Assessment of Oysters and Barnacles along the Chassahowitzka, Homosassa, and Lower Withlacoochee River Systems
Final Report

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Executive Summary

The purpose of the study is to provide technical support to the Southwest Florida Water Management District (District) on minimum flows and levels and its effect on specific sessile macroinvertebrate communities that are dependent on the maintenance of optimal estuarine conditions in the coastal rivers along the Springs Coast of Florida. This evaluation assesses the occurrence and condition of oysters and barnacles in the Chassahowitzka, Homosassa, and Lower Withlacoochee Rivers.

Both the Chassahowitzka and Homosassa Rivers are relatively short rivers (13 kilometers or less) and derive much of their flow from nearby springs, whereas the Withlacoochee River is much longer (257 km) and derives its flow from both surface water drainage and spring flow (via its tributary, the Rainbow River). The surface salinity of the rivers was modeled by the District for the Chassahowitzka and the Homosassa over the last 3 years to show general patterns of salinity that affects shallow–dwelling organisms such as intertidal oysters and barnacles. Unlike the other two rivers in this study, the District salinity model is not available for the lower Withlacoochee River.

In general, oysters in both the Chassahowitzka and the Homosassa Rivers are found in the mesohaline (5 to 18 ppt) areas of the river whereas barnacles occur in both the oligohaline (0.5 to < 5 ppt) and mesohaline areas. The total number of barnacle samples from the mesohaline areas was low due to substrate being preoccupied by oyster growth. Based on limited salinity data available for the Withlacoochee River, it appears likely that oysters and barnacles in the Withlacoochee River follow a similar pattern with oysters limited to the lower, more saline, portions of the river, and barnacles occurring farther up river.

The study mapped the location of oyster bars and aggregations of oysters in up to 50 locations per river. Oysters were sampled preferentially from oyster bars (where they existed) from three general areas in each river to capture oysters growing in differing salinities based on their upstream or downstream location. Group A was the most upstream, Group B was an intermediate location, and Group C represents the most downstream. Nine samples split between the three groups were collected from the Homosassa and the Chassahowitzka Rivers (three samples from each group). In the Lower Withlacoochee River, 13 total samples were collected from three sampling groups (four each from Group A and B, and five samples from Group C). Oysters were collected from 0.5 m by 0.5 m quadrats (where feasible). The number of oysters per 0.25 square meters (m^2) and the percent live was determined, and a subsample was collected from the quadrat. Sample collections allowed further assessment of oyster size parameters through lab analysis and oyster Condition Index (CI) to be calculated.

Differences in the oyster metrics from the three sampling groups were compared using nonparametric statistics.

In addition, this study mapped and sampled intertidal barnacles in the three river systems. Where substrate was suitable, 10 cm by 10 cm quadrats were affixed to hard, relatively flat surfaces and barnacles were assessed (density, percent live, and basal diameter) and collected for lab analysis of organic matter.

Oysters

When comparing Chassahowitzka River oyster CI between the sampling groups, there was no significant difference between Groups A and B. However, Group C oysters had a significantly higher CI, which indicates that oysters in Group C (higher salinity area) were in better condition than those from either A or B. Based on continuous recorder data from the year preceding Water & Air's sampling event, Group C experienced the highest salinities of the three groups. Group C was bracketed by two USGS stations (USGS 02310674 downstream and USGS 02310673 upstream), both stations show monthly average salinities between 8.2 and 17.3 ppt which fall mostly within the optimal range for *Crassotrea virginica.*

Homosassa River oyster CI was significantly higher for the furthest upstream Group A sites than for the more-downstream Groups B and C sites. This indicates that oysters collected from the upstream Group A sites were in better condition than oysters collected from the downstream locations.

The District's 3-year average salinity model for the Homosassa River predicts that oysters in Group A were experiencing average surface salinity (5 to 8 ppt) below the low end of the optimal range (10 to 28 ppt). The District's salinity model indicates that the area where Group B samples were collected has salinities on the low end of the optimal salinity range and this is where the tallest oysters were collected. Group C had the lowest CI and shortest height of the three groups but appears to have experienced salinities in the optimal range based on both data from the 3-year average model and the data collected at USGS 02310712. Unlike the Chassahowitzka River, the salinity model for the Homosassa River does not explain the higher CI values in Group A oysters. On the Homosassa, Group A sites may not necessarily reflect low salinity conditions since the connection of Battle Creek and Petty Creeks to the Gulf of Mexico through Mason Creek creates additional pathways for higher salinity waters to reach those sites.

The Lower Withlacoochee River showed a pattern similar to the Chassahowitzka River in that the CI was not significantly different between upstream Groups A and B but that Group C had a significantly higher CI for the downstream sites. This indicates that oysters collected from the Group C sites (higher salinity) were in better condition than oysters collected in Group A and B sites.

According to the South Florida Water Management District (2014), "oyster condition index typically increases with increasing salinity downstream". The Chassahowitzka and Lower Withlacoochee Rivers oyster data conform to this trend, but for the Homosassa River, the opposite trend is seen where the upstream Group A sites had higher CI values. This may be explained by the more complex geography of the Homosassa River where the river has multiple inputs (creek connections) for saline water from the Gulf of Mexico to reach the sampled areas (Group A) along Petty and Battle Creeks, in addition to the main stem of the river.

Barnacles

In the Chassahowitzka, oysters may outcompete barnacles for hard substrate, but also create habitat by adding hard substrate to the environment with their shells. There were no significant differences in any of the barnacle metrics between the oligohaline and mesohaline zones, which could be the result of small sample sizes.

Again, in the Homosassa and Halls rivers, the presence of oysters seems to be an important factor in the distribution of barnacles. Like the Chassahowitzka, there were no significant differences (with a small sample size) in any of the barnacle metrics from samples collected from the oligohaline and mesohaline portions of the river.

In the Withlacoochee, there were no designated salinity zones (due to lack of a District model) to test, but there were significant correlations between the barnacle metrics: number of live and dead barnacles per 0.01 m^2, number of live barnacles, and mean diameter and river kilometer (RKm). Barnacles were generally larger further from the mouth of the river but were less common.

1.0 Introduction

The District contracted with Water & Air Research, Inc. (Water & Air) to map and characterize oysters and barnacles along the Chassahowitzka, Homosassa, and Lower Withlacoochee River systems in support of updating the rivers' minimum flows and levels. By state statute, the minimum flow for a given watercourse is defined as the limit at which further withdrawals would be significantly harmful to the water resources or the ecology of the area. The previous recommended minimum flows for the Chassahowitzka and Homosassa Rivers were detailed in separate reports by the District and Balanced Environmental Management Systems, Inc. (2012) for the Chassahowitzka River, and HSW Engineering, Inc. for the Homosassa River. Currently, updates to the minimum flows reports for the Chassahowitzka and Homosassa Rivers are in preparation. The minimum flows process is just starting for the Lower Withlacoochee River.

This report was prepared to support efforts to establish minimum flows and levels criteria for these rivers by documenting the occurrence of oysters and barnacles because they are indicators of the rivers' salinity regimes. One of the objectives of this study was to determine if and how oysters and or barnacles are related to the river corridors (i.e., to determine whether there is a correlation with population parameters to the RKm location). Another objective was to compare groups of sample sites (Salinity Groups) clustered in discrete areas of similar salinity, to each other to gain insight as to the effects on the animals between these locations and their different salinity regimes.

Both oysters and barnacles are affected by water conditions, including salinity and temperature (Poirrier and Partridge 1979; Nasrolahi et al. 2016; Dineen and Hines 1994; Wrange et al. 2014). Larval oysters and barnacles are mobile zooplankton that settle on hard substrates and undergo metamorphosis into adult forms (generally true, although some barnacles species prefer soft substrate). Their condition as adults reflect the availability of food as filter feeding organisms, and tolerance to biotic (e.g., parasites and predators) and abiotic stressors (such as temperature, salinity, and competition for space).

Barnacles and oysters occur in both subtidal and intertidal zones and have varying optimal salinity ranges. Changes in salinity that move the organisms outside of the optimal salinity regime can have impacts on growth, disease, and predator stress (Barnes et al. 2007). Barnacles are a diverse group of crustaceans that tolerate a wide range of salinities from oligohaline conditions to marine (or even hyperhaline) waters depending on species. The most prevalent species in these rivers (Culter 2010), *Balanus subalbidus*, has a known distribution from nearly freshwater to 16 ppt and occurs as the dominant barnacle in in oligohaline waters of the southeastern United States (Poirrier and Partridge 1979). Barnacles are sometimes considered to be nuisance organisms because they foul boats, machinery, pilings, and seawalls so that their movement upstream into historically freshwater reaches of rivers is significant. Oysters do best in mesohaline and lower polyhaline (10 to 28 ppt, Wilson et al. 2005) zones that exclude their marine predators such as the oyster drill. Both organisms enrich the estuarine community by filtering the water and by providing habitat and food resources used by other invertebrates and fish.

1.1 Geographic Setting

The Chassahowitzka River system is located mostly in southwestern Citrus County, Florida, and parts of some of its southernmost tributaries occur within in northwestern Hernando County (Figure 1). The main stem of the river flows approximately 9 km from a series of springs westward to the Gulf of Mexico (Figure 2). Tributary creeks that contribute spring flow to the river include Baird Creek, Crab Creek, Salt Creek, Potter Creek, Crawford Creek, and Ryle Creek.

The surface drainage for the Chassahowitzka encompasses 230 km^2. In addition to the above-mentioned creeks, other named marsh drainage creeks within the study area include Johnson, Lone Cabbage, and Twin Creek along the southern shoreline, and Stevenson Creek on the north shoreline (Figure 2). Gator Creek breaks off of the Chassahowitzka River main stem at approximately RKm 4.5 and rejoins the river further downstream at approximately RKm 3.5. Little Gator Creek connects Gator Creek to the main stem near RKm 3.0.

The Homosassa River system is located within Citrus County and is approximately 10 km north of the Chassahowitzka River. Like the Chassahowitzka River, the Homosassa River is spring-fed, originating from three Main Springs (1, 2, and 3). The river flows approximately 13 km downstream from its source to the Gulf of Mexico near Shell Island (Figure 3).

The surface water drainage basin of the Homosassa River consists of over 144 km^2; however, the spring shed extends over 699 km^2 (Knochenmus and Yobbi 2001). The Halls River is a spring-fed tributary to the Homosassa River joining the river approximately 2 km downstream. The Halls River is approximately 5 km long (Figure 3). Other tributaries of the Homosassa include Price Creek and Salt River to the north, and Battle and Petty Creeks to the south. Battle and Petty Creeks join to form Mason Creek connecting these three creeks to the Gulf, south of the mouth of the Homosassa River. Salt River connects the Homosassa River system to the Crystal River system to the north and to the Gulf of Mexico through other connecting tidal creek systems.

The Withlacoochee River originates in the Green Swamp and flows approximately 257 km through eight counties discharging into the Gulf of Mexico near Yankeetown, Florida. The Withlacoochee River derives most of its flow from drainage, although springflow from the Rainbow River discharges into the Withlacoochee River near Dunnellon. The Lower Withlacoochee River is confined to a section of the river starting near the downstream end of the Bypass Channel at the Inglis Spillway where it discharges water from Lake Rousseau to the lower river. The lower river continues downstream 15 km to the river's mouth where it meets the Gulf of Mexico (Figure 4). The RKm designations were provided by the District and start at RKm 15 at the Inglis Spillway and end at RKm 0 near the mouth of the river. The assessment area includes the main stem of the river, Bennetts Creek, and the area around Chambers Island and out into the Gulf of Mexico approximately 1 km (Figure 4).

Historical alterations in the 2,100-acre Withlacoochee watershed started in the 1800's. Impacts to the system include logging, ranching, mining, and navigation alterations. The section of the river from the Inglis Spillway to the Gulf of Mexico is a mostly natural channel, tidal, characterized by low relief, and contains limestone outcrops.

The District has modeled surface salinity in the Chassahowitzka and Homosassa Rivers to aid in the interpretation of data collected in this assessment. Appendix Figures J-1 and J-2 show aerials depicting an output of the salinity models for the Homosassa and the Chassahowitzka Rivers showing the surface water salinities averaged over the last 3 years to help define the location of freshwater (< 0.5 ppt), oligohaline (0.5 to < 5 ppt), and mesohaline (5 to 18 ppt) areas of the rivers.

The oligohaline sections of the Chassahowitzka River occur from the headwaters to near RKm 5 (Appendix Figure J-1). The remaining parts of the main stem of the river are in the mesohaline zone to RKm 1 except for the creeks which generally conform to the zone in which they connect to the river. One exception is Crawford Creek, which is oligohaline upstream and mesohaline downstream. In the main stem of the Homosassa River there is a short freshwater zone that transitions to oligohaline at RKm 12.6 and extends to near RKm 7. The rest of the main stem of the Homosassa River is in the mesohaline zone. The Battle/Petty/Mason Creeks area is also in the mesohaline zone. There is no comparable salinity model for the Lower Withlacoochee River.

The United States Geological Survey (USGS) and the District operate continuous conductivity, temperature, and depth (CTD) data recording stations on all three rivers. With the exception of the District station (SWFWMD Citrus 2 on the Withlacoochee River) CTD data is available for the USGS stations for many years prior to 2018. However, continuous CTD data collection for the District station began, on January 20, 2018. At the time of this report, the District station data presented is not finalized and is considered provisional.

There are four USGS stations on the Chassahowitzka River (Figure 2). These include USGS Station 02310650 near RKm 8.7, USGS Station 02310663 near RKm 5.1, USGS Station 02310673 near RKm 2.4, and USGS Station 02310674 near RKm 0.7.

For the Homosassa River system, there are two USGS stations on the Halls River and two USGS stations on the Homosassa River (Figure 3). For the Halls River these include USGS Station 02310689 near RKm HL-3.2 and USGS Station 02310690 near RKm HL-1.4. On the Homosassa River, these include USGS Station 02310700 near RKm 8.9 and USGS Station 02310712 near RKm 0.0.

The Lower Withlacoochee River has one USGS station and one District station (Figure 4). The District Station (SWFWMD Citrus 2) is located near RKm 5.5. The USGS Station (02313272) is downstream of the river mouth and is located near RKm 0.4.

The tides associated with the three rivers are semidiurnal and unequal ranging from 0.6 to 1.4 m (Wolfe et al. 1990). However, the shallow tidal systems are strongly affected by wind direction, particularly wind coming from the southwest, which pushes water into the higher reaches of the rivers.

The climate of the area is humid subtropical. The presence of the Gulf of Mexico moderates both high and low temperatures. Rainfall averages 54 inches annually with highest rainfall in occurring June through September (Leeper et al. 2012).

1.2 Comparisons to Previous Studies

1.2.1 Oysters

Previous oyster studies exist for the Springs Coast rivers and estuaries on Florida's west coast. Table 1 summarizes the historic ecological assessments and their comparability with the current work described in this report. The Withlacoochee River oysters have been studied the most (Sprinkel 1986; SWRF and Dooris 2009; Estevez 2011). The Chassahowitzka has one mollusc study characterizing some oyster growth parameters (Estevez 2007) and to a limited extent, oyster distribution. Whereas the Homosassa, has been studied the least, with only limited oyster bar mapping conducted (Water & Air 2010).

<u>Chassahowitzka River</u>

In 2007, Estevez conducted a study on the molluscs (including oysters) of the Chassahowitzka River to identify downstream patterns of species dispersion. Estevez established transects that cross the river perpendicular to flow at every kilometer from 0 to 5 RKm, with five subtidal, petite ponar samples collected at evenly spaced locations on each transect. Intertidal areas were sampled on the adjacent river banks using a spade, or petite ponar (where wading not possible) along with some hand collection of rarer molluscs. Oyster density, height, and percentage of live oysters was determined (Table 1).

Table 1. Previous ecological work on oysters and barnacles in study area (Mollusc studies included oysters. AFDW = ash free dry weight)

Author/Date	River	Topic	Mapping	Density	Size	Percent Live	Biomass	Oyster Condition Index	Methods and Differences
Sprinkel 1986	Withlacoochee	oysters		X	height	X		X	Selected 3 oyster bars- offshore, inshore and mid (only inshore and mid stations comparable); density based on surface counts only, quarterly samples for 2 years
Estevez 2007	Chassahowitzka	molluscs		X	height	X			Density based on surface counts only
SWRF and Dooris 2009	Withlacoochee	oysters	X	X	height	X			Mapped oyster bars with GPS throughout their study area; Density based on surface counts only
Estevez 2011	Withlacoochee	molluscs		X	height	X			
Water & Air 2010	Homosassa	molluscs	X						Mapping on mainstem of river only
Water & Air 2018 (this study)	Chassahowitzka, Homosassa, Halls, Withlacoochee	oysters	X	X	height	X		X	Mapped up to 50 intertidal oyster bars; density determined using Baggett et al. 2014
Culter 2010	Homosassa, Halls, Withlacoochee	barnacles	X	X	basal diameter	X	AFDW		Intertidal and subtidal data make comparisons difficult; *in situ* collections and growth plates. Only growth plate barnacles had AFDW
Water & Air 2018 (this study)	Chassahowitzka, Homosassa, Halls, Withlacoochee	barnacles	X	X	basal diameter	X	AFDW		Intertidal only; *in situ* collections

Homosassa River

Water & Air characterized the molluscs of the Homosassa River using methods similar to Estevez (2007) previously summarized, however, no oysters were collected on the transects. Oyster bars were mapped along the main stem of the Homosassa River near the mouth.

Withlacoochee River

In 1984 and 1985 Mote Marine Laboratory conducted ecological studies on oysters and oyster reefs associated with five Florida west coast estuaries including the Withlacoochee River to determine the effects of river flow and resulting salinities on oysters (Sprinkel 1986). Three oyster bars near the Withlacoochee River mouth were selected for study, a nearshore, middle, and an offshore reef location (Sprinkel 1986). Two of these stations (nearshore and middle) are in the oyster assessment area as defined for Water & Air's current work. Oyster parameters assessed by Sprinkel include all parameters also evaluated by Water & Air: density, percent live, height, and CI (Table 1). However, Sprinkel's oyster density was determined by counts of only surface oysters within the quadrat, differing from the current work that used the methods described by Baggett et al. (2014) which excavate through the oyster profile within the quadrat and count oysters in all living layers of oyster.

SWRF, LLC and Dooris & Associates, LLC. (2009) mapped oyster bars on the Withlacoochee River and characterized oysters including density, height, and percent live. Their measurement of oyster density was conducted similar to Sprinkel's (1986) methods, thus, density comparisons with Water & Air's work in this study are only marginally useful due to differing methods.

More recently, Estevez (2011) conducted a study of the molluscs of the Withlacoochee River to identify downstream patterns of species dispersion. Using nearly identical methods to that used on the Chassahowitzka River, he used transects to collect molluscs every kilometer from 0 to 5 RKm. Along each transect, five subtidal, petite ponar samples were collected at "evenly spaced" spots. Intertidal areas were sampled using a spade, or petite ponar (where wading not possible) and some hand collection of rare or cryptic species molluscs. Density of oysters, height of oysters, and percentage of live oysters was determined (Table 1).

1.2.2 Barnacles

A study of barnacles was conducted on the Homosassa, Halls, and Withlacoochee Rivers in 2008 and 2009 (Culter 2010). The work evaluated the species present, proportion of live to dead barnacles, size range, and upstream extent along existing hard substrates on the rivers. Culter collected barnacles from eight locations along the Homosassa (seven samples) from RKm 9.35 to 12.7 and Halls River (one sample) at RKm 0.4. On the Withlacoochee River, two barnacle collections were made at RKm 3.1 and 5.0. The Water & Air evaluation allows some comparisons with data collected almost a decade earlier. However, it should be noted that Culter's work included a survey of both intertidal and subtidal oysters, whereas this work looked only at intertidal barnacles. Comparisons were not made with barnacles from growth plates put into the river as part of this work (Culter 2010).

2.0 Methods

2.1 Salinity Methods

Daily specific conductance (SC) values (µS/cm at 25 °C) for the time period February 1, 2017 to April 30, 2018 were obtained from the USGS website (https://waterdata.usgs.gov/nwis/qw) for each of the USGS continuous recorder water monitoring stations and converted to salinity values using the equation Salinity = 0.0006 x (SC – 0.292) (Water & Air Research, Inc. 1994). The District provided daily 15-minute continuously-recorded salinity values for the time period January 20, 2018 to August 29, 2018 from the Citrus 2 water monitoring station on the Withlacoochee River. At the time of this report, this data was provisional. This data was summarized to daily values for the time period February 1, 2017 to April 30, 2018. Descriptive tables of average monthly salinity, standard deviation, and number were produced for each USGS and the District water monitoring station. Scatter plots of daily salinity for the time period February 1, 2017 to April 30, 2018 were produced for each USGS and the District water monitoring station. Daily total precipitation (inches) for the time period February 1, 2017 to April 30, 2018 was obtained from the Florida Automated Weather Network (FAWN) (https://fawn.ifas.ufl.edu/data) Lecanto, Florida station. A scatter plot of daily total precipitation for the time period February 1, 2017 to April 30, 2018 was produced for the Lecanto station. Based on the optimal salinity for growth and reproduction of *Crassostrea virginica* being between 10 to 28 ppt (Wilson et al. 2005), the number of days and percent exceedance when the daily salinity value was less than 10 ppt or greater than 28 ppt was calculated at the water quality stations from February 1, 2017 to April 30, 2018.

2.2 Oyster Mapping

The locations of up to 50 oyster bars and other oyster aggregations (per scope of work) were mapped for each river (Figures 5, 6, and 7). The assessment areas within which the oyster areas were to be mapped for each river were provided by the District in ESRI shapefile format (Figures 2, 3, and 4).

Of highest mapping priority, were oyster bars occurring on or in close proximity to the main stem of a given river. Oyster bars were defined as an area of contiguous, dense live oyster clusters and/or remnant oyster shell bars with live clusters larger than 4.57 meters by 4.57 meters (15 feet by 15 feet) in size. However, in lieu of oyster bars near the main river stem, other oyster areas were mapped. Those included linear shoreline areas with either scattered oyster clusters or oyster-encrusted rock of at least 9.14 meters (30 feet) in length.

Initially, high resolution aerial photographic imagery (Google 2018) was used to perform an aerial photographic interpretation (API) of the assessment areas to identify possible oyster bars. Multiple years' imagery was used to perform this task given the variability of image quality (tide stage, water clarity, etc., when the aerial was taken) as it relates to identifying oyster bars. For each potential oyster bar occurrence, a center point latitude and longitude were recorded for the approximate center of the bar. They were then digitally mapped, uniquely numbered and uploaded to a tablet running mobile GIS software.

Suspected oyster bars were located by a Water & Air field team using a GPS-capable tablet operating out of an airboat, generally on a falling or low tide. The field team verified oyster bar locations, collected field data, and added or deleted oyster bars from the API list based on condition and proximity to the main stem of the river. Once verified, the oyster bars were field-truthed for location. Field data including shape and size, vegetation presence, and estimated percentage of live reef area were collected on a field sheet.

However, for some rivers, oyster bars near the main river stem were scarce. In these instances, other oyster areas such as scattered oyster clusters and oyster-encrusted rocks along the shoreline were mapped. These areas were located by visual inspection by the field team and not identified through API. Mapping for these oyster areas was conducted by collecting GPS points at either end of the linear shoreline extent covered by oyster growth.

The field data sheets were compiled in an Excel spreadsheet. Mapped oyster area location data were imported from the tablet into a GIS program. Center point data collected in the field was verified against the original API data for oyster bars. Polygons were then adjusted or drawn for all mapped oyster bars. Mapped shoreline oyster areas were overlaid on aerial imagery used to produce the API oyster bar data. Polylines were drawn along the linear extent of the shoreline oyster areas. A center point latitude and longitude were then recorded for the approximate center of the oyster area and uniquely numbered.

It should be noted that Homosassa River oyster areas exceeded 50 oyster bar locations, the maximum specified by the District for inclusion (Figure 6). Therefore, some smaller oyster areas in the Homosassa River were not mapped or included in the total for the river. Mapping efforts on the Homosassa River began on March 22, 2018 and concluded on March 23, 2018.

The Lower Withlacoochee River exceeded 50 oyster area locations as well (Figure 7). However, unlike the Homosassa River, the Lower Withlacoochee River contained a mix of oyster bars and other oyster growth areas including scattered oyster clusters and oysters attached to rocky shoreline features. Mapping efforts on the Lower Withlacoochee River began on March 29, 2018 and concluded on April 20, 2018.

Overall, the Chassahowitzka River had relatively small number of oyster area locations. A total of 10 oyster bars and other oyster areas were identified throughout its assessment area (Figure 5). Mapping efforts on the Chassahowitzka River began on February 21, 2018 and concluded on April 2, 2018.

2.3 Field Sample Collections for Oysters

Based on our initial field reconnaissance of the area, both the District and Water & Air agreed on general locations where oysters would be sampled. The focus was to spread sampling over three geographic sampling groups based on concentrations of oyster areas within each unique river system. Water & Air collected three to five oyster samples from three distinct areas, per river. In areas where oyster bars were located, they were sampled preferentially over scattered shoreline oyster clusters or oyster-encrusted rocks. Oyster areas closest to the main stem river channels were preferentially sampled. Assessments were made consistent with standard monitoring methods (Baggett et al. 2014).

The sample areas for the Chassahowitzka River listed from upstream to downstream are: RKm 5 to 4 (Group A), RKm 3 to 2 (Group B), and RKm 2 to 1 (Group C) (Figure 8). Three samples were collected per sampling group. A total of nine samples were collected on five oyster bars and four shoreline oyster areas. Oyster samples were collected on the Chassahowitzka River the days of March 27 and April 2, 2018.

For the Homosassa River these areas include the Petty, Battle, and Mason Creeks area (Group A), RKm 3 to 2 (Group B), and RKm 2 to 1 (Group C) (Figure 9). Three samples were collected per sampling group. All nine samples were collected on oyster bars. Oyster samples were collected on the Homosassa River the days of March 22, 23, and 28, 2018.

For the Lower Withlacoochee River, samples were collected from three areas on the river, listed from upstream to downstream; RKm 2 to 1 (Group A), RKm 1 to 0 (Group

B), and RKm 0 to -1 (Group C) (Figure 10). Four samples were collected per sampling group, with the exception of Group C. At one large oyster bar on the Lower Withlacoochee River, two quadrats (approximately 68 m apart) were collected from the bar, resulting in five samples for Group C. Therefore, a total of 13 samples were collected from 5 oyster bars and 8 shoreline oyster areas. Oyster samples were collected on the Withlacoochee River the days of March 29 and April 19, 20, and 21, 2018.

Sample collection of oysters was generally conducted during a falling or low tide. Sampling of oyster bars began by placing a 0.5 meter by 0.5 meter (0.25 m^2) PVC quadrat staked with rebar at a haphazard location on the bar. Oyster density per 0.25 m^2 was determined by counting all oysters with both valves attached within the quadrat. The live percentage of oysters was calculated by opening the bivalve of at least 25 oysters within the quadrat. The live percentage was used to determine the number of oyster to collect in order to obtain at least 25 live oyster samples for processing in the laboratory.

In some instances, requisite number of bars could not be found within the sample group areas. In those cases, collections were made from scattered shoreline oyster clumps. Therefore, density could not be determined for those non-continuous areas of oysters due to the patchy occurrence of oyster clusters. For each of these oyster clump areas, collection of oysters from an area larger than the 0.25 m^2 quadrat was necessary to obtain the appropriate number of samples for a live percent determination and for processing in the laboratory. This occurred at some locations on the Lower Withlacoochee and Chassahowitzka Rivers. All nine samples on the Homosassa River were collected from oyster bars.

Samples were bagged, labeled, and transported, on ice, during the same day of collection to Water & Air's laboratory and stored in a refrigerator overnight. Upon arrival of the samples at the lab, the chain of custody (COC) was signed and dated (with time) by the receiving person.

2.4 Laboratory Procedures for Oyster Samples

Oldest samples (those collected first in the field) were processed first. Bagged oysters were dumped into a metal sieve with 0.50-inch mesh and rinsed with tap water and placed in a clean bucket. From the bucket 25 individuals were selected, assigned a specimen number, and processed. The measurements for each oyster were recorded on a bench sheet according to specimen number. Because oysters were often attached to other oysters, clusters were broken up as carefully as possible and damaged specimens were not used. The shells of specimens to be used were blotted dry and barnacles, mussels, common jingles (*Anomia simplex*) and other encrusting organisms were removed with pliers or an oyster knife. A toothbrush or wire brush was used to remove fouling algae or other soft organisms from the surface of the shell if needed. Clean and dry oysters were measured (height in mm, Baggett et al. 2014) with calipers and then placed whole on the scale (Mettler-Toledo© PM-100) and weighed to the nearest 0.001 gram and recorded as whole wet weight (WWW). After WWW was recorded, specimens were opened using an oyster knife and the tissue was removed and placed into labeled aluminum weighing dishes to be dried. Care was taken to remove any shell fragments from the tissue. The shell valves (and any loose fragments) were blotted dry and placed in a tared weigh dish on the scale. This measurement was recorded as shell wet weight (SWW). Oyster tissue was dried for at least 48 hours at 60° C until it reached a constant weight. When dry, tissue was placed in a tared plastic (anti-static) weighing dish on the scale recorded as tissue dry weight (TDW).

The equation for oyster CI used for this report was taken from Baggett et al., 2014 and produces higher values for individuals with more meat (tissue) potentially reflecting better environmental/growing conditions. The denominator (WWW-SWW) represents the internal shell cavity capacity.

$$CI = (TDW \times 100)/(WWW-SWW)$$

Oyster heights are not part of this equation and represent a separate measurement of oyster size which also provide information about oyster growth and survivorship (Baggett et al. 2014).

2.5 Field Collection of Barnacles

On each river, barnacles were visually searched for on existing hard substrata. The search area was typically narrowed to within 0.2 km upstream and downstream of each RKm. However, barnacles were searched for outside of that area if no suitable substrate was found within that 0.4 km zone. Substrata where barnacles were surveyed included both natural and man-made substances. Examples of locations surveyed include both concrete and wooden navigation aids, signs, docks, seawalls, and tree trunks. Only intertidal or shallow subtidal areas were searched visually from the boat or by walking along the shoreline at low to mid tide.

Locations with suitable substrate were located and recorded with a GPS, regardless of barnacle presence (Figures 11, 12, and 13). This includes the locations where barnacles were sampled, where barnacles were not present and where barnacles were present but were unsampleable. Examples of unsampleable locations included barnacles growing on oyster-encrusted navigational aids and barnacles visibly growing in deeper, subtidal areas on dock pilings.

Sampling of barnacles began by placing a quadrat, made of thick plastic sheeting with a 10 cm by 10 cm opening, over the area to be sampled. The quadrat was secured to the substrate by either bungee cords or duct tape. The barnacles present within the quadrat were then counted and assessed for being alive or dead by probing the barnacle opening for intact opercular plates. Next, the basal diameter of 25 random barnacles were measured with calipers and recorded.

Once the data were collected, the area within the quadrat was gently cleaned with a soft brush to remove attached algae and other miscellaneous organisms, scraped with a metal scraper/putty knife to remove the barnacles from the substrate. Scraped barnacles were collected in a fine net below the quadrat.

Samples were bagged, labeled, and transported, on ice, during the same day of collection to Water & Air's laboratory. Upon arrival of the samples at the lab, the COC was signed and dated (with time) by the receiving person.

2.6 Laboratory Procedures for Barnacle Samples

Upon receipt of samples at Water & Air, the samples were removed from the cooler with ice and placed in a freezer at -18°C to hold the samples for shipment to the laboratory, ALS Environmental (ALS). Samples were stored at -18 C until shipment. Once all the samples were collected, they were prepared for shipment to ALS to be muffled. The COC form was completed with all the sample documentation listed. Frozen samples were placed in a cooler with ice and shipped to ALS overnight. Sample receipt was verified with ALS. Data from loss on ignition procedure (at 400°C) were returned to Water & Air electronically in PDF and Excel form.

2.7 Statistical Methods

Statistical analyses were conducted in MINITAB version 16.2.4 and JMP version 14. Data were tested for normality and equality of variances.

Oyster Sample Analyses

Data were not normally distributed for any of the rivers, thus the non-parametric Mann-Whitney test was used to test for significant differences of the medians between oyster sampling groups (based on presumed salinity) within each river. Field-collected variables tested for differences between sampling groups were: total number of oysters, percentage of live oysters, and estimated percent of oyster bar made up of live oysters. Laboratory measures of oyster samples tested for differences between sampling groups were: height and CI.

The nonparametric Spearman's rank correlation test was used to determine correlations between measured lab and field variables and river kilometer.

Results of all statistical tests were considered significant at the $p \leq 0.05$ level.

Barnacle Sample Analyses

Data were not normally distributed for any of the rivers, thus, medians for barnacle field and laboratory measures in two river salinity zones (oligohaline or mesohaline based on 3-year average salinity models for the Chassahowitzka and Homosassa) were tested for significant differences using the Mann-Whitney test. Field-collected variables tested were: density of barnacles (number per quadrat), number of live barnacles, percentage of live barnacles, and barnacle diameter. Laboratory-collected variables tested were: the total dry weight of the sample and the percent organic matter. The Halls River consisted of only one salinity zone (oligohaline) based on the model (in combination with the Homosassa) and no salinity model was available for the Lower Withlacoochee River, so no Mann-Whitney tests were run on data from these rivers.

The nonparametric Spearman's rank correlation test was used to determine correlations between measured lab and field variables and river kilometer. These tests were run on the data from all four rivers.

Results of all statistical tests were considered significant at the $p \leq 0.05$ level.

3.0 Results

3.1 Salinity Results

3.1.1 Chassahowitzka River

At the USGS Station 02301650 Chassahowitzka River near Homosassa, Florida average monthly salinity values from water bottom recordings ranged from a maximum of 5.59 ppt to a minimum 0.61 ppt (Table 2). At the USGS Station 02310663 Chassahowitzka River near Chassahowitzka, Florida average monthly salinity values from water bottom recordings ranged from a maximum of 14.75 ppt to a minimum 2.65 ppt (Table 3). At the USGS Station 02310673 Chassahowitzka River near Dog Island average monthly salinity values from water top recordings ranged from a maximum of 18.33 ppt to a minimum 5.40 ppt, and from water bottom recordings ranged from a maximum of 18.84 ppt to a minimum 5.33 ppt (Table 4). At the USGS Station 02310673 Chassahowitzka River near mouth average monthly salinity values from water top recordings ranged from a maximum of 20.36 ppt to a minimum 7.29 ppt, and from water bottom recordings ranged from a maximum of 19.85 ppt to a minimum 7.01 ppt (Table 5).

Table 2. Mean bottom recording salinity (ppt) summarized by month and year at USGS Station 02310650 Chassahowitzka River near Homosassa, Florida.

		Bottom								
Date	N	Maximum			Mean			Minimum		
2017										
Feb	28	4.03	±	0.19	1.70	±	0.21	1.04	±	0.06
Mar	31	3.79	±	0.60	1.67	±	0.35	1.08	±	0.10
Apr	30	4.61	±	0.23	2.35	±	0.31	1.38	±	0.14
May	31	5.17	±	0.32	2.76	±	0.25	1.70	±	0.18
Jun	30	5.59	±	0.34	2.94	±	0.22	1.89	±	0.12
Jul	31	5.49	±	0.28	2.68	±	0.13	1.67	±	0.14
Aug	31	5.26	±	0.29	2.44	±	0.29	1.31	±	0.15
Sep	30	3.89	±	0.86	1.72	±	0.35	0.90	±	0.20
Oct	31	2.92	±	0.38	1.14	±	0.31	0.61	±	0.05
Nov	30	2.95	±	0.21	1.11	±	0.20	0.67	±	0.05
Dec	31	3.11	±	0.41	1.25	±	0.20	0.80	±	0.04
2018										
Jan	31	2.61	±	0.87	1.12	±	0.18	0.82	±	0.05
Feb	28	3.38	±	0.30	1.35	±	0.14	0.86	±	0.04
Mar	31	3.84	±	0.27	1.76	±	0.25	1.02	±	0.09
Apr	30	4.39	±	0.29	1.95	±	0.28	1.16	±	0.05

Table 3. Mean bottom recording salinity (ppt) summarized by month and year at USGS Station 02310663 Chassahowitzka River near Chassahowitzka, Florida.

		Bottom								
Date	N	Maximum			Mean			Minimum		
2017										
Feb	28	8.54	±	2.71	4.66	±	0.93	3.20	±	0.09
Mar	31	9.13	±	3.43	5.18	±	1.86	3.12	±	0.30
Apr	30	14.05	±	2.73	8.86	±	2.04	4.17	±	0.60
May	31	14.75	±	2.95	9.96	±	2.26	5.24	±	1.57
Jun	30	14.02	±	2.35	9.18	±	1.50	4.91	±	0.64
Jul	31	11.38	±	2.11	6.55	±	0.81	4.16	±	0.22
Aug	31	10.55	±	2.82	6.05	±	1.28	3.81	±	0.48
Sep	30	8.28	±	1.86	4.53	±	0.80	2.96	±	0.60
Oct	31	10.59	±	4.03	6.58	±	2.46	3.42	±	0.96
Nov	30	10.76	±	3.62	6.53	±	2.17	3.07	±	0.43
Dec	31	9.19	±	3.10	4.99	±	1.37	2.94	±	0.21
2018										
Jan	31	7.33	±	2.87	3.91	±	0.87	2.65	±	0.10
Feb	28	8.19	±	2.06	4.17	±	0.59	2.81	±	0.11
Mar	31	12.44	±	3.54	7.06	±	2.18	3.47	±	0.43
Apr	30	12.54	±	3.87	7.45	±	2.48	3.84	±	0.62

Table 4. Mean top and bottom recording salinity (ppt) summarized by month and year at USGS Station 02310673 Chassahowitzka River at Dog Island.

		Top			Bottom		
Date	N	Maximum	Mean	Minimum	Maximum	Mean	Minimum
2017							
Feb	28	14.68 ± 1.64	9.78 ± 1.26	6.14 ± 0.75	14.50 ± 1.67	9.75 ± 1.26	6.29 ± 0.77
Mar	31	15.32 ± 2.10	10.77 ± 2.18	7.06 ± 1.77	15.10 ± 2.29	10.72 ± 2.20	7.21 ± 1.85
Apr	30	17.60 ± 1.74	13.75 ± 1.92	10.01 ± 1.88	17.72 ± 1.72	13.93 ± 1.90	10.30 ± 1.89
May	31	18.33 ± 1.73	14.75 ± 1.84	10.70 ± 1.88	18.84 ± 1.65	15.26 ± 1.77	11.27 ± 1.86
Jun	30	17.07 ± 1.35	13.60 ± 1.31	9.92 ± 1.22	17.80 ± 1.40	14.26 ± 1.35	10.57 ± 1.21
Jul	31	14.49 ± 1.04	10.96 ± 0.93	7.74 ± 0.71	14.98 ± 1.08	11.38 ± 0.96	8.17 ± 0.83
Aug	31	13.72 ± 1.14	10.11 ± 1.51	7.14 ± 1.62	14.17 ± 1.14	10.41 ± 1.54	7.41 ± 1.62
Sep	30	11.76 ± 1.48	8.25 ± 1.44	5.53 ± 1.39	11.65 ± 1.70	8.15 ± 1.49	5.46 ± 1.48
Oct	31	14.24 ± 2.56	10.77 ± 2.46	7.50 ± 2.08	14.30 ± 2.53	10.82 ± 2.42	7.56 ± 2.07
Nov	30	15.43 ± 2.08	11.17 ± 2.16	7.15 ± 1.56	15.61 ± 2.07	11.31 ± 2.14	7.34 ± 1.64
Dec	31	13.71 ± 1.65	9.60 ± 1.70	6.14 ± 1.19	13.97 ± 1.67	9.81 ± 1.70	6.36 ± 1.20
2018							
Jan	31	13.94 ± 1.78	8.97 ± 1.31	5.40 ± 0.69	13.01 ± 2.85	8.48 ± 1.74	5.33 ± 0.84
Feb	28	13.06 ± 1.24	8.80 ± 0.99	5.49 ± 0.60	13.22 ± 1.28	8.96 ± 0.99	5.68 ± 0.61
Mar	31	16.69 ± 2.57	12.27 ± 2.47	8.19 ± 1.90	17.12 ± 2.75	12.65 ± 2.57	8.64 ± 1.94
Apr	30	16.87 ± 2.37	12.57 ± 2.19	8.34 ± 1.75	17.43 ± 2.50	13.06 ± 2.32	8.88 ± 1.88

Table 5. Mean top and bottom recording salinity (ppt) summarized by month and year at USGS Station 02310674 Chassahowitzka River.

		Top			Bottom		
Date	N	Maximum	Mean	Minimum	Maximum	Mean	Minimum
2017							
Feb	28	16.31 ± 1.44	12.24 ± 1.20	8.28 ± 0.94	16.23 ± 1.42	12.29 ± 1.15	8.46 ± 0.85
Mar	31	17.08 ± 1.90	13.30 ± 2.00	9.47 ± 1.89	16.79 ± 1.83	13.17 ± 1.90	9.52 ± 1.73
Apr	30	19.45 ± 1.56	16.20 ± 1.72	12.82 ± 1.90	18.93 ± 1.50	15.85 ± 1.63	12.74 ± 1.80
May	31	20.36 ± 1.63	17.31 ± 1.50	13.77 ± 1.78	19.85 ± 1.56	17.03 ± 1.39	13.91 ± 1.55
Jun	30	19.08 ± 1.19	16.29 ± 1.09	13.08 ± 1.13	18.64 ± 1.17	16.07 ± 1.08	13.30 ± 1.18
Jul	31	16.19 ± 0.93	13.31 ± 0.85	10.20 ± 0.85	15.97 ± 0.91	13.22 ± 0.79	10.32 ± 0.79
Aug	31	15.77 ± 0.90	12.59 ± 1.17	9.45 ± 1.65	15.24 ± 0.84	12.29 ± 1.07	9.49 ± 1.54
Sep	30	13.31 ± 1.83	10.04 ± 1.73	6.89 ± 2.06	12.87 ± 1.71	9.80 ± 1.63	7.01 ± 1.77
Oct	31	15.77 ± 2.10	12.86 ± 2.06	9.64 ± 1.99	15.64 ± 2.10	12.86 ± 2.02	9.86 ± 1.96
Nov	30	17.36 ± 1.81	13.77 ± 1.92	9.70 ± 1.87	17.35 ± 1.79	13.90 ± 1.87	10.14 ± 1.85
Dec	31	15.57 ± 1.32	11.98 ± 1.47	8.44 ± 1.36	15.50 ± 1.34	11.94 ± 1.47	8.50 ± 1.39
2018							
Jan	31	15.42 ± 2.05	11.17 ± 1.82	7.29 ± 1.14	14.88 ± 2.21	10.82 ± 1.86	7.13 ± 1.13
Feb	28	14.74 ± 1.06	11.17 ± 0.90	7.56 ± 0.76	14.48 ± 0.90	11.03 ± 0.85	7.52 ± 0.77
Mar	31	18.36 ± 2.54	14.56 ± 2.45	10.64 ± 2.07	18.32 ± 2.53	14.58 ± 2.42	10.83 ± 1.98
Apr	30	18.59 ± 2.09	14.99 ± 2.01	11.10 ± 1.88	18.49 ± 2.14	14.96 ± 2.01	11.37 ± 1.80

There was a decreasing salinity gradient from the USGS station near mouth (total mean top water salinity 13.47 ppt and bottom water salinity 13.33 ppt) compared to the upper river station near Chassahowitzka, Florida (total mean bottom water salinity 6.39 ppt). This salinity gradient corresponds with the different oyster biological sampling sites with Group A associated with lower salinity, Group B with moderate salinity, and Group C with higher salinity (Figure 8).

