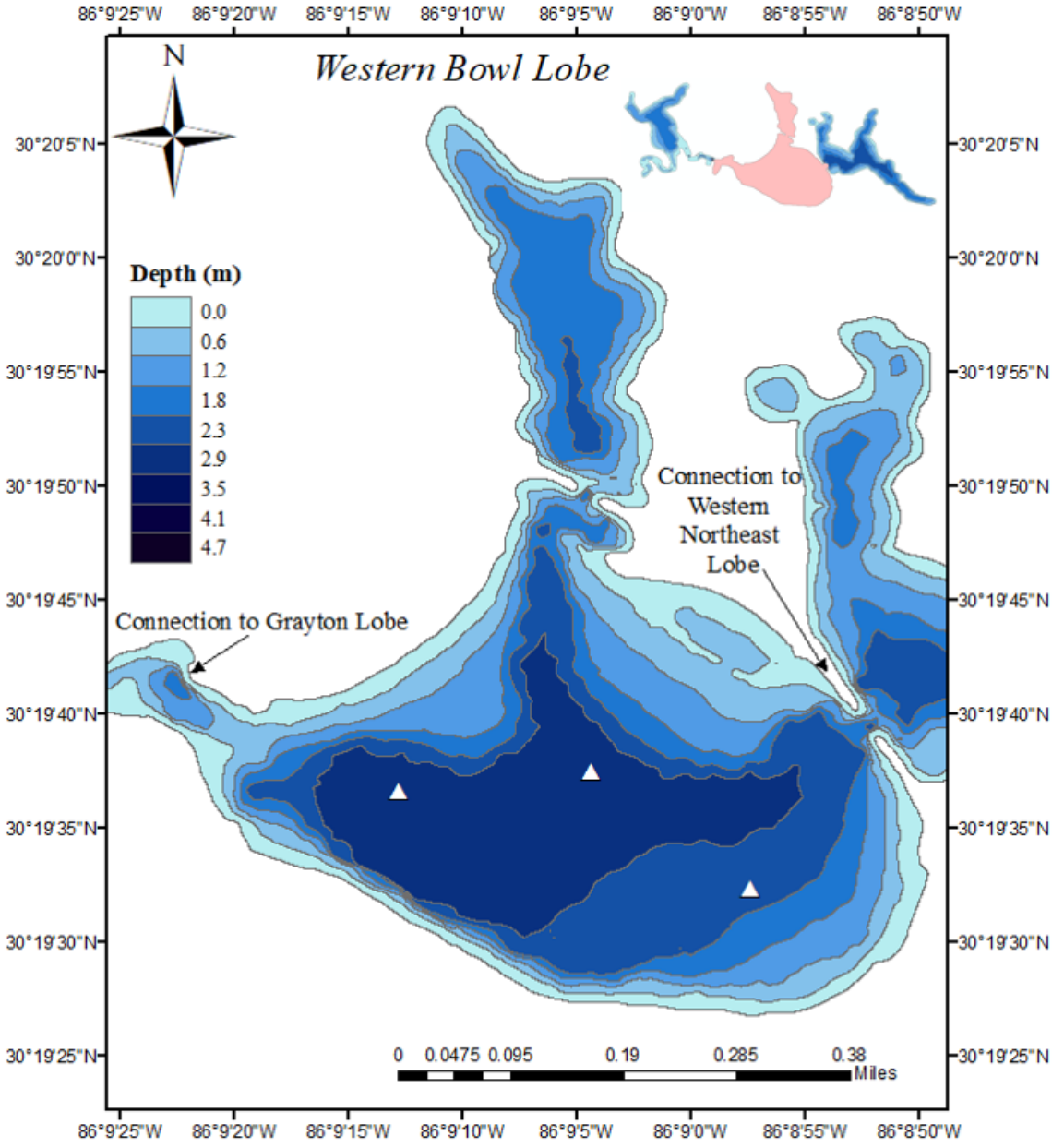

Surface
max: 9.06
mean: 6.89
min: 5.74
increasing
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
Surface
max: 13.75
mean: 2.13
min: 0.06
No trend
Salinity (ppt)
25
20
15
10
5
0
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

Nutrient Trend Analyses




Surface
max: 79.82
mean: 7.27
min: 1
No trend
CHL (micrograms/L)
60
40
20
Surface
max: 2.59
mean: 1.28
min: 0.4
increasing
Secchi depth (m)
2.5
2.0
1.5
1.0
0.5
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Date

Western Bowl Lake Lobe, Walton County



Lake Description

The Western Lake system is an irregularly-shaped lake system approximately 300 meters from the Gul of Mexico. The system is the second largest coastal dune lake system, with a total surface area of 98 hectares (980,000 m^2) and an approximate volume of 1,590,000 m^3. The system is divided first by a shallow, narrow channel into western and eastern lobes, and then again by Highway 30A into a central and northeastern lobe. Connectivity between the three lobes is maintained by two bridges. Western Bowl Lobe refers to the central lobe of Western Lake. It is a large system with a surface area of 45 hectares (450,000 m^2) and an approximate volume of 730,000 m^3. Long-term water chemistry monitoring for Western Bowl Lobe occurs at three stations denoted as white

triangles on the map above. Western Bowl Lobe does not have a direct connection to the gulf, but rather has indirect interactions with the gulf through its connection to Grayton Lobe. However, the long, narrow channel separating Grayton and Western Bowl Lobes acts as a bottleneck for seawater inflows, and as a result Western Bowl lobe and Western Northeast Lobes have markedly different salinity regimes from Grayton Lobe (5ppt, 5ppt and 11ppt respectively).

Water Chemistry Data- 2019

Summary statistics include mean, maximum (Max), minimum (Min), median, and standard error (Std Error) calculated for both surface and bottom measurements for temperature, dissolved oxygen (DO), pH, and salinity, as well as surface measurements total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), secchi depth, as well as. These statistics represent 2019 water chemistry data.

2019 Summary Statistics

	min	mean	max	Std.Error
Temperature top	15.24	20.77	25.44	2.58
Temperature bottom	20.54	21.23	21.68	0.3
DO (mg/L) top	7.3	7.56	7.81	0.13
DO (mg/L) bottom	0.51	2.05	4.87	1.22
pH top	7.46	7.76	8.27	0.22
pH bottom	7.25	7.63	8.08	0.21
Salinity (ppt) top	4.87	7.16	10.75	1.57
Salinity (ppt) bottom	10.81	20.82	26.53	4.35
TP (micrograms/L)	6.35	10.98	18.25	2.58
TN (micrograms/L)	146.59	333.64	519.74	83.96
CHL (micrograms/L)	2	4.12	9.32	1.74

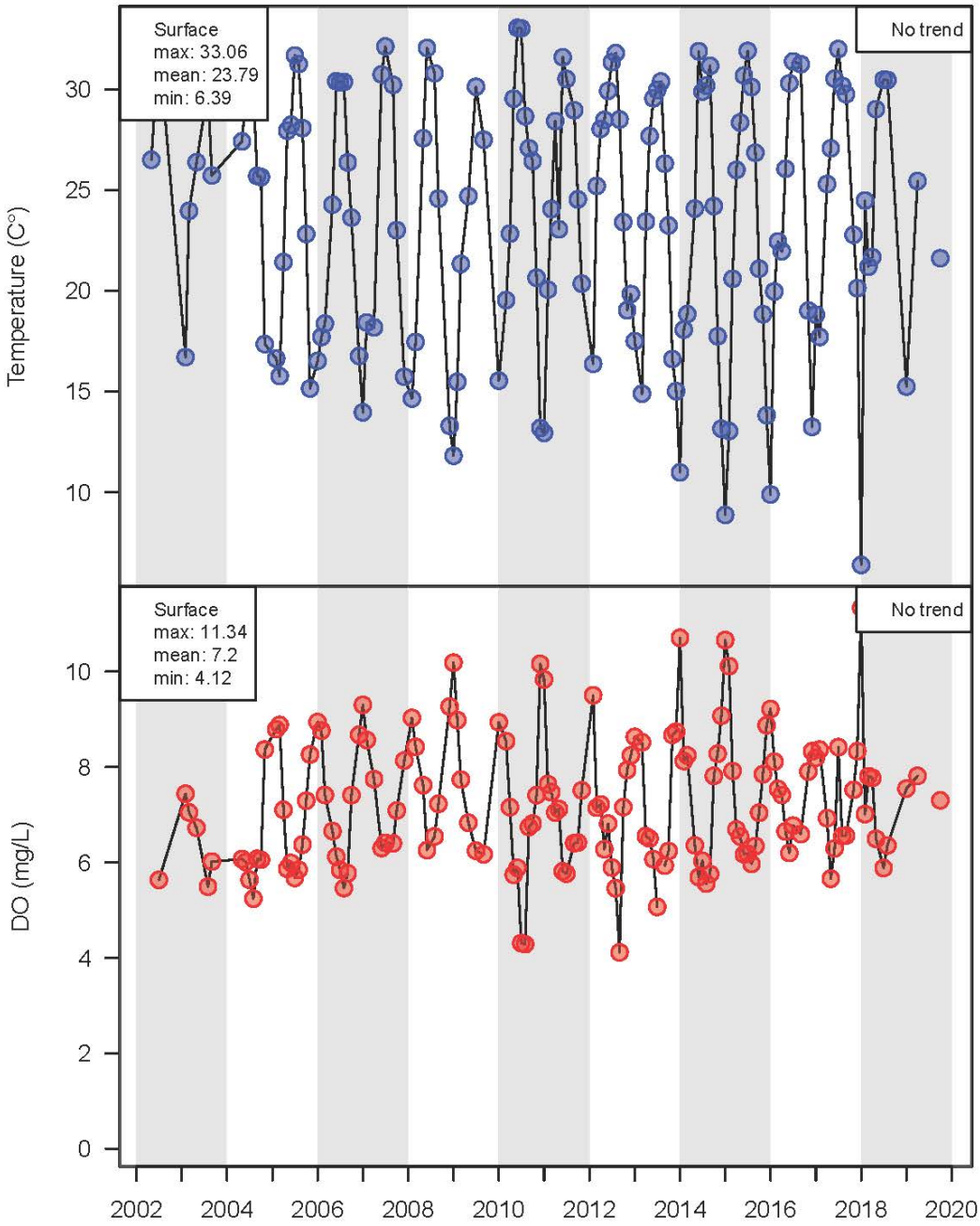
Water Chemistry Data- 2003 through 2019

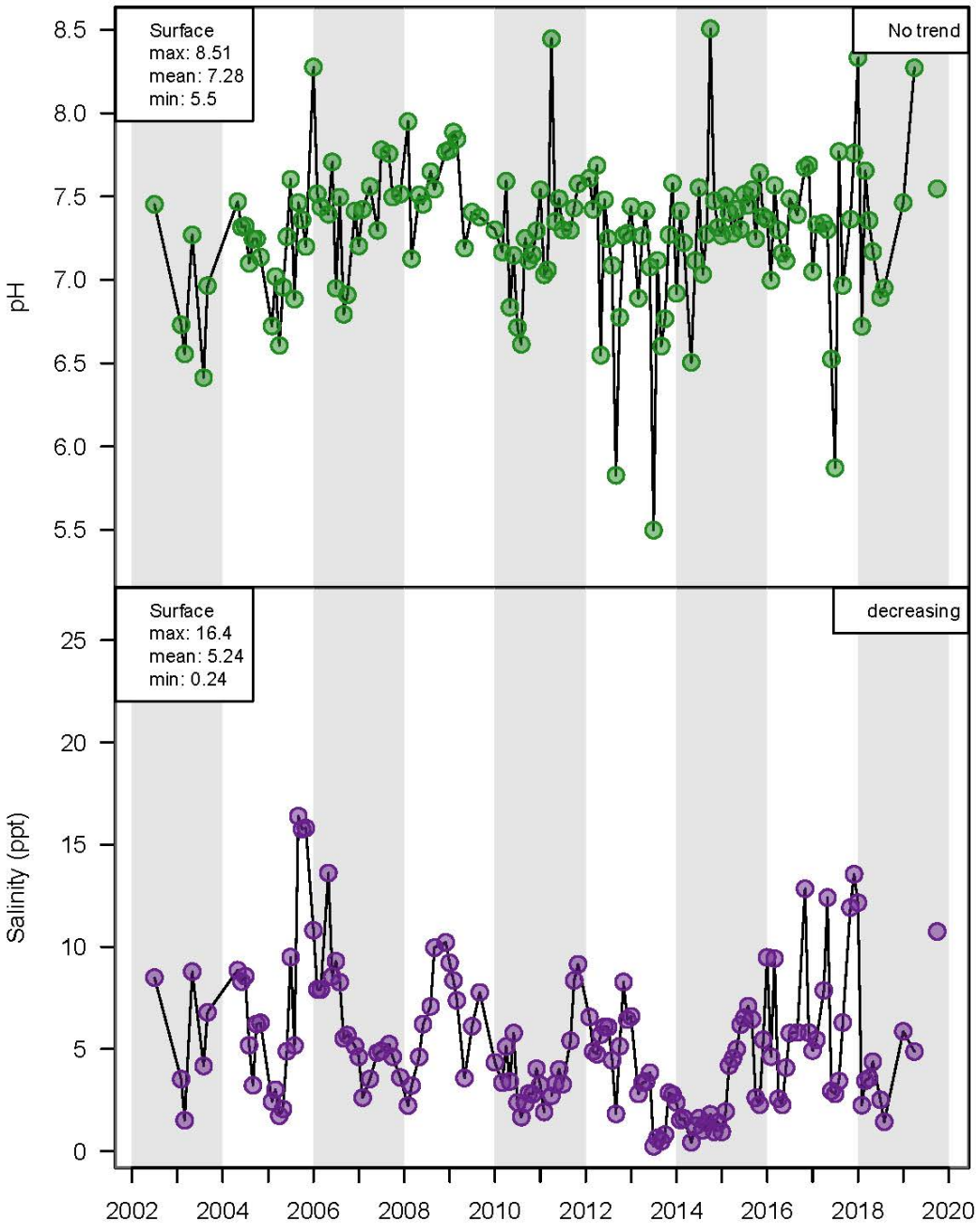
Summary statistics include mean, maximum (max), and minimum (min) summary statistics calculated on an annual basis using monthly data for hydrolab data variables; temperature, dissolved oxygen (DO), pH, and salinity as well as nutrient data variables total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), and