Maximum daily salinity values occurred in May and June 2017 and March and April 2018, while minimum daily salinity values occurred in September and October 2017. (Figures 14 through 19). Local precipitation is documented in Figure 20.

Based on the optimal salinity for growth and reproduction of *Crassostrea virginica* being between 10 to 28 ppt, the number of days and percent exceedance when the daily salinity value was less than 10 ppt or greater than 28 ppt was calculated at the water quality stations from February 1, 2017 to April 30, 2018. The number of days that salinity was less than 10 ppt increased from the river mouth (32 days and 7.06 percent at mean water top recordings, and 39 days and 8.63 percent at mean water bottom recordings) to the upper river station near Chassahowitzka, Florida (409 days and 90.29 percent at mean water bottom recordings) (Table 6). There were no days when salinity was greater than 28 ppt at the four water quality stations (Table 7). These results correspond with the decreasing salinity gradient from the river mouth to the upper river segment.

3.1.2 Homosassa River

At the USGS Station 02310689 Halls River near Homosassa Springs, Florida average monthly salinity values from water bottom recordings ranged from a maximum of 6.23 ppt to a minimum 2.67 ppt (Table 8). At the USGS Station 02310690 Halls River near Homosassa, Florida average monthly salinity values from water bottom recordings ranged from a maximum of 6.51 ppt to a minimum 1.86 ppt (Table 9). At the USGS Station 02310700 Homosassa River near Homosassa, Florida average monthly salinity values from water top recordings ranged from a maximum of 10.99 ppt to a minimum 2.59 ppt, and from water bottom recordings ranged from a maximum of 11.96 ppt to a minimum 2.11 ppt (Table 10). At the USGS Station 02310712 Homosassa River near Shell Island average monthly salinity values from water top recordings ranged from a maximum of 25.24 ppt to a minimum 10.49 ppt, and from water bottom recordings ranged from a maximum of 24.91 ppt to a minimum 10.77 ppt (Table 11).

Table 6. Percent of days when daily salinity value was less than optimal 10 ppt at the water quality stations from 02/01/2017 to 04/30/2018.

	Top			Bottom		
Site	Maximum	Mean	Minimum	Maximum	Mean	Minimum
02310674 Chassahowitzka River at river mouth	0.44	7.06	56.51	0.66	8.63	54.20
02310673 Chassahowitzka River at Dog Island	0.69	38.48	85.48	2.24	35.87	81.61
02310663 Chassahowitzka River near Chassahowitzka, FL	n/a	n/a	n/a	46.14	90.29	99.78
02310712 Homosassa River at Shell Island	0.22	0.89	9.80	0.22	0.88	9.51
02310700 Homosassa River at Homosassa, Florida	83.76	98.35	99.76	76.94	96.45	99.56
02313272 Withlacoochee River at Chambers Island	0	0.44	84.44	0	0.23	71.17

Table 7. Percent of days when daily salinity value was greater than optimal 28 ppt at the water quality stations from 02/01/2017 to 04/30/2018.

	Top			Bottom		
Site	Maximum	Mean	Minimum	Maximum	Mean	Minimum
02310674 Chassahowitzka River at river mouth	0	0	0	0	0	0
02310673 Chassahowitzka River at Dog Island	0	0	0	0	0	0
02310663 Chassahowitzka River near Chassahowitzka, FL	n/a	n/a	n/a	0	0	0
02310712 Homosassa River at Shell Island	0	0	0	0	0	0
02310700 Homosassa River at Homosassa, Florida	0	0	0	0	0	0
02313272 Withlacoochee River at Chambers Island	0.44	0	0	0.92	0	0

Table 8. Mean recording salinity (ppt) summarized by month and year at USGS Station 02310689 Halls River at Homosassa Springs, Florida.

Date	N	Maximum			Mean			Minimum		
2017										
Feb	5	5.59	±	0.07	5.18	±	0.30	4.21	±	0.75
Mar	31	5.54	±	0.50	5.10	±	0.60	4.12	±	0.89
Apr	30	4.50	±	0.39	4.17	±	0.36	3.45	±	0.32
May	31	5.58	±	2.84	4.72	±	1.27	3.93	±	0.68
Jun	30	4.32	±	0.74	4.00	±	0.38	3.59	±	0.50
Jul	31	3.85	±	0.34	3.59	±	0.36	2.85	±	0.48
Aug	31	3.48	±	0.17	3.24	±	0.16	2.67	±	0.38
Sep	30	4.15	±	1.34	3.78	±	1.37	3.01	±	1.28
Oct	31	6.23	±	0.55	5.76	±	0.56	5.15	±	0.99
Nov	30	5.91	±	0.34	5.67	±	0.49	5.11	±	0.75
Dec	31	5.90	±	0.30	5.62	±	0.41	4.79	±	0.86
2018										
Jan	31	6.02	±	0.38	5.73	±	0.43	5.06	±	0.89
Feb	28	6.14	±	0.15	5.78	±	0.32	4.71	±	0.86
Mar	31	5.75	±	0.47	5.12	±	0.67	4.10	±	0.92
Apr	30	5.14	±	0.51	4.69	±	0.36	3.92	±	0.61

Table 9. Mean bottom recording salinity (ppt) summarized by month and year at USGS Station 02310690 Halls River near Homosassa, Florida.

		Bottom								
Date	N	Maximum			Mean			Minimum		
2017										
Feb	28	3.17	±	0.52	2.20	±	0.21	4.59	±	0.70
Mar	31	2.94	±	0.61	1.97	±	0.15	4.17	±	1.03
Apr	30	3.33	±	0.54	2.45	±	0.35	4.46	±	0.89
May	31	4.84	±	2.30	3.46	±	1.17	6.51	±	3.99
Jun	24	3.87	±	1.09	2.89	±	0.57	5.31	±	2.47
Jul	31	2.77	±	0.17	2.27	±	0.14	3.48	±	0.38
Aug	31	2.74	±	0.28	2.26	±	0.23	3.27	±	0.38
Sep	30	2.41	±	0.54	1.86	±	0.35	3.34	±	1.02
Oct	31	3.94	±	0.87	2.82	±	0.64	5.61	±	1.02
Nov	30	3.61	±	0.47	2.55	±	0.28	5.12	±	0.61
Dec	31	3.39	±	0.38	2.34	±	0.19	4.96	±	0.56
2018										
Jan	31	3.49	±	0.61	2.46	±	0.37	5.21	±	0.66
Feb	28	3.36	±	0.41	2.34	±	0.27	4.99	±	0.51
Mar	31	3.34	±	0.57	2.35	±	0.34	4.62	±	1.19
Apr	30	3.36	±	0.80	2.39	±	0.48	4.90	±	2.01

Table 10. Mean top and bottom recording salinity (ppt) summarized by month and year at USGS Station 02310700 Homosassa River at Homosassa, Florida.

		Top			Bottom		
Date	N	Maximum	Mean	Minimum	Maximum	Mean	Minimum
2017							
Feb	28	6.12 ± 2.61	3.65 ± 0.86	2.73 ± 0.24	7.11 ± 3.00	4.17 ± 1.05	3.09 ± 0.37
Mar	31	6.33 ± 2.59	3.82 ± 1.39	2.67 ± 0.42	7.06 ± 2.85	4.31 ± 1.82	2.82 ± 0.54
Apr	30	9.28 ± 2.89	5.52 ± 1.55	3.79 ± 0.81	10.40 ± 3.08	6.56 ± 2.03	4.05 ± 0.98
May	31	10.99 ± 4.16	7.35 ± 3.25	4.94 ± 1.86	11.96 ± 3.82	8.27 ± 3.30	5.25 ± 2.08
Jun	30	9.65 ± 2.74	6.06 ± 1.72	4.21 ± 0.93	10.44 ± 2.61	6.74 ± 2.05	4.14 ± 0.98
Jul	31	7.27 ± 1.75	4.19 ± 0.79	2.74 ± 0.32	7.76 ± 1.92	4.40 ± 1.03	2.69 ± 0.38
Aug	31	7.66 ± 1.99	4.48 ± 0.94	3.02 ± 0.56	8.88 ± 1.98	5.25 ± 1.26	3.26 ± 0.64
Sep	30	3.93 ± 1.54	2.62 ± 0.68	2.08 ± 0.37	4.38 ± 1.78	2.78 ± 0.86	2.11 ± 0.39
Oct	31	6.18 ± 3.05	4.39 ± 1.69	3.41 ± 1.01	6.95 ± 3.16	4.80 ± 2.07	3.51 ± 1.21
Nov	30	5.36 ± 2.19	3.67 ± 0.84	2.95 ± 0.33	6.60 ± 2.57	4.15 ± 1.30	2.95 ± 0.46
Dec	31	4.92 ± 1.53	3.33 ± 0.56	2.72 ± 0.24	5.60 ± 1.94	3.56 ± 0.83	2.67 ± 0.34
2018							
Jan	31	4.41 ± 0.99	3.09 ± 0.34	2.59 ± 0.19	5.04 ± 1.51	3.26 ± 0.55	2.55 ± 0.24
Feb	28	5.17 ± 1.39	3.39 ± 0.56	2.71 ± 0.17	5.50 ± 1.53	3.43 ± 0.61	2.65 ± 0.22
Mar	31	8.52 ± 3.16	5.16 ± 1.71	3.38 ± 0.69	10.02 ± 3.13	6.12 ± 2.25	3.62 ± 0.82
Apr	30	7.65 ± 3.87	4.69 ± 1.85	3.09 ± 0.63	8.48 ± 3.91	5.22 ± 2.24	3.24 ± 0.79

Table 11. Mean top and bottom recording salinity (ppt) summarized by month and year at USGS Station 02310712 Homosassa River at Shell Island.

		Top			Bottom		
Date	N	Maximum	Mean	Minimum	Maximum	Mean	Minimum
2017							
Feb	28	20.97 ± 1.13	17.57 ± 1.45	13.78 ± 1.87	21.01 ± 1.13	17.69 ± 1.39	13.79 ± 1.86
Mar	31	21.29 ± 1.37	17.97 ± 2.29	14.69 ± 2.95	21.14 ± 1.35	17.90 ± 2.20	14.58 ± 2.95
Apr	30	22.59 ± 0.69	20.04 ± 0.81	17.27 ± 1.31	22.38 ± 1.10	19.78 ± 1.35	17.05 ± 1.85
May	31	24.38 ± 1.11	21.58 ± 1.01	18.67 ± 1.46	24.25 ± 1.05	21.51 ± 0.96	18.65 ± 1.41
Jun	30	24.61 ± 1.02	21.89 ± 1.13	18.99 ± 1.38	24.02 ± 0.93	21.40 ± 1.09	18.57 ± 1.37
Jul	31	25.24 ± 0.97	21.78 ± 0.98	18.12 ± 1.12	24.91 ± 0.96	21.56 ± 0.95	17.92 ± 1.13
Aug	31	24.36 ± 1.03	20.70 ± 0.95	16.87 ± 1.56	24.51 ± 1.06	20.95 ± 0.82	17.02 ± 1.41
Sep	30	17.66 ± 2.88	14.22 ± 2.91	10.49 ± 2.90	18.25 ± 2.74	14.71 ± 2.97	10.77 ± 2.98
Oct	31	18.87 ± 1.98	15.82 ± 2.06	12.46 ± 2.24	19.44 ± 1.84	16.37 ± 2.01	12.85 ± 2.21
Nov	30	20.98 ± 2.00	17.68 ± 2.13	13.81 ± 2.45	21.22 ± 2.04	17.95 ± 2.15	13.96 ± 2.48
Dec	31	19.90 ± 0.98	16.11 ± 1.58	12.32 ± 1.86	20.12 ± 1.00	16.36 ± 1.57	12.43 ± 1.86
2018							
Jan	31	18.56 ± 2.68	14.84 ± 2.85	11.15 ± 3.13	18.88 ± 2.66	15.13 ± 2.78	11.31 ± 3.13
Feb	28	18.74 ± 1.36	15.78 ± 1.38	12.45 ± 1.49	18.85 ± 1.35	15.91 ± 1.37	12.50 ± 1.49
Mar	31	23.59 ± 1.30	20.19 ± 1.89	16.46 ± 2.50	23.79 ± 1.33	20.42 ± 1.87	16.56 ± 2.52
Apr	30	21.66 ± 1.48	18.57 ± 1.60	15.33 ± 2.13	21.68 ± 1.48	18.61 ± 1.62	15.36 ± 2.08

There was a decreasing salinity gradient from the USGS station near Shell Island (total mean top water salinity 18.32 ppt and bottom water salinity 18.44 ppt) compared to the upper river station near Homosassa, Florida (total mean top water salinity 4.43 ppt and total mean bottom water salinity 4.88 ppt). This salinity gradient corresponds with the different oyster biological sampling sites with Group A associated with lower salinity, Group B with moderate salinity, and Group C with higher salinity (Figure 8).

Maximum daily salinity values occurred in May and June 2017 and March and April 2018, while minimum daily salinity values occurred in September 2017 and January 2018 (Figures 21 through 26). Rainfall in the local area is documented in Figure 20.

Based on the optimal salinity for growth and reproduction of *Crassostrea virginica* being between 10 to 28 ppt, the number of days and percent exceedance when the daily salinity value was less than 10 ppt or greater than 28 ppt was calculated at the water quality stations from February 1, 2017 to April 30, 2018. The number of days that salinity was less than 10 ppt increased from Shell Island (4 days and 0.89 percent at mean water top recordings, and 4 days and 0.88 percent at mean water bottom recordings) to the upper river station near Homosassa, Florida (418 days and 98.35 percent at mean top bottom recordings, and 435 days and 96.45 percent at mean water bottom recordings) (Table 6). There were no days when salinity was greater than 28 ppt at the four water quality stations (Table 7). These results correspond with the decreasing salinity gradient from the river mouth to the upper river segment.

3.1.3 Lower Withlacoochee River

At the USGS Station 02313222 Withlacoochee River near Chambers Island average monthly salinity values from water top recordings ranged from a maximum of 25.41 ppt to a minimum 2.35 ppt, and from water bottom recordings ranged from a maximum of 25.70 ppt to a minimum 2.47 ppt (Table 12). At the SWFWMD Citrus 2 Station average monthly

Table 12. Mean top and bottom recording salinity (ppt) summarized by month and year at USGS Station 02313272 Withlacoochee River at Chambers Island.

		Top			Bottom		
Date	N	Maximum	Mean	Minimum	Maximum	Mean	Minimum
2017							
Feb	28	21.51 ± 0.97	16.23 ± 2.21	5.53 ± 3.29	22.42 ± 1.00	17.93 ± 2.68	6.89 ± 5.03
Mar	31	22.53 ± 1.23	16.94 ± 2.10	5.63 ± 2.67	23.77 ± 1.43	18.89 ± 2.54	6.57 ± 4.04
Apr	30	23.48 ± 0.87	18.97 ± 1.32	8.53 ± 3.68	24.56 ± 1.21	20.82 ± 1.69	10.01 ± 4.86
May	31	25.05 ± 1.26	20.57 ± 1.16	9.41 ± 3.13	25.44 ± 1.12	21.78 ± 1.27	10.80 ± 4.06
Jun	30	24.52 ± 0.95	19.93 ± 1.10	8.20 ± 3.10	24.82 ± 0.83	21.42 ± 1.34	10.13 ± 4.75
Jul	31	25.41 ± 1.45	20.68 ± 1.98	9.11 ± 4.98	25.70 ± 1.45	22.25 ± 2.00	11.01 ± 6.77
Aug	31	23.16 ± 1.37	18.31 ± 2.35	6.85 ± 4.96	23.09 ± 1.28	19.50 ± 2.27	8.55 ± 6.56
Sep	30	21.11 ± 1.65	15.39 ± 3.16	3.69 ± 4.23	21.62 ± 1.63	17.29 ± 3.64	6.26 ± 7.70
Oct	31	24.42 ± 1.57	18.82 ± 2.89	5.64 ± 4.98	24.73 ± 1.49	21.21 ± 3.00	10.38 ± 8.63
Nov	30	23.23 ± 0.86	17.31 ± 2.04	2.94 ± 3.45	23.71 ± 0.84	19.13 ± 2.24	4.44 ± 6.06
Dec	31	21.75 ± 1.05	15.26 ± 1.92	2.35 ± 3.57	22.39 ± 0.86	17.24 ± 2.22	3.80 ± 6.06
2018							
Jan	31	23.30 ± 1.27	16.17 ± 3.47	2.85 ± 4.24	22.46 ± 1.46	19.33 ± 2.93	6.84 ± 6.57
Feb	28	23.25 ± 1.94	16.11 ± 3.03	2.25 ± 2.31	23.23 ± 2.46	18.69 ± 2.91	6.72 ± 6.52
Mar	31	23.75 ± 0.92	18.41 ± 2.59	6.79 ± 5.63	24.19 ± 0.98	20.03 ± 2.42	8.77 ± 6.57
Apr	30	21.85 ± 1.49	15.62 ± 2.34	3.39 ± 3.52	22.04 ± 1.54	16.06 ± 1.97	2.47 ± 2.09

salinity values from water top recordings ranged from a maximum of 0.38 ppt to a minimum 0.17 ppt, and from water bottom recordings ranged from a maximum of 3.86 ppt to a minimum 1.12 ppt (Table 13).

Table 13. Mean top and bottom recording salinity (ppt) summarized by month and year at SWFWMD Citrus 2 Withlacoochee River.

		Top			Bottom		
Date	N	Mean			Mean		
2018							
Jan	12	0.18	±	0.02	0.18	±	0.02
Feb	28	0.22	±	0.11	1.12	±	1.89
Mar	31	0.38	±	0.36	3.86	±	4.64
Apr	30	0.17	±	0.05	0.84	±	1.60

There was a decreasing salinity gradient from the USGS station near Chambers Island (total mean top water salinity 17.64 ppt and bottom water salinity 19.52 ppt) compared to the upper river SWFWMD Citrus 2 Station (total mean top water salinity 0.25 ppt and total mean bottom water salinity 1.77 ppt). This salinity gradient corresponds with the different oyster biological sampling sites with Group A associated with lower salinity, Group B with moderate salinity, and Group C with higher salinity (Figure 8).

Maximum daily salinity values occurred in February and July 2017 and March, April, May, and July 2018, while minimum daily salinity values occurred in February, September, and October 2017 and February and April 2018 (Figures 27 through 30). Local precipitation is documented in Figure 20.

Based on the optimal salinity for growth and reproduction of *Crassostrea virginica* being between 10 to 28 ppt, the number of days and percent exceedance when the daily salinity value was less than 10 ppt or greater than 28 ppt was calculated at the water quality stations from February 1, 2017 to April 30, 2018. The number of days that salinity was less than 10 ppt at Chambers Island was 2 days and 0.44 percent at mean water top recordings, and 1 day and 0.23 percent at mean water bottom recordings (Table 6). The number of days that salinity was greater than 28 ppt at Chambers Island was 2 days and 0.44 percent at maximum water top recordings, and 4 days and 0.92 percent at maximum water bottom recordings (Table 7).

3.1.4 Salinity Conclusions

There was a decreasing salinity gradient from the USGS stations near the river mouth compared to the upper river stations for all three rivers (Chassahowitzka, Homosassa, and Lower Withlacoochee). This salinity gradient corresponds with the different oyster biological sampling sites with Group A associated with lower salinity, Group B with moderate salinity, and Group C with higher salinity.

For all three rivers the number of days and percent exceedance when the daily salinity value was less than 10 ppt increased from river mouth to the upper river segment. There were 2 to 4 days when salinity was greater than 28 ppt at the Withlacoochee River near Chambers Island station. These results correspond with the decreasing salinity gradient from the river mouth to the upper river segment.

3.2 Oyster Results

3.2.1 Chassahowitzka River

Oyster Mapping

The total area mapped for oyster bars in the Chassahowitzka River system was 1,674 m^2. The most upstream oyster area mapped was RKm 4.6. The locations of five oyster bars and four areas of shoreline with oyster clusters were mapped in the main stem of the river and one oyster bar was mapped in an unnamed creek north of the main stem (Figure 5). Oyster bar areas (in m^2) and GPS coordinates taken near the center of each bar or shoreline area with oyster clusters are listed Appendix A, Table 1.

Oyster Sample Results

The nine Chassahowitzka oyster sampling sites were divided by river location into three groups (Figure 8, Table 14). Group A consisted of only oyster clusters for which densities were not measured and percent live not recorded. No significant difference was found for percentage of live oysters on the bars (p = 0.149) or the total number of oysters between (p = 0.387) Groups B and C (sample sizes were 2 and 3, respectively). A boxplot for percent estimated live area (a different measure from percent live) and percent live oysters by salinity group (B and C) is given in Appendix Figure B-1.

Laboratory measures of oyster individuals from the salinity groups did show some differences. Median oyster height was significantly higher for Group A (46.5 ± 9.42 mm, median ± standard deviation) than Group B (38 ± 12.66 mm; p = 0.0006). Median height was not significantly different between Group A (46.5 ± 19.42 mm) versus Group C (39 ± 14.69 mm; p = 0.0788), nor was it different between Group B (38 ± 12.66 mm) versus Group C (39 ± 14.69 mm; p = 0.058).

Median CI was not significantly different between Group A (6.80 ± 3.10) compared to Group B (6.55 ± 2.27; p = 0.766). However, median oyster CI was significantly higher for Group C (7.56 ± 1.52) than Group A (6.80 ± 3.10; p = 0.0115). Group C (7.56 ± 1.52) also had a significantly higher (p = 0.0027) CI than C versus Group B (6.55 ± 2.27).

Based on continuous recorder data from the year preceding Water & Air's sampling event, Group C experienced the highest salinities of the three groups. Group C had USGS 02310674 downstream and USGS 02310673 upstream (Figure 8), both show monthly average salinities (Tables 3 and 4) between 8.2 and 17.3 ppt which fall mostly within the optimal range for *Crassotrea virginica* which is 10 to 28 ppt (Wilson et al. 2005).

Table 14. Oyster sample information including mean (± standard deviation) for oyster height and condition index from the Chassahowitzka River in Citrus and Hernando Counties, Florida.

Sample Date	RKm Group	Salinity Group	Oyster Area Name	Location Type*	Number per 0.25 m^2	% Live	Mean Height (mm)	Mean Condtion Index
4/2/2018	RKm 1-2	C	Chss_01	bar	700	76	40 ± 8	7.92 ± 1.13
4/2/2018	RKm 1-2	C	Chss_10	clusters	n/a	n/a	57 ± 17	6.93 ± 1.85
4/2/2018	RKm 1-2	C	Chss_02	bar	279	84	37 ± 7	7.66 ± 1.37
3/27/2018	RKm 2-3	B	Chss_03	bar	741	92	28 ± 8	8.23 ± 2.73
4/2/2018	RKm 2-3	B	Chss_04	bar	714	92	40 ± 7	6.74 ± 1.21
4/2/2018	RKm 2-3	B	Chss_05	bar	372	88	50 ± 12	5.52 ± 1.78
3/27/2018	RKm 4-5	A	Chss_07	clusters	n/a	n/a	65 ± 22	8.29 ± 3.36
3/27/2018	RKm 4-5	A	Chss_08	clusters	n/a	n/a	37 ± 10	5.98 ± 3.34
3/27/2018	RKm 4-5	A	Chss_09	clusters	n/a	n/a	48 ± 12	5.96 ± 1.78

bar = oyster bar, clusters = scattered oyster clusters along the shoreline

3.2.2 Homosassa River

<u>Oyster Mapping</u>

The total area of oyster bars mapped in the Homosassa River was 14,964 m^2 (Appendix A, Table 2). The locations of the 31 oyster bars associated with the main stem of the river and 19 oyster bars associated with Petty/Battle/Mason Creeks south of the main stem were mapped (Figure 6). The most upstream oyster area mapped occurs at RKm 5.7 near the intersection of the main stem of the Homosassa River with Petty Creek.

<u>Oyster Samples Results</u>

The Homosassa oyster sampling sites (all located in oyster bars) were grouped according to river location into presumed salinity groups (Figure 9, Table 15). No significant differences were found for percentage of live oysters on the bars between any of the groups (A vs. B, p = 0.081; A vs C, p = 0.077; and B vs C, p = 0.302, n = 3 for all groups). Similarly, no differences were found in the total number of oysters between (A vs. B, p = 0.663; A vs C, p = 1.000; and B vs C, p = 1.000, n = 3 for all groups). A boxplot for percent estimated live area (a different measure from percent live) and percent live oysters by salinity group is given in Figure C-1.

Laboratory measures of oyster individuals from the salinity groups did show some differences. Oysters from Group B were, on average, the tallest. Median oyster height was significantly longer for Group B (65 ± 16.8 mm) than Group A (57 ± 20.31 mm, p = 0.0182) and also significantly higher for Group B (65 ± 16.8 mm) versus Group C (54 ± 12.19 mm; p = 0.0.00001). Median oyster height was not significantly different between Group A and Group C (p = 0.268).

Table 15. Information for oyster samples including mean (± standard deviation) for oyster height and condition index of oysters collected on the nine oyster bars in the Homosassa River in Citrus County, Florida.

Sample Date	RKm Group	Salinity Group	Oyster Area Name	Number per 0.25 m^2	% Live	Mean Height (mm)			Mean Condition Index		
3/28/2018	RKm 1-2	C	Homo_39	364	96.0	55	±	10	7.45	±	1.36
3/28/2018	RKm 1-2	C	Homo_37	362	92.0	56	±	12	7.83	±	2.99
3/28/2018	RKm 1-2	C	Homo_40	225	92.0	54	±	14	6.58	±	1.11
3/28/2018	RKm 2-3	B	Homo_22	261	92.0	59	±	13	7.23	±	1.41
3/28/2018	RKm 2-3	B	Homo_21	116	88.0	74	±	19	7.06	±	1.97
3/28/2018	RKm 2-3	B	Homo_25	429	92.0	66	±	15	7.26	±	1.83
3/22/2018	Petty/Battle/Mason Creek	A	Homo_01	190	72.0	53	±	15	10.93	±	3.85
3/22/2018	Petty/Battle/Mason Creek	A	Homo_04	317	69.2	70	±	24	10.45	±	2.15
3/23/2018	Petty/Battle/Mason Creek	A	Homo_18	448	68.0	58	±	19	6.78	±	2.86

In contrast to oyster height, the highest median CI was found in Group A (9.24 ± 3.59) which had a median CI higher than the other two groups. Group B had a CI significantly lower than Group A (7.61 ± 1.74, p = 0.0001), as did Group C (7.25 ± 2.04; p = 0.0001). Median CI was not significantly different between Group B and Group C (p = 0.652).

Based on the available USGS data from the most recent year, it is difficult to estimate what the salinity was at the sample sites in Group A and in Group B as the closest monitoring stations are over 2 km away (Table 13). Group C sample sites are over 1 km away from USGS Station 02310712 (Figure 9). But the modeled 3-year surface salinity values can be examined (Appendix J-2). The model predicts that oysters in Group A were experiencing average surface salinity (5 to 8 ppt) below the low end of the optimal range (10 to 28 ppt). The 3-year model indicates that the area where Group B samples were collected has salinities on the low end of the optimal salinity range and this is where the tallest oysters were collected. Group C had the lowest CI and shortest height of the three groups but appears to have experienced salinities in the optimal range based on both data from the 3-year average model and the data collected at USGS 02310712 for both surface and bottom measures of salinity.

3.2.3 Lower Withlacoochee River

Oyster Mapping

The mapped area of a combination of oyster bars, oyster clusters, and oyster-covered rock shoreline in the Lower Withlacoochee River covered 59,212 m^2 (Appendix A, Table 3, Figure 7). Other smaller oyster bars were present in the river system and numerous smaller oyster-covered rock shorelines were noted along the river and side channels but were not mapped. The most upstream oyster area mapped occurred approximately RKm 2.2, near Pat's Elbow.

Oyster Samples Results

The Lower Withlacoochee River's 12 oyster sampling sites were grouped according to river location into salinity groups with Group C most downstream and Group A most upstream (Figure 10, Table 16). No oyster bars were present in Group A, two were present in Group B, and three were present in Group C. No significant differences in median percentage of live oysters between Groups B and C (p = 0.3865). Similarly, the number of oysters per quadrat was also not significantly different (p = 0.773). The greatest percentage of live oysters (100 percent) was recorded at site 43A and the highest density of oysters (in the study) occurred at site 35 (Table 16, Figure 10). A boxplot for percent live oysters by salinity group is given in Figure D-1.

Laboratory measures of oyster individuals from the three different presumed salinity groups did show some differences. Group C had the tallest oysters. Median oyster height was significantly higher for Group C (59 ± 16.15 mm, median ± standard deviation) than in samples from Group A (56 ± 13.81 mm; p = 0.0476). Median height was also significantly higher for Group C (59 ± 16.15 mm) when compared with Group B (54.5 ± 15.63 mm, p = 0.0088). Median oyster height was not significantly different between Groups A and B (p = 0.5308).

Similar to oyster height, the higher oyster condition indices were found in samples from Group C. Median CI was significantly higher for Group C (9.63 ± 1.86) than Group A (6.6 ± 1.38; p = 0.00001) and when compared with Group B (6.42 ± 2.64, p = 0.00001). Median CI was not significantly different between Group A and Group B (p = 0.517).

USGS continuous recorder 02313272 is located in the area of the Lower Withlacoochee River from which Group C samples were collected and thus should give a good indication of what salinity conditions were experienced by the oysters collected from that area. Mean top salinity ranged from 15.3 to 20.7 and bottom salinity ranged from 16.1 to 22.3 (Table 14), all within the optimal range for *C. virginica*. Group C had the tallest oysters and those with the highest median CI. A hydrodynamic salinity model for the Lower Withlacoochee River is still being developed, therefore a direct comparison of salinity data to oysters from Group A and B is not presented in this report.

Table 16. Information for oyster samples including mean (± standard deviation) for oyster height and condition index of oysters collected from the Withlacoochee River, Citrus and Levy Counties, Florida.

Sample Date	RKm Group	Salinity Group	Oyster Area Name	Bar	Number per 0.25 m^2	% Live	Mean Height (mm)			Mean Condition Index		
4/19/2018	RKm -1-0	C	With_22	clusters	n/a	n/a	62.44	±	14.94	10.13	±	1.62
4/20/2018	RKm -1-0	C	With_35	bar	1151	80.0	63.44	±	15.39	10.73	±	2.58
4/20/2018	RKm -1-0	C	With_39	clusters	n/a	n/a	71.36	±	21.09	8.90	±	1.32
4/20/2018	RKm -1-0	C	With_43A	bar	790	100.0	60.26	±	14.52	9.16	±	1.40
4/21/2018	RKm -1-0	C	With_43B	bar	823	92.6	54.60	±	8.84	8.54	±	1.15
3/29/2018	RKm 0-1	B	With_02	clusters	n/a	n/a	53.02	±	16.08	6.66	±	3.70
4/19/2018	RKm 0-1	B	With_03	bar	607	76.0	63.02	±	17.49	6.70	±	2.72
4/19/2018	RKm 0-1	B	With_18	clusters	n/a	n/a	53.48	±	13.30	6.44	±	1.14
4/19/2018	RKm 0-1	B	With_21	bar	784	84.0	58.16	±	14.06	6.53	±	2.53
2/18/2018	RKm 1-2	A	With_05	clusters	n/a	n/a	61.62	±	12.60	6.28	±	1.48
4/19/2018	RKm 1-2	A	With_06	rock bar	n/a	n/a	49.56	±	10.18	6.18	±	1.08
4/19/2018	RKm 1-2	A	With_12	clusters	n/a	n/a	51.64	±	10.39	6.16	±	1.66
4/19/2018	RKm 1-2	A	With_51	clusters	n/a	n/a	67.58	±	13.85	6.94	±	1.14

Note: bar = oyster bar, clusters = scattered oyster clusters along the shoreline, rock bar = oysters attached to rocks.

3.3 Barnacle Results

3.3.1 Chassahowitzka River Barnacles

Barnacle Occurrence

Six barnacle samples were collected in the Chassahowitzka River between RKm 1 to 7 (Figure 11, Table 17). The most upstream intertidal barnacles were observed near RKm 7.0. Based on the 3-year average surface salinity model (Appendix Figure J-1) the sample sites were divided into two salinity groups (n = 3). The three most upstream sites (RKm 5.0, 6.0, and 7.0) are considered to be oligohaline (mean salinity < 5 ppt) sites and the three sites further downstream (RKm 1.0, 2.4, and 4.3) are considered to be mesohaline (mean salinity 5 to 18 ppt).

Table 17. Results from barnacle samples collected from the Chassahowitzka River in Citrus and Hernando counties, Florida.

Date	River Km	Sample Name	Number per 0.01 m^2	% Live	Mean (± SD) Diameter (mm)	Dry Weight (g)	% Organic Matter	% Ash
3/14/2018	1.0	Chss 5	10	100.0	5.1 ± 1.8	0.35	6.6	93.4
3/14/2018	2.4	Chss 6	9	66.7	8.1 ± 2.8	0.51	7.1	92.9
3/14/2018	4.3	Chss 4	21	61.9	6.0 ± 2.5	0.54	5.1	94.9
3/13/2018	5.0	Chss 3	40	45.0	9.9 ± 3.3	0.62	7.0	93.0
3/13/2018	6.0	Chss 2	25	88.0	6.5 ± 3.2	0.67	5.3	94.7
3/13/2018	7.0	Chss 1	14	100.0	3.6 ± 1.6	0.26	16.3	83.7

Barnacle Sample Results

The number of barnacles recorded in a single quadrat (per 0.01 m^2) in the Chassahowitzka ranged from 9 to 40 individuals with the highest barnacle density at RKm 5.0 (an oligohaline site). No significant difference (p = 0.1904) was found between the median total number of individuals per quadrat in the mesohaline samples (10.0) compared with the oligohaline samples (25.00; Appendix Tables E2 - E4, Figure E-1).

No significant difference (p = 0.0809) was found between the median number of live barnacles per quadrat in the mesohaline samples (10.0) compared with the oligohaline samples (18.00; Appendix Tables E2 - E4, Figure E-1).

No significant difference (p = 1.0000) was found between the median percentage of live barnacles in the mesohaline samples (66.7) compared with the oligohaline samples (88.0; Appendix Tables E2 - E4, Figure E-2).

No significant difference (p = 1.0000) was found between the median barnacle diameter in the mesohaline samples (6.0 mm) compared with the oligohaline samples (6.5 mm; Appendix Tables E2 - E4, Figure E-3). The sample with the largest mean diameter was collected at RKm 5.0 (Table 17).

No significant difference (p = 0.6625) was found between the median dry weight of the total barnacle sample in the mesohaline samples (0.514 g) compared with the oligohaline samples (0.623 g; Appendix Tables E2 - E4, Figure E-4).

No significant difference (p = 0.6625) was found between the median percentage organic matter in the total barnacle sample in the mesohaline samples (6.6 percent) compared with the oligohaline samples (7.0 percent ; Appendix Tables E2 - E4, Figure E-4) The sample with the highest percentage of organic matter (16.3 percent) was collected at RKm 7.0 (Table 17).

The percentage of organic matter in the barnacle samples did not have a close correlation (R^2 = 0.204) with percentage of live barnacles in the sample (Figure E-6).

RKm was not significantly correlated with any of the field or laboratory barnacle attributes quantified in this study (Appendix Table E-5). For the measurements of barnacle populations collected in this study (with a very small sample size) no differences were detected between the salinity groups or with RKm.

3.3.2 Homosassa and Halls River Barnacles

<u>Barnacle Occurrence</u>

Eight barnacle samples were collected in the Homosassa River. One sample (Hmss 8) was collected near the mouth of the river (RKm 0.1) and the rest were collected from RKm 4.9 to 11.2 (Figure 12, Table 18). Barnacles were observed between the mouth and RKm 4.9, but not collected because suitable substrate for barnacle sample collection was not present and most hard surfaces were covered with oysters (sometimes mixed with barnacles). Between RKm 11.2 and 13.0, no barnacles were observed. Based on the 3-year average surface salinity model (Appendix Figure J-2), samples from RKm 8.0 and higher were classified as oligohaline and those up to RKm 7.0 were classified as mesohaline.

In the Halls River, five barnacle samples were collected between RKm 0.5 to 4.1 (Figure 12, Table 18). No barnacles were present in the Halls River above RKm 4.1 that could be sampled. Based on the 3-year average surface salinity model (Appendix Figure J-2) all of the samples from the Halls River are considered to be from oligohaline sites.

Table 18. Results from barnacle samples collected from the Homosassa and Halls Rivers, Citrus County, Florida.

Date	River km	Sample Name	Number per 0.01 m^2	% Live	Diameter (mm)			Dry Weight (g)	% Organic Matter	% Ash
3/28/2018	0.1	Hmss 8	19	36.8	10.3	±	4.3	0.39	16.0	84.0
3/28/2018	4.9	Hmss 7	55	23.6	4.4	±	1.6	0.36	7.4	92.6
3/28/2018	5.8	Hmss 6	89	89.9	4.9	±	1.7	0.57	5.1	94.9
3/26/2018	7.0	Hmss 5	69	79.7	4.5	±	1.7	0.37	6.6	93.4
3/26/2018	8.0	Hmss 4	80	78.8	5.2	±	1.9	0.37	7.2	92.8
3/26/2018	8.9	Hmss 3	97	17.5	5.6	±	1.4	0.49	5.8	94.2
3/26/2018	10.0	Hmss 2	98	60.2	5.4	±	1.6	0.56	5.6	94.4
3/26/2018	11.2	Hmss 1	78	55.1	5.8	±	2.1	0.46	5.5	94.5
3/23/2018	0.5	Hlls 5	61	86.9	5.2	±	1.9	0.35	5.5	94.5
3/23/2018	1.5	Hlls 4	92	81.5	9.9	±	1.9	0.39	5.1	94.9
3/23/2018	2.2	Hlls 1	51	64.7	9.2	±	3.1	0.38	6.3	93.7
3/23/2018	3.2	Hlls 2	55	89.1	8.6	±	2.7	0.46	4.9	95.1
3/23/2018	4.1	Hlls 3	93	91.4	7.2	±	2.7	0.64	7.1	92.9

Barnacle Sample Results

Homosassa River Proper

The number of barnacles recorded in a single quadrat (per 0.01 m^2) in the Homosassa ranged from 19 to 98 individuals with the highest barnacle densities recorded near RKms 9 and 10, both oligohaline sites (Table 18). No significant difference (p = 0.112) was found between the median total number of individuals per quadrat in the mesohaline samples (62.0) compared with the oligohaline samples (88.5; Appendix Tables F2 - F4, Figure F-1).

No significant difference (p = 0.665) was found between the median number of live barnacles per quadrat in the mesohaline samples (34.0) compared with the oligohaline samples (62.0; Appendix Tables F2 - F4, Figure F-1).

No significant difference (p = 0.665) was found between the median percentage of live barnacles in the mesohaline samples (58.3) compared with the oligohaline samples (74.1; Appendix Tables F2 - F4, Figure F-2).

No significant difference (p = 0.312) was found between the median barnacle diameter in the mesohaline samples (4.72 mm) compared with the oligohaline samples (10.3 mm; Appendix Tables F2 - F4, Figure F-3). The sample with the largest mean diameter was collected at RKm 0.1 (Table 18).

No significant difference (p = 0.665) was found between the median dry weight of the total barnacle sample in the mesohaline samples (0.40 g) compared with the oligohaline samples (0.54 g; Appendix Tables F2 - F4, Figure F-4).

No significant difference (p = 0.4705) was found between the median percentage organic matter in the total barnacle sample in the mesohaline samples (7.0 percent) compared with the oligohaline samples (6.85 percent; Appendix Tables E2 - E4, Figure E-4) The sample with the highest percentage of organic matter (16.3 percent) was collected at RKm 7.0 (Table 18).

The percentage of organic matter in the barnacle samples did not have a correlation (R^2 = 0.097) with percentage of live barnacles in the sample (Appendix Figure F-6).

RKm was not significantly correlated with any of the field or laboratory barnacle attributes quantified in this study (Appendix Table F-5). For the measurements of barnacle populations collected in this study (with a small sample size) no differences were detected between the salinity groups or with RKm.

Halls River

The number of barnacles recorded in a single quadrat (per 0.01 m^2) in the Homosassa ranged from 51 to 93 individuals with the highest barnacle densities recorded the furthest from the confluence with the Homosassa (Table 18, Figure 12, Appendix Table F-6). The mean number of barnacles 70.4 ± 20.49 (mean ± standard deviation, Appendix Table F-6). The mean number of live barnacles per quadrat was 59.0 ± 20.9 and the mean percentage of live barnacles was 82.7 ± 10.7. The mean diameter of barnacles in the samples from the Halls River was 8.0 ± 1.9 mm. The mean dry weight of the barnacle samples collected from the Halls River was 0.44 ± 0.12 grams.

The mean percentage of organic matter in the barnacle samples collected from the Halls River was 5.8 ± 0.9 percent. The percentage of organic matter in the barnacle samples did not have a correlation (R^2 = 0.010) with percentage of live barnacles in the sample (Figure F-7).

RKm was not significantly correlated with any of the field or laboratory barnacle attributes quantified in this study except total sample dry weight (Appendix Table F-7). Sample dry weight was significantly correlated with RKm (p = 0.037), indicating samples with more material were collected farther from the confluence with the Homosassa River (Appendix Table F-7, Figure 12).

3.3.3 Lower Withlacoochee River Barnacles

Barnacle Occurrence

Eight barnacle samples were collected in the Lower Withlacoochee River between RKm -0.1 and 8.6 (Figure 13, Table 19). At one location (RKm 0.9) barnacles were observed, but not collected because they were intermixed with oysters. No intertidal barnacles on the Lower Withlacoochee River were observed upstream of RKm 8.6. No 3-year average surface salinity model was available at the time of the writing of this report.

Table 19. Results from barnacle samples collected from the Withlacoochee River, Citrus and Levy Counties, Florida.

Date	River km	Sample Name	Number per 0.01 m^2	% Live	Mean (± SD) Diameter (mm)	Dry Weight (g)	% Organic Matter	% Ash
3/29/2018	-0.1	With 1	124	91.1	6.6 ± 1.6	0.8225	4.4	95.6
3/29/2018	2.1	With 2	41	56.1	7.4 ± 1.6	0.4002	5.4	94.6
4/5/2018	4.5	With 8	17	94.1	8.1 ± 2.6	0.5911	11.4	88.6
4/3/2018	5.2	With 7	17	58.8	7.6 ± 1.8	0.5251	21.7	78.3
4/3/2018	6.0	With 6	4	0.0	14.8 ± 4.0	0.4326	5.4	94.6
4/3/2018	7.0	With 3	12	0.0	9.5 ± 1.7	0.6845	6.7	93.3
4/3/2018	8.0	With 4	16	25.0	10.3 ± 2.1	0.4503	12.1	87.9
4/3/2018	8.6	With 5	10	30.0	12.0 ± 3.3	0.5500	4.7	95.3

Barnacle Sample Results

The number of barnacles recorded in a single quadrat (per 0.01 m^2) in the Withlacoochee ranged from 4 to 124 individuals with the highest barnacle density nearest to the mouth (Table 19, Figure 13). Two of the samples contained only dead barnacles (RKm 6.0 and RKm 7.0). The mean number of barnacles 30.1 ± 39.4 (mean ± standard deviation, Appendix Table G-1). The mean number of live barnacles per quadrat was 21.1 ± 38.0 and the mean percentage of live barnacles was 44.4 ± 36.9. The mean diameter of barnacles in the samples from the Withlacoochee River was 9.5 ± 2.7 mm. The mean dry weight of the barnacle samples collected from the Withlacoochee River was 0.557 ± 0.142 grams.

The mean percentage of organic matter in the barnacle samples collected from the Withlacoochee River was 9.0 ± 6.0 percent. The percentage of organic matter in the barnacle samples did not have a correlation (R^2 = 0.006) with percentage of live barnacles in the sample (Appendix Figure G-1).

RKm was significantly correlated with some of the field or laboratory barnacle attributes quantified in this study (Appendix Table G-2). The number of individual barnacles per quadrat was correlated with RKm (p = 0.011) as was the number of live barnacles in the quadrat (p = 0.017), and the mean diameter (p = 0.010). Barnacles were larger further from the mouth of the river, but less common away from the mouth.

4.0 Within River Comparisons with Previous Studies

4.1 Oysters

<u>Mapping and Upstream Oyster Occurrence</u>

The most upstream, live intertidal oyster collected on the Chassahowitzka River by Estevez (2007) was at RKm 1.0 along his regularly spaced transects. He observed live oyster reefs at RKm 2.0 which is downstream of Water & Air's most upstream intertidal oyster area at 4.6 RKm. Estevez also made intertidal collections to measure oyster size and found live intertidal oysters at Rkms 3.0 and 4.0. Estevez also observed smaller oyster reefs upstream at RKm 6 but found only dead oysters. It should also be noted that the RKm measures used by Estevez were similar to that in the Water & Air work, however RKm measures did vary. Exact differences in RKm measures could not be determined with the limited number of location coordinates provided in the Estevez report. Therefore, the Estevez observations are useful, but precise comparisons would require conversion of the RKm locations to the current District system.

In 2010, Water & Air mapped three oyster bars on the main stem of the Homosassa River at Rkms 0.1, 0.6, and 1.4 to identify the most upstream bars during a study of all molluscs but did not specifically characterize the oysters. In 2018, Water & Air determined the most upstream intertidal oyster bar was a small one located near the mouth of Petty Creek at approximately RKm 4.6.

On the Lower Withlacoochee River, Estevez (2011) sampled molluscs every half kilometer on transects. The location of most upstream, live intertidal oyster collection was at RKm 0.5 Estevez (2007) observed dead oysters near Pat's elbow, the most upstream location where live oysters were found by SWRF and Dooris in 2009 and Water & Air in 2018. The furthest upstream oysters mapped by SWRF and Dooris were approximately 150 meters downstream from where Water & Air found them in the current study .

Both Water & Air (2018) and SWRF and Dooris (2009) conducted extensive mapping of oyster habitat in the Lower Withlacoochee River. Both studies, coincidentally, mapped 51 intertidal oyster locations, and although general locations were similar, the geographic configurations of specific bars and oyster areas were different. This is likely due to differing mapping methods, and some variation of oyster bars between sampling times, especially at the river mouth. SWRF and Dooris walked oyster bar perimeters with a GPS at or near low tide, whereas Water & Air used aerial photo interpretation with ground-truthing to map the system. Water & Air found a mean of 1019 m^2 of oyster habitat per location, whereas SWRF and Dooris found 639 m^2. The SWRF and Dooris (2009) method could more easily exclude areas of shell only, shell hash, or dead reef.

Density

In the 2007 mollusc study, Estevez determined the density of Chassahowitzka intertidal oysters using petite ponar sample collections of live and dead oysters at RKm 0 and RKm 1. He found a density of approximately 850 oysters per m^2 at RKm 0 and 25 oysters per m^2 at RKm 1. Water & Air found a mean density of 2245 oysters per m^2 using a 0.25 m^2 quadrat following the methods of Baggett et al. (2014).

In Sprinkel's 1986 work on the Withlacoochee, mean oyster density was 319 per m^2 ranging from 153 to 599 for the nearshore station and mean oyster density of 234 oysters per m^2 ranging from 72 to 420 for the midshore station. In the SWRF and Dooris study on the Withlacoochee, they found mean density of 136 oysters per m^2 with a range of 21 to 433. On the Withlacoochee River the density of intertidal oysters collected by Estevez (2011) at Rkms 0.0 and 0.5 was 300 and 25 oysters per m^2 respectively. Water & Air found a mean density of 2431.2 oysters per m^2 using a 0.25 quadrat following the methods of Baggett et al. (2014). Both in Sprinkel's 1986 study and that of SWRF and Dooris (2009), only surface oysters in the quadrat were counted, rather than excavating the area as per Baggett et al. (2014) making these estimates not comparable to the Water & Air work. Predictably, Water & Air's density estimates that include layered oysters are higher than both studies.

Height

Estevez (2007) measured the median height of live intertidal oysters on the Chassahowitzka River at Rkms 1.0, 2.0, 3.0 and 4.0 as 32 mm, 22 mm, 37 mm and 47 mm respectively as approximated from a graph of his data. The median height of oysters at the nine Water & Air stations is 40.0 mm.

For the Withlacoochee River, three previous ecological evaluations of oysters collected height data. Sprinkel (1986) determined the mean oyster height to be 69.6 mm, (with a range of 66.1 to 74.8 mm) from the nearshore oyster bar and mean height of 57.6 mm (with a range of 51.0 to 63.4 mm) for the midshore oyster bar. SWRF and Dooris (2009) found a mean height of 61.4 mm with a range of 19.0 to 118.0 mm for their extensive characterization of Withlacoochee River oysters, however in both studies cited, large oysters were preferentially selected. Estevez (2011) measured the median height by lining up the oysters according to height and selecting the median oyster to measure.

At RKm -0.5, 0 and 0.5 the median oysters measured 30 mm, 35 mm and 50 mm respectively. In this study, Water & Air determined the median height for oysters from the nine stations between RKm -1 to 1 to be 58 mm.

Percent Live

In Sprinkel's work on the Withlacoochee, the percent live oysters were obtained quarterly (eight times) for each sampling area (Sprinkel 1986). They found a mean of 82 percent live oysters for the nearshore station (range of 70 to 98 percent) and a mean of 67 percent for the mid station (range of 30 to 85 percent). In the SWRF and Dooris study, they found mean percent live oysters of 81.46 with a range of 63.3 to 94.0 for the whole study area. This percentage is comparable to Water & Air's stations where mean percent live oyster was 89.7 with a range of 76 to 100 percent. Although Water & Air's percent live was higher, it represents only five sample collections, whereas, SWRF and Dooris (2009) collected over 500 samples and Sprinkel (1986) collected nearly 100 samples.

Condition Index

No comparisons of CI can be made for the Chassahowitzka or Homosassa Rivers, as this data has never been collected there before this study. However, Withlacoochee River oyster condition (using the same formula for CI) was previously assessed by Sprinkel (1986) over eight consecutive quarters from two locations. They found a mean CI of 7.0 with range of 5.1 to 10.6 for the nearshore station and mean of 6.7 with range of 5.4 to 8.4 for the middle station. The mean CI for Water & Air's Group C stations was 9.49 with a range from 4.66 to 14.06, higher than that found in Sprinkel's 1986 study. The results from the Sprinkel study provided seasonal collections over 2 years, compared to Water & Air's one time collection from the general area.

4.2 Barnacles

A Springs Coast area barnacle study (Culter 2010) provides some comparisons for two rivers in this evaluation, the Homosassa/Halls River system and the Lower Withlacoochee River. This study determined the upstream extent of natural barnacle populations, the percentage live, range of basal diameters, and density.

Historical comparisons of the upstream penetration of barnacles with this current work on the Homosassa/Halls and Lower Withlacoochee River is complicated by the differing study methods between the 2018 data (Water & Air) and the 2009 data (Culter 2010). The Culter work includes intertidal and subtidal barnacle collections on existing structures without characterizing them as intertidal or subtidal in the data presented. Whereas, the Water & Air work included only intertidal barnacles. Therefore, the comparisons presented for Culter (2010) in this section may not be valid, however, some observations are worth discussion.

The data suggest that intertidal barnacles may occur much farther upstream in 2018 than has been previously noted on the Halls River. Water & Air collected intertidal barnacles on the Halls River up to RKm 4.1 and Culter (2010) had only one collection on the Halls at RKm 0.4. On the Homosassa, Culter made subtidal collections up to RKm 12.3, but he suggests that the first intertidal barnacle collection occurred at RKm 11.2, the same location as Water & Air's most upstream intertidal barnacle collection. It should be noted that the RKm system used by Culter differed somewhat from the current study.

On the Withlacoochee River, Culter (2010) found the most upstream barnacles at RKm 6.5 and he describes a robust intertidal barnacle community at RKm 3.1. Water & Air found no live barnacles at RKms 6.0 and 7.0 (but did find some dead ones), and 25 and 30 percent live barnacles at RKm 8.0 and 8.6, respectively. From RKm 5.2 downstream toward the mouth, the percentage of live barnacles in all the samples was over 50 percent. Barnacle densities were far higher at RKms -0.1 and 2.1, than upstream. In Water & Air's 2018 work, it appears RKm 5.2 is a reasonable approximation of the limit of upstream intertidal barnacle distribution.

Comparisons of measures of barnacle communities (density, percent live, and basal diameter) between the Culter work (2010) and this current work are problematic because in the report Culter does not distinguish between subtidal and intertidal barnacle samples. Intertidal versus subtidal locations would have subjected the barnacles to different abiotic conditions even if they were located at the same RKm, as a saline wedge might have been present with subtidal barnacles experiencing higher salinities than intertidal ones, in addition to the intertidal ones also experiencing potential desiccation and heat stress, less feeding time, and exposure to freshwater pulses through rainfall.

5.0 Summary, Discussions, and Conclusions

5.1 Oysters

<u>Chassahowitzka River</u>

The total area mapped for oyster bars in the Chassahowitzka River system was 1,674 m^2. Of the three rivers studied, it contained the least amount of oyster habitat. This total area includes only oyster bars and excludes accumulations of scattered shoreline oyster clumps, encrusting oysters on man-made objects, and areas of natural rock encrusted with oysters. All oyster areas mapped on the Chassahowitzka River are shown in Figure 5.

The most upstream oyster area mapped by Water & Air was near RKm 4.6. Estevez (2007) also evaluated oysters in the Chassahowitzka in a study on molluscs, making his most upstream intertidal collections of live oysters in the vicinity of RKm 4.0. He found oyster shell areas further upstream near RKm 6.0, but no live oysters.

A comparison of oyster density and percent live among the three salinity groups yielded no significant results in the Mann-Whitney tests, likely due to low sample sizes. Water & Air found an overall mean oyster density of 2245 ± 873 (mean ± standard deviation) per m^2 over the whole river using a 0.25 m^2 quadrat following the methods of Baggett et al. (2014). Estevez (2007) found a density of approximately 850 oysters per m^2 at RKm 0 and 25 oysters per m^2 at RKm 1, using a different assessment method (intertidal collections with a petite ponar at regularly-spaced transects along the river). Much higher densities such as those found by Water & Air (2018) would be expected for samples from targeted oyster bars using methods described by Baggett et al. (2014) compared to those in the Estevez work (2007).

Chassahowitzka River oyster CI was not different between salinity Groups A and B. However, Group C oyster CI was significantly higher indicating that oysters from this higher salinity, more downstream area were in better condition than oysters from the more upstream A and B groups.

Based on continuous recorder data from the year preceding, Group C experienced the highest salinities of the three groups. Group C was bracketed by two USGS stations (USGS 02310674 downstream and USGS 02310673 upstream), both stations show monthly average salinities between 8.2 and 17.3 ppt which fall mostly within the optimal range for the eastern oyster, *Crassotrea virginica.*

Homosassa River System

The area of oyster bars mapped in the Homosassa River covered at least 14,964 m^2. Oyster habitat extent found in the Homosassa River system was larger than in the Chassahowitzka River, but much less than the Withlacoochee River. There were 31 mapped oyster bars associated with the main stem of the Homosassa River and 19 mapped oyster bars associated with Petty/Battle/Mason Creeks south of the main stem (Figure 6). Other smaller oyster bars and other areas exist in the river system and numerous oyster/rock shorelines were noted along the river. However, mapping was focused just on oyster bars in the main stem of the river and was capped at 50 locations by the study design.

The most upstream intertidal oyster bar Water & Air identified was a small one located near the mouth of Petty Creek at approximately RKm 4.6. In an earlier study by Water & Air (2010) on molluscs, oyster bar locations were mapped along the main stem of the river and the most upstream oyster bar identified was located near RKm 1.4.

Water & Air found an overall mean density of 1,205 ± 447 oysters per m^2 for all Homosassa stations in Salinity Groups A, B, and C combined using a 0.25 m^2 quadrat following the methods of Baggett et al. (2014). No earlier density measurements are available for comparison from the Homosassa River, however historic data from the Withlacoochee is available, but not directly comparable due to the use of different methods. In Sprinkel's (1986) work on the Withlacoochee, mean oyster density is 319 per m^2 for the nearshore station and 234 oysters per m^2 for the midshore station. In the SWRF and Dooris study (2009) on the Withlacoochee, they found mean overall density of 136 oysters per m^2. On the Withlacoochee River the density of intertidal oysters collected by Estevez (2011) at Rkms 0.0 and 0.5 was 300 and 25 oysters per m^2 , respectively. Both the Sprinkel and SWRF and Dooris methods selected for the largest oysters and counted only those at the surface of their quadrat. The Estevez (2011) work used the same methods described above for the Chassahowitzka in 2007. A much higher density of oysters was found by Water & Air in 2018 at Homosassa oyster bars using methods described by Baggett et al. (2014) compared to methods in the Sprinkel (1986), SWRF and Dooris (2009) or Estevez (2011) work as expected due to the preferential size selection in the previous studies.

A comparison of oyster density and percentage of live oysters among the three sampling groups on the Homosassa River yielded no significant results in Mann-Whitney tests, likely due to low sample sizes.

Homosassa River oyster CI was significantly higher for the furthest upstream Salinity Group A sites than for the downstream Salinity Groups B and C sites. This indicates that oysters collected from the upstream Group A sites were in better condition than oysters collected from the downstream locations associated with Groups B and C.

The District's 3-year average salinity model for the Homosassa River predicts that oysters in Group A experienced average surface salinities of 5 to 8 ppt which is below the low end of the optimal range (10 to 28 ppt). This is also where the tallest oysters were collected. Group C had the lowest condition index and shortest height of the three groups but appears to have experienced salinities in the optimal range based on both data from the 3-year average model and the data collected at USGS 02310712. Unlike the Chassahowitzka River, the salinity model for the Homosassa River does not explain the higher CI values in Group A oysters.

On the Homosassa, Group A sites may be influenced by the connection of Battle Creek and Petty Creeks to the Gulf of Mexico through Mason Creek creating additional pathways for higher salinity waters to reach those sites, other than through the main stem of the river. However, the surface salinity model does not provide any evidence for this. Shoreline vegetation along the Petty/Battle Creek area appear more similar to downstream river sections near the Group B oyster stations (Water & Air, 2018b).

Conditions other than salinity might be factors in promoting oyster growth in this area, such as food supply or low dessication stress. The geography of the river system in this area is complex, interconnecting with Gulf waters through numerous pathways to the north of the Homosassa main stem (Salt River and unnamed creeks), and to the south through Mason Creek. In the Battle/Petty/Mason Creek area numerous shallows and constrictions occur in this system created by oyster bars and marsh islands that at times create conditions of high flow oyster bars. Further study of this area may help explain why a suboptimal salinity range creates more favorable oyster growth conditions than those located in an optimal salinity range.

It should also be noted that some of the oysters (specifically those from Bar 21, Group B and some other individuals) collected from the Homosassa river system were not in good condition. The shells on many individuals were porous and flakey and appeared to be infected with shell-boring sponge. These specimens were more difficult to handle in the laboratory.

Lower Withlacoochee River

Fifty-one areas of oyster bars, oyster aggregations, or oyster-covered rock shoreline were mapped in the Lower Withlacoochee River covering at least 55,989 m^2, the most oyster habitat in the three rivers studied. Other smaller oyster bars were present in the river system and numerous oyster-covered rock shoreline areas of small spatial extent were noted along the river and side channels but were not mapped because the study scope was focused on oyster bars in the main stem of the river and capped the mapping at 50 locations. All oyster areas mapped on the Withlacoochee River are shown in Figure 7.

The most upstream oyster area mapped by Water & Air occurred at approximately RKm 2.2, near Pat's Elbow. This is consistent with the furthest upstream extent of oyster mapped by SWRF and Dooris, occurring approximately 150 meters downstream from Water & Air's location. Estevez (2011) sampled molluscs on transects at every 0.5 kilometer and the most upstream, live intertidal oyster he collected was at RKm 0.5. Although the differences in methods make comparisons difficult, his observation of dead oysters near Pat's elbow is informative. It is near the most-upstream location live oysters that were found by both SWRF and Dooris in 2009 and Water & Air in 2018.

Water & Air found an overall mean density of 3,612 ± 1401 oysters per m^2 for all Withlacoochee stations in 2018. A much higher density of oysters was found by Water & Air in 2018 using the methods of Baggett et al. (2014) compared to previous estimates for Withlacoochee oyster bars in Sprinkel 1986, SWRF and Dooris 2009, and Estevez 2011 which used different methods (Table 1).

While the field-measured variables of number of oysters per quadrat and percentage of live oysters were not significantly different among the sampling groups, the laboratory measures of oyster height and CI did show differences. Oysters from Group C were on average taller than those from Group A and Group B and had a higher CI. This pattern in the Lower Withlacoochee River is similar to that seen in the Chassahowitzka River, with CI and height higher for Group C, the higher-salinity downstream site, indicating that these oysters were in better condition than oysters collected from Group A and B sites (which were not different from each other).

USGS continuous recorder 02313272, located in the area of the Lower Withlacoochee River where Group C samples were collected, should provide a good estimate of what salinity conditions were experienced by the oysters collected from that area. At this station, the mean top salinity ranged from 15.3 to 20.7 and mean bottom salinity ranged from 16.1 to 22.3, all within the optimal range for the eastern oyster (*C. virginica)*.

<u>Conclusions</u>

The Chassahowitzka River and the Withlacoochee River had higher CI values for the most downstream stations (Group C). In both rivers, salinity values for the Group C stations likely conform to the range of optimal salinity values for oyster health based on published ranges. However, this pattern did not hold for the Homosassa River. The most upstream stations (Group A) had the highest CI. The reason for this was not apparent, but complex flow patterns in the mid-river area may be the cause of more favorable conditions for oysters. Of the three rivers studied, the Homosassa River had the most complex geography that could allow for higher flows and movement of saline water from the Gulf of Mexico to mid river regions. Further study of this area may help explain why a suboptimal salinity range (based on the District's model), creates more favorable oyster growth conditions than those located in the downstream stations within an optimal salinity range.

To test for differences between oyster communities in different areas of the river (as a proxy for salinity), more replicate samples (preferably from a random sampling design) from each area would be helpful. As would the collection of *in situ* salinity measurements at the time of sample collection from water immediately near the oysters being collected. Formally incorporating a check for the oyster-boring sponge, *Cliona*, as part of the lab and/or field methods would also help improve knowledge of the status of the oyster populations in these rivers.

5.2 Barnacles

Chassahowitzka River

Barnacle distribution in the Chassahowitzka did not show clear patterns. It is likely oysters outcompeted barnacles in many locations. When oysters and barnacles co-occurred, barnacles could not be sampled (removal from the substrate was not possible). However, oysters do probably increase habitat for barnacles as live oysters and empty shells provide hard substrate which barnacles need to grow.

Comparisons of barnacle metrics from samples collected from the mesohaline versus the oligohaline area did not yield any significant results. This may be due to the small number of samples (six total, three per salinity class). Low sample size might also be why no significant effects were associated with RKm.

The relationship of percent composition of organic material from scraped barnacle samples with the number of live barnacles present in the samples was weak (R^2 = 0.204), but the strongest of the four rivers. The use of the metric "percent organic matter" as an indicator of barnacle condition is confounded by the inclusion of empty barnacle shells (and any other material) also found in the quadrat.

Homosassa and Halls Rivers

Barnacle distribution in the Homosassa seemed to be partly dictated by oysters and the presence/absence of hard substrate. Oysters and barnacles co-occurred between RKm 0.3 and 4.1, but barnacle samples were not collected due to the previously mentioned methodical limitations. Between RKm 4.9 and RKm 11.2 barnacle samples were collected from hard substrate, not in the presence of oysters. After RKm 11.2 some potentially suitable substrate was present, but it was not colonized by barnacles this may be due to larval dispersal, insufficiently-haline conditions, or some other environmental factor. Interestingly, the largest (on average) barnacles in the Homosassa were found very near the mouth of the river. Barnacles were distributed along the Halls River until RKm 4.1, with the entire stretch being classified as oligohaline.

Comparisons of barnacle metrics from samples collected from the mesohaline area compared with oligohaline area of the Homosassa did not yield any significant results. This may be due to the small number of samples (eight total, four per salinity class). Low samples size might also be why no significant effects were seen for river kilometer. One significant correlation was seen in the Halls River with RKm and that was the total dry weight of the sample.

The relationship of percent composition of organic material from scraped barnacle samples with number of live barnacles present in the samples was very weak (R^2 =

0.097) Homosassa as well as the Halls rivers ($R^2 = 0.010$) likely due to the confounding factors described above.

Lower Withlacoochee River

Barnacle distribution in the Withlacoochee appears to follow a pattern similar to the Homosassa in that no barnacles were present at the most upstream locations despite potentially suitable substrate. No barnacles were recorded after RKm 8.6 in the Withlacoochee. This may be due to salinity below 0.5 ppt, the low-salinity limit for *Balanus subalbidus* (Porrier and Partridge 1979) or another reason like larval supply.

Significant correlations with RKm were seen for some of the barnacle metrics, specifically, the number of barnacles in the quadrat (live and dead), the number of live barnacles, and mean diameter. Barnacles were larger but less common the further away from the river mouth. Increased diameter of *B. subalbidus* with decreasing salinity in gradient estuaries was documented by Porrier and Partridge (1979).

The relationship of percent composition of organic material from scraped barnacle samples with number of live barnacles present in the samples was the weakest of all four rivers ($R^2 = 0.006$). Only two of the eight samples collected from this river had more than 60 percent live barnacles and two contained only a small number of empty shells.

Conclusions

The results from the barnacle sampling from all four rivers suggest that more samples are needed to detect differences in barnacle density (both live and total), percentage live, and basal diameter. *In situ* collection of salinity measurements near the site of barnacle samples would also be helpful.

In future work, more attention needs to be paid to barnacle species identity as barnacles of specific species may reflect more clear patterns of distribution. Porrier and Partridge (1979) found that *Balanus subalbidus* might be a good bioindicator of salinity, being the dominant species in the oligohaline zone (low salinity limit of 0.5 ppt) with its relative abundance and basal diameter decreasing in waters over 6 ppt, disappearing at salinities over 16 ppt. Above 6 ppt it was gradually replaced by *B. improvisus* and *B. eburneus*. Both of these congeneric species are known from the part of Florida that encompasses the study area and are known to be difficult to distinguish from *B. subalbidus* without laboratory examination (Fofonoff et al. 2019), so it is possible these species were present in the more downstream samples.

Barnacle sample total dry weight (as scraped from a small quadrat) is not very informative metric for understanding the health or condition of the barnacles sampled because it includes both live and dead barnacles and also likely reflects factors such as barnacle density, size of individuals, species identity (as shell thickness varies), and any sediment or fouling organisms that could not be excluded at the time of collection. Lots of small live barnacles will likely weigh less than a few large empty shells but could grow into a healthy population in a matter of weeks after a disturbance.

Similarly, the percent organic matter of samples scraped from a small quadrat is not an informative metric for understanding the health and condition of the barnacles present in the field. These samples can contain both live and dead (empty) barnacles (as well as potentially the shell bases of deceased barnacles whose upright shell portions have fallen off) as the tissue makes up a very small percentage of even a healthy, live barnacle. Our results here show there is no correlation between the number of live barnacles and the percent organic matter. If ash-free dry weight is to be used as a metric to examine the condition of barnacles, individual, intact, live barnacles identified to species (and measured) should be used.

Comparison of Barnacles and Oysters for River System Monitoring

Considering the limitations on the methods included in this study, the data collected on the oyster communities in this study provides more informative results than that from the barnacle samples. Monitoring of the primarily-oligohaline barnacle species, *Balanus subalbidus* might provide insight into prevailing salinity at locations that continuous recorders cannot be deployed. In mesohaline areas oysters, likely outcompete barnacles for space and in these areas, oyster condition, size, and density might be better indicators of the status of the benthic macroinvertebrate community.

6.0 References

Baggett, L.P, S.P. Powers, R. Brumbaugh, L.D., Coen, B. DeAngelis, J. Greene, B. Hancock, and S. Morlock. 2014. Oyster Habitat Restoration Monitoring and Assessment Handbook, The Nature Conservancy, Arlington, Va. 96 pp.

Barnes, T.K., A.K. Volety, K. Chartier, F.J. Mazzotti and L. Pearlstine. 2007. A habitat suitability index model for the eastern oyster (*Crassostrea virginica*), a tool for the restoration of the Caloosahatchee Estuary, Florida. Journal of Shellfish Research, Vol. 26, No. 4, 949-959.

Culter, J.K. 2010. Evaluation of the Spatial Extent, Density and Growth Rates of Barnacles in the Crystal, Homosassa and Withlacoochee Rivers, Florida. Mote Marine Laboratory, Sarasota, Florida, Prepared for the Southwest Florida Water Management District, Brooksville, Florida.

Dineen, J.F. Jr, and A.H. Hines. 1994. Effects of salinity and adult extract on settlement of the oligohaline barnacle *Balanus subalbidus*. Marine Biology 119:423-430.

Estevez, E.D. 2007. Chassahowitzka Mollusk Survey. Letter report prepared for the Southwest Florida Water Management District, Brooksville, Florida by Mote Marine Laboratory, Sarasota, Florida.

Fofonoff P.W., G.M. Ruiz, B. Steves, C. Simkanin, and J.T. Carlton. 2019. National Exotic Marine and Estuarine Species Information System. http://invasions.si.edu/nemesis/. Access Date: 8-Jan -2019

Heyl, Michael, Doug Leeper, Ron Basso, and Marty Kelly. 2012. Recommended Minimum Flows and Levels for the Chassahowitzka River System. Southwest Florida Water Management District, Brooksville, Florida, and Balanced Environmental Management Systems, Inc.

Knochenmus, L.A. and D.K. Yobbi. 2001. Hydrology of the coastal springs groundwater basin and adjacent parts of Pasco, Hernando and Citrus Counties, Florida. USGS Water Resources Investigations Report 2001-4230.

Leeper, Douglas A., Michael Heyl, Ron Basso, and Marty Kelly. 2012. Recommended Minimum Flows and Levels for the Homosassa River System. Southwest Florida Water Management District, Brooksville, Florida and HSW Engineering, Inc., Tampa Florida

Lucas, A., and P.G. Beninger. 1985. The use of physiological condition indices in marine bivalve aquaculture. Aquaculture 44:187-200.

McClave, J.T., and T. Sincich. 2000. Statistics (Eight Edition). Prentice Hall, Upper Saddle River, New Jersey.

Minitab. 2000. User's Guide Parts 1 and 2. Minitab, State College, Pennsylvania.

Nasrolahi, Ali, Jonathan Havenband, Anna-Lisa Wrange and Christian Pansch. 2016. Population and life-stage specific sensitivities to temperature and salinity stress in barnacles. Scientific Reports 6: 32263 DOI:1038/srep32263.

Poirrier, M.A. and M.R. Partridge, 1979. The barnacle *Balanus subalbidus* as a salinity bioindicator in the oligohaline estuarine zone. Estuaries 2: 204-206.

South Florida Water Management District. 2014. 2014 System Status Report Chapter 4: Northern Estuaries. West Palm Beach, Florida.

Sprinkel, Jay. 1986. Oyster Reefs, Volume IV in a Series: A Data Collection for Selected Coastal Estuaries in Hernando, Citrus, and Levy Counties, Florida. Mote Marine Laboratory, Sarasota, Florida, Prepared for the Southwest Florida Water Management District, Brooksville, Florida.

SWRF, LLC and Dooris & Associates, LLC. 2009. Characterization of oyster bars in the Withlacoochee River and Estuary. Prepared for the Southwest Florida Water Management District, Brooksville, Florida.

Volety, A.K., M. Savarese, S.G. Tolley, W.S. Arnold, P. Sime, P. Goodman, R.H. Chamberlain, and P.H. Doering. 2009. Eastern oysters (*Crassostrea virginica*) as an indicator of Everglades ecosystems. Ecological Indicators 95:S120-S136.

Water & Air Research, Inc. 2018. Draft Report for Assessment of Oysters and Barnacles Along the Chassahowitzka, Homosassa, and Lower Withlacoochee River Systems. Prepared for the Southwest Florida Water Management District, Brooksville, Florida.

Water & Air Research, Inc. 2018b. Final Report for Shoreline Vegetation Assessment of the Chassahowitzka and Homosassa River Systems. Prepared for the Southwest Florida Water Management District, Brooksville, Florida.

Water & Air Research, Inc. 2010. Mollusc Survey of the Homosassa River. Gainesville, Florida. Prepared for the Southwest Florida Water Management District, Brooksville, Florida.

Water & Air Research, Inc. and SDI Environmental Services, Inc. 1994. Second Interpretive Report Tampa Bypass Canal and Hillsborough River Monitoring Program. Prepared for West Coast Regional Water Supply Authority. Clearwater.

Wilson C., L. Scotto, J. Scarpa, A. Volety, S. Laramore, and D. Haunert. 2005. Survey of water quality, oyster reproduction and oyster health status in the St. Lucie Estuary. Journal of Shellfish Research 24:157-165.

Wolfe, S.J. (Editor). 1990. An Ecological Characterization of the Florida Springs Coast: Pithlachascotee to Waccasassa Rivers. U.S. Fish and Wildlife Service. Biological Report 90 (21).

Wrange, Lisa-Anna, Carl Andre, Torbjorn Lundh, Ulrika Lind, Anders Blomberg, and Per J. Jonsson. 2014. Importance of plasticity and local adaptation for coping with changing salinity in coastal areas: a test case with barnacles in the Baltic Sea. Evolutionary Biology 14:156.

Yobbi, D., and L.A. Knochenmus. 1989. Salinity and Flow Relations and Effects of Reduced Flow in the Chassahowitzka River and Homosassa River Estuaries, Southwest Florida. U. S. Geological Survey in cooperation with the Southwest Florida Water Management District, Tallahassee, Florida.

SWRF, LLC and Dooris & Associates, LLC. 2009. Characterization of oyster bars in the Withlacoochee River and Estuary. Prepared for the Southwest Florida Water Management District, Brooksville, Florida.

Volety, A.K., M. Savarese, S.G. Tolley, W.S. Arnold, P. Sime, P. Goodman, R.H. Chamberlain, and P.H. Doering. 2009. Eastern oysters (*Crassostrea virginica*) as an indicator of Everglades ecosystems. Ecological Indicators 95:S120-S136.

Water & Air Research, Inc. 2018. Draft Report for Assessment of Oysters and Barnacles Along the Chassahowitzka, Homosassa, and Lower Withlacoochee River Systems. Prepared for the Southwest Florida Water Management District, Brooksville, Florida.

Water & Air Research, Inc. 2018b. Final Report for Shoreline Vegetation Assessment of the Chassahowitzka and Homosassa River Systems. Prepared for the Southwest Florida Water Management District, Brooksville, Florida.

Water & Air Research, Inc. 2010. Mollusc Survey of the Homosassa River. Gainesville, Florida. Prepared for the Southwest Florida Water Management District, Brooksville, Florida.

Water & Air Research, Inc. and SDI Environmental Services, Inc. 1994. Second Interpretive Report Tampa Bypass Canal and Hillsborough River Monitoring Program. Prepared for West Coast Regional Water Supply Authority. Clearwater.

Wilson C., L. Scotto, J. Scarpa, A. Volety, S. Laramore, and D. Haunert. 2005. Survey of water quality, oyster reproduction and oyster health status in the St. Lucie Estuary. Journal of Shellfish Research 24:157-165.

Wolfe, S.J. (Editor). 1990. An Ecological Characterization of the Florida Springs Coast: Pithlachascotee to Waccasassa Rivers. U.S. Fish and Wildlife Service. Biological Report 90 (21).

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Yobbi, D., and L.A. Knochenmus. 1989. Salinity and Flow Relations and Effects of Reduced Flow in the Chassahowitzka River and Homosassa River Estuaries, Southwest Florida. U. S. Geological Survey in cooperation with the Southwest Florida Water Management District, Tallahassee, Florida.

FIGURES

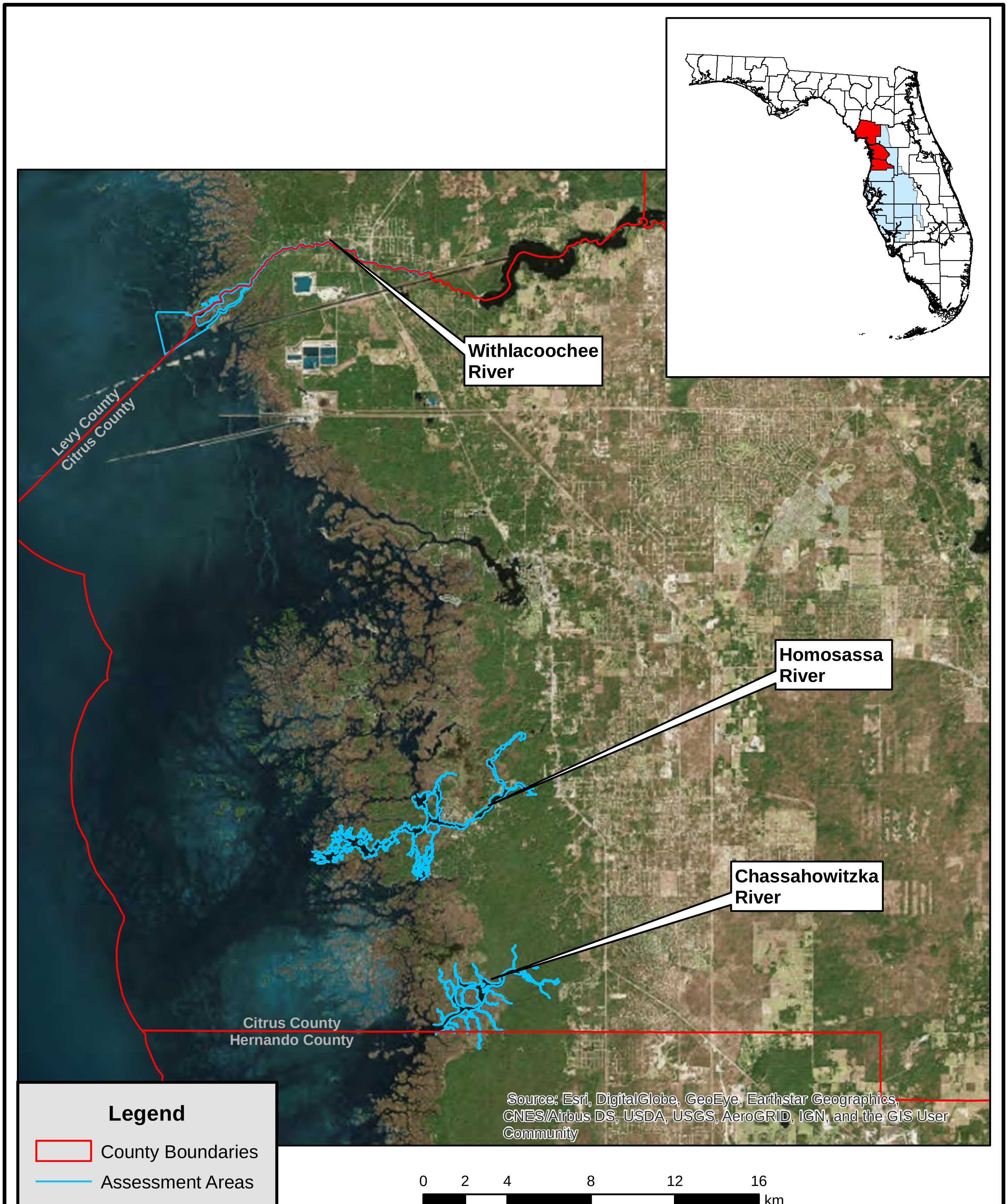

Figure 1.
Location Map of the Chassahowitzka, Homosassa and Withlacoochee Rivers
Levy, Citrus, and Hernando Counties, Florida

Source: SWFWMD, 2018; U.S. Census Bureau, 2013; Water & Air Research, Inc., 2018.