secchi depth,. Summary statistics and trends represent results from long-term analyses among annual means from 2003 through 2019.

Times series plots display the inter-annual (monthly variability within the year - circles) and intra-annual variance (variability among years - triangles). Columns delineate three year time intervals.

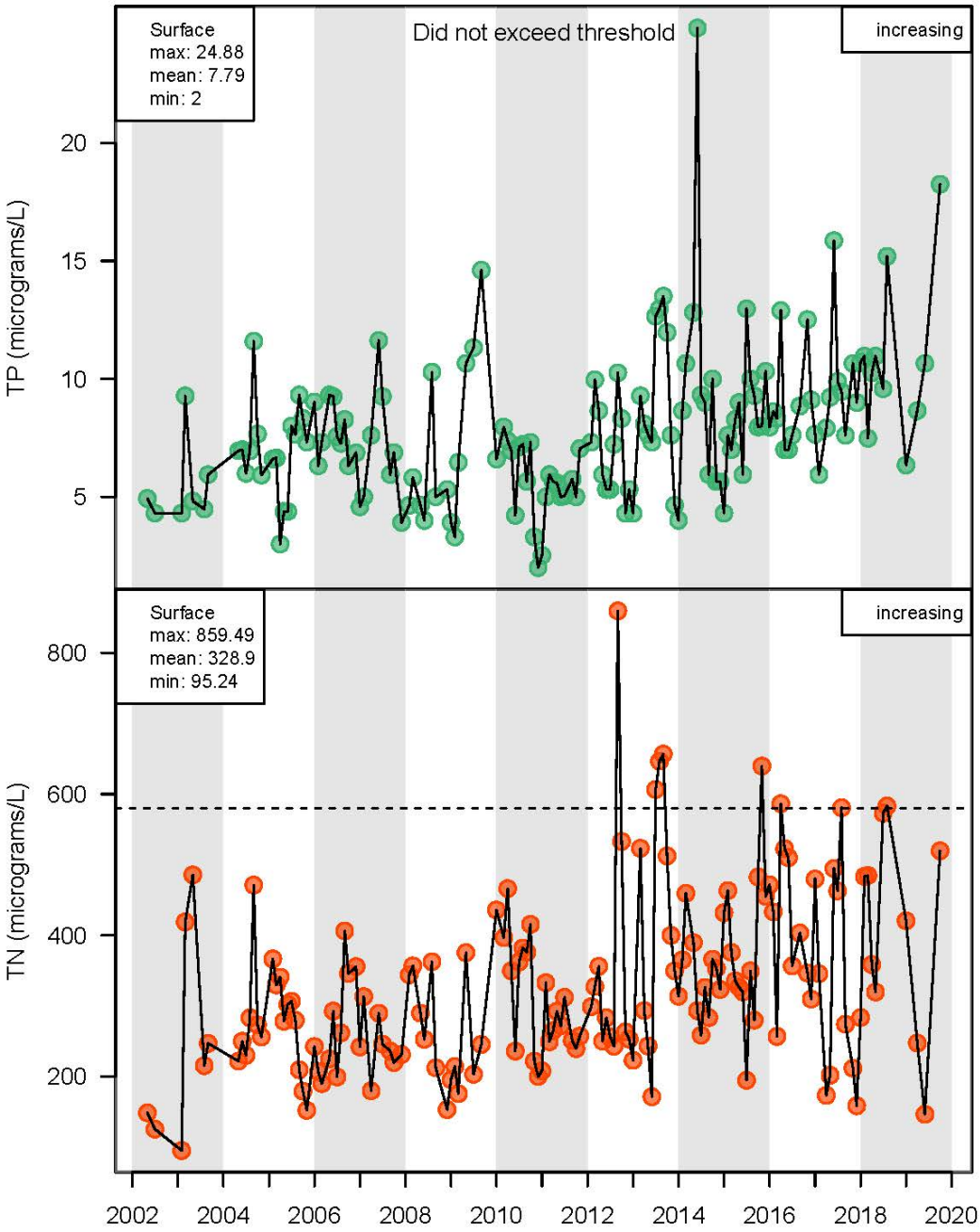
Kendall-Tau trend analysis results are shown for each water chemistry variable on the top-left of each plot. *No trend* indicates there was no significant trend found among the years examined (2003 through 2019). *Increasing* indicates a significant, positive trend was found over time. *Decreasing* indicates a significant, negative trend was found among the years examined. *Insufficient data* indicates insufficient annual data (year averages) were available for trend analysis.