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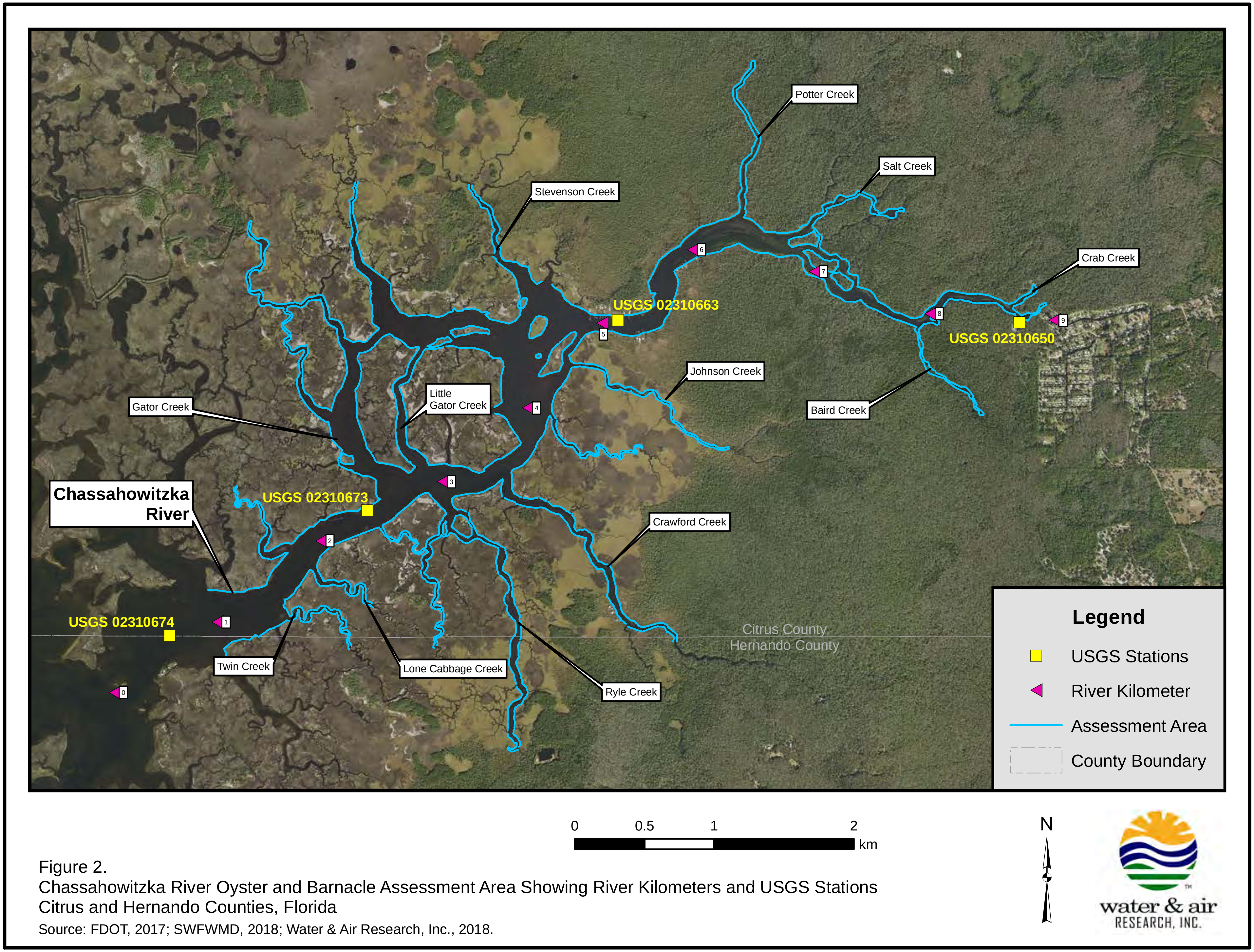

Figure 2.
Chassahowitzka River Oyster and Barnacle Assessment Area Showing River Kilometers and USGS Stations
Citrus and Hernando Counties, Florida
Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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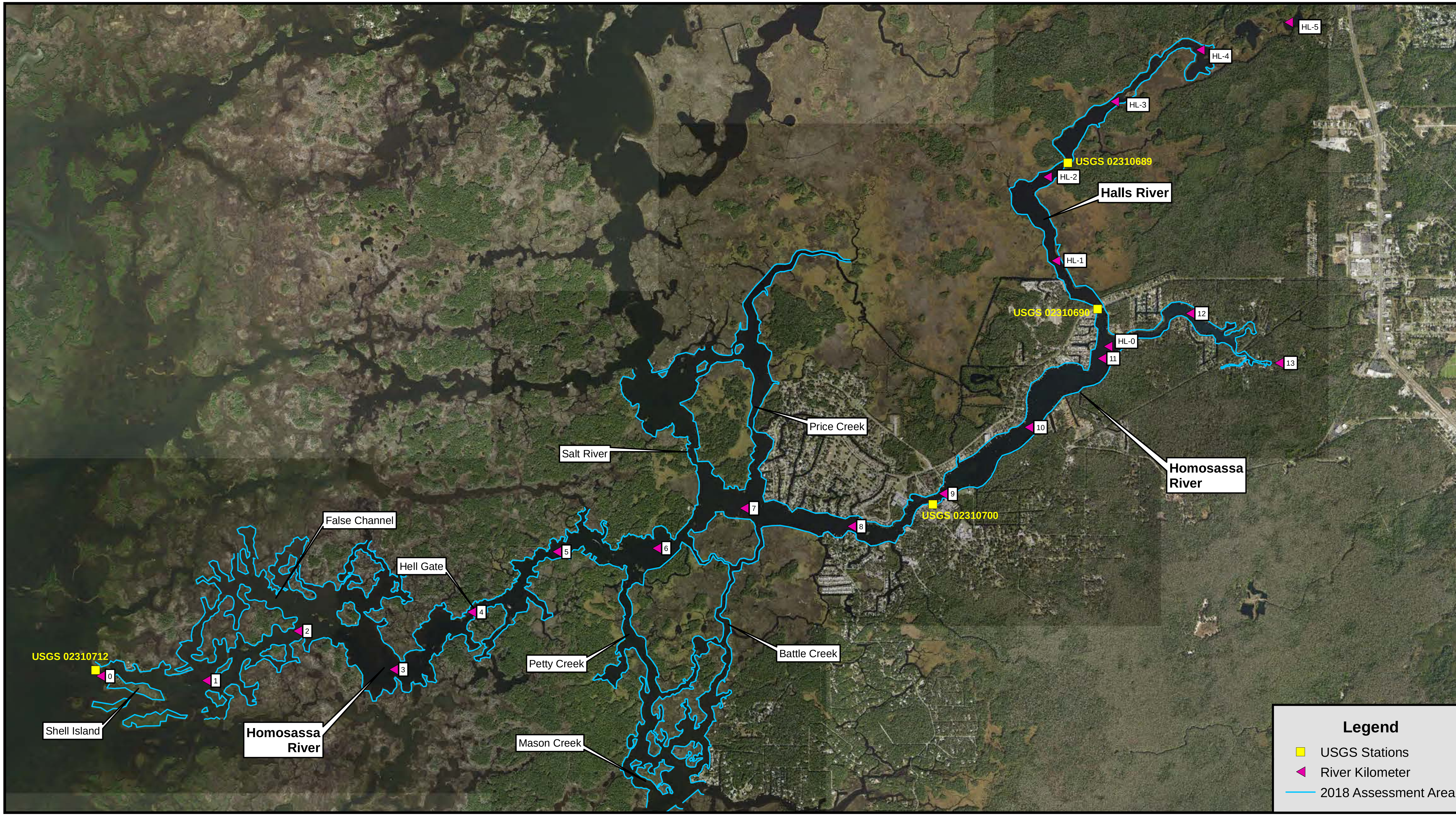

Figure 3.
Homosassa River Oyster and Barnacle Assessment Area Showing River Kilometers and USGS Stations
Citrus County, Florida

Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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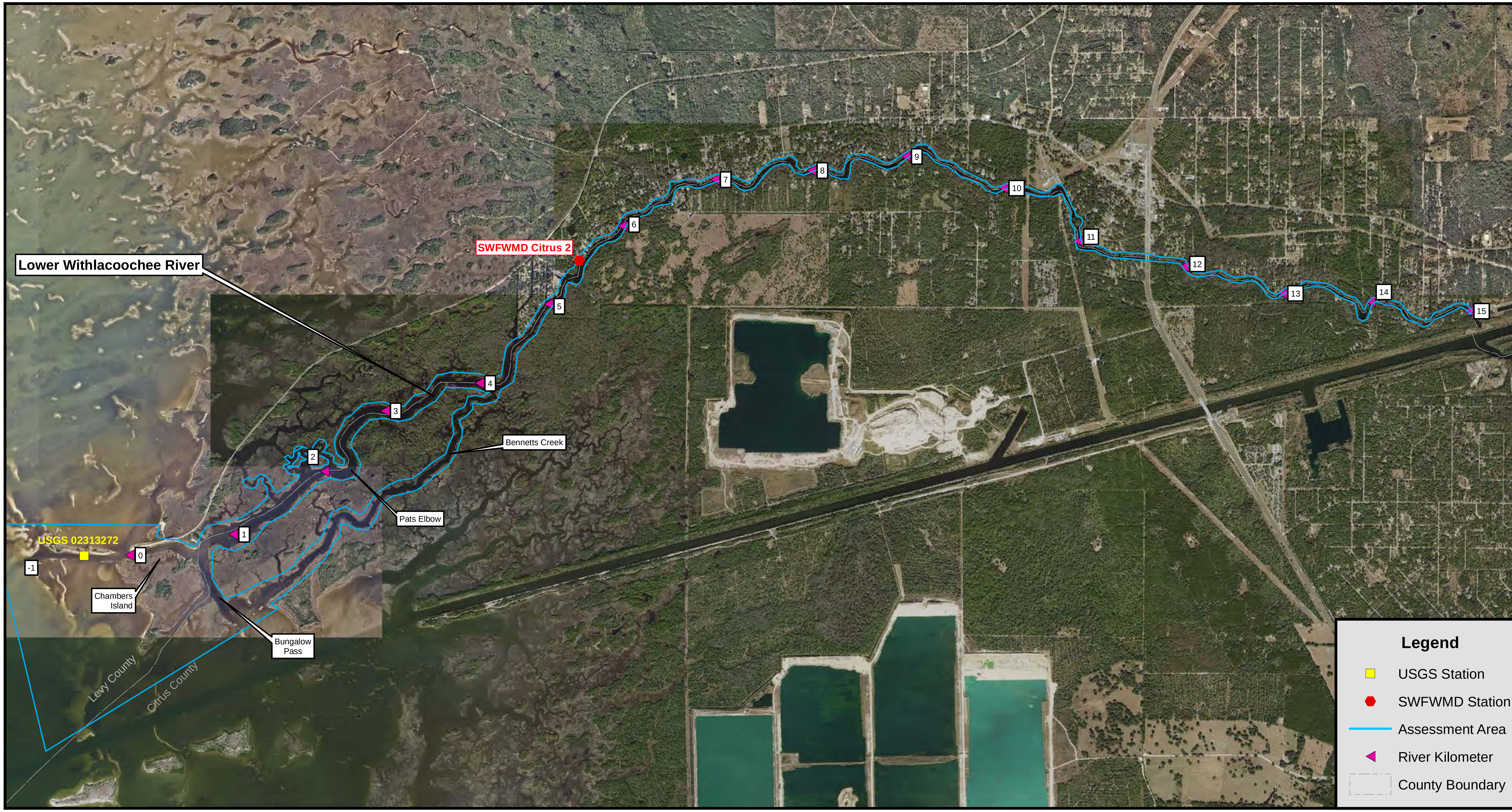

Figure 4.
Lower Withlacoochee River Oyster and Barnacle Assessment Area Showing River Kilometers and USGS / SWFWMD Stations
Levy and Citrus Counties, Florida

Source: FDOT, 2016, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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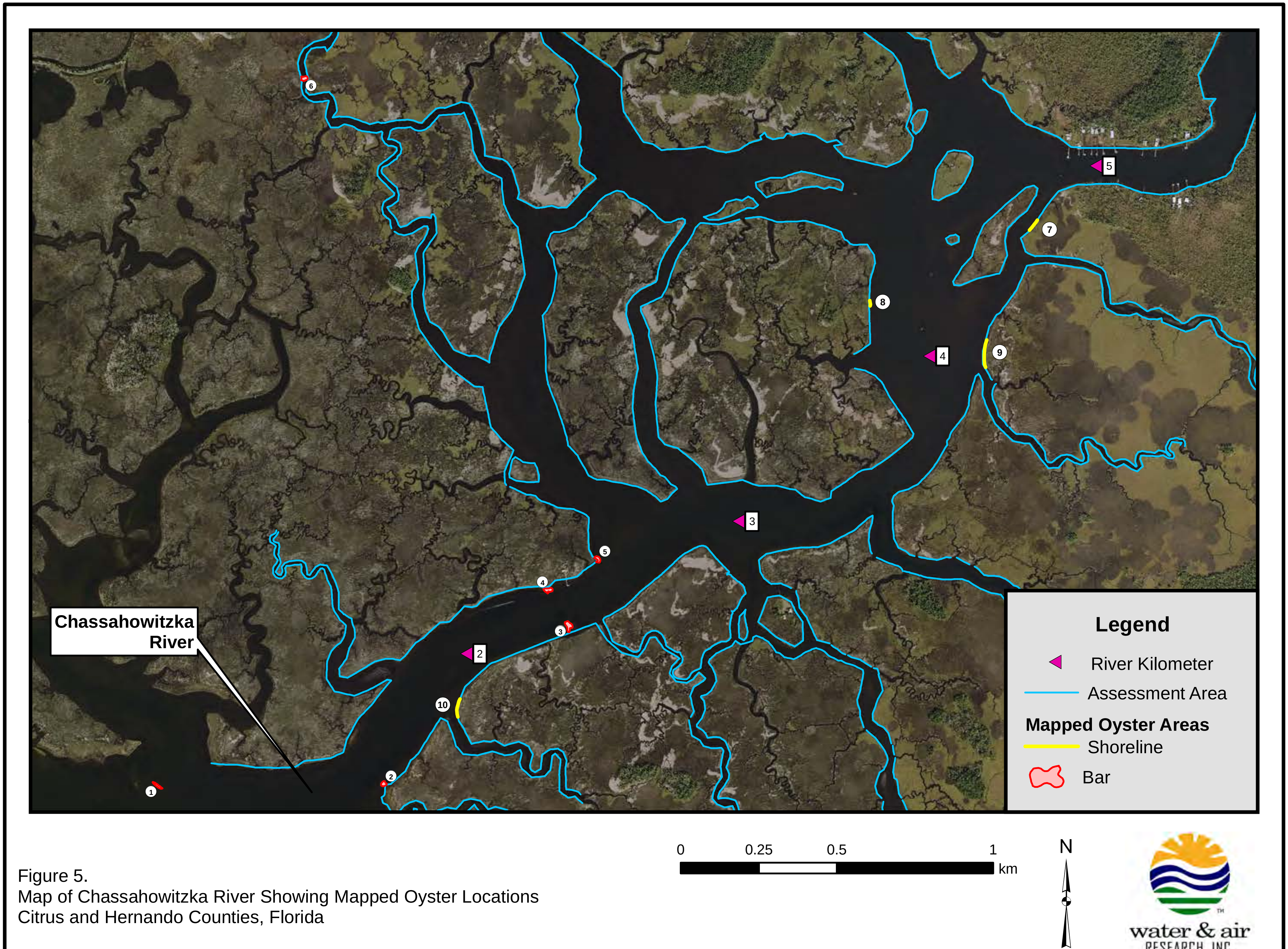

Figure 5.
Map of Chassahowitzka River Showing Mapped Oyster Locations
Citrus and Hernando Counties, Florida

Source: FDOT, 2017; SWFWMD, 2016; Water & Air Research, Inc., 2018.

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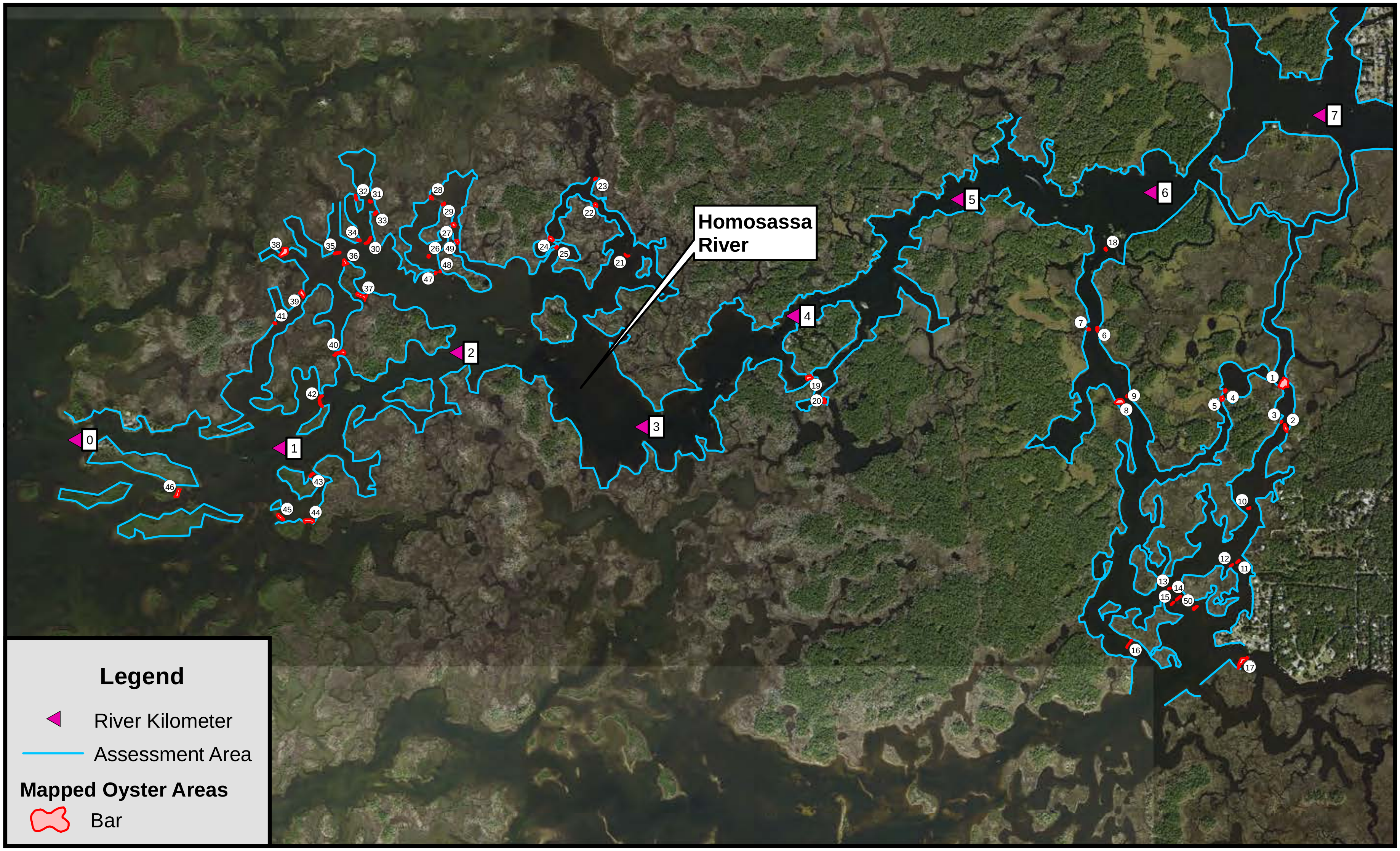

Figure 6.
Map of Homosassa River Showing Mapped Oyster Locations
Citrus County, Florida

Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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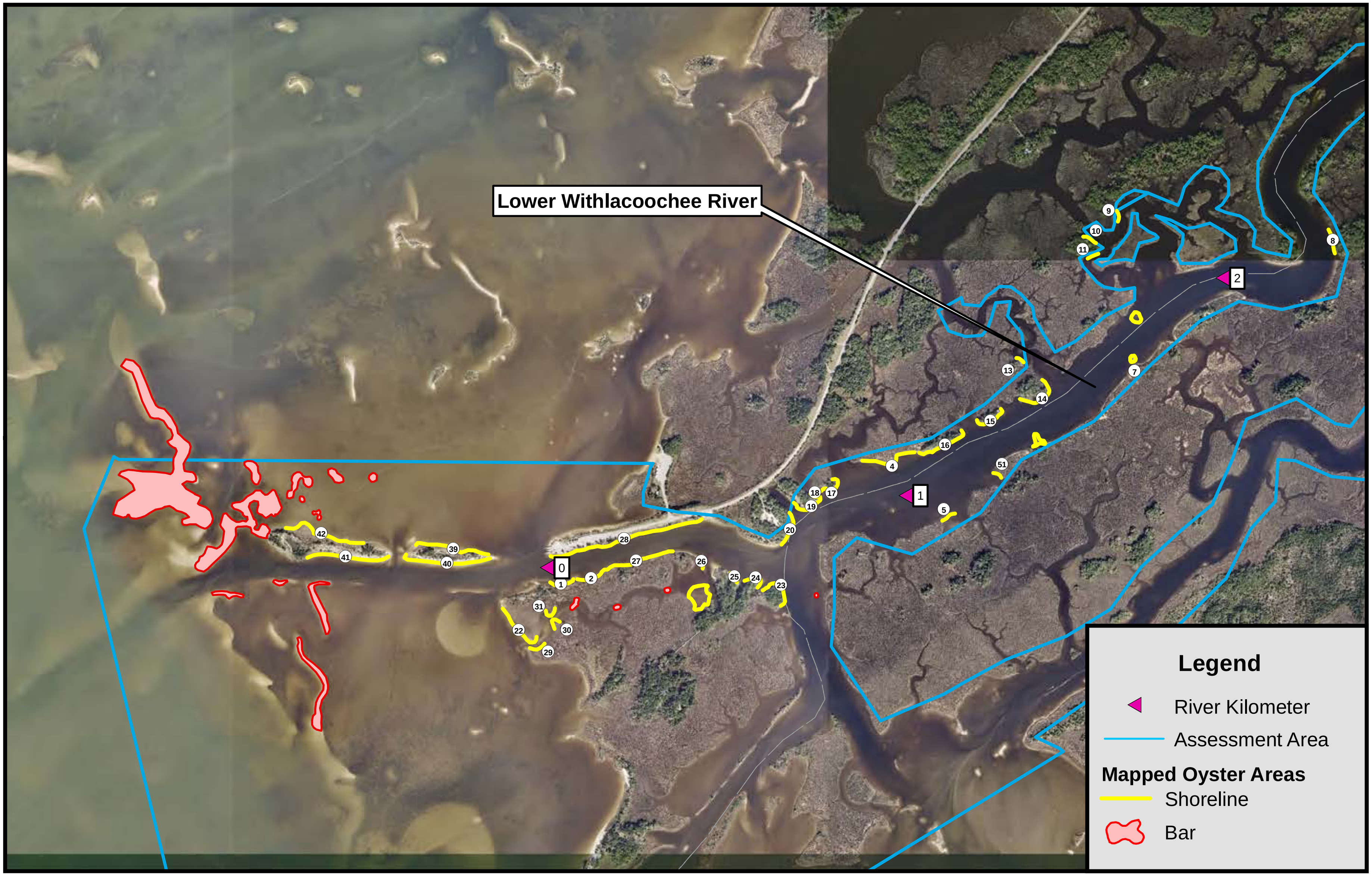

Figure 7.
Map of Lower Withlacoochee River Showing Mapped Oyster Locations
Levy and Citrus Counties, Florida

Source: FDOT, 2016, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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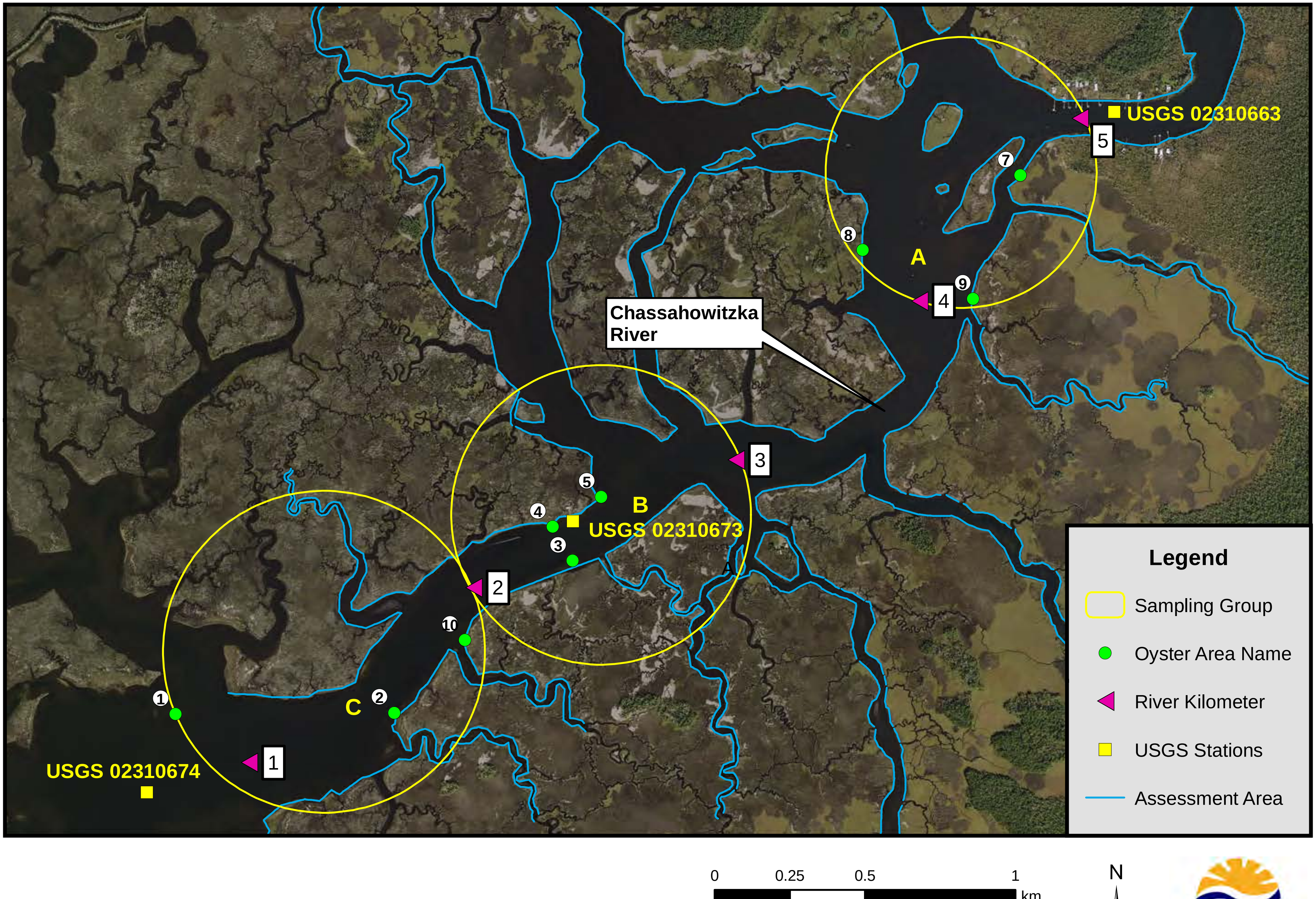

Figure 8.
Map of Chassahowitzka River Showing Oyster Sampling Locations
Citrus and Hernando Counties, Florida

Source: FDOT, 2017; SWFWMD, 2016; Water & Air Research, Inc., 2018.

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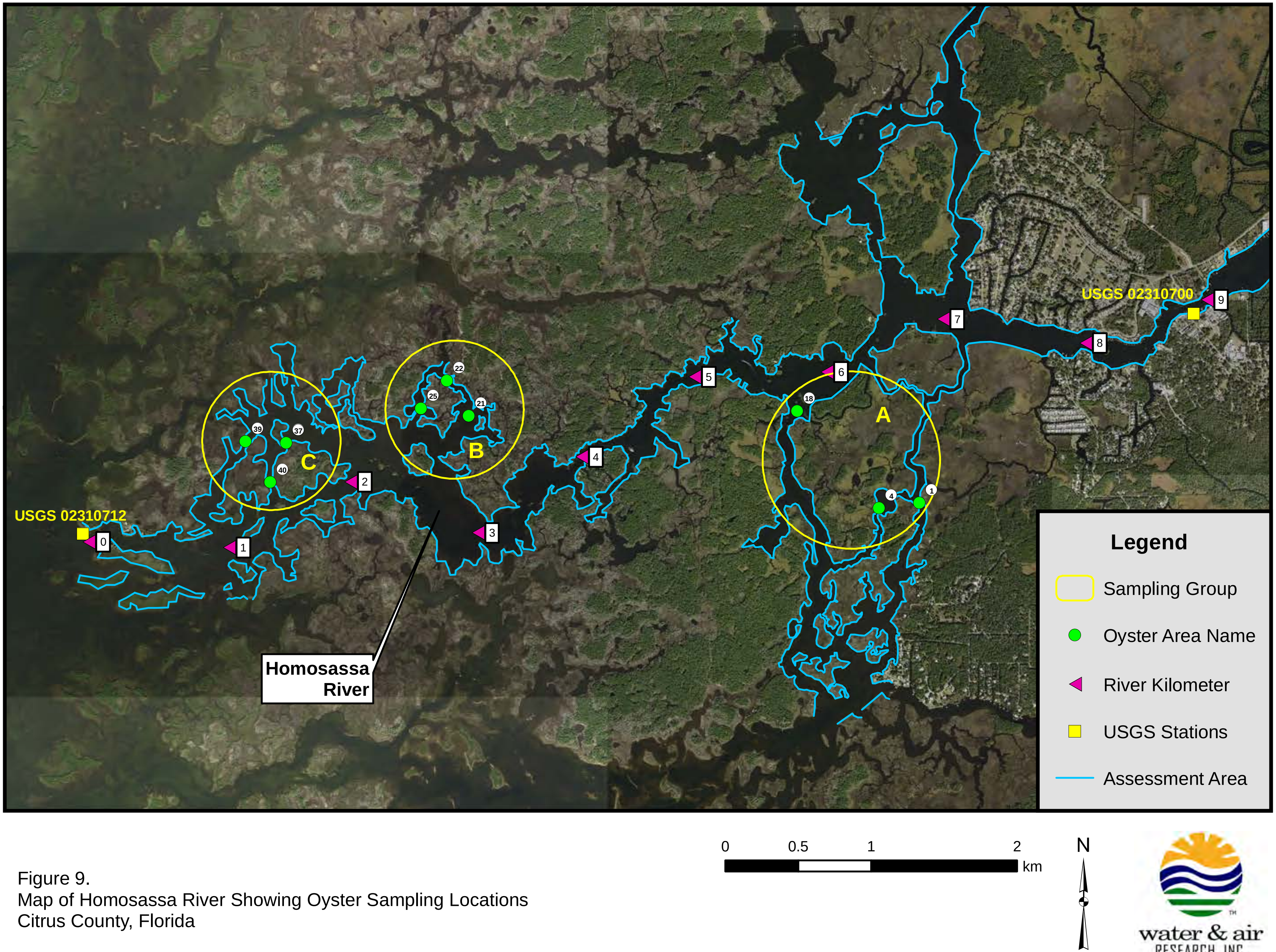

Figure 9.
Map of Homosassa River Showing Oyster Sampling Locations
Citrus County, Florida

Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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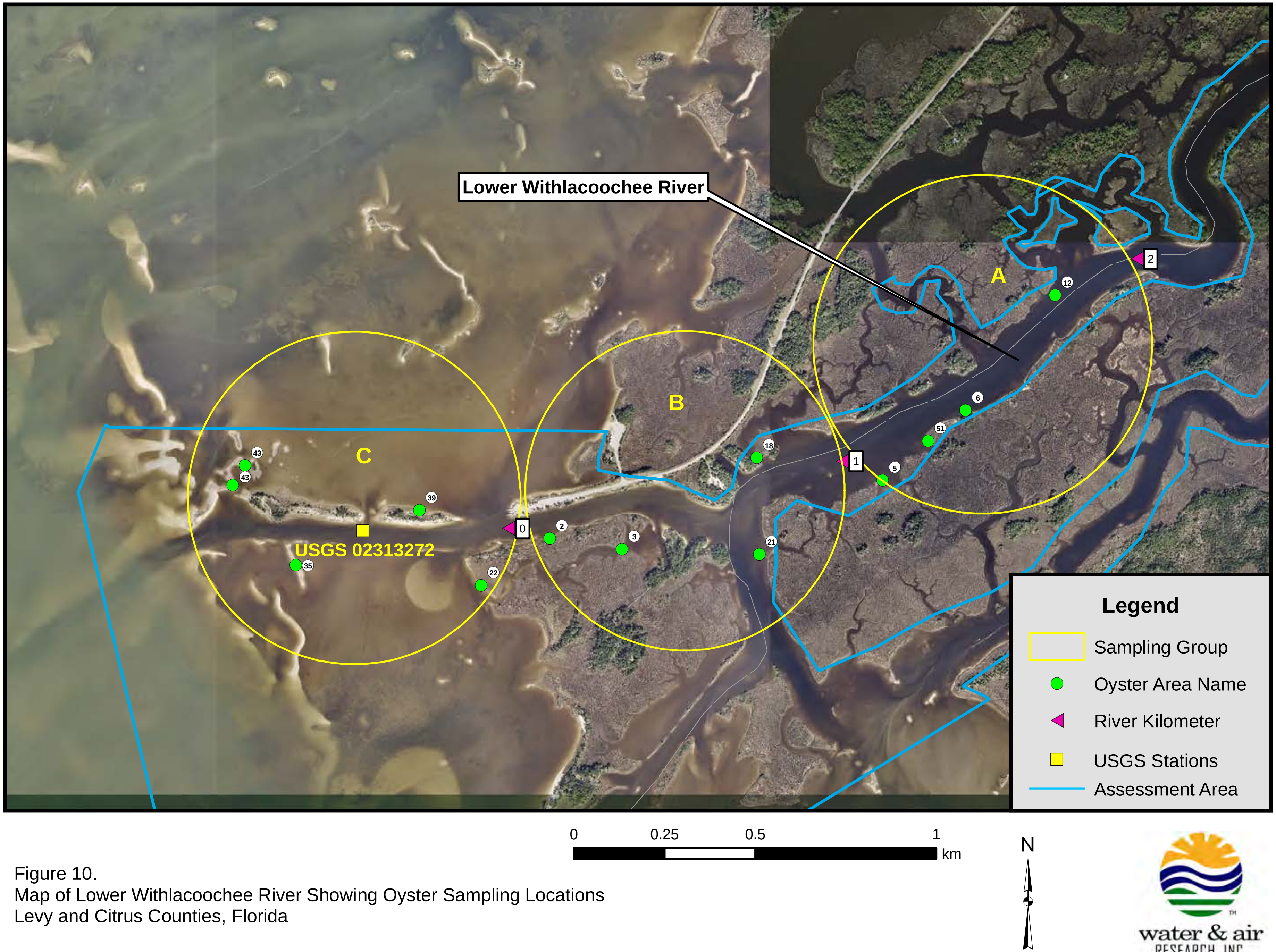

Figure 10.
Map of Lower Withlacoochee River Showing Oyster Sampling Locations
Levy and Citrus Counties, Florida

Source: FDOT, 2016, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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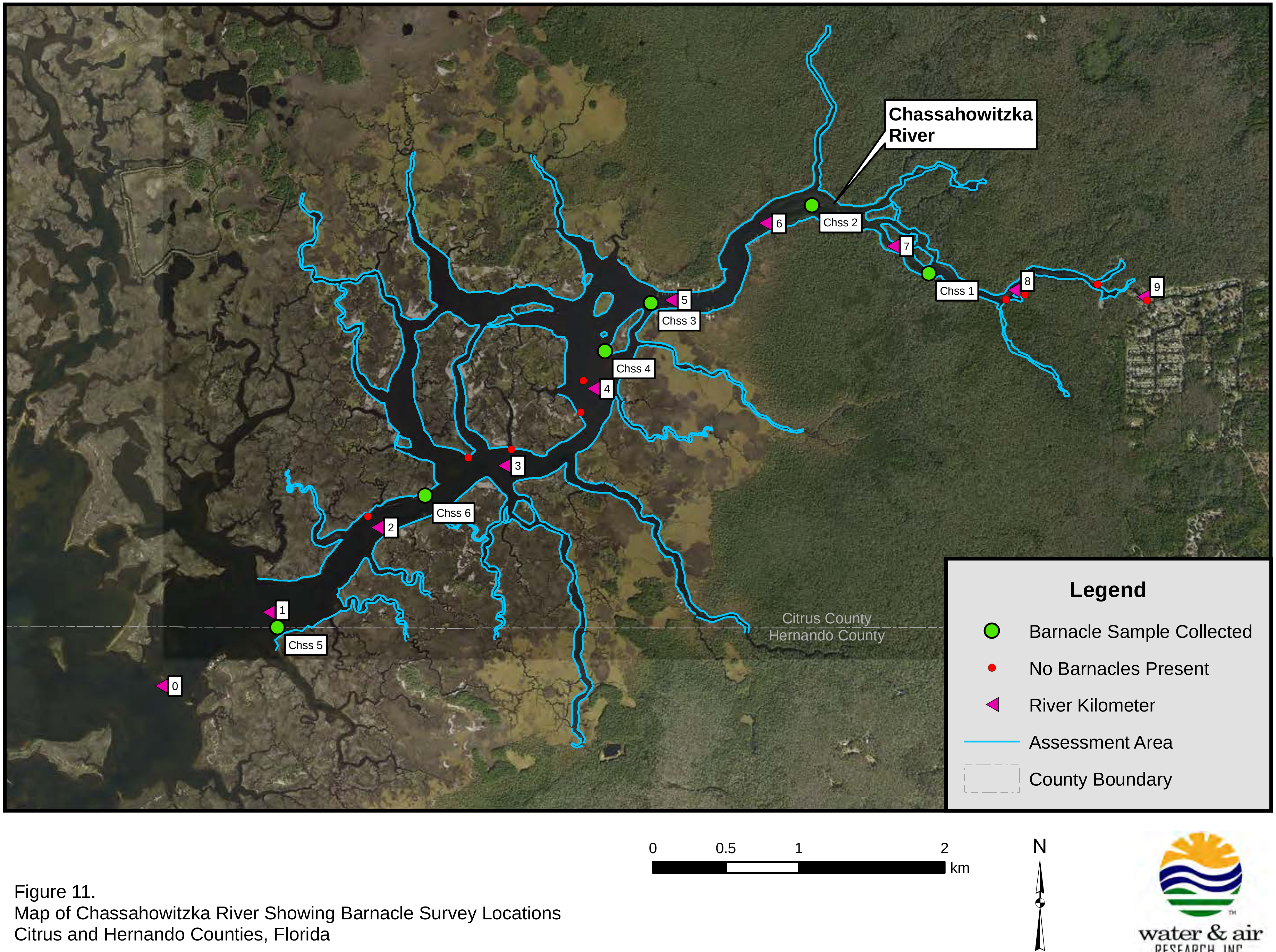

Figure 11.
Map of Chassahowitzka River Showing Barnacle Survey Locations
Citrus and Hernando Counties, Florida
Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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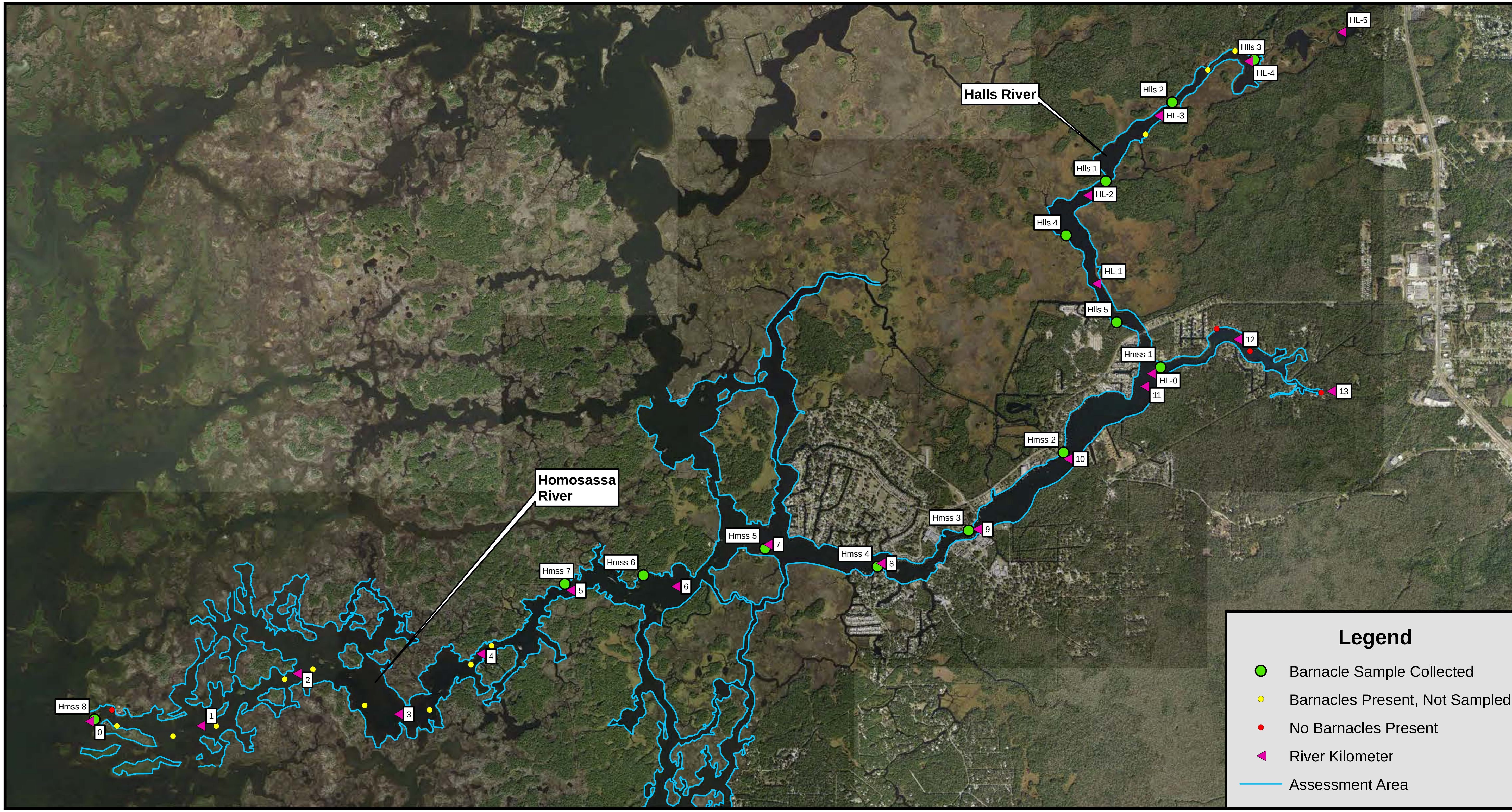

Figure 12.
Map of Homosassa and Halls River Showing Barnacle Survey Locations
Citrus County, Florida

Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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Figure 13.
Map of Lower Withlacoochee River Showing Barnacle Survey Locations
Levy and Citrus Counties, Florida

Source: FDOT, 2016, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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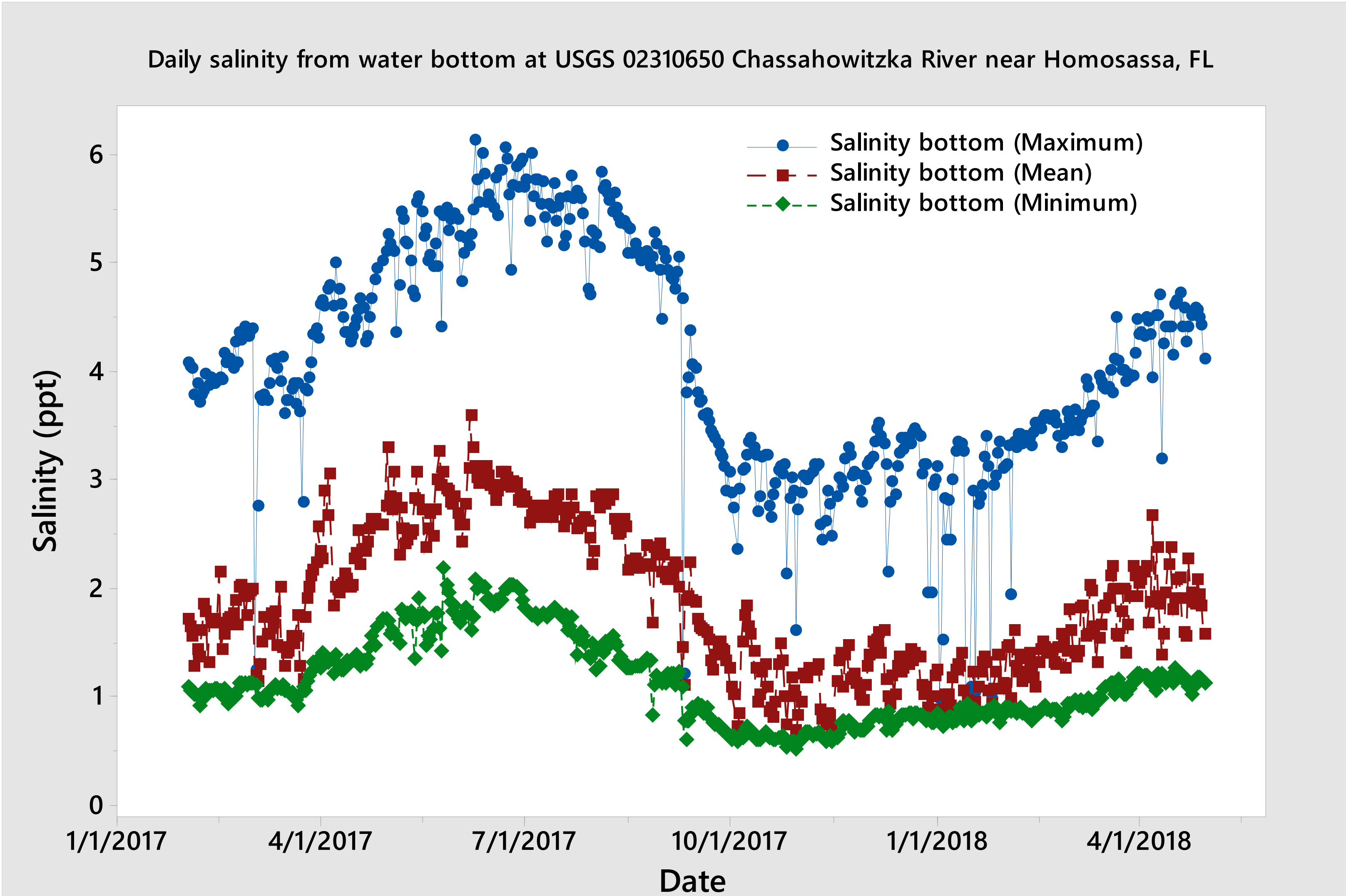


Figure 14. Maximum, mean, and minimum daily salinity (ppt) values from water bottom samples at USGS Station 02310650 Chassahowitzka River near Homosassa, Florida from 2/1/2017 to 4/30/2018.

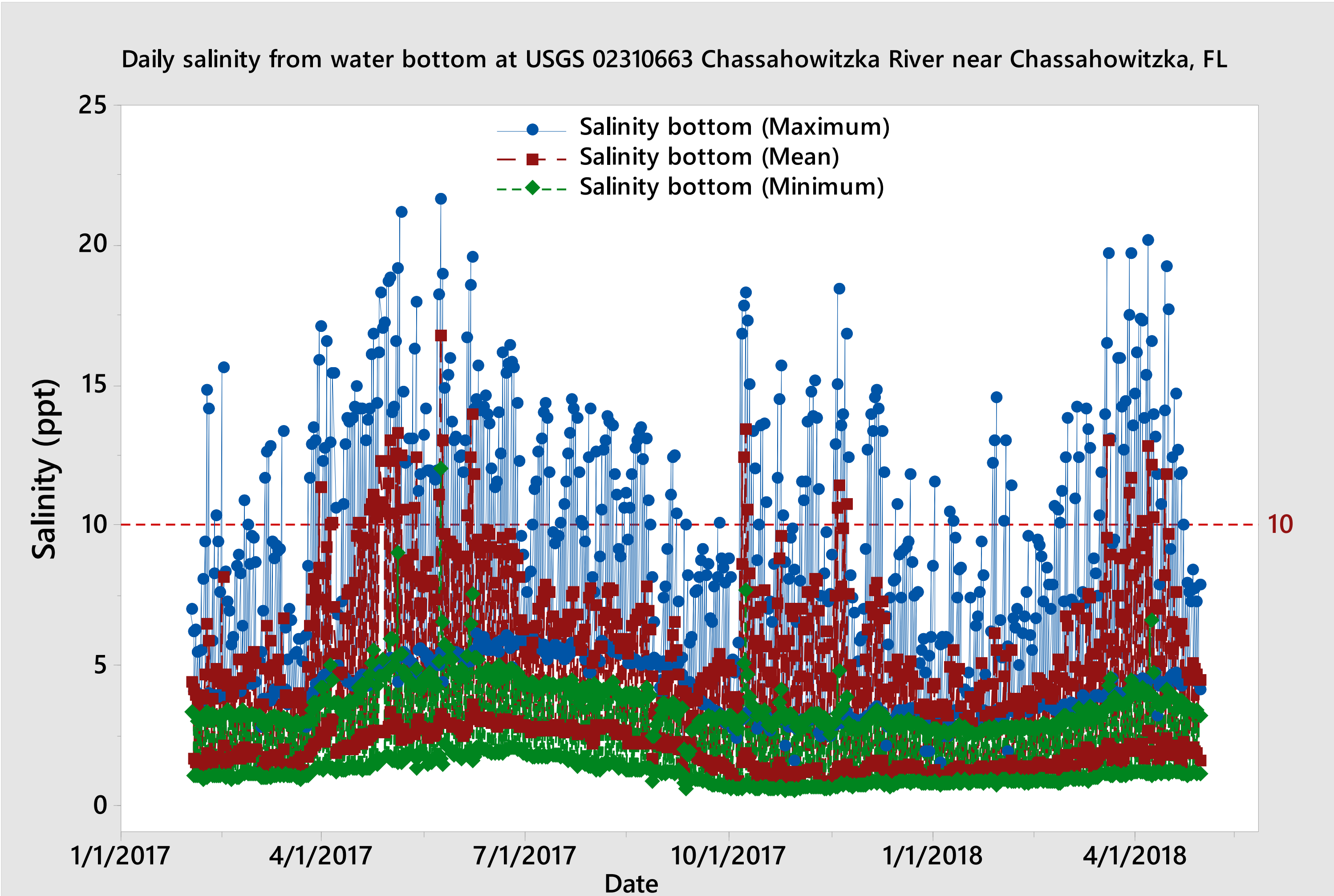


Figure 15. Maximum, mean, and minimum daily salinity (ppt) values from water bottom samples at USGS Station 02310663 Chassahowitzka River near Chassahowitzka, Florida from 2/1/2017 to 4/30/2018. Dashed line at 10 ppt marks the minimum salinity tolerance level for optimal growth and reproduction of *Crassostrea virginica*.

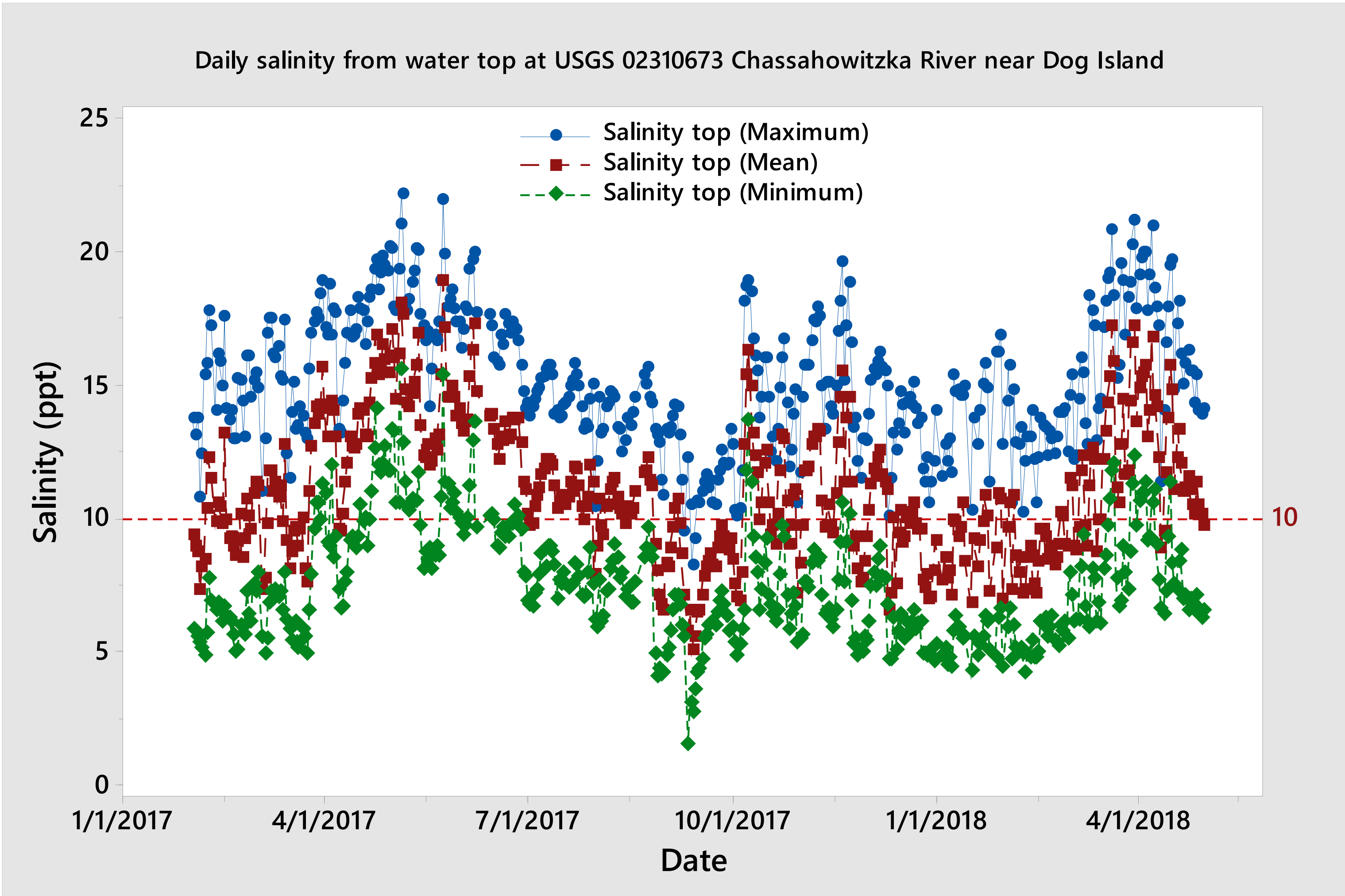


Figure 16. Maximum, mean, and minimum daily salinity (ppt) values from water top samples at USGS Station 02310673 Chassahowitzka River near Dog Island from 2/1/2017 to 4/30/2018. Dashed line at 10 ppt marks the minimum salinity tolerance level for optimal growth and reproduction of *Crassostrea virginica*.

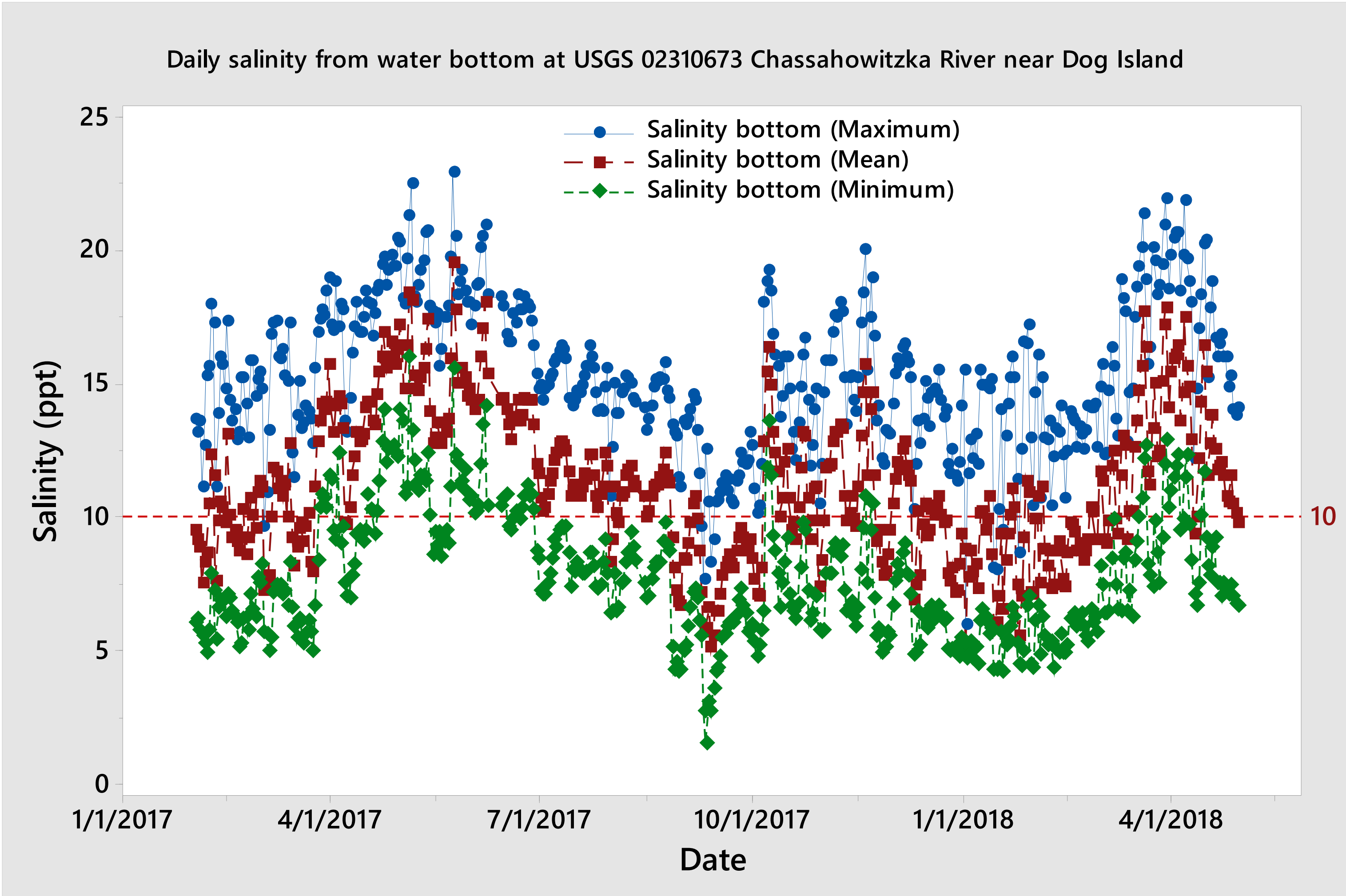


Figure 17. Maximum, mean, and minimum daily salinity (ppt) values from water bottom samples at USGS Station 02310673 Chassahowitzka River near Dog Island from 2/1/2017 to 4/30/2018. Dashed line at 10 ppt marks the minimum salinity tolerance level for optimal growth and reproduction of *Crassostrea virginica*.

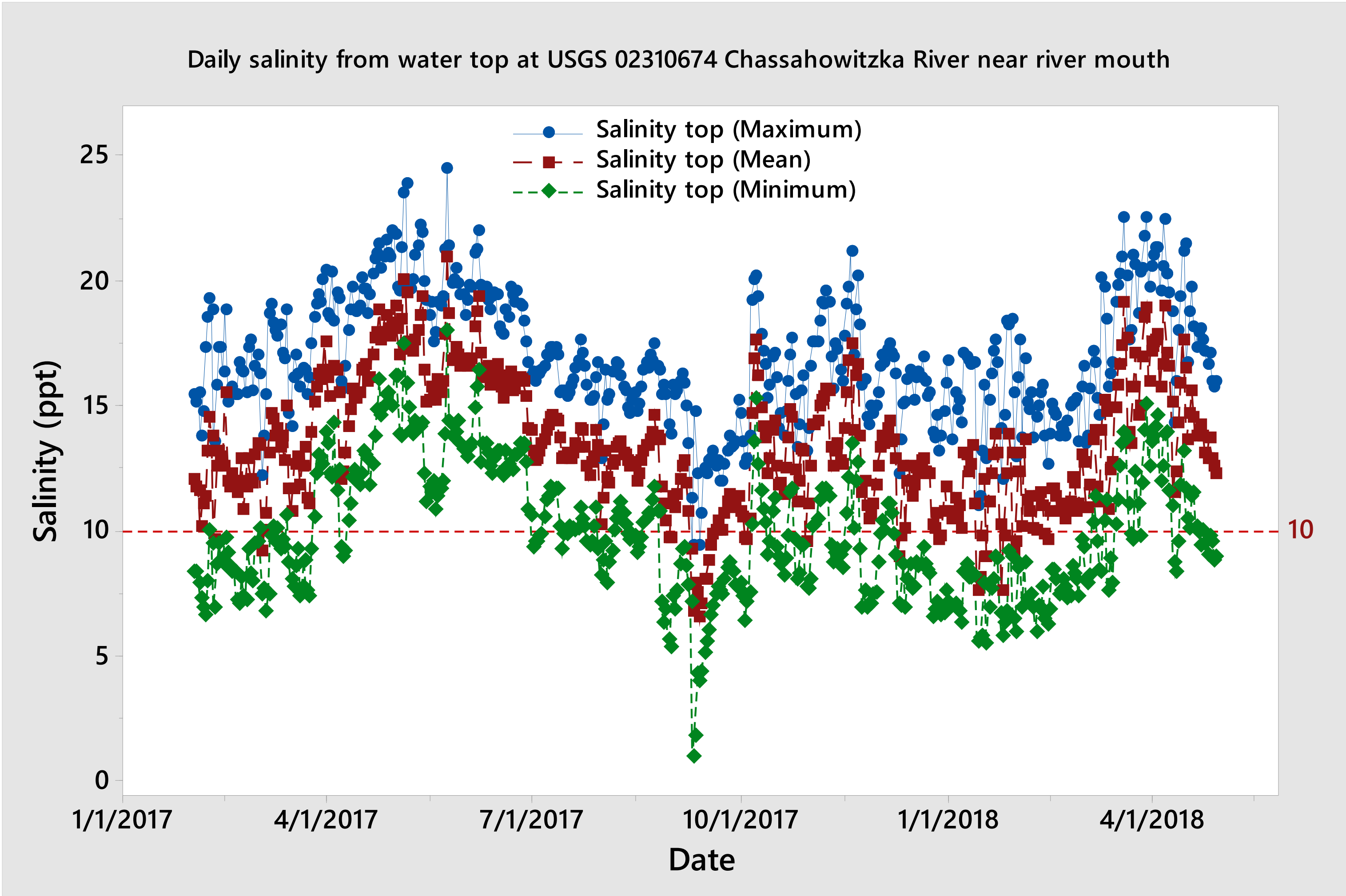


Figure 18. Maximum, mean, and minimum daily salinity (ppt) values from water top samples at USGS Station 02310674 Chassahowitzka River near river mouth from 2/1/2017 to 4/30/2018. Dashed line at 10 ppt marks the minimum salinity tolerance level for optimal growth and reproduction of *Crassostrea virginica*.

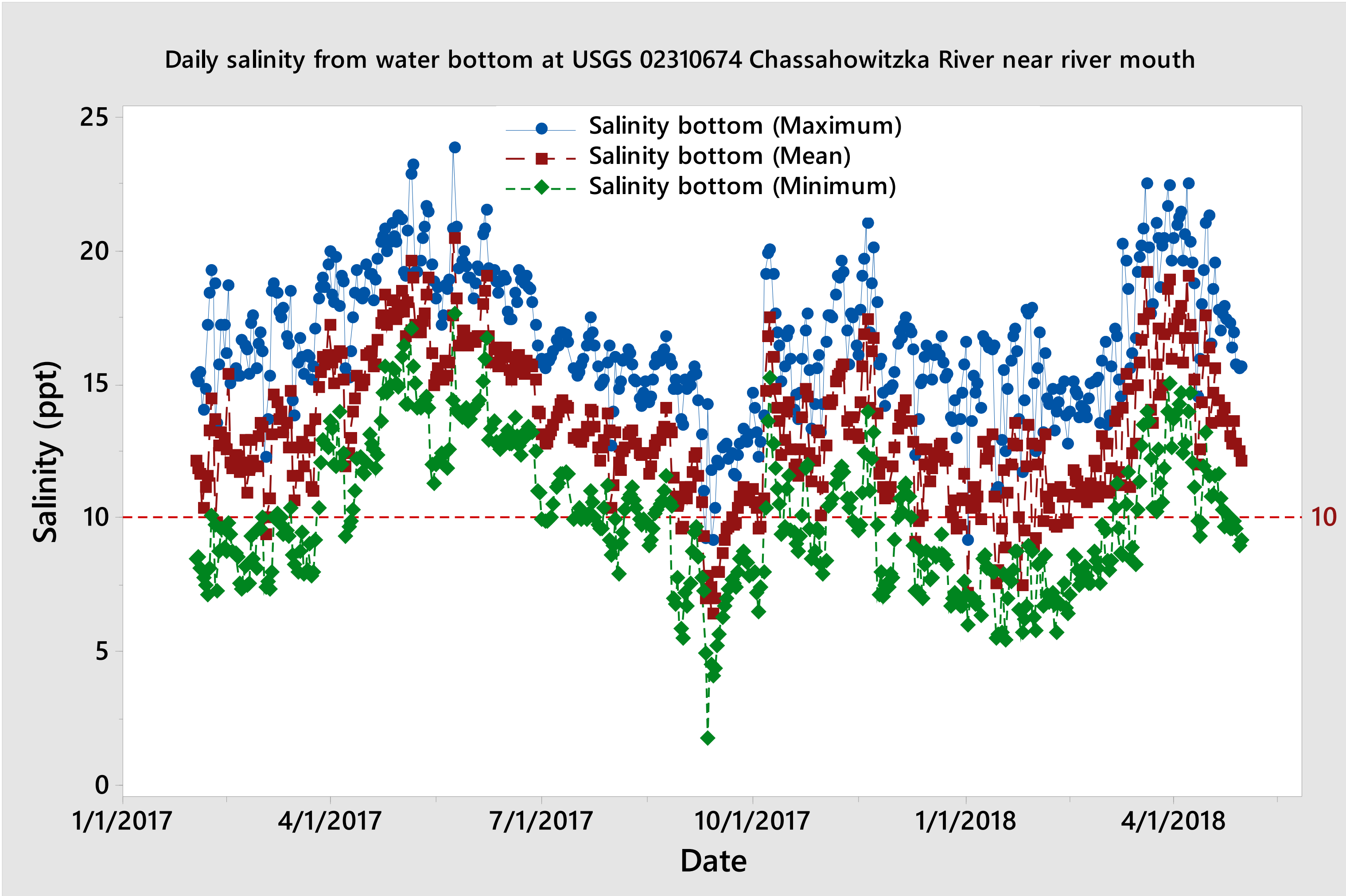


Figure 19. Maximum, mean, and minimum daily salinity (ppt) values from water bottom samples at USGS Station 02310674 Chassahowitzka River near river mouth from 2/1/2017 to 4/30/2018. Dashed line at 10 ppt marks the minimum salinity tolerance level for optimal growth and reproduction of *Crassostrea virginica*.

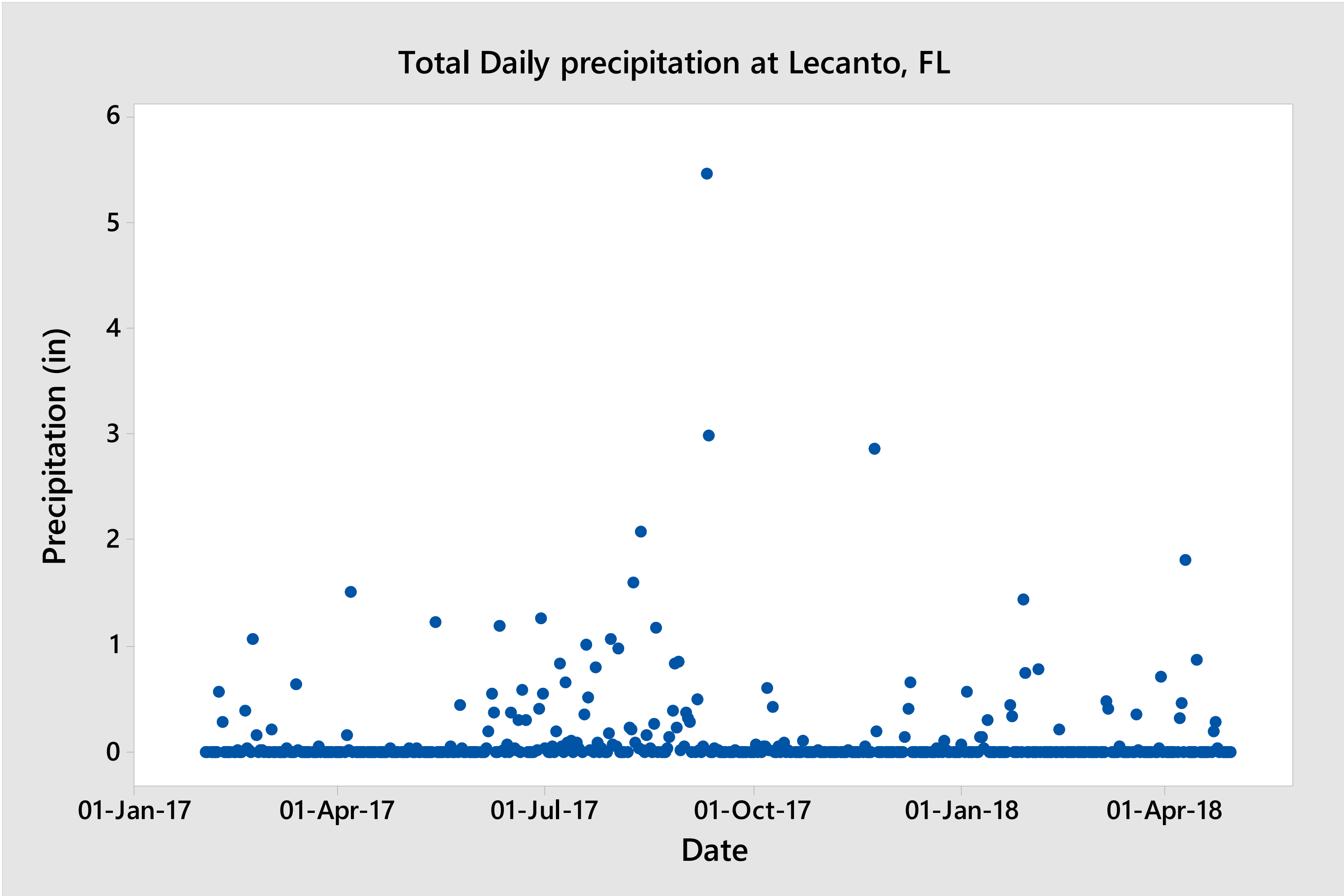


Figure 20. Total daily precipitation (inches) from 2/1/2017 to 4/30/2018 recorded at the Lecanto, Florida station for the Florida Automated Weather Network.

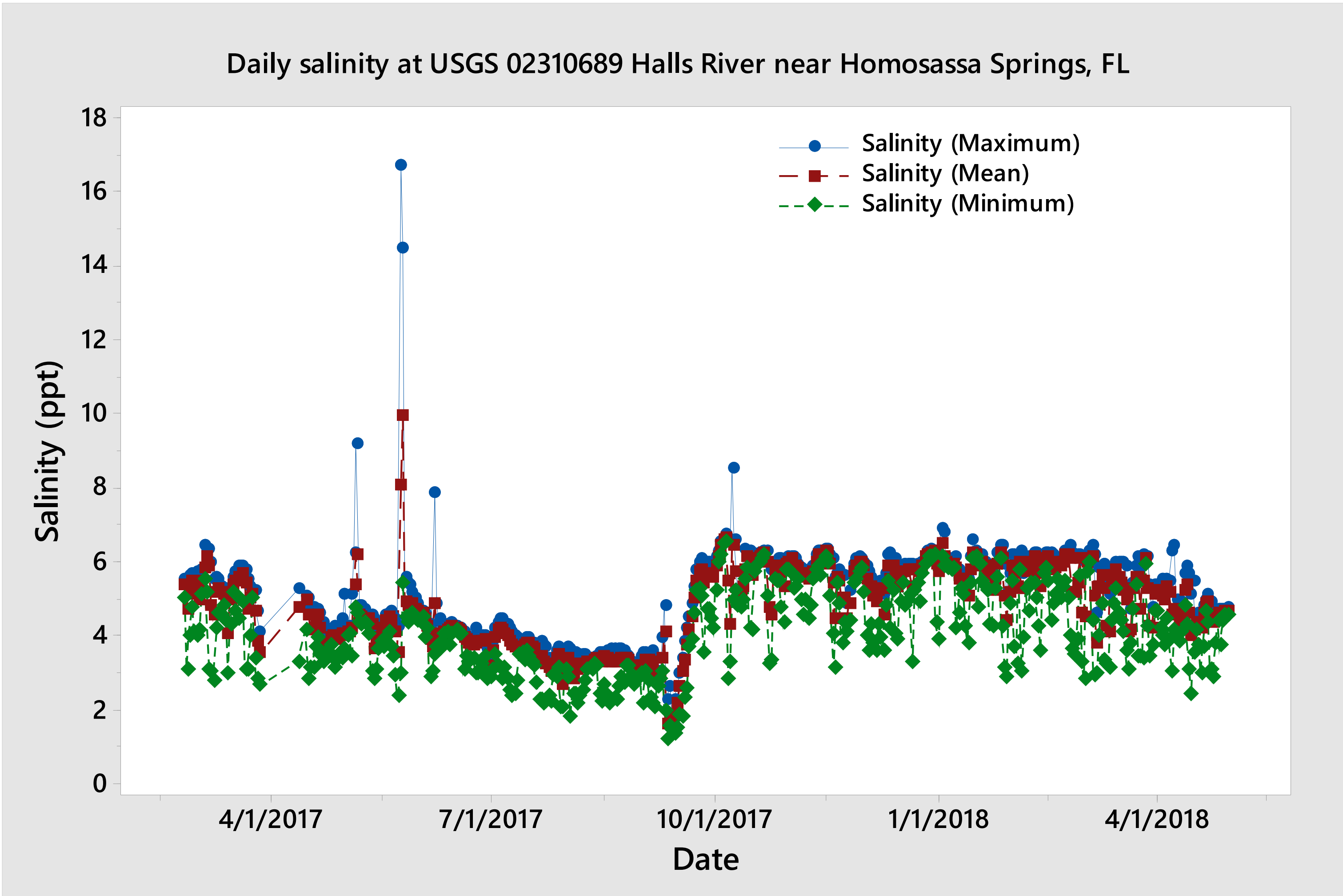


Figure 21. Maximum, mean, and minimum daily salinity (ppt) values from water samples at USGS Station 02310689 Halls River near Homosassa Springs, Florida from 2/1/2017 to 4/30/2018.

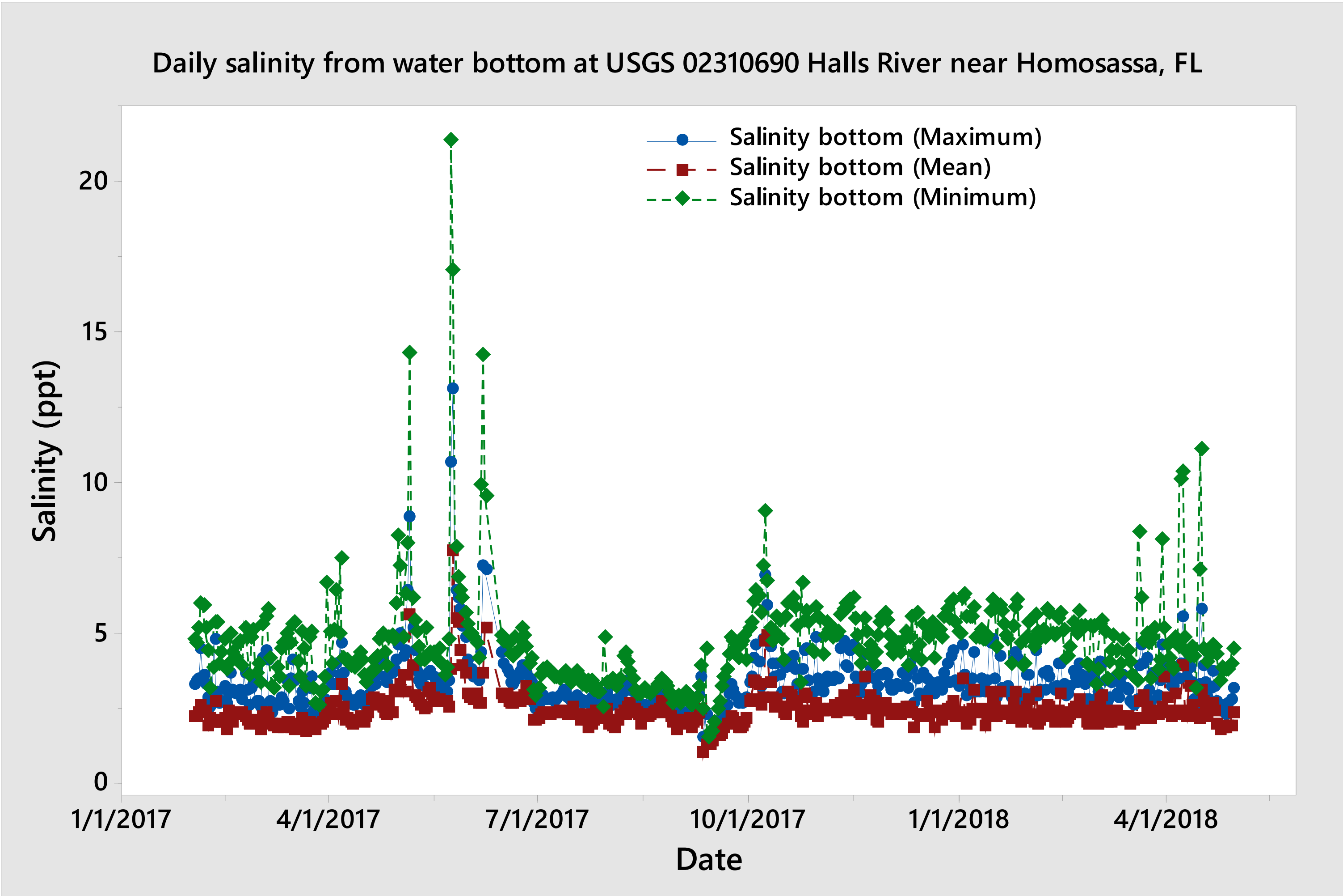


Figure 22. Maximum, mean, and minimum daily salinity (ppt) values from water bottom samples at USGS Station 02310690 Halls River near Homosassa, Florida from 2/1/2017 to 4/30/2018.

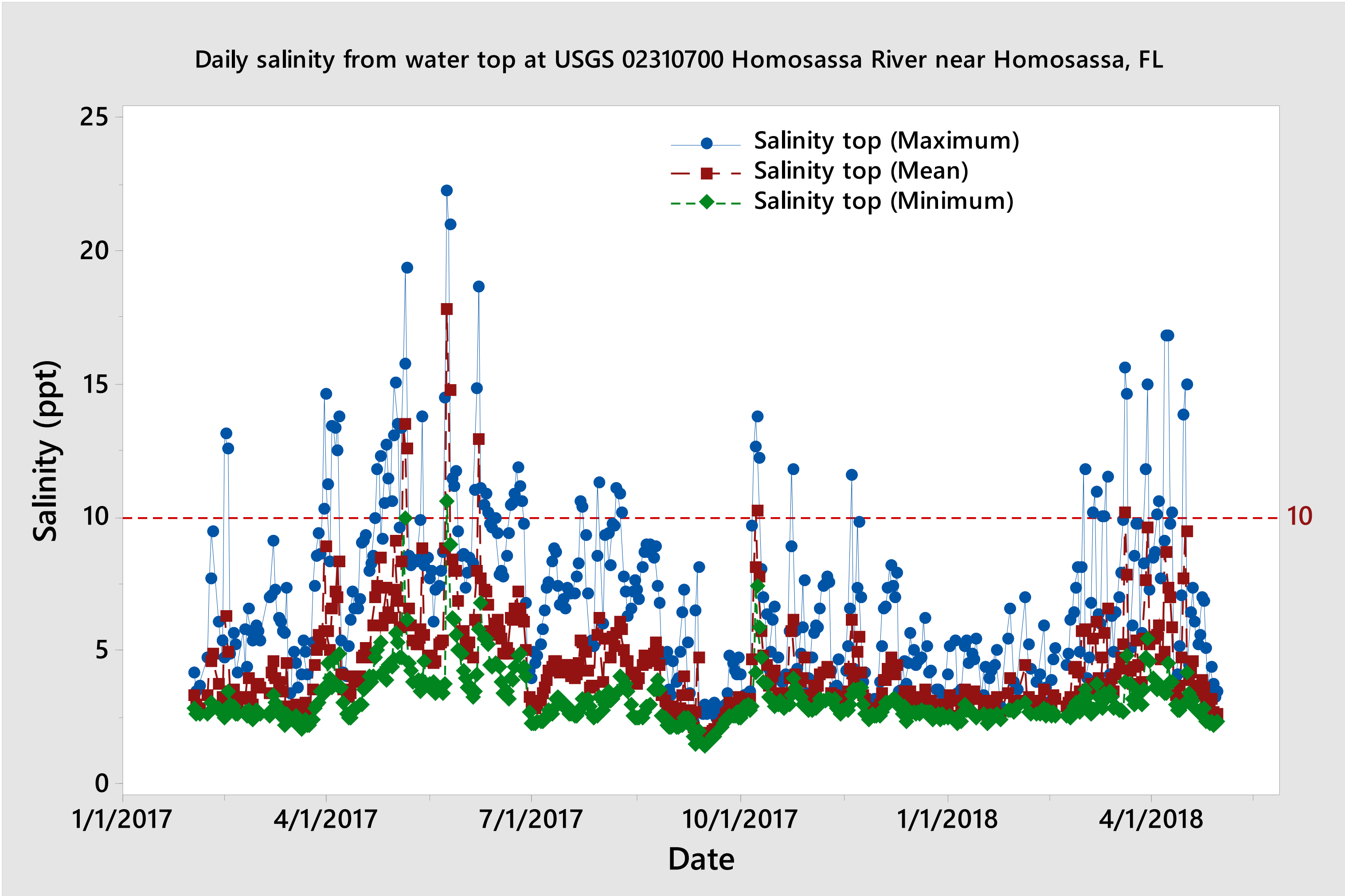


Figure 23. Maximum, mean, and minimum daily salinity (ppt) values from water top samples at USGS Station 02310700 Homosassa River near Homosassa, Florida from 2/1/2017 to 4/30/2018. Dashed line at 10 ppt marks the minimum salinity tolerance level for optimal growth and reproduction of *Crassostrea virginica*.

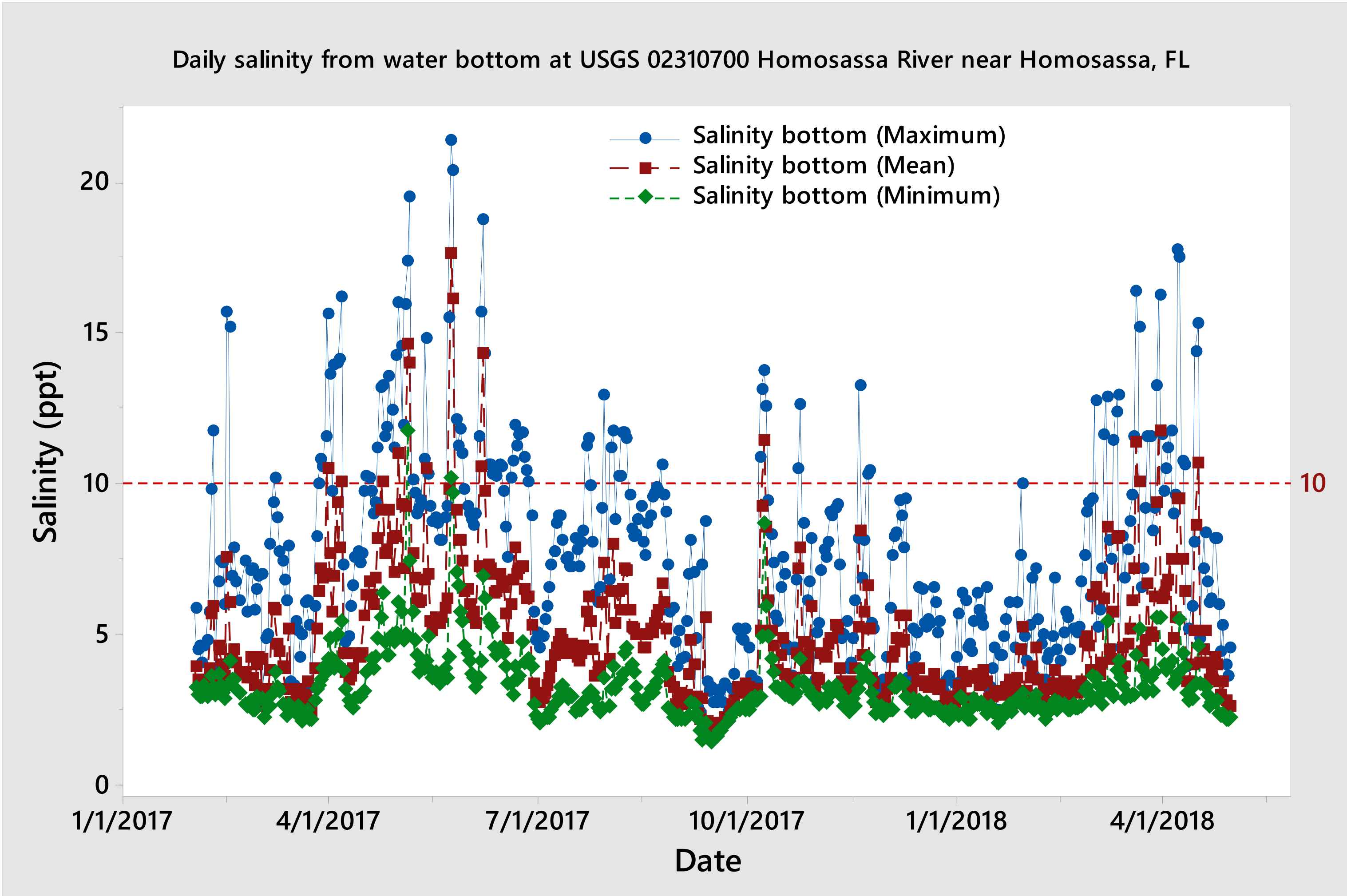


Figure 24. Maximum, mean, and minimum daily salinity (ppt) values from water bottom samples at USGS Station 02310700 Homosassa River near Homosassa, Florida from 2/1/2017 to 4/30/2018. Dashed line at 10 ppt marks the minimum salinity tolerance level for optimal growth and reproduction of *Crassostrea virginica*.