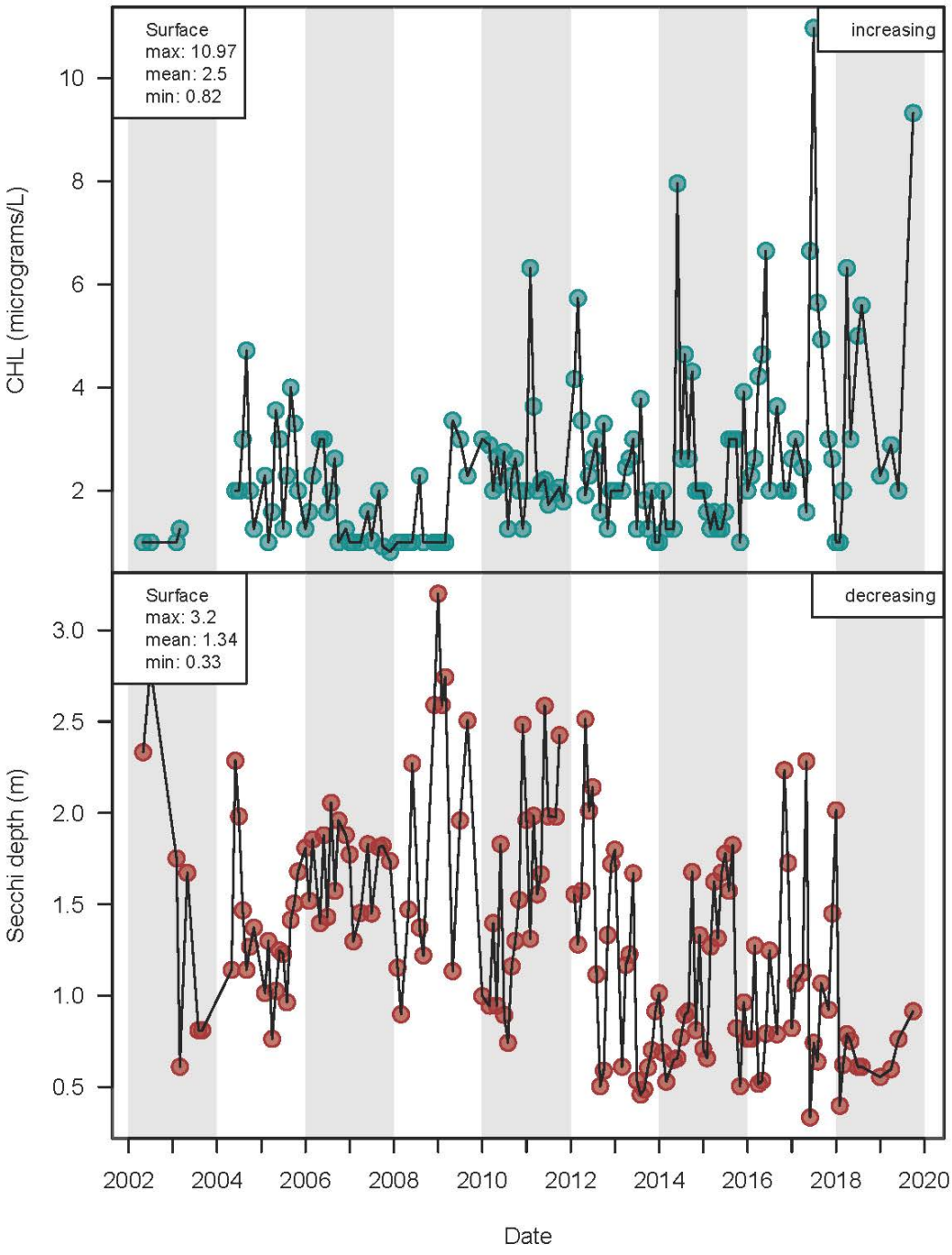
Hydrolab Trend Analyses



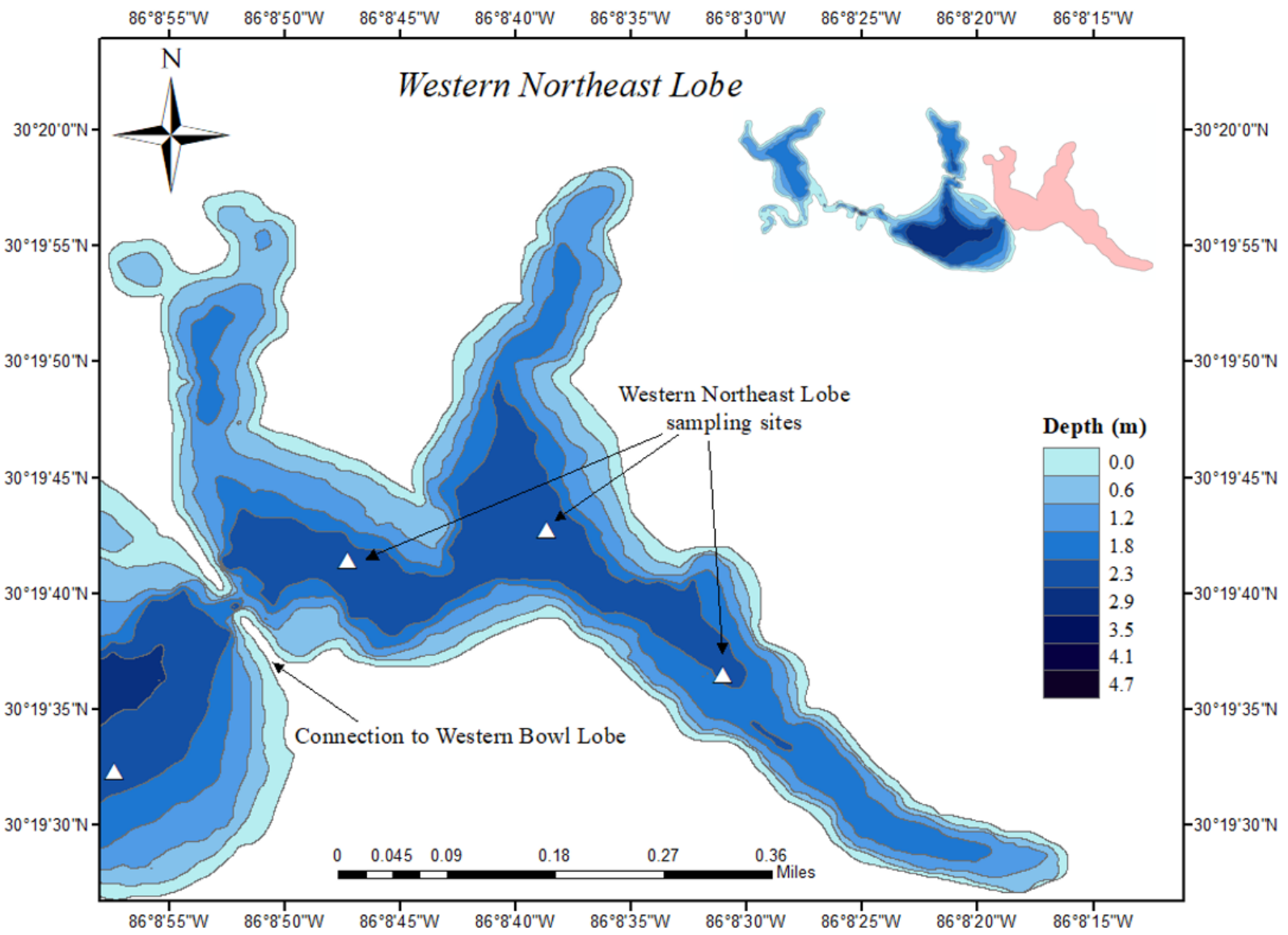

Surface
max: 8.51
mean: 7.28
min: 5.5
No trend
pH
8.5
8.0
7.5
7.0
6.5
6.0
5.5
Surface
max: 16.4
mean: 5.24
min: 0.24
decreasing
Salinity (ppt)
25
20
15
10
5
0
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

Nutrient Trend Analyses




Surface
max: 10.97
mean: 2.5
min: 0.82
increasing
CHL (micrograms/L)
10
8
6
4
2
Surface
max: 3.2
mean: 1.34
min: 0.33
decreasing
Secchi depth (m)
3.0
2.5
2.0
1.5
1.0
0.5
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Date

Western Northeast Lake Lobe, Walton County



Lake Description

The Western Lake system is an irregularly-shaped lake system approximately 300 meters from the Gul of Mexico. The system is the second largest coastal dune lake system, with a total surface area of 98 hectares (980,000 m^2) and an approximate volume of 1,590,000 m^3. The system is divided first by a shallow, narrow channel into western and eastern lobes, and then again by Highway 30A into a central and northeastern lobe. Connectivity between the three lobes is maintained by two bridges. Western Northeast Lobe refers to the northeastern lobe of Western Lake. It is a large system with a surface area of 30 hectares (300,000 m^2) and an approximate volume of 500,000 m^3. Long-term water chemistry monitoring for Western Northeast Lobe occurs at three stations denoted as white triangles on the map above. Western Northeast Lobe does not have a direct

connection to the gulf, but rather has indirect interactions with the gulf through its connection to Grayton Lobe through Western Bowl Lobe. However, the long, narrow channel separating Grayton and Western Bowl Lobes acts as a bottleneck for seawater inflows, and as a result Western Bowl lobe and Western Northeast Lobes have markedly different salinity regimes from Grayton Lobe (5ppt, 5ppt and 11ppt respectively).

Water Chemistry Data- 2019

Summary statistics include mean, maximum (Max), minimum (Min), median, and standard error (Std Error) calculated for both surface and bottom measurements for temperature, dissolved oxygen (DO), pH, and salinity, as well as surface measurements total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), secchi depth, as well as. These statistics represent 2019 water chemistry data.