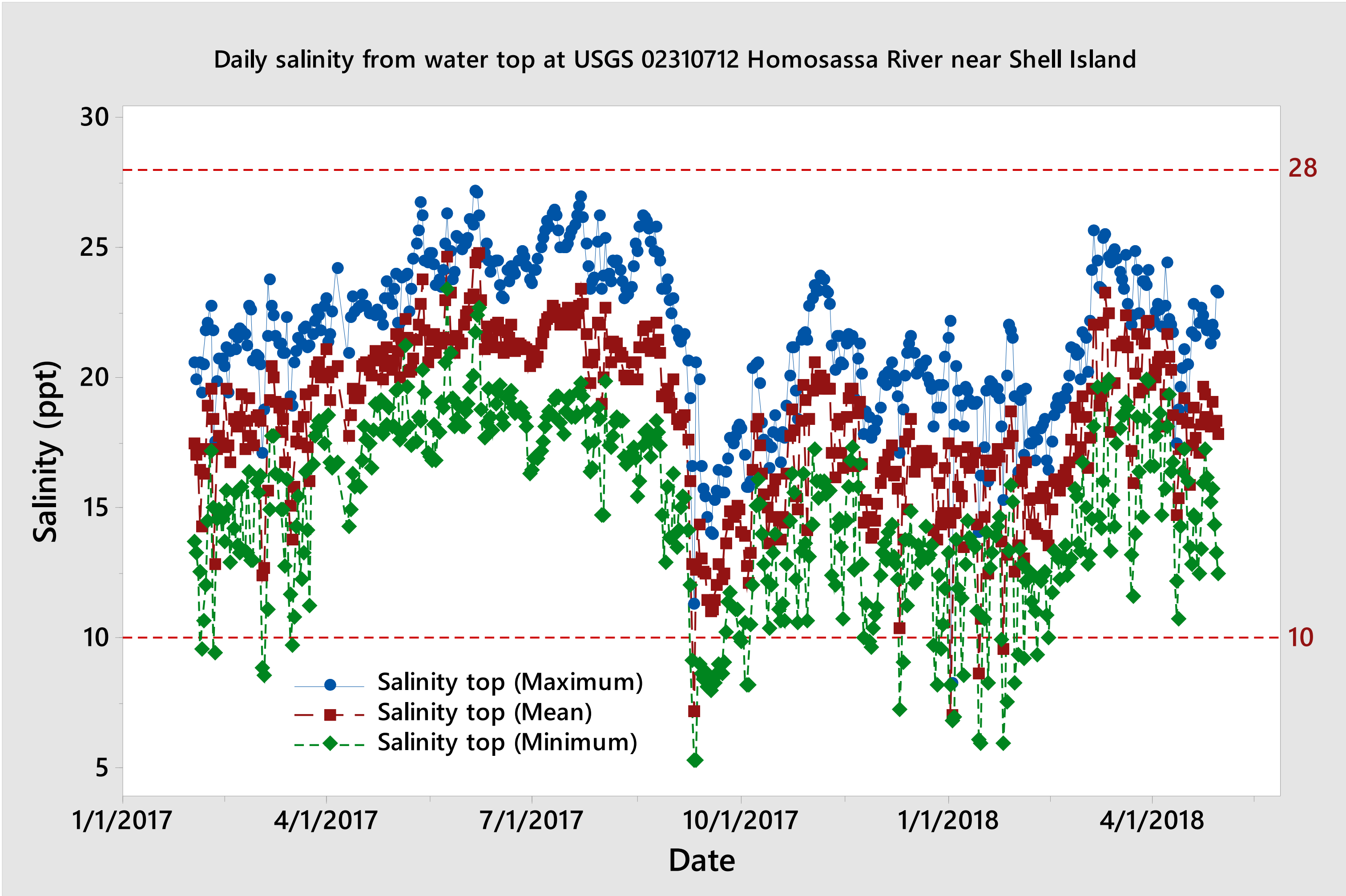


Figure 25. Maximum, mean, and minimum daily salinity (ppt) values from water top samples at USGS Station 02310712 Homosassa River near Shell Island from 2/1/2017 to 4/30/2018. Dashed lines at 10 ppt and 28 ppt marks the minimum and maximum salinity tolerance level for optimal growth and reproduction of *Crassostrea virginica*.

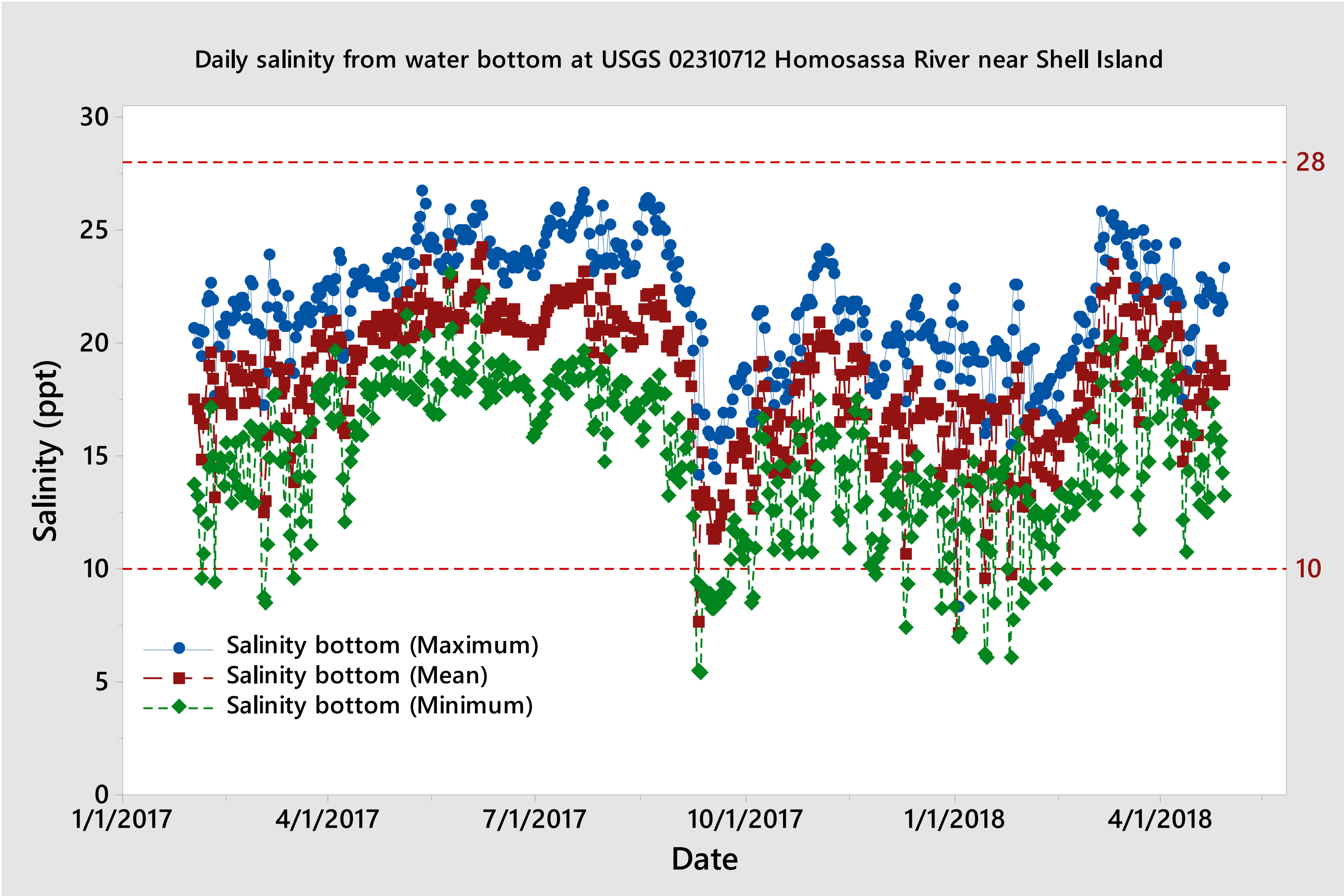


Figure 26. Maximum, mean, and minimum daily salinity (ppt) values from water bottom samples at USGS Station 02310712 Homosassa River near Shell Island from 2/1/2017 to 4/30/2018. Dashed lines at 10 ppt and 28 ppt mark the minimum and maximum salinity tolerance level for optimal growth and reproduction of *Crassostrea virginica*.

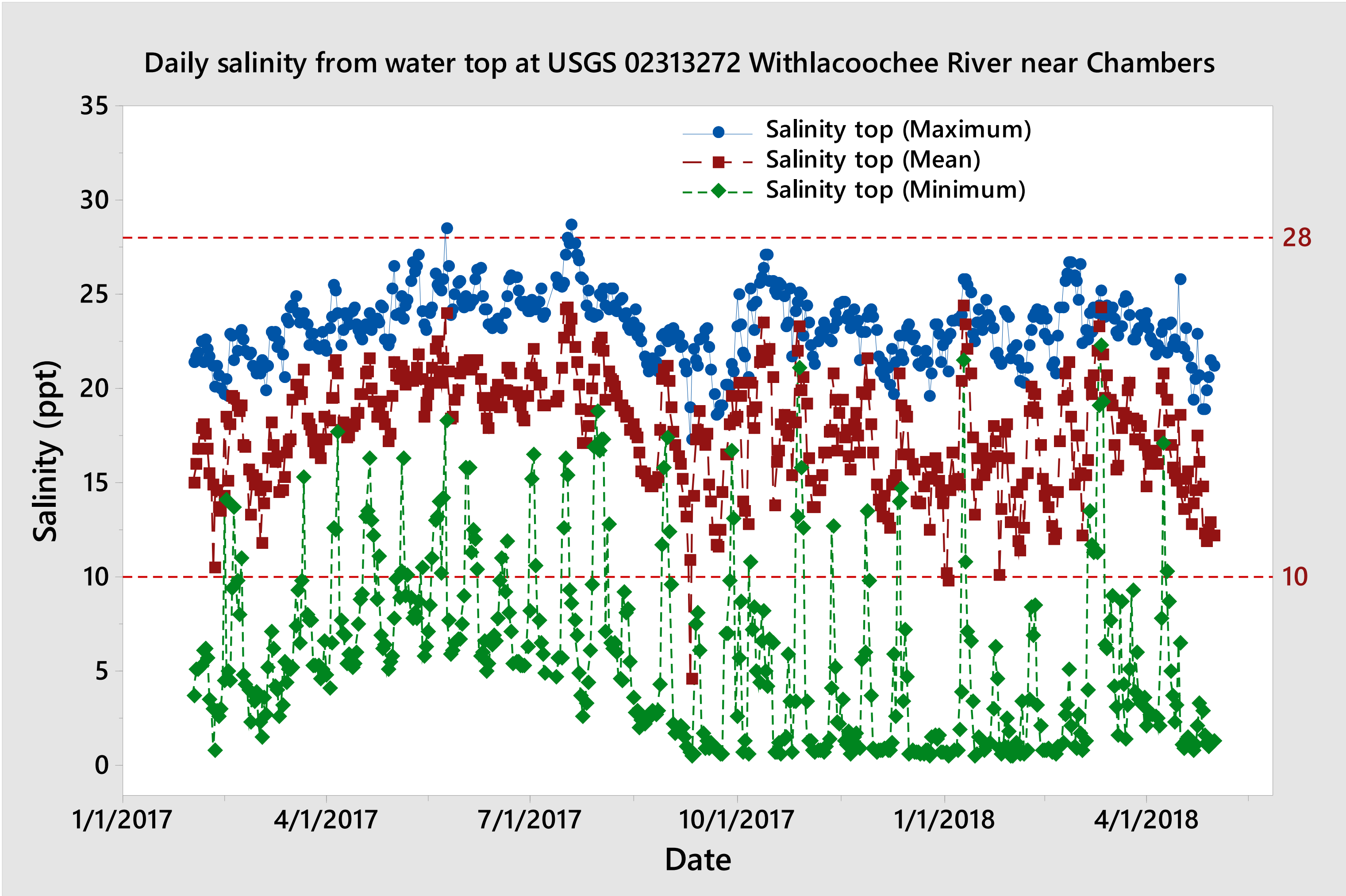


Figure 27. Maximum, mean, and minimum daily salinity (ppt) values from water top samples at USGS Station 02313272 Withlacoochee River near Chambers from 2/1/2017 to 4/30/2018. Dashed lines at 10 ppt and 28 ppt mark the minimum and maximum salinity tolerance level for optimal growth and reproduction of *Crassostrea virginica*.

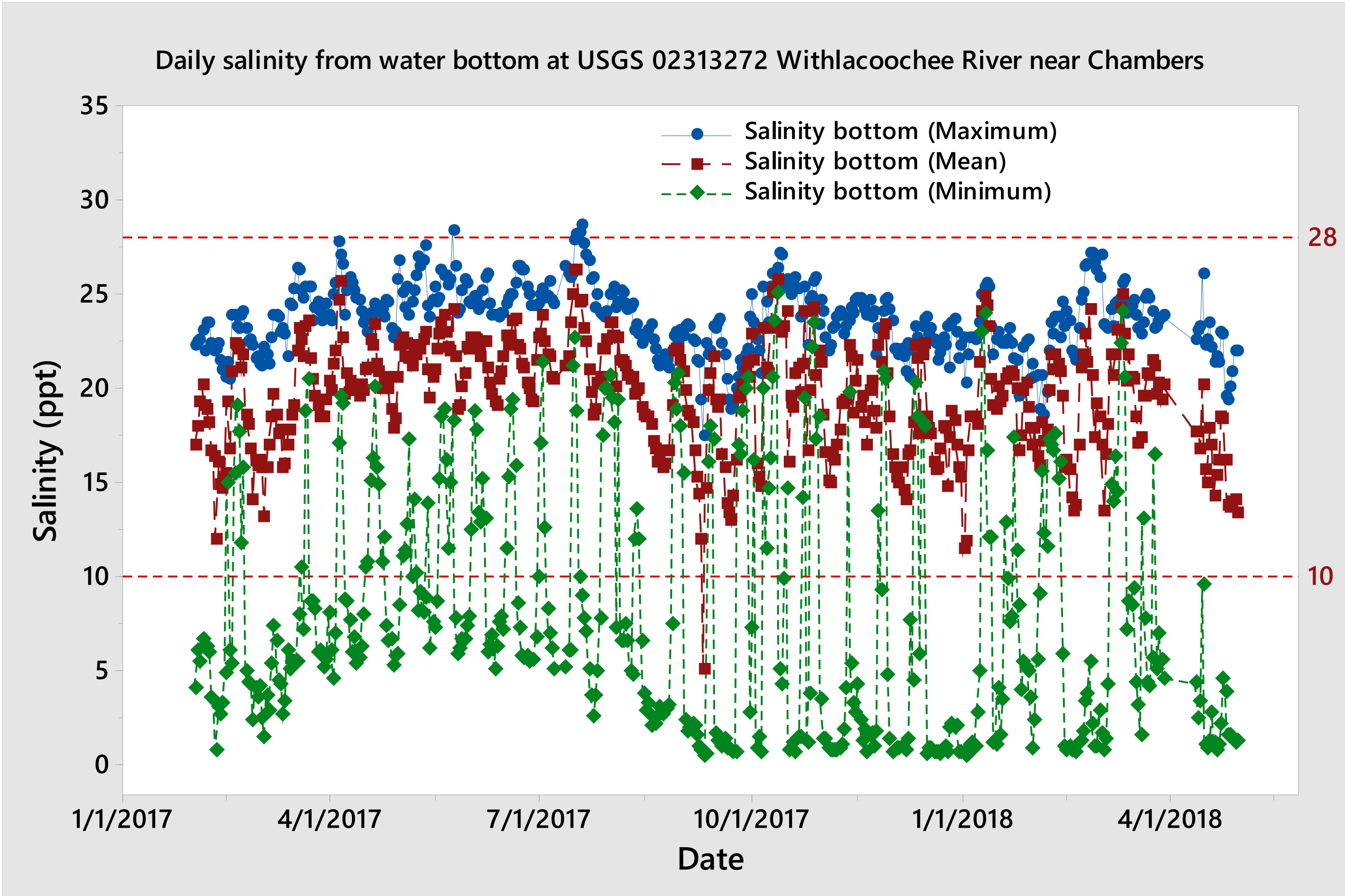


Figure 28. Maximum, mean, and minimum daily salinity (ppt) values from water bottom samples at USGS Station 02313272 Withlacoochee River near Chambers from 2/1/2017 to 4/30/2018. Dashed lines at 10 ppt and 28 ppt mark the minimum and maximum salinity tolerance level for optimal growth and reproduction of *Crassostrea virginica*.

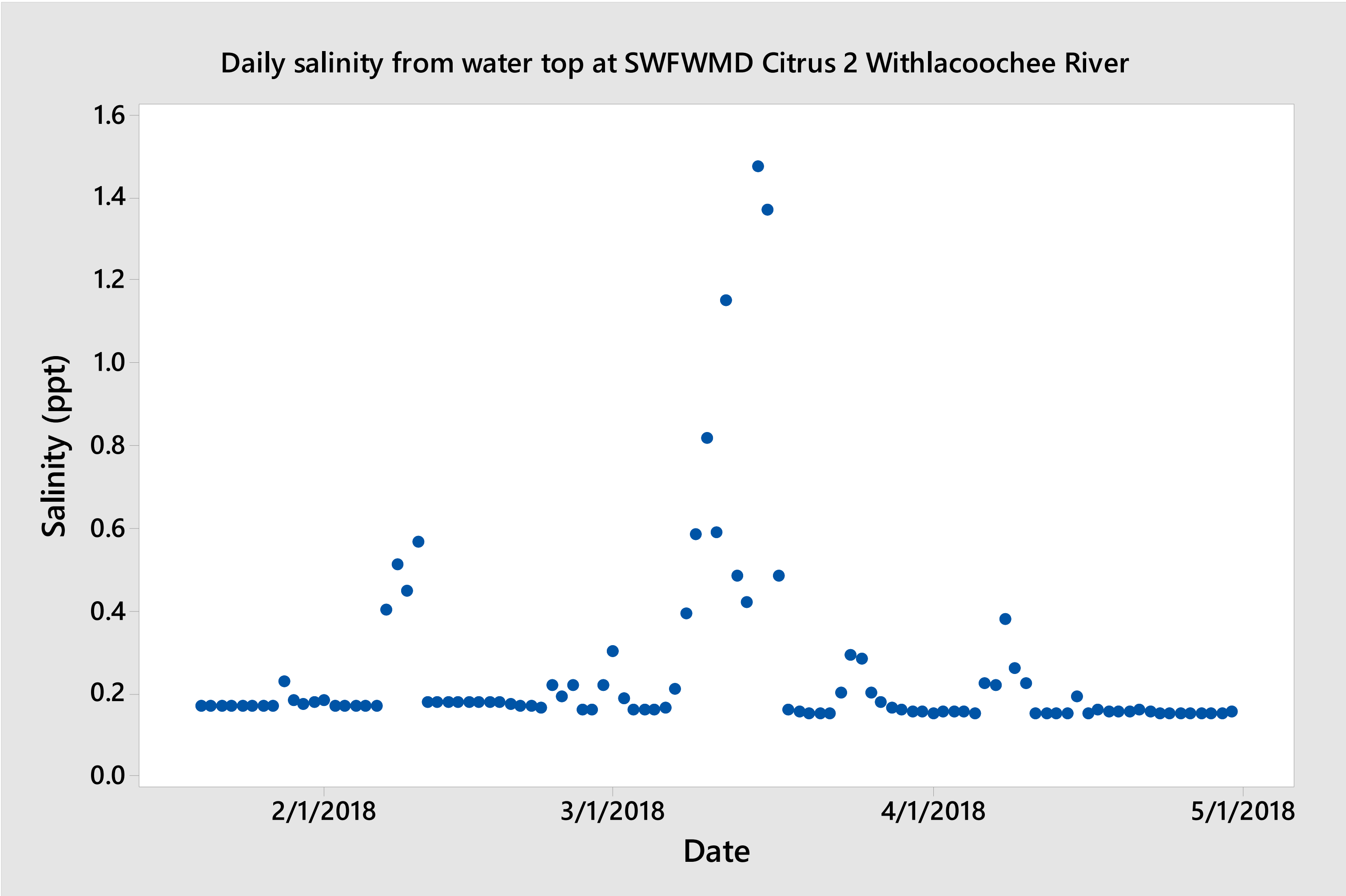


Figure 29. Mean daily salinity (ppt) values from water top samples at SWFWMD Citrus 2 Withlacoochee River from 1/20/2018 to 4/30/2018.

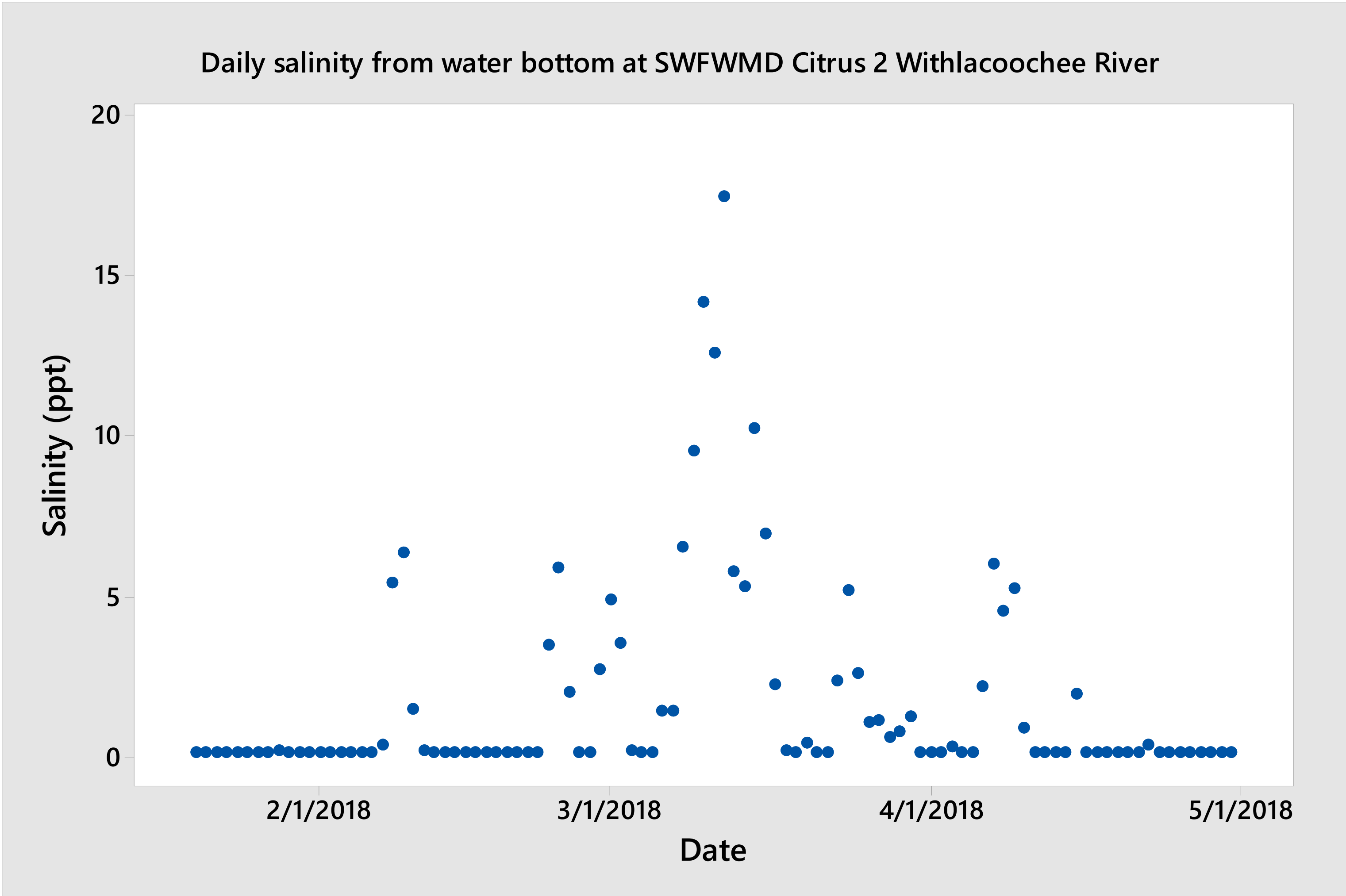


Figure 30. Mean daily salinity (ppt) values from water bottom samples at SWFWMD Citrus 2 Withlacoochee River from 1/20/2018 to 4/30/2018.

APPENDIX A

MAPPING AND SAMPLE COLLECTION INFORMATION

Appendix A Table 1. Mapped Oyster Locations on the Chassahowitzka River, Citrus and Hernando Counties, Florida.

Survey Date	Oyster Area Name	Location Type*	Latitude	Longitude	Area (m^2)
4/2/2018	Chas_01	bar	28.696800	-82.638199	200.47
4/2/2018	Chas_02	bar	28.696899	-82.630798	203.14
3/27/2018	Chas_03	bar	28.701500	-82.624702	466.21
4/2/2018	Chas_04	bar	28.702499	-82.625397	312.65
4/2/2018	Chas_05	bar	28.703400	-82.623802	234.35
2/21/2018	Chas_06	bar	28.717199	-82.633499	257.09
3/27/2018	Chas_07	clusters	28.713100	-82.609596	n/a
3/27/2018	Chas_08	clusters	28.710800	-82.614899	n/a
3/27/2018	Chas_09	clusters	28.709400	-82.611198	n/a
4/2/2018	Chas_10	clusters	28.699100	-82.628403	n/a
Total Area					**1674**

* Note: bar = oyster bar, clusters = scattered oyster clusters along the shoreline

Appendix A Table 2. Mapped Oyster Locations on the Homosassa River, Citrus County, Florida.

Survey Date	Oyster Area Name	Location Type*	Latitude	Longitude	Area (m^2)
3/22/2018	Homo_01	bar	28.773201	-82.637253	1579.41
3/22/2018	Homo_02	bar	28.771299	-82.637181	459.79
3/22/2018	Homo_03	bar	28.771556	-82.637371	66.09
3/22/2018	Homo_04	bar	28.772866	-82.640078	145.03
3/22/2018	Homo_05	bar	28.772522	-82.640242	274.92
3/22/2018	Homo_06	bar	28.775473	-82.646272	185.99
3/22/2018	Homo_07	bar	28.775448	-82.646677	108.93
3/22/2018	Homo_08	bar	28.772389	-82.645207	786.14
3/22/2018	Homo_09	bar	28.772624	-82.644837	45.49
3/22/2018	Homo_10	bar	28.767877	-82.638911	98.29
3/22/2018	Homo_11	bar	28.765614	-82.639441	105.97
3/22/2018	Homo_12	bar	28.765446	-82.639739	67.95
3/22/2018	Homo_13	bar	28.764460	-82.642706	60.03
3/22/2018	Homo_14	bar	28.764053	-82.642278	150.09
3/22/2018	Homo_15	bar	28.763833	-82.642562	90.64
3/22/2018	Homo_16	bar	28.762105	-82.644660	183.20
3/22/2018	Homo_17	bar	28.761394	-82.639181	829.23
3/23/2018	Homo_18	bar	28.778851	-82.645886	112.68
3/23/2018	Homo_19	bar	28.773332	-82.660150	466.67
3/23/2018	Homo_20	bar	28.772341	-82.659396	205.52
3/23/2018	Homo_21	bar	28.778453	-82.668951	112.25
3/23/2018	Homo_22	bar	28.780613	-82.670503	216.83
3/23/2018	Homo_23	bar	28.781717	-82.670534	126.63
3/23/2018	Homo_24	bar	28.779145	-82.672602	339.55
3/23/2018	Homo_25	bar	28.778807	-82.672370	74.17
3/23/2018	Homo_26	bar	28.778391	-82.678535	121.02
3/23/2018	Homo_27	bar	28.779734	-82.677330	299.27
3/23/2018	Homo_28	bar	28.780875	-82.678428	203.44
3/23/2018	Homo_29	bar	28.780608	-82.677840	147.34
3/23/2018	Homo_30	bar	28.779025	-82.681419	358.68
3/23/2018	Homo_31	bar	28.780705	-82.681349	118.86
3/23/2018	Homo_32	bar	28.780868	-82.682053	181.36
3/23/2018	Homo_33	bar	28.780211	-82.681113	165.30
3/23/2018	Homo_34	bar	28.779062	-82.681894	115.65
3/23/2018	Homo_35	bar	28.778509	-82.682937	250.07
3/23/2018	Homo_36	bar	28.778132	-82.682559	428.93
3/23/2018	Homo_37	bar	28.776695	-82.681765	647.94
3/23/2018	Homo_38	bar	28.778546	-82.685470	1005.01
3/23/2018	Homo_39	bar	28.776786	-82.684623	535.21
3/23/2018	Homo_40	bar	28.774263	-82.682866	629.56
3/23/2018	Homo_41	bar	28.775493	-82.685914	111.96

Appendix A Table 2. Mapped Oyster Locations on the Homosassa River, Citrus County, Florida.

Survey Date	Oyster Area Name	Location Type*	Latitude	Longitude	Area (m^2)
3/23/2018	Homo_42	bar	28.772209	-82.683741	501.90
3/23/2018	Homo_43	bar	28.769077	-82.684112	130.42
3/23/2018	Homo_44	bar	28.767126	-82.684214	603.69
3/23/2018	Homo_45	bar	28.767280	-82.685619	466.24
3/23/2018	Homo_46	bar	28.768258	-82.690547	525.20
3/23/2018	Homo_47	bar	28.777691	-82.678186	71.14
3/23/2018	Homo_48	bar	28.777746	-82.677979	53.32
3/23/2018	Homo_49	bar	28.779014	-82.677158	201.98
3/22/2018	Homo_50	bar	28.763628	-82.641484	199.37
Total Area					**14,964**

* Note: bar = oyster bar

Appendix A3. Mapped Oyster Locations on the Withlacoochee River, Citrus and Levy Counties, Florida.

Survey Date	Oyster Area Name	Location Type*	Latitude	Longitude	Area (m^2)
3/29/2018	With_01	clusters	29.0005758	-82.7613872	n/a
3/29/2018	With_02	clusters	29.0006860	-82.7606689	n/a
3/29/2018	With_03	bar	29.0004312	-82.7586493	168.44
4/18/2018	With_04	clusters	29.0033186	-82.7527147	n/a
4/18/2018	With_05	clusters	29.0021856	-82.7512551	n/a
4/18/2018	With_06	rock bar	29.0039540	-82.7489311	n/a
4/18/2018	With_07	rock bar	29.0058639	-82.7464377	n/a
4/18/2018	With_08	clusters	29.0086087	-82.7411914	n/a
4/18/2018	With_09	rock bar	29.0091633	-82.7468315	n/a
4/18/2018	With_10	clusters	29.0086317	-82.7475671	n/a
4/18/2018	With_11	clusters	29.0082417	-82.7474999	n/a
4/18/2018	With_12	clusters	29.0068125	-82.7463466	n/a
4/18/2018	With_13	clusters	29.0058327	-82.7494001	n/a
4/18/2018	With_14	rock bar	29.0049051	-82.7488153	n/a
4/18/2018	With_15	rock bar	29.0044329	-82.7500823	n/a
4/18/2018	With_16	clusters	29.0037927	-82.7514218	n/a
4/18/2018	With_17	rock bar	29.0026991	-82.7543098	n/a
4/18/2018	With_18	clusters	29.0027028	-82.7547863	n/a
4/18/2018	With_19	rock bar	29.0023994	-82.7548534	n/a
4/18/2018	With_20	clusters	29.0018212	-82.7554286	n/a
4/19/2018	With_21	bar	29.0003259	-82.7547299	86.36
4/19/2018	With_22	clusters	28.9995077	-82.7625975	n/a
4/19/2018	With_23	clusters	29.0005046	-82.7556164	n/a
4/19/2018	With_24	clusters	29.0007127	-82.7562601	n/a
4/19/2018	With_25	clusters	29.0007464	-82.7568887	n/a
4/19/2018	With_26	clusters	29.0010759	-82.7577414	n/a
4/19/2018	With_27	clusters	29.0010930	-82.7594693	n/a
4/20/2018	With_28	clusters	29.0016644	-82.7596124	n/a
4/20/2018	With_29	clusters	28.9990572	-82.7620281	n/a
4/20/2018	With_30	clusters	28.9997091	-82.7616843	n/a
4/20/2018	With_31	clusters	28.9998290	-82.7616932	n/a
4/20/2018	With_32	bar	29.0000934	-82.7610757	408.79
4/20/2018	With_33	bar	29.0000260	-82.7599747	201.50
4/20/2018	With_34	clusters	29.0002941	-82.7578092	n/a
4/20/2018	With_35	bar	29.0000049	-82.7678405	2189.73
4/20/2018	With_36	bar	29.0005364	-82.7688563	303.50
4/20/2018	With_37	bar	29.0002512	-82.7701919	769.77
4/20/2018	With_38	bar	28.9983066	-82.7676775	3451.88
4/20/2018	With_39	clusters	29.0013688	-82.7643558	n/a
4/20/2018	With_40	clusters	29.0010142	-82.7644168	n/a
4/20/2018	With_41	clusters	29.0011293	-82.7670121	n/a

Appendix A3. Mapped Oyster Locations on the Withlacoochee River, Citrus and Levy Counties, Florida.

Survey Date	Oyster Area Name	Location Type*	Latitude	Longitude	Area (m^2)
4/20/2018	With_42	clusters	29.0016550	-82.7676628	n/a
4/20/2018	With_43	bar	29.0021466	-82.7697119	12496.83
4/20/2018	With_44	bar	29.0024841	-82.7682882	1635.15
4/20/2018	With_45	bar	29.0021539	-82.7678643	149.81
4/20/2018	With_46	bar	29.0030175	-82.7674092	273.47
4/20/2018	With_47	bar	29.0029952	-82.7664198	854.89
4/20/2018	With_48	bar	29.0031302	-82.7695453	364.34
4/20/2018	With_49	bar	29.0032805	-82.7715405	1329.82
4/20/2018	With_50	bar	29.0031549	-82.7499615	31305.09
4/19/2018	With_51	clusters	29.0039480	-82.7489110	n/a
Total Area					**55,989**

* Note: bar = oyster bar, clusters = scattered oyster clusters along the shoreline, rock bar = oysters attached to rocks

Appendix A Table 4. Barnacle Sample Location Information from the Chassahowitzka River, Citrus, and Hernando Counties, Florida.

Date	River Km	Sample Name	Sample Substrate	Latitude	Longitude
3/14/2018	1.0	Chss 5	wood and PVC marker	28.694410	-82.635030
3/14/2018	2.4	Chss 6	PVC, pilings with oysters	28.702620	-82.624700
3/14/2018	4.3	Chss 4	PVC and metal pole	28.711620	-82.612110
3/13/2018	5.0	Chss 3	refuge wood sign post	28.714600	-82.608920
3/13/2018	6.0	Chss 2	PVC channel marker	28.719510	-82.597660
3/13/2018	7.0	Chss 1	PVC channel marker	28.716530	-82.589410

Appendix A Table 5. Location Information for Barnacle Samples from the Homosassa and Halls Rivers, Citrus County, Florida.

Date	River km	Sample Name	Sample Substrate	Latitude	Longitude
3/28/2018	0.1	Hmss 8	wooden channel marker	28.770660	-82.695100
3/28/2018	4.9	Hmss 7	wood post wrapped in plastic	28.781430	-82.653560
3/28/2018	5.8	Hmss 6	PVC pipe 6"	28.782130	-82.646620
3/26/2018	7.0	Hmss 5	wood post	28.784260	-82.635870
3/26/2018	8.0	Hmss 4	concrete seawall	28.782900	-82.625910
3/26/2018	8.9	Hmss 3	PVC pipe 6"	28.785750	-82.617860
3/26/2018	10.0	Hmss 2	metal seawall	28.791860	-82.609490
3/26/2018	11.2	Hmss 1	channel post, wood	28.798540	-82.600970
3/23/2018	0.5	Hlls 5	concrete seawall	28.802030	-82.604870
3/23/2018	1.5	Hlls 4	sabal palm	28.808800	-82.609390
3/23/2018	2.2	Hlls 1	metal/PVC poles	28.813030	-82.605890
3/23/2018	3.2	Hlls 2	sabal palm	28.819200	-82.600060
3/23/2018	4.1	Hlls 3	wood sign	28.822540	-82.592810

Appendix A Table 6. Barnacle Sample Locations from the Withlacoochee River, Citrus and Levy Counties, Florida.

Date	River km	Sample Name	Sample Substrate	Latitude	Longitude
3/29/2018	-0.1	With 1	concrete square post	29.000560	-82.763090
3/29/2018	2.1	With 2	wood post	29.007750	-82.743340
4/5/2018	4.5	With 8	wood post	29.017981	-82.727043
4/3/2018	5.2	With 7	PVC post	29.022167	-82.722910
4/3/2018	6.0	With 6	wood post	29.027481	-82.717049
4/3/2018	7.0	With 3	wood beam	29.031073	-82.708894
4/3/2018	8.0	With 4	wood post	29.031826	-82.700015
4/3/2018	8.6	With 5	wood post	29.033030	-82.694236

APPENDIX B

CHASSAHOWITZKA RIVER OYSTER FIELD MEASURES PLOT

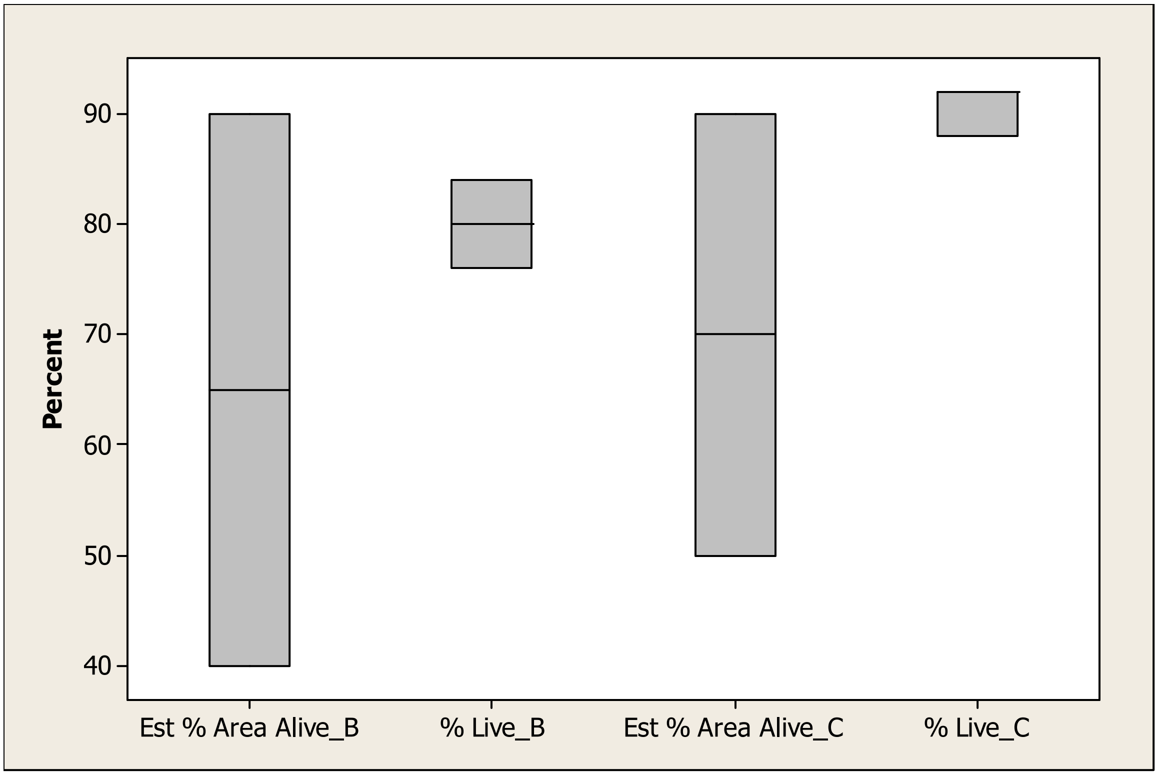


Figure B-1. Boxplot for Chassahowitzka River oyster field data for the estimated percent area alive and percent live oysters parameters for Salinity Group B versus C.

APPENDIX C

HOMOSASSA RIVER OYSTER FIELD MEASURES PLOT

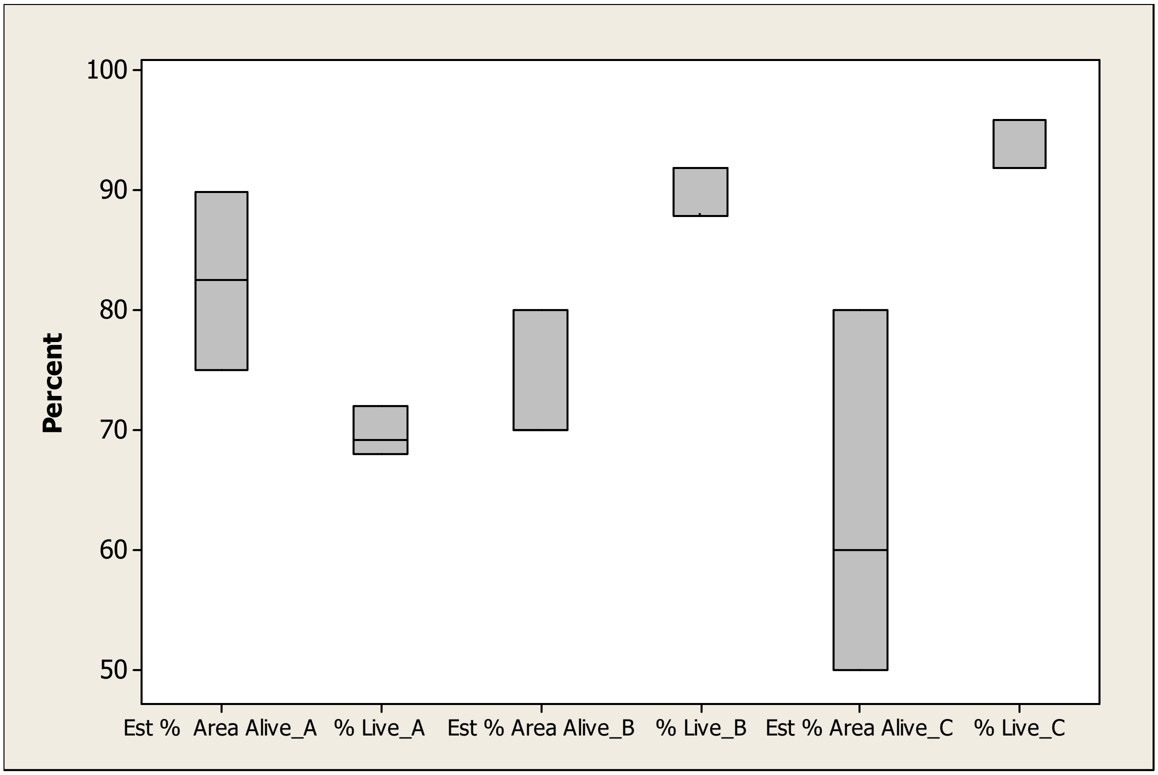


Figure C-1. Boxplot for Homosassa River oyster field data for the estimated percent area alive and percent live oysters parameters for Salinity Group A versus Group B and Group C.

APPENDIX D

WITHLACOOCHEE RIVER OYSTER FIELD MEASURES PLOT

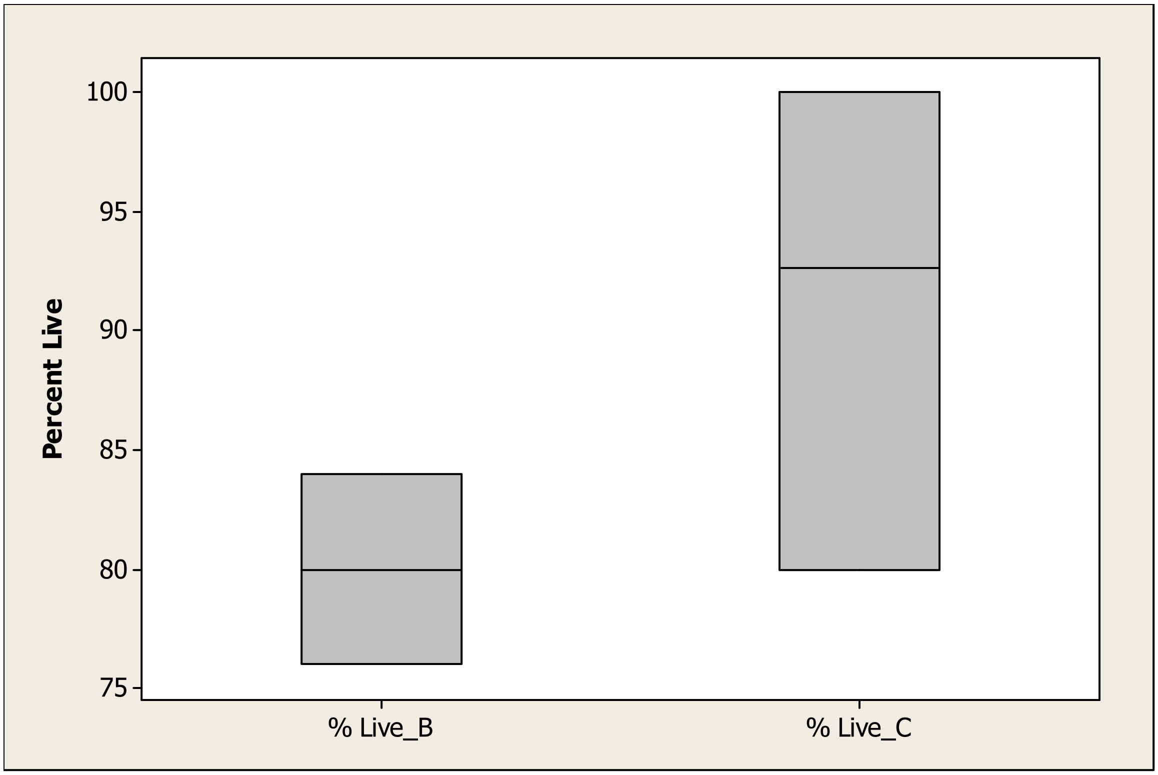


Figure D-1. Boxplot for Lower Withlacoochee River oysters of the percentage of live oysters salinity Group B vs. Group C. Estimated percent area alive was not graphed since there was only one data point.

APPENDIX E

CHASSAHOWITZKA RIVER BARNACLE RESULTS

Table E-1. Descriptive Statistics for all Chassahowitzka River Barnacle Laboratory and Field Data.

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
NperQuadrant	6	19.83	11.69	9	9.75	17.5	28.75	40
Total Live	6	13.83	5.67	6	9	13.5	19	22
Total Dead	6	6.00	8.37	0.00	0.00	3.00	11.50	22.00
%Live	6	76.93	22.53	45.00	57.68	77.33	100.00	100.00
Meandiameter	6	6.53	2.22	3.64	4.74	6.22	8.56	9.92
DryWeight	6	0.49	0.16	0.26	0.33	0.53	0.63	0.67
%OrganicMatter	6	7.90	4.20	5.10	5.25	6.80	9.40	16.30

NperQuadrant - number of barnacles counted in a 10 square centimeter quadrant; Q1 - first quartile; Q3 - 3rd quartile; StDev - standard deviation.

Table E-2. Descriptive Statistics for Chassahowitzka River Oligohaline Barnacle Laboratory and Field Data.

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
NperQuadrant_o	3	26.33	13.05	14.00	14.00	25.00	40.00	40.00
Total Live_o	3	18.00	4.00	14.00	14.00	18.00	22.00	22.00
Total Dead_o	3	8.33	11.93	0.00	0.00	3.00	22.00	22.00
%Live_o	3	77.7	28.9	45.0	45.0	88.0	100.0	100.0
Meandiameter_o	3	6.680	3.140	3.640	3.640	6.480	9.920	9.920
DryWeight_o	3	0.518	0.222	0.263	0.263	0.623	0.669	0.669
%OrganicMatter_o	3	9.530	5.920	5.300	5.300	7.000	16.300	16.300

NperQuadrant - number of barnacles counted in a 10 square centimeter quadrant; Q1 - first quartile; Q3 - 3rd quartile; StDev - standard deviation.

Table E-3. Descriptive Statistics for Chassahowitzka River Mesohaline Barnacle Laboratory and Field Data.

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
NperQuadrat_m	3	13.33	6.66	9.00	9.00	10.00	21.00	21.00
Total Live_m	3	9.67	3.51	6.00	6.00	10.00	13.00	13.00
Total Dead_m	3	3.67	4.04	0.00	0.00	3.00	8.00	8.00
%Live_m	3	76.2	20.8	61.9	61.9	66.7	100.0	100.0
Meandiameter_m	3	6.388	1.552	5.100	5.100	5.952	8.111	8.111
DryWeight_m	3	0.4687	0.1033	0.3505	0.3505	0.5137	0.5419	0.5419
%OrganicMatter_m	3	6.267	1.041	5.100	5.100	6.600	7.100	7.100

NperQuadrant - number of barnacles counted in a 10 square centimeter quadrant; Q1 - first quartile; Q3 - 3rd quartile; StDev - standard deviation.

Table E-4. Chassahowitzka River Barnacle Laboratory and Field Data Mann-Whitney Test Results for Significant Difference of the Medians (*P* values). Comparison of Oligohaline to Mesohaline Zones.

	NperQuadrant_o	Total Live_o	Total Dead_o	%Live_o	Meandiameter_o	DryWeight_o	%OrganicMatter_o
NperQuadrant_m	0.1904						
Total Live_m		0.0809					
Total Dead_m			1.0000				
%Live_m				1.0000			
Meandiameter_m					1.0000		
DryWeight_m						0.6625	
%OrganicMatter_m							0.6625

Significant results are given in bold font. NperQuadrant - number of barnacles counted in a 10 square centimeter quadrant; Q1 - first quartile; Q3 - 3rd quartile; "o" indicates oligohaline and "m" indicates mesohaline data.

Table E-5. Spearman's Rank Correlation Test Results for Chassahowitzka River Barnacle Lab and Field Data (Test result is above the *P* -value).

	River Kilometer
NperQuadrant	0.459
P Value	0.360
Total Live	0.705
P Value	0.118
Total Dead	0.163
P Value	0.758
Percent Live	0.011
P Value	0.983
Mean Diameter	-0.151
P Value	0.775
Dry Weight	0.112
P Value	0.833
%Organic Matter	0.500
P Value	0.312

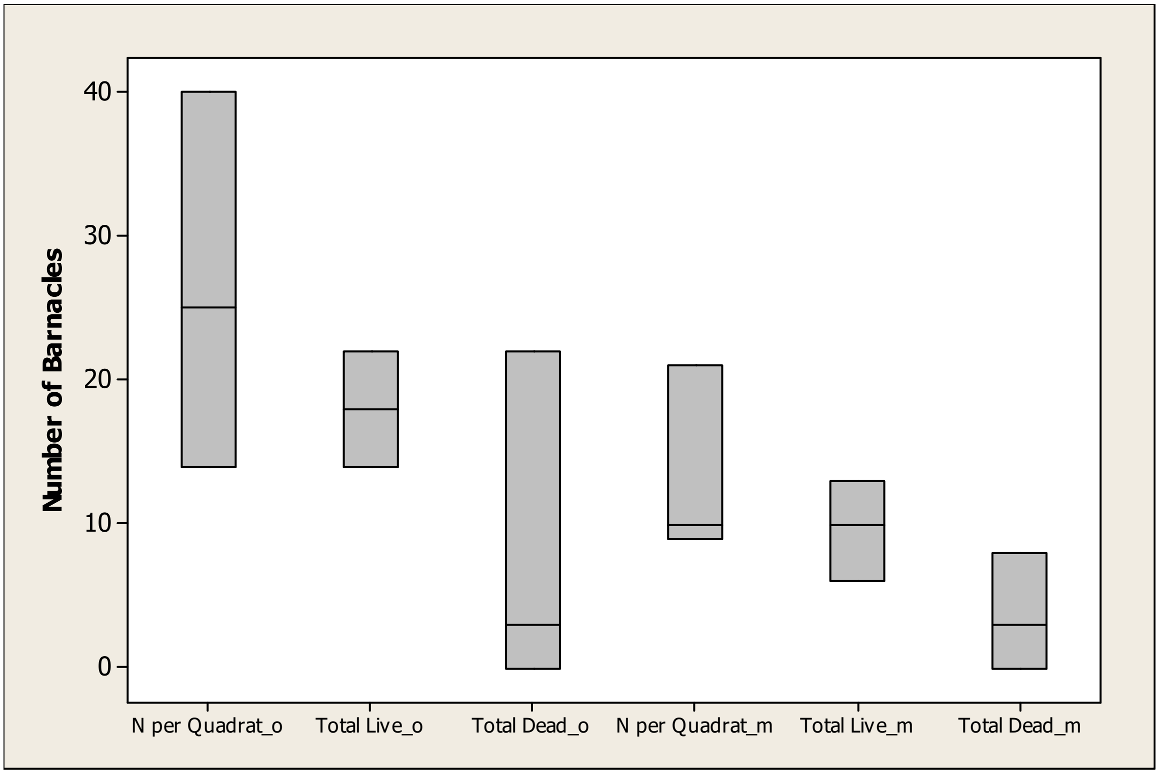


Figure E-1. Boxplot for Chassahowitzka River barnacle field data - number per quadrat, total dead, and total live oysters for oligohaline versus the mesohaline areas. “o” indicates oligohaline and “m” indicates mesohaline data.

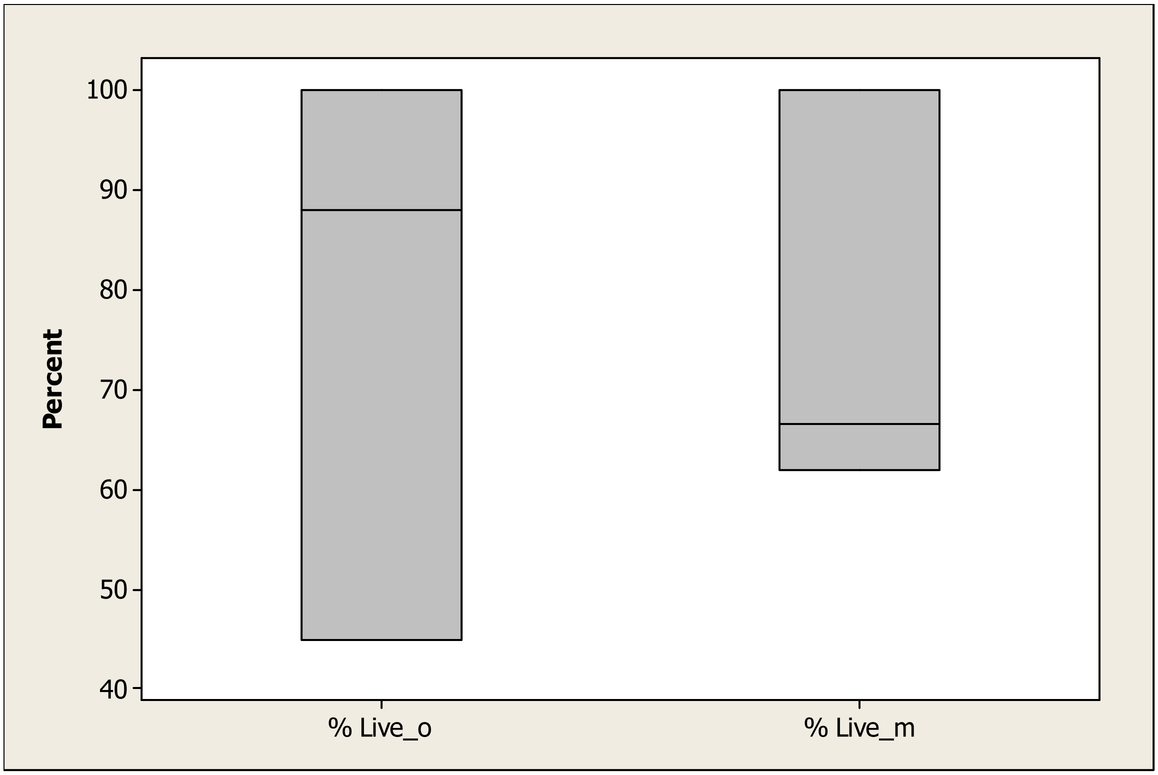


Figure E-2. Boxplot for Chassahowitzka River barnacle field data - percent live barnacles for oligohaline versus the mesohaline areas. “o” indicates oligohaline and “m” indicates mesohaline data.

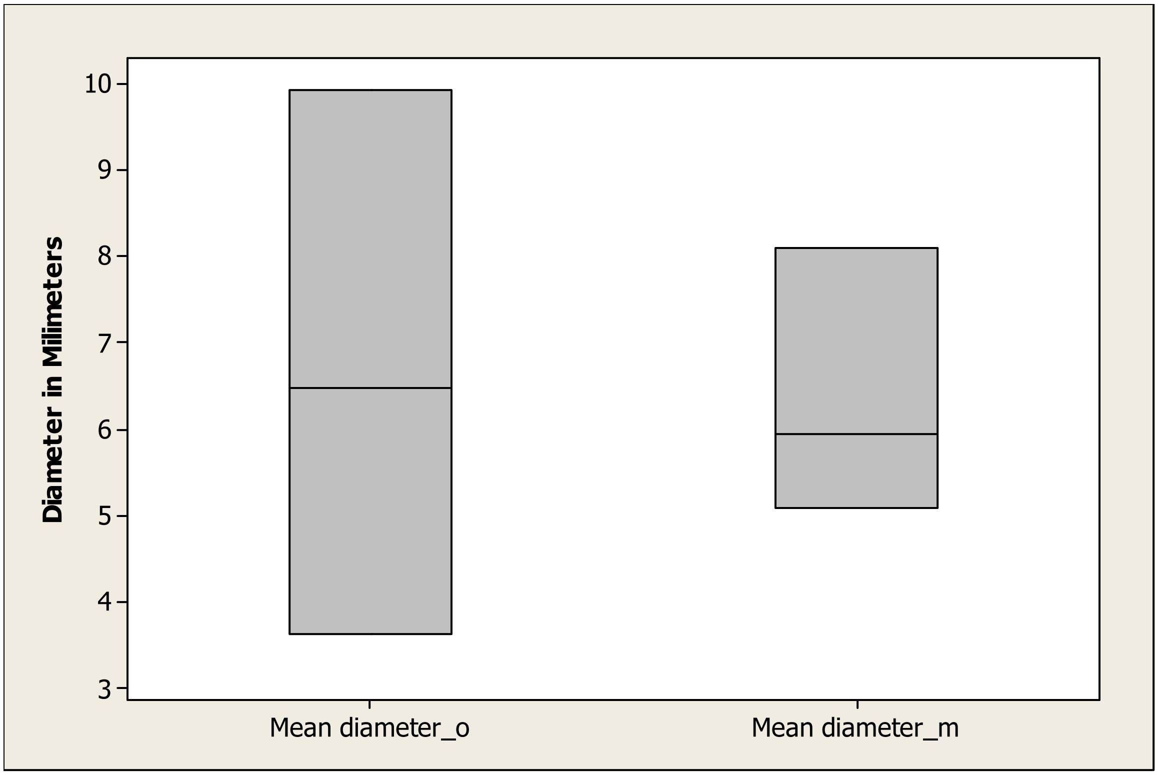


Figure E-3. Boxplot for Chassahowitzka River barnacle field data - barnacle mean diameter for oligohaline versus the mesohaline areas. “o” indicates oligohaline and “m” indicates mesohaline data.

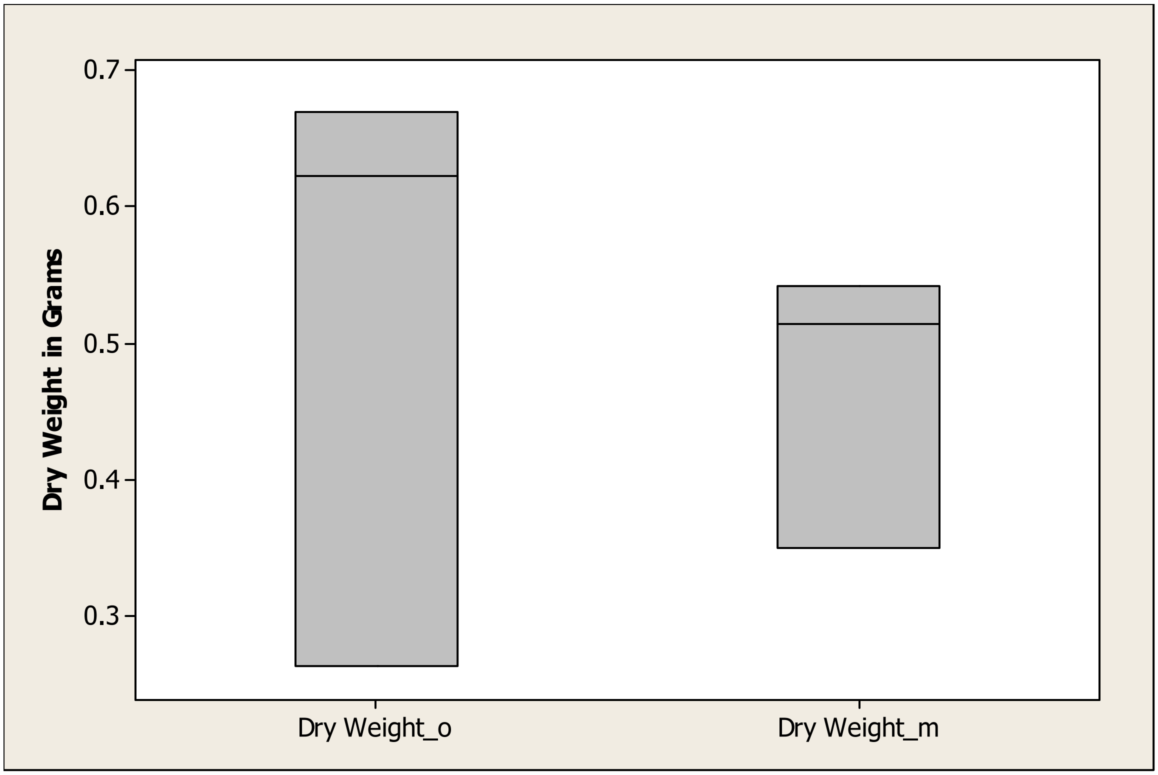


Figure E-4. Boxplot for Chassahowitzka River barnacle field data – dry weight for oligohaline versus the mesohaline areas. “o” indicates oligohaline and “m” indicates mesohaline data.

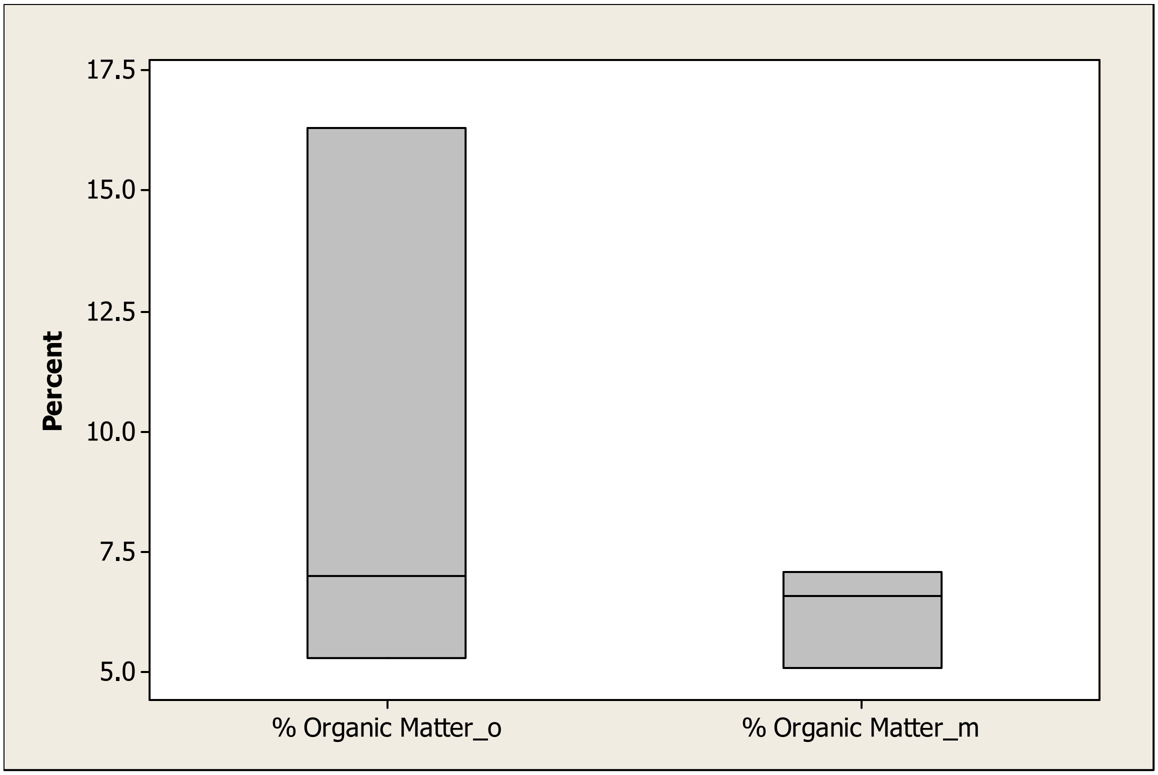


Figure E-5. Boxplot for Chassahowitzka River barnacle field data – percent organic matter for oligohaline versus the mesohaline areas. "o" indicates oligohaline and "m" indicates mesohaline data.

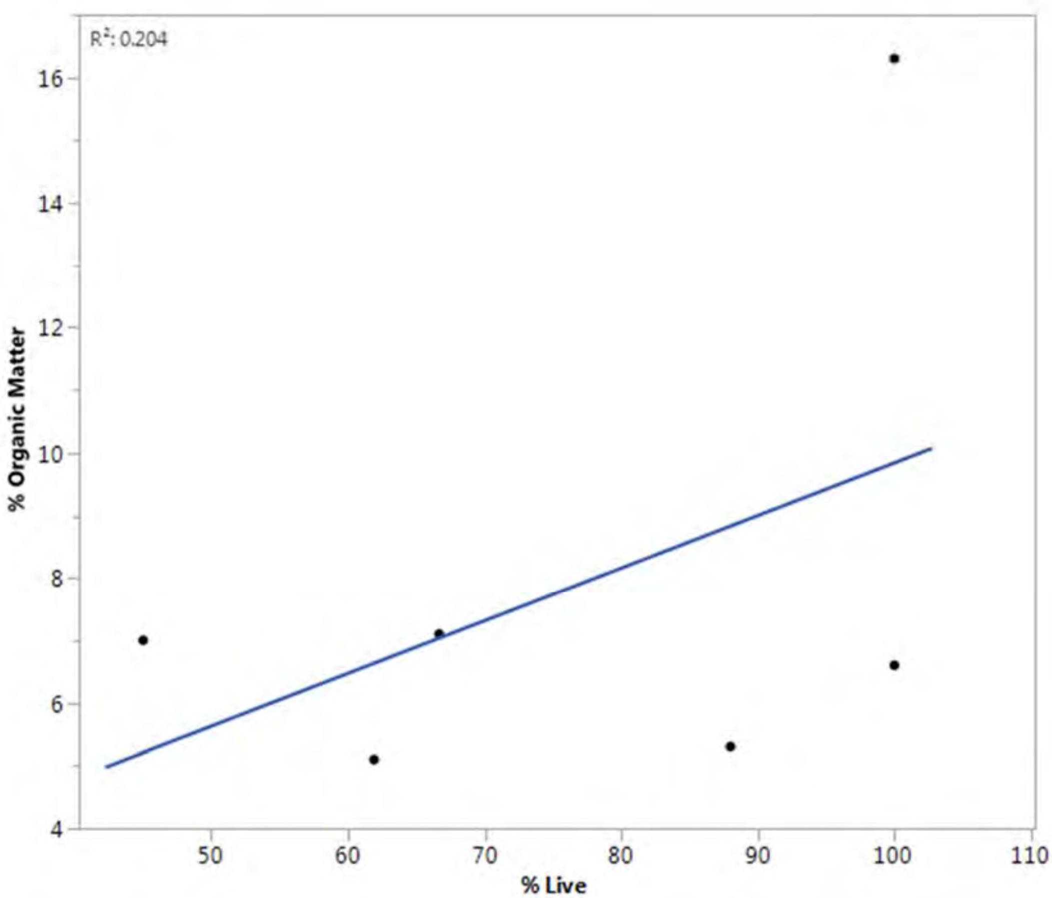


Figure E-6. Percent organic matter found in Chasshowitzka barnacle samples against percent of barnacles that were alive when the sample was collected in the field.

APPENDIX F

HOMOSASSA RIVER BARNACLE RESULTS

Table F-1. Descriptive Statistics for Homosassa River Barnacle Laboratory and Field Measures

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
# per Quadrat	8	73.1	26.2	19.0	58.5	79.0	95.0	98.0
Total Live	8	42.1	26.8	7.0	14.0	49.0	62.0	80.0
Total Dead	8	31.0	23.7	9.0	12.5	26.0	41.3	80.0
% Live	8	55.2	27.1	17.5	26.9	57.7	79.5	89.9
Mean Diameter	8	5.8	1.9	4.4	4.6	5.4	5.8	10.3
Dry Weight	8	0.4	0.1	0.4	0.4	0.4	0.5	0.6
% Organic Matter	8	7.4	3.6	5.1	5.5	6.2	7.4	16.0

Table F-2. Descriptive Statistics for Homosassa River Oligohaline Barnacle Laboratory and Field Measures

Variable	**N**	**Mean**	**StDev**	**Minimum**	**Q1**	**Median**	**Q3**	**Maximum**
# per Quadrat_o	4	88.3	10.7	78.0	78.5	88.5	97.8	98.0
Total Live_o	4	45.5	20.9	17.0	23.5	51.0	62.0	63.0
Total Dead_o	4	42.8	26.6	17.0	21.5	37.0	69.8	80.0
% Live_o	4	52.9	25.7	17.5	26.9	57.7	74.1	78.8
Mean Diameter_o	4	5.6	0.3	5.2	5.3	5.6	5.8	5.8
Dry Weight_o	4	0.5	0.1	0.4	0.4	0.5	0.5	0.6
% Organic Matter_o	4	6.0	0.8	5.5	5.5	5.7	6.9	7.2

Table F-3. Descriptive Statistics for Homosassa River Mesohaline Barnacle Laboratory and Field Measures

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
# per Quadrat_m	4	58.0	29.5	19.0	28.0	62.0	84.0	89.0
Total Live_m	4	38.8	34.8	7.0	8.5	34.0	73.8	80.0
Total Dead_m	4	19.3	15.3	9.0	9.8	13.0	35.0	42.0
% Live_m	4	57.5	32.2	23.6	26.9	58.3	87.3	89.9
Mean Diameter_m	4	6.0	2.8	4.4	4.5	4.7	8.9	10.3
Dry Weight_m	4	0.4	0.1	0.4	0.4	0.4	0.5	0.6
% Organic Matter_m	4	8.8	4.9	5.1	5.5	7.0	13.9	16.0

Table F-4. Homosassa River Barnacle Laboratory and Field Data Mann-Whitney Test Results for Significant Difference of the Medians (*P* values). Comparison of Oligohaline to Mesohaline Zones.

	NperQuadrant_o	Total Live_o	Total Dead_o	%Live_o	Meandiameter_o	DryWeight_o	%OrganicMatter_o
NperQuadrant_m	0.1124						
Total Live_m		0.6650					
Total Dead_m			0.1939				
%Live_m				0.6650			
Meandiameter_m					0.3123		
DryWeight_m						0.6650	
%OrganicMatter_m							0.4705

Table F-5. Spearman's Rank Correlation Test Results for Homosassa Barnacle Measures (Test result is above the P-value).

	River Kilometer
N per Quadrat	0.667
***P* Value**	0.071
Total Live	0.333
***P* Value**	0.420
Total Dead	0.452
***P* Value**	0.260
Percent Live	0.000
***P* Value**	1.000
Mean Diameter	0.310
***P* Value**	0.456
Dry Weight	0.357
***P* Value**	0.385
% Organic Matter	-0.612
***P* Value**	0.102

Table F-6. Descriptive Statistics for all Halls River Barnacle Laboratory and Field Measures

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
N per Quadrat	5	70.4	20.5	51.0	53.0	61.0	92.5	93.0
Total Live	5	59.0	20.9	33.0	41.0	53.0	80.0	85.0
Total Dead	5	11.4	5.6	6.0	7.0	8.0	17.5	18.0
% Live	5	82.7	10.7	64.7	73.1	86.9	90.2	91.4
Mean Diameter	5	8.0	1.9	5.2	6.2	8.6	9.5	9.9
Dry Weight	5	0.4	0.1	0.4	0.4	0.4	0.5	0.6
% Organic Matter	5	5.8	0.9	4.9	5.0	5.5	6.7	7.1

Table F-7 . Spearman's Rank Correlation Test Results for Halls River Barnacle Measures

(Test result is above the P-value.)

	River Kilometer
NperQuadrant	0.200
***P* Value**	0.747
Total Live	0.200
***P* Value**	0.747
Total Dead	-0.308
***P* Value**	0.614
Percent Live	0.600
***P* Value**	0.285
Mean Diameter	0.000
***P* Value**	1.000
Dry Weight	**0.900**
***P* Value**	**0.037**
%Organic Matter	0.300
***P* Value**	0.624

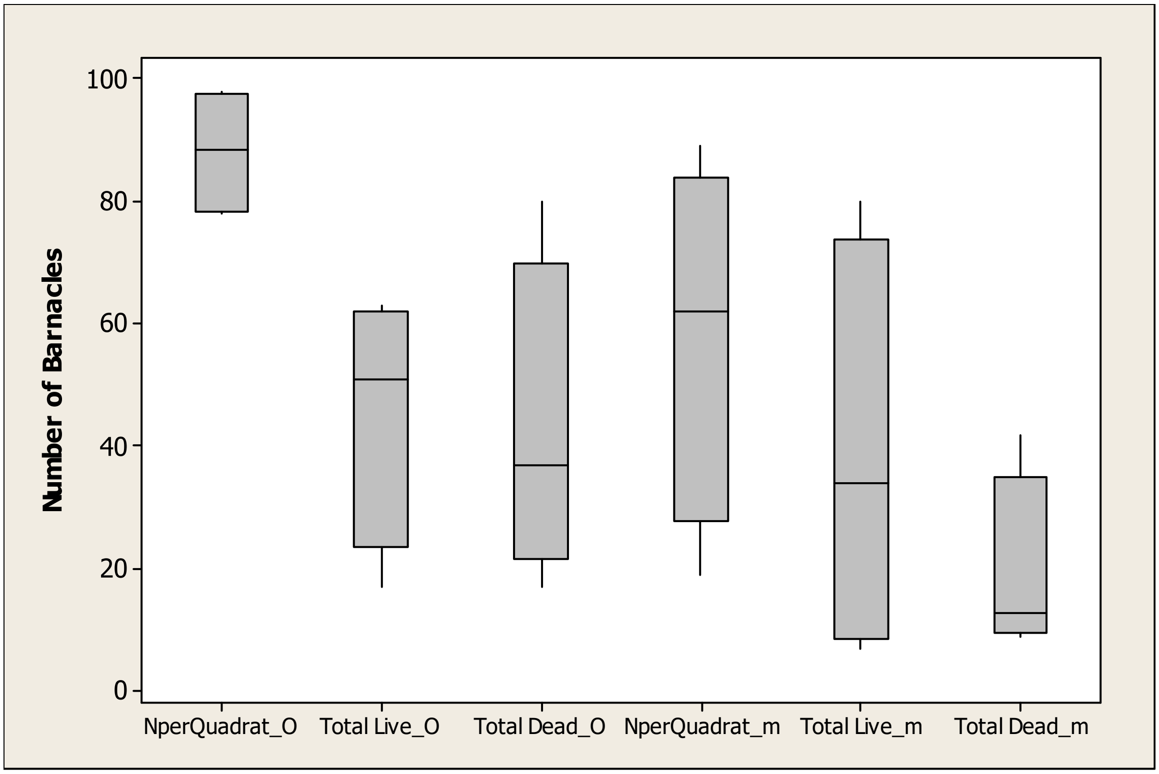


Figure F-1. Boxplot for Homosassa River barnacle field data - number per quadrat, total dead, and total live oysters for oligohaline versus the mesohaline areas. “o” indicates oligohaline and “m” indicates mesohaline data.

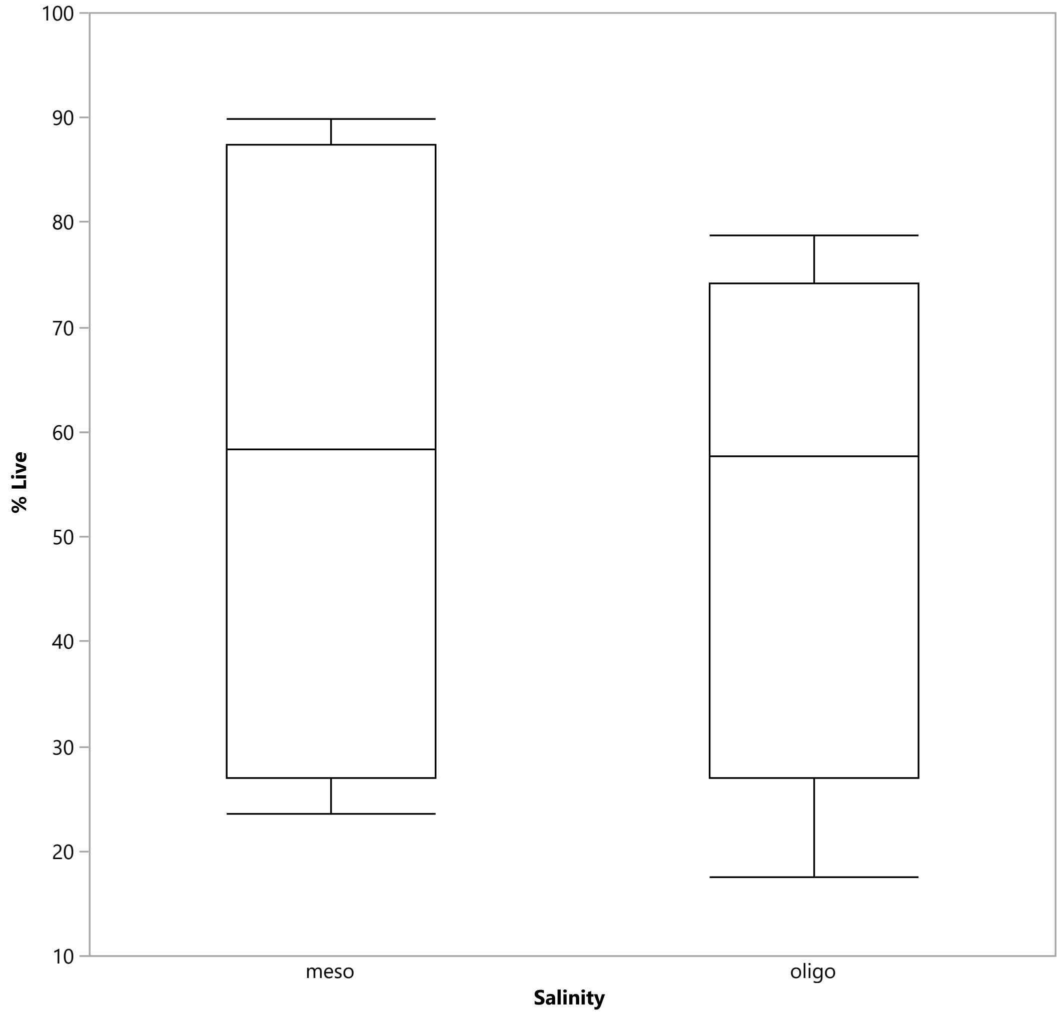


Figure F-2. Boxplot of the percentage of live barnacles in samples collected from mesohaline and oligohaline portions of the Homosassa River.

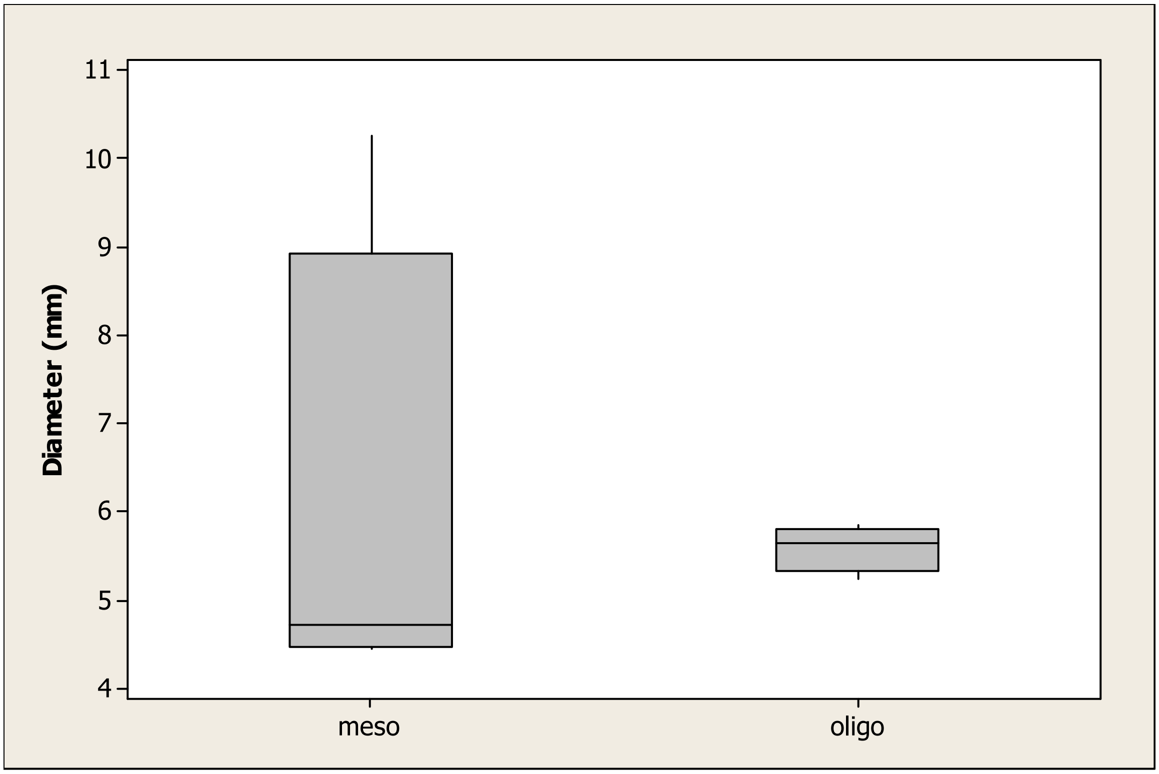


Figure F-3. Boxplot of the mean diameter of barnacles in samples collected from mesohaline and oligohaline portions of the Homosassa River.