2019 Summary Statistics

	min	mean	max	Std.Error
Temperature top	19.99	26.35	30.96	2.01
Temperature bottom	19.52	25.88	30.81	1.82
DO (mg/L) top	4.63	5.64	6.71	0.32
DO (mg/L) bottom	0.55	1.72	4.83	0.72
pH top	6.67	7.22	7.48	0.13
pH bottom	6.67	7.06	7.35	0.09
Salinity (ppt) top	3.54	7.84	11.39	1.4
Salinity (ppt) bottom	7.92	13.87	17.51	1.63
TP (micrograms/L)	7.56	11.4	15.88	1.15
TN (micrograms/L)	341.71	395.59	515.86	26.64
CHL (micrograms/L)	2	3.63	8.96	1.09

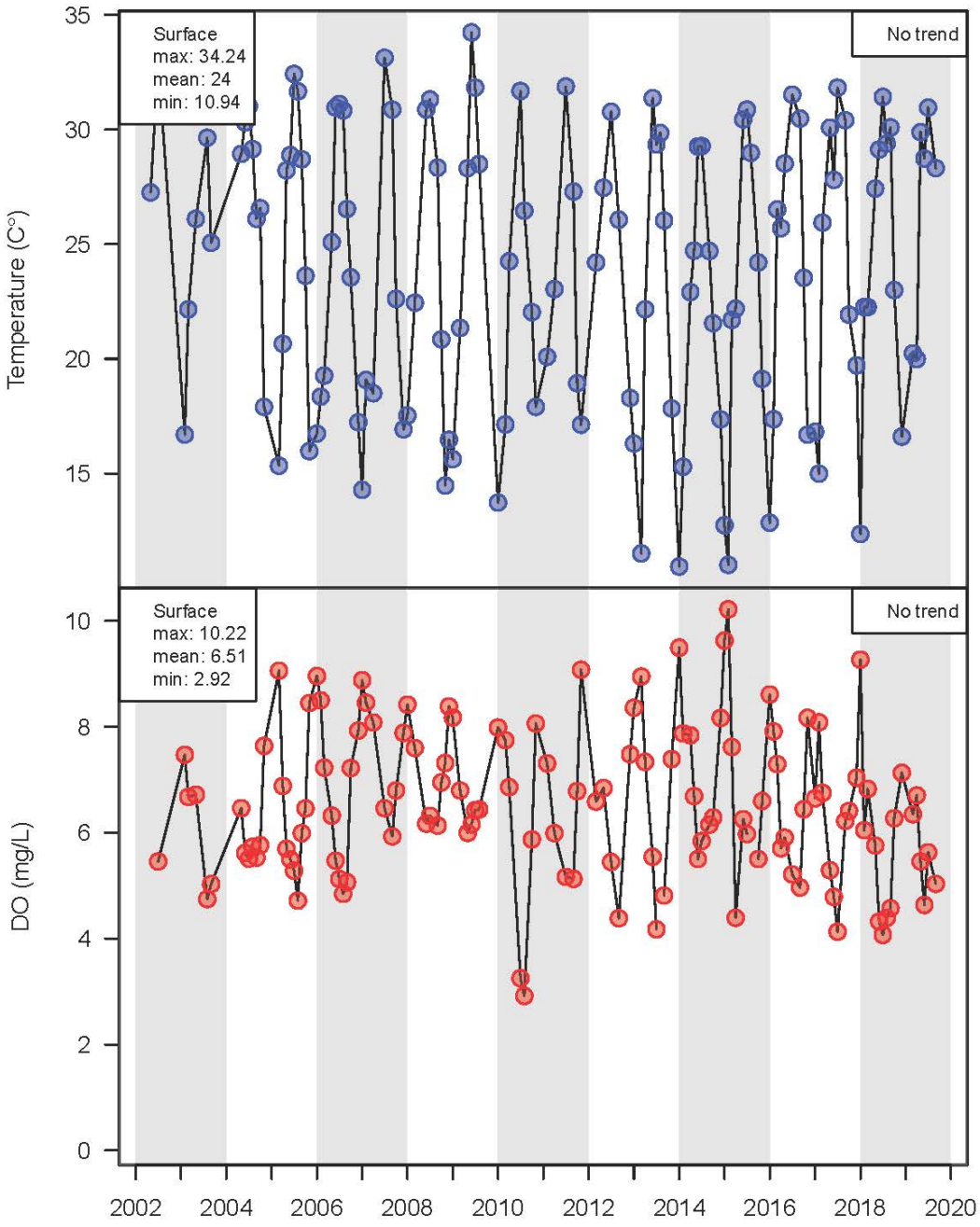
Water Chemistry Data- 2003 through 2019

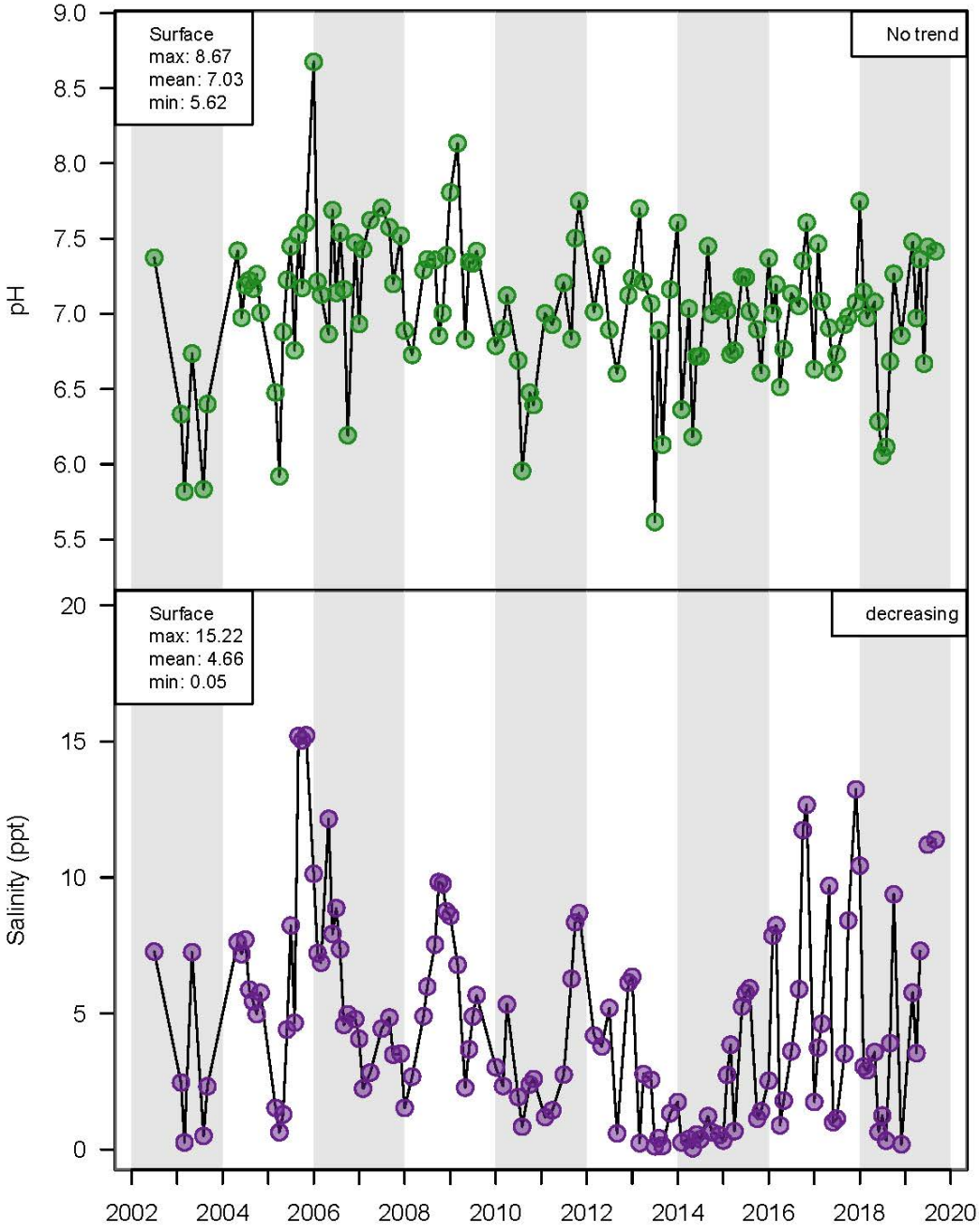
Summary statistics include mean, maximum (max), and minimum (min) summary statistics calculated on an annual basis using monthly data for hydrolab data variables; temperature, dissolved oxygen (DO), pH, and salinity as well as nutrient data variables total phosphorous (TP), total nitrogen (TN), total chlorophyll (CHL), and secchi depth,. Summary statistics and trends represent results from long-term analyses among annual means from 2003 through 2019.

Times series plots display the inter-annual (monthly variability within the year - circles) and intra-annual variance (variability among years - triangles). Columns delineate three year time intervals.

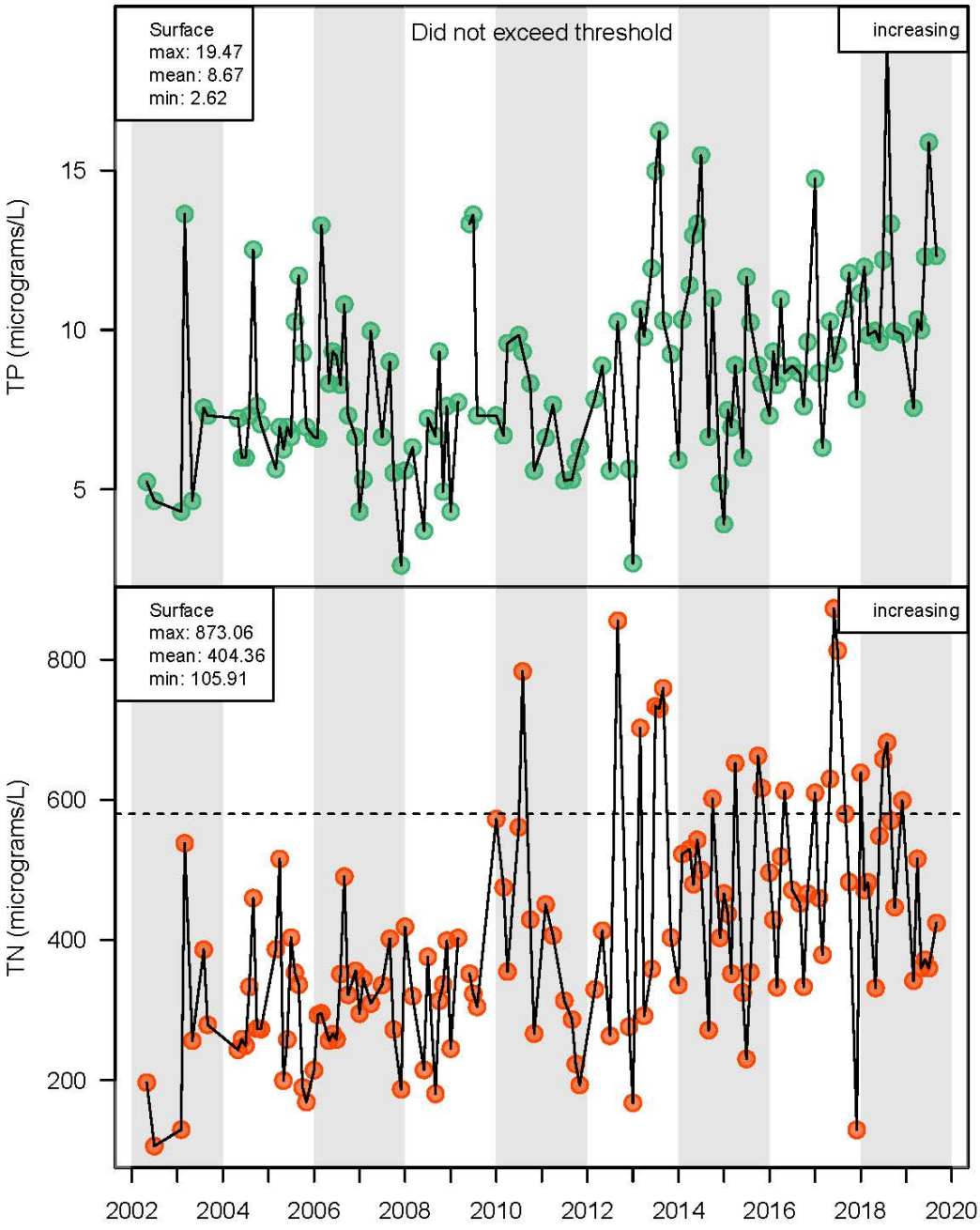
Kendall-Tau trend analysis results are shown for each water chemistry variable on the top-left of each plot. *No trend* indicates there was no significant trend found among the years examined (2003 through 2019). *Increasing* indicates a significant, positive trend was found over time. *Decreasing* indicates a significant, negative trend was found among the years examined. *Insufficient data* indicates insufficient annual data (year averages) were available for trend analysis.

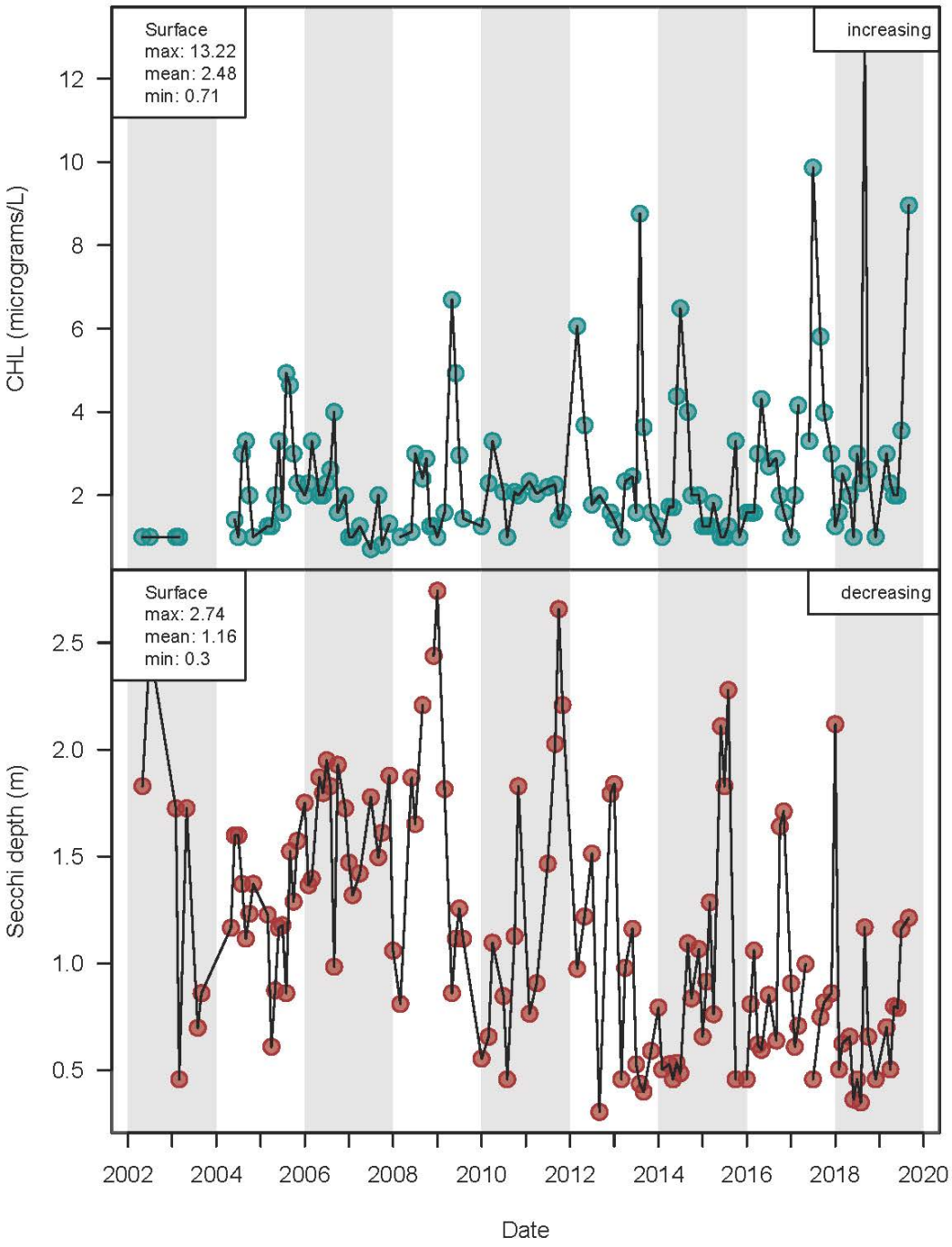
Hydrolab Trend Analyses




Surface
max: 8.67
mean: 7.03
min: 5.62
No trend
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
Surface
max: 15.22
mean: 4.66
min: 0.05
decreasing
Salinity (ppt)
20
15
10
5
0
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

Nutrient Trend Analyses




Surface
max: 13.22
mean: 2.48
min: 0.71
increasing
CHL (micrograms/L)
12
10
8
6
4
2
Surface
max: 2.74
mean: 1.16
min: 0.3
decreasing
Secchi depth (m)
2.5
2.0
1.5
1.0
0.5
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Date

References:

Bachmann, R.W., D.L. Bigham, M.V. Hoyer, and D.E. Canfield, Jr. 2012. Factors determining the distributions of total phosphorus, total nitrogen, and chlorophyll a in Florida lakes. Lake and Reservoir Management 28:10-26 [doi:10.1080/07438141.2011.646458].

Canfield, Jr., D. E., and M. V. Hoyer. 1988. Regional geology and the chemical and trophic state characteristics of Florida lakes. Lake and Reservoir Management 4:21-31 [doi:10.1080/07438148809354375].

Griffith, G.E., D.E. Canfield, Jr., C.A. Horsburg, and J.M. Omernik. 1997. Lake regions of Florida. EPA (U.S. Environmental Protection Agency), report R-97/127 Corvallis, Oregon.