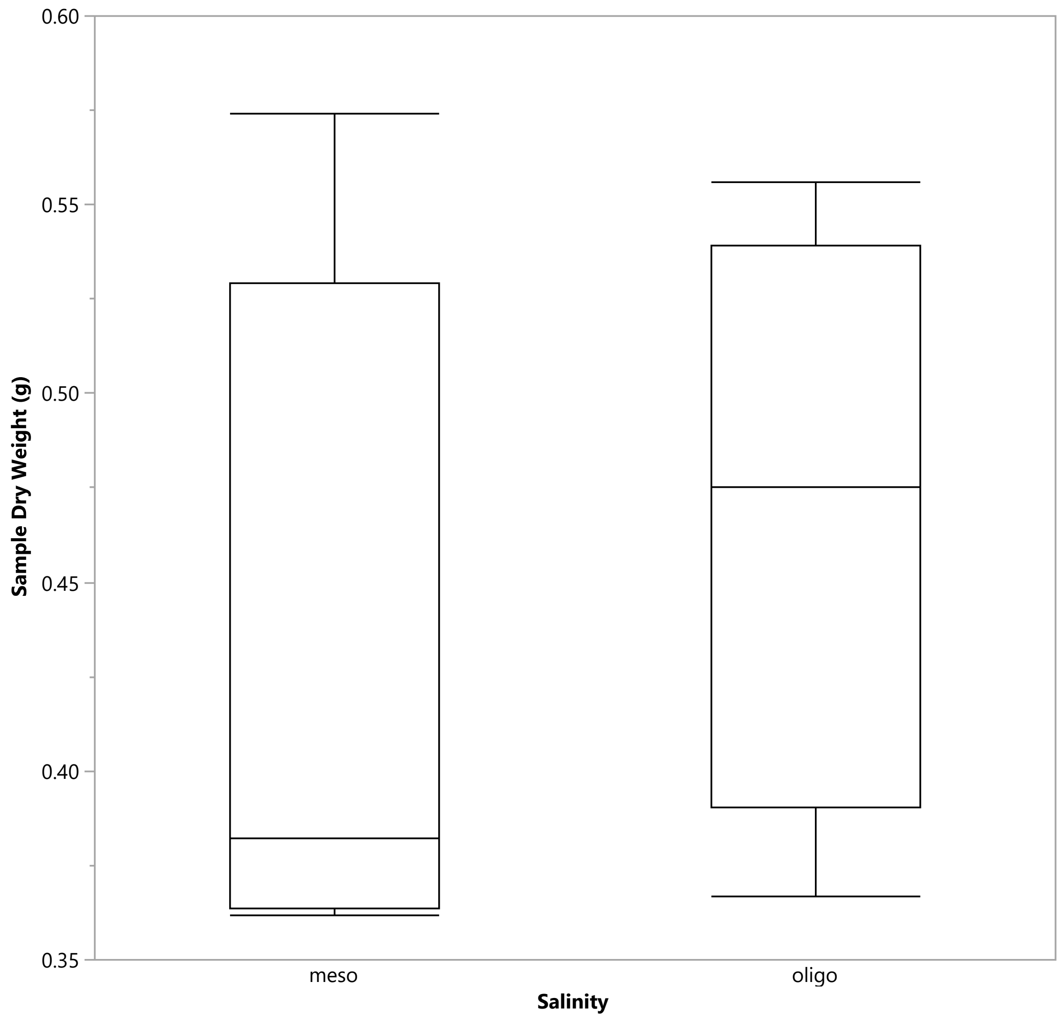


Figure F-4. Boxplot of the dry weight of barnacles in samples collected from mesohaline and oligohaline portions of the Homosassa River.

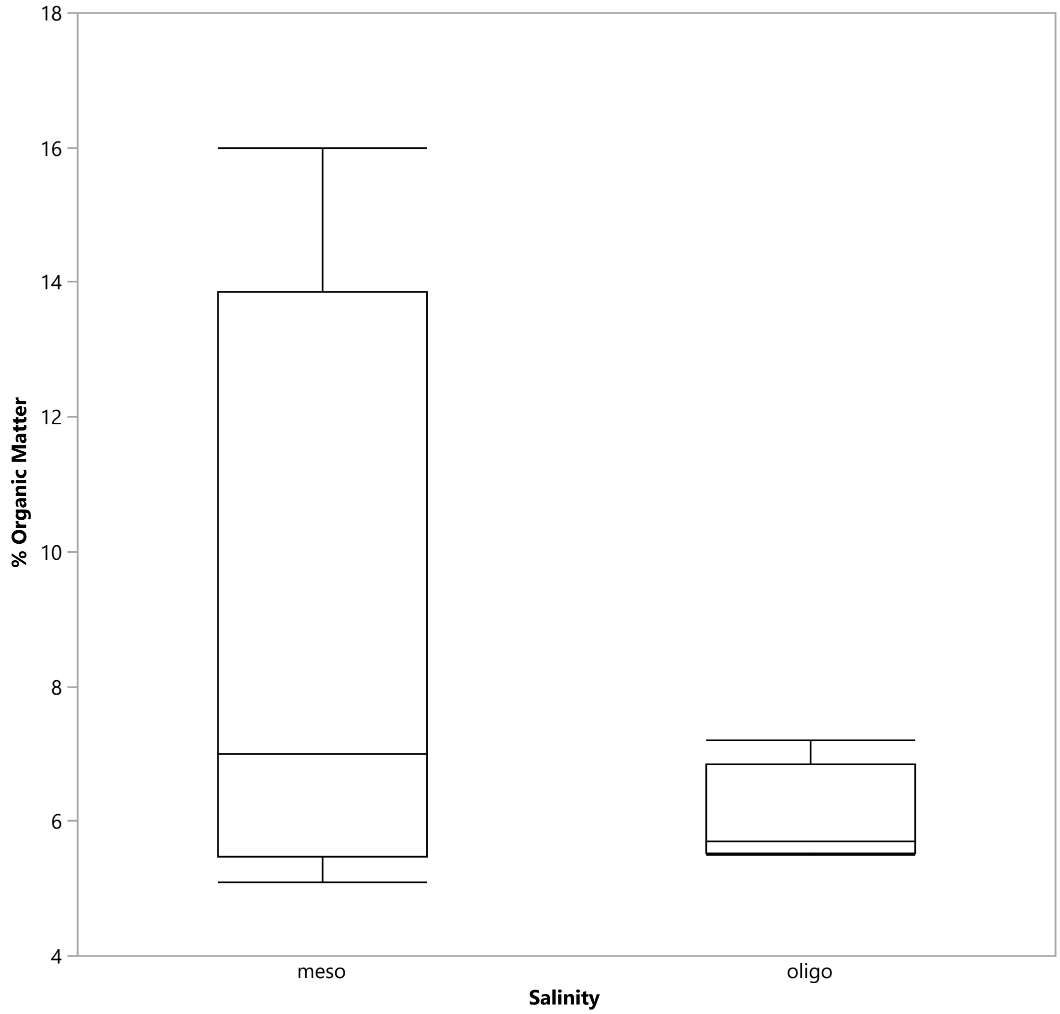


Figure F-5. Boxplot of the percentage organic material barnacle samples collected from mesohaline and oligohaline portions of the Homosassa River.

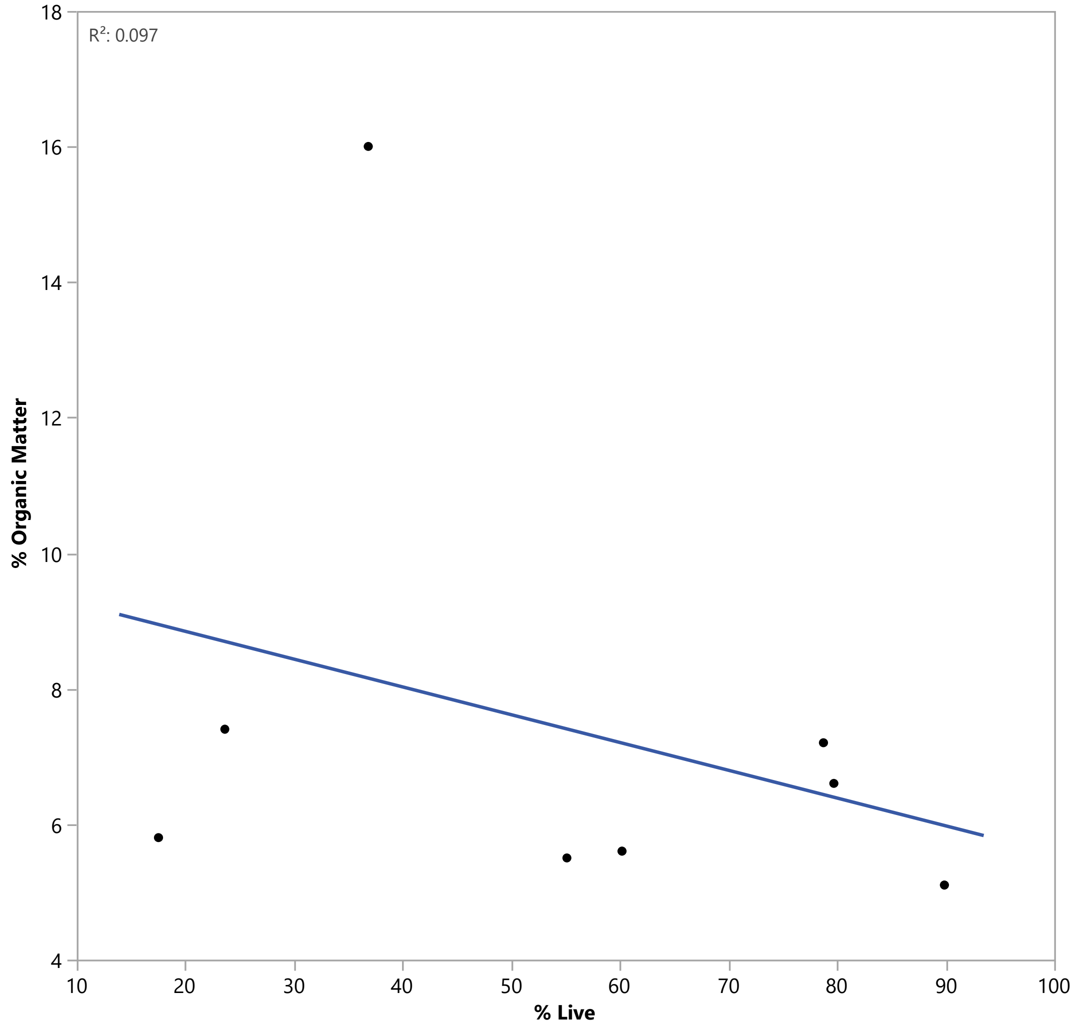


Figure F-6. Percent organic matter found in Homosassa barnacle samples against percent of barnacles that were alive when the sample was collected in the field.

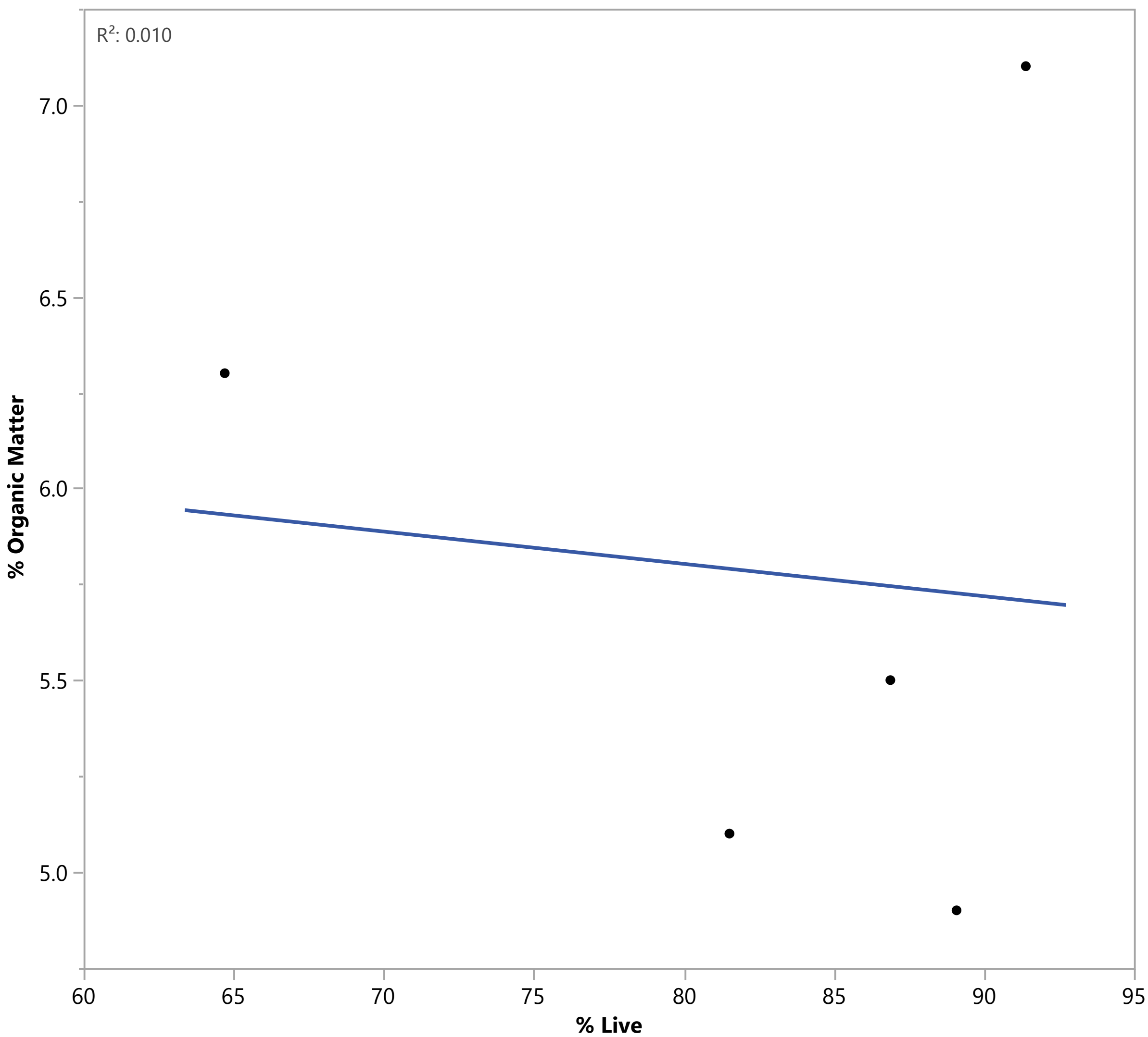


Figure F-7. Percent organic matter found in Halls River barnacle samples against percent of barnacles that were alive when the sample was collected in the field.

APPENDIX G

WITHLACOOCHEE RIVER BARNACLE RESULTS

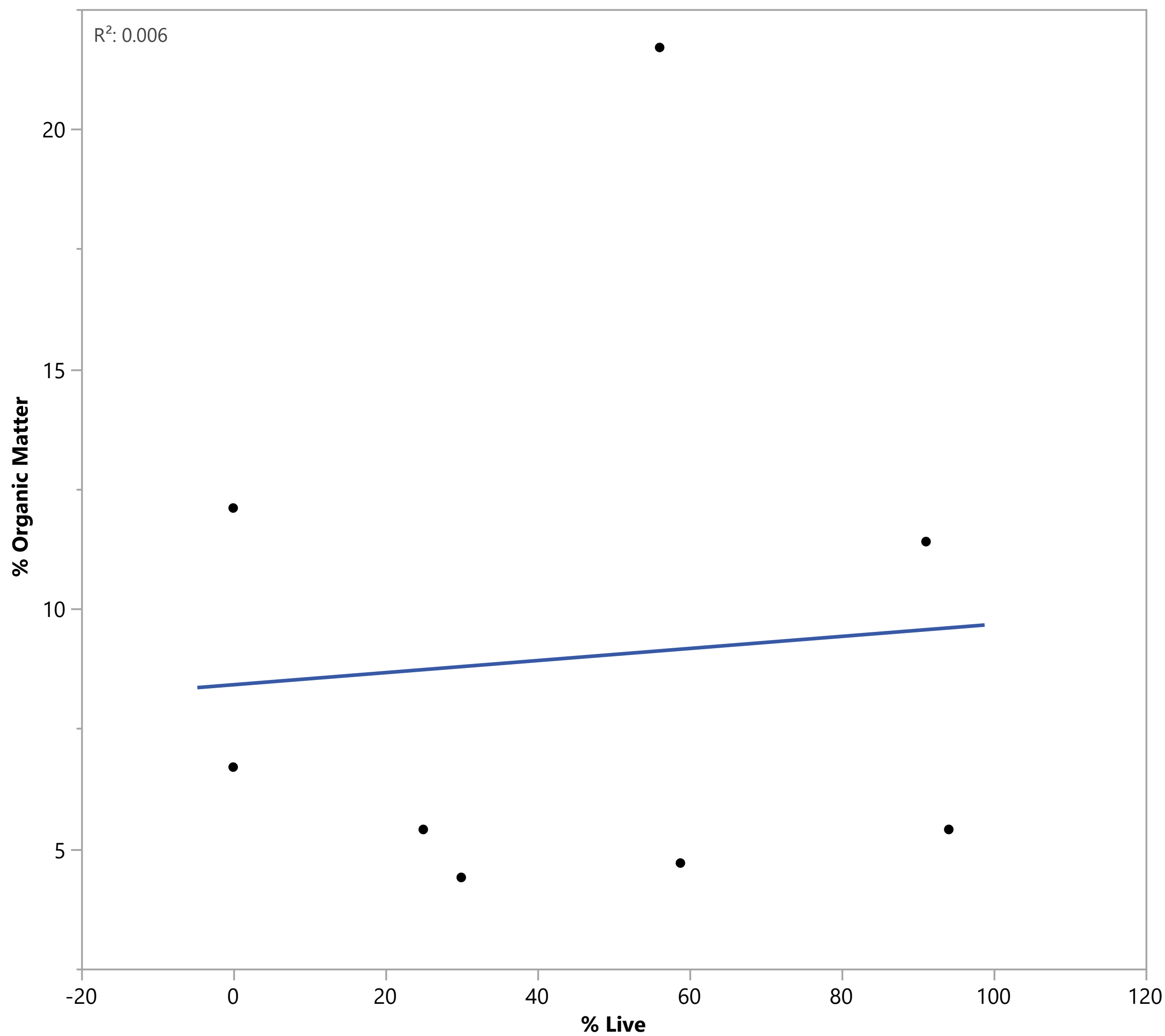


Figure G-1. Percent organic matter found in the Withlacoochee River barnacle samples against percent of barnacles that were alive when the sample was collected in the field. Note that two samples of the samples contained no live barnacles.

Table G-1. Descriptive Statistics for Withlacoochee River Barnacle Sample Laboratory and Field Measures

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
N per Quadrat	8	30.1	39.4	4.0	10.5	16.5	35.0	124.0
Total Live	8	21.1	38.0	0.0	0.8	7.0	21.3	113.0
Total Dead	8	9.0	5.4	1.0	4.8	9.0	12.0	18.0
% Live	8	44.4	36.9	0.0	6.3	43.0	83.1	94.1
Mean Diameter	8	9.5	2.7	6.6	7.5	8.8	11.6	14.8
Dry Weight	8	0.557	0.142	0.400	0.437	0.538	0.661	0.823
% Organic Matter	8	9.0	6.0	4.4	4.9	6.1	11.9	21.7

Table G-2. Spearman's Rank Correlation Test Results for Withlacoochee River Barnacle Measures
(Test result is above the P-value.)

	River Kilometer
N per Quadrat	-0.826
P Value	**0.011**
Total Live	-0.802
P Value	**0.017**
Total Dead	-0.036
P Value	0.932
Percent Live	-0.659
P Value	0.076
Mean Diameter	0.833
P Value	**0.010**
Dry Weight	0.143
P Value	0.736
% Organic Matter	-0.575
P Value	0.136

APPENDIX H

OYSTER FIGURES

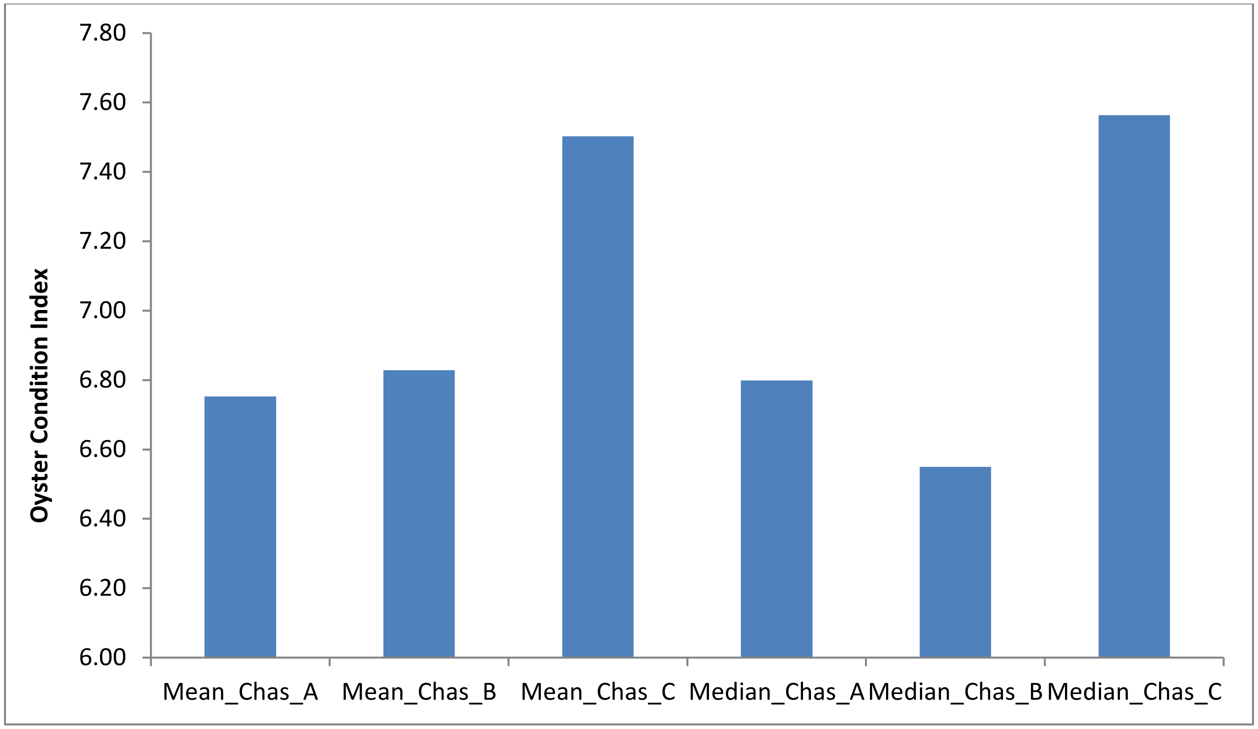


Figure H-1. Chassahowitzka River Means and Medians for the Oyster Condition Index.

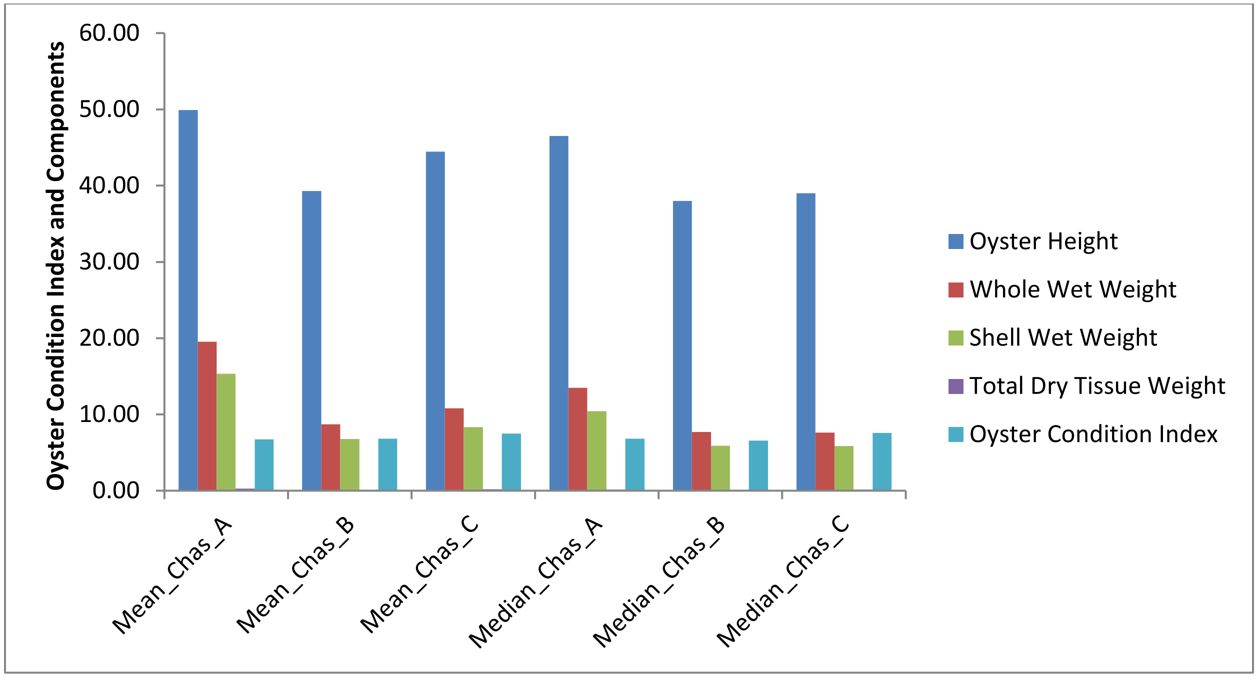


Figure H-2. Chassahowitzka River Means and Medians for the Oyster Condition Index and its Component Inputs.

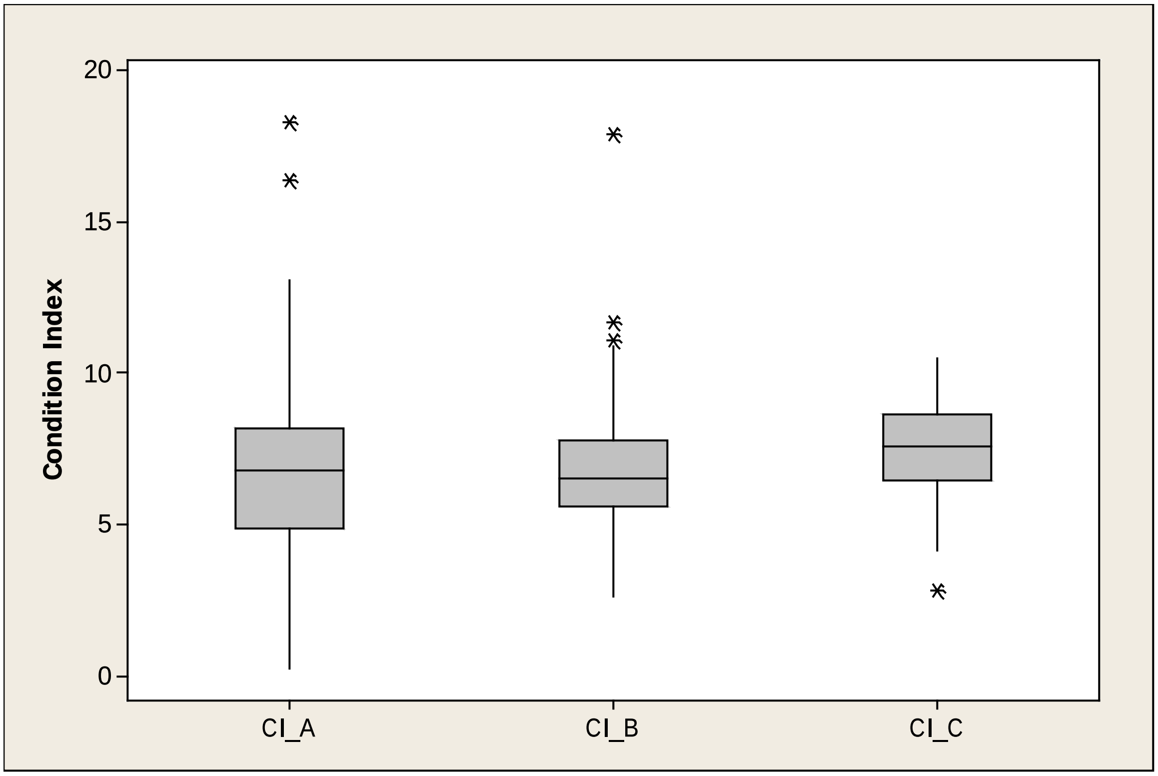


Figure H-2.2. Box and Whisker plot for Chassahowitzka River Condition Index by Salinity Group.

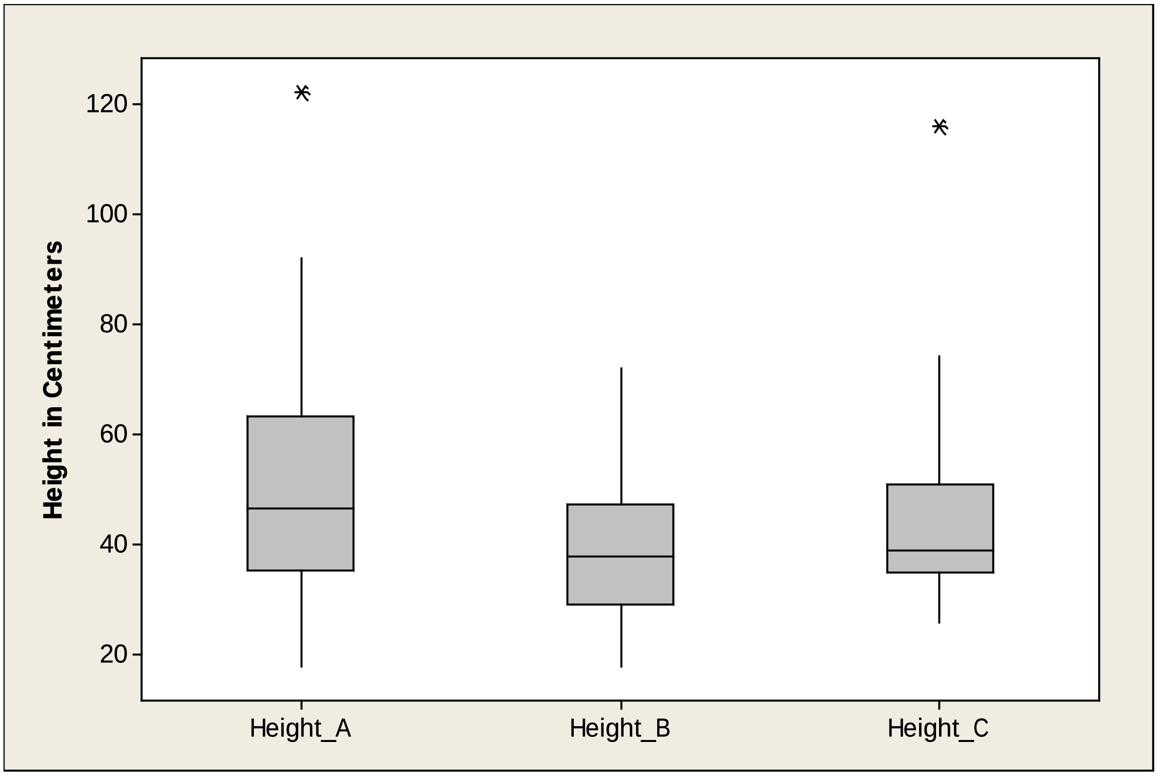


Figure H-2.3. Box and Whisker plot for Chassahowitzka River Index Oyster Height by Salinity Group.

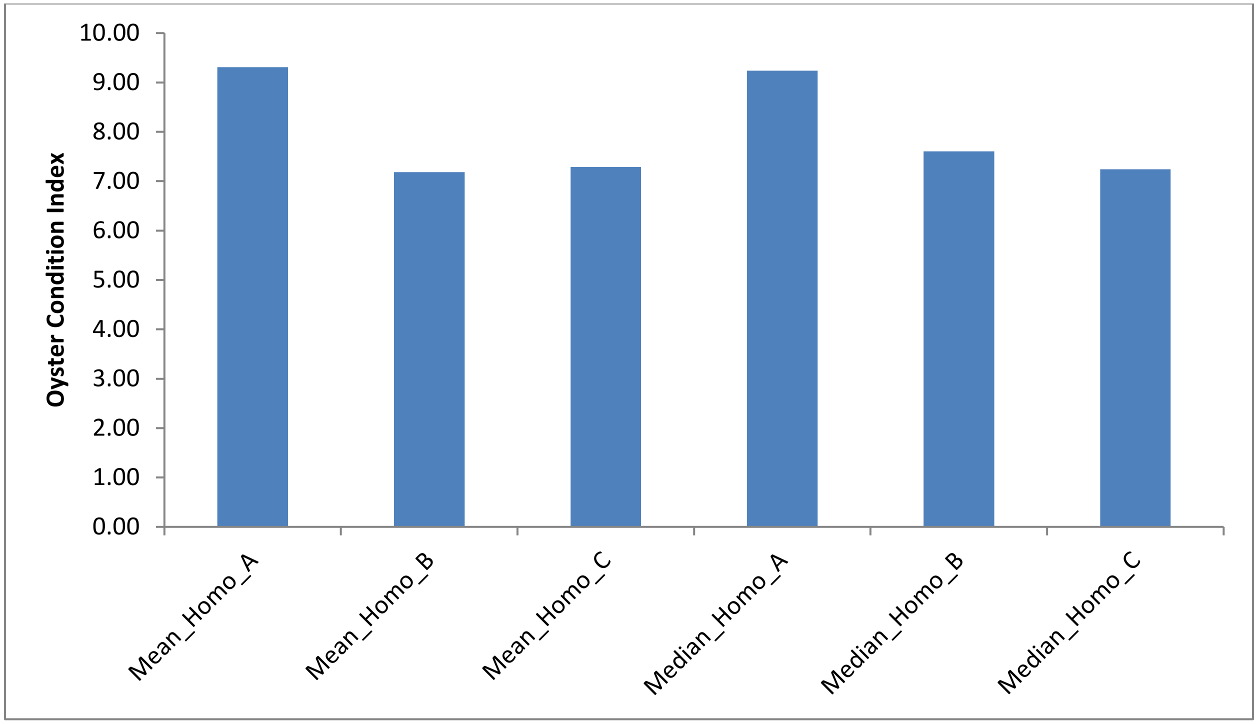


Figure H-3. Homosassa River Means and Medians for the Oyster Condition Index

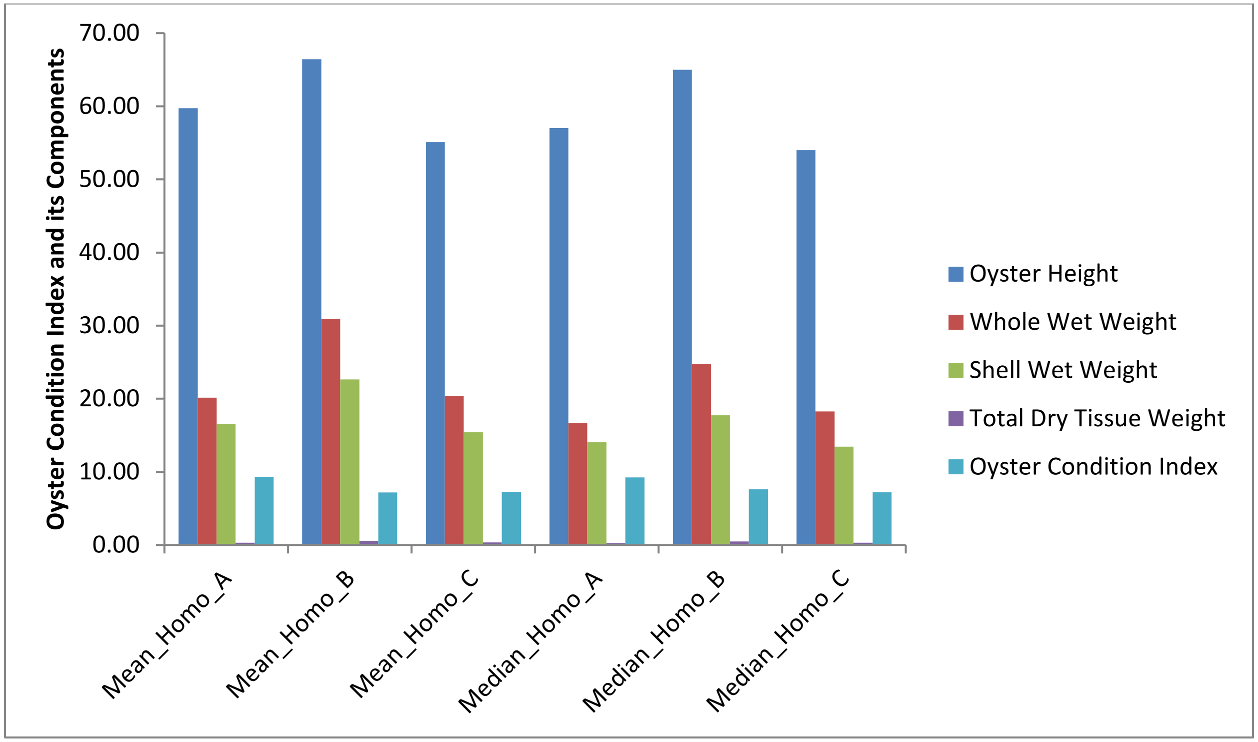


Figure H-4. Homosassa River Means and Medians for the Oyster Condition Index and its Component Inputs.

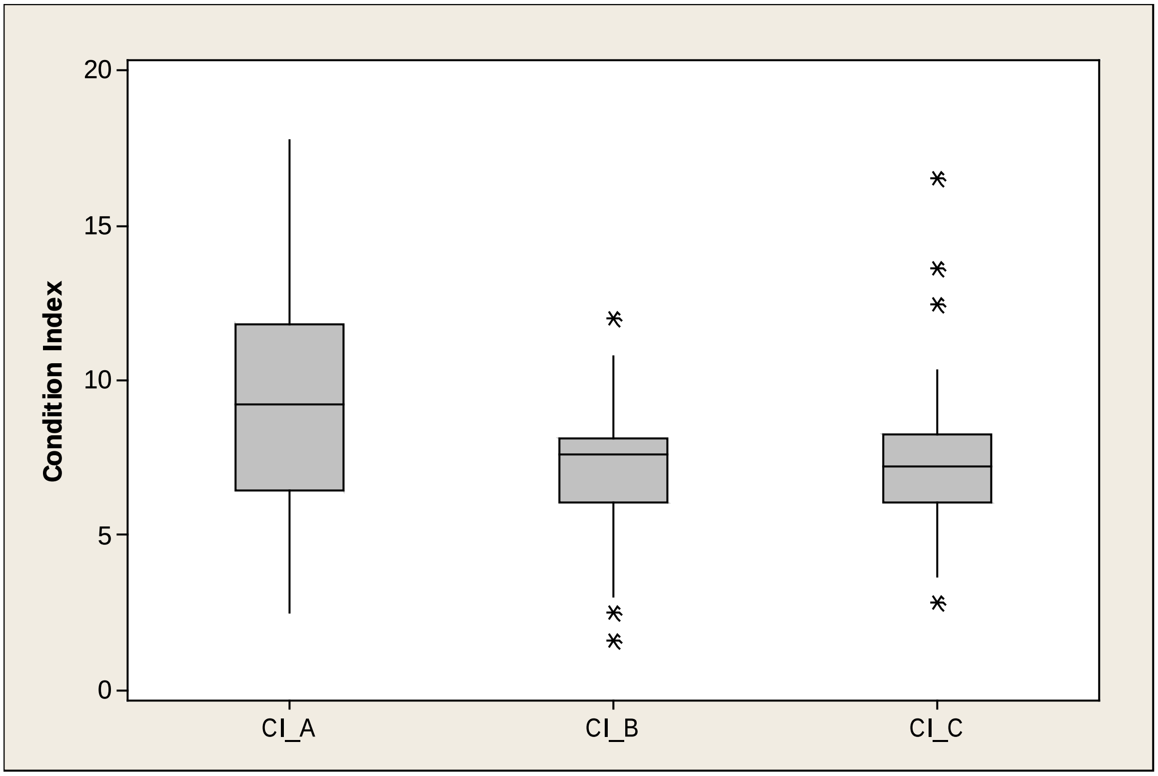


Figure H-4.2. Box and Whisker plot for Homosassa River Condition Index by Salinity Group.

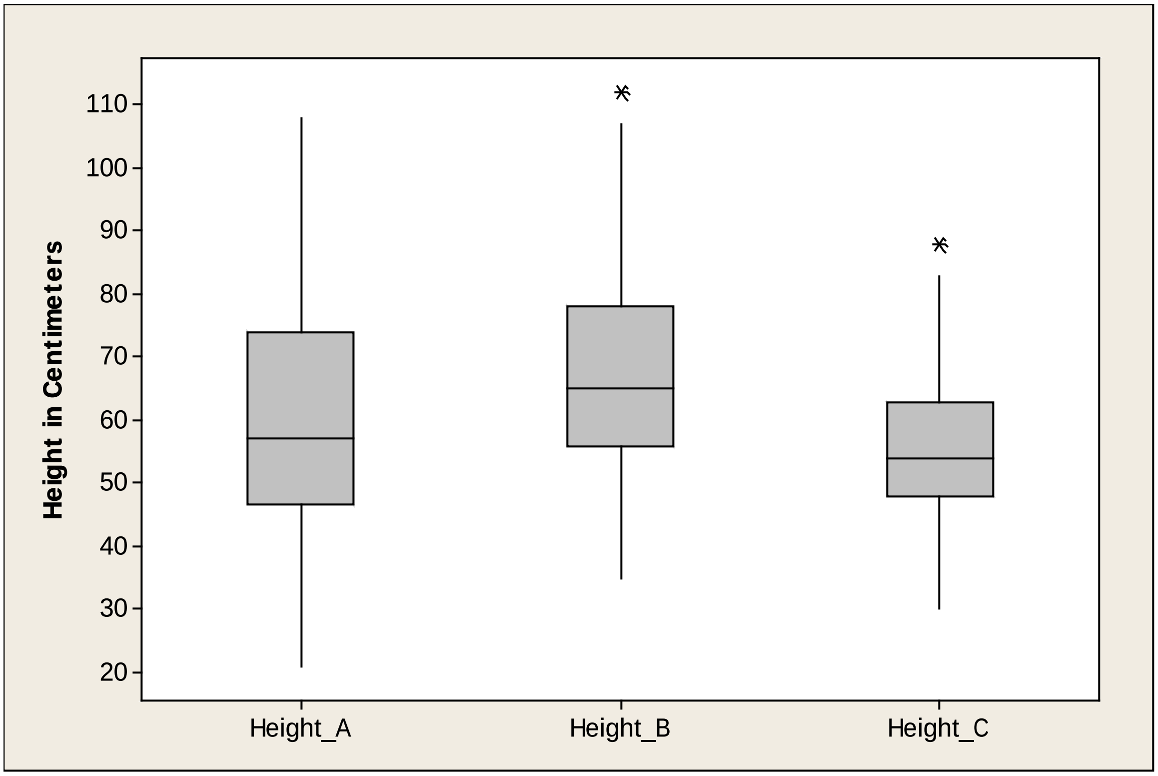


Figure H-4.3. Box and Whisker plot for Homosassa River Oyster Height by Salinity Group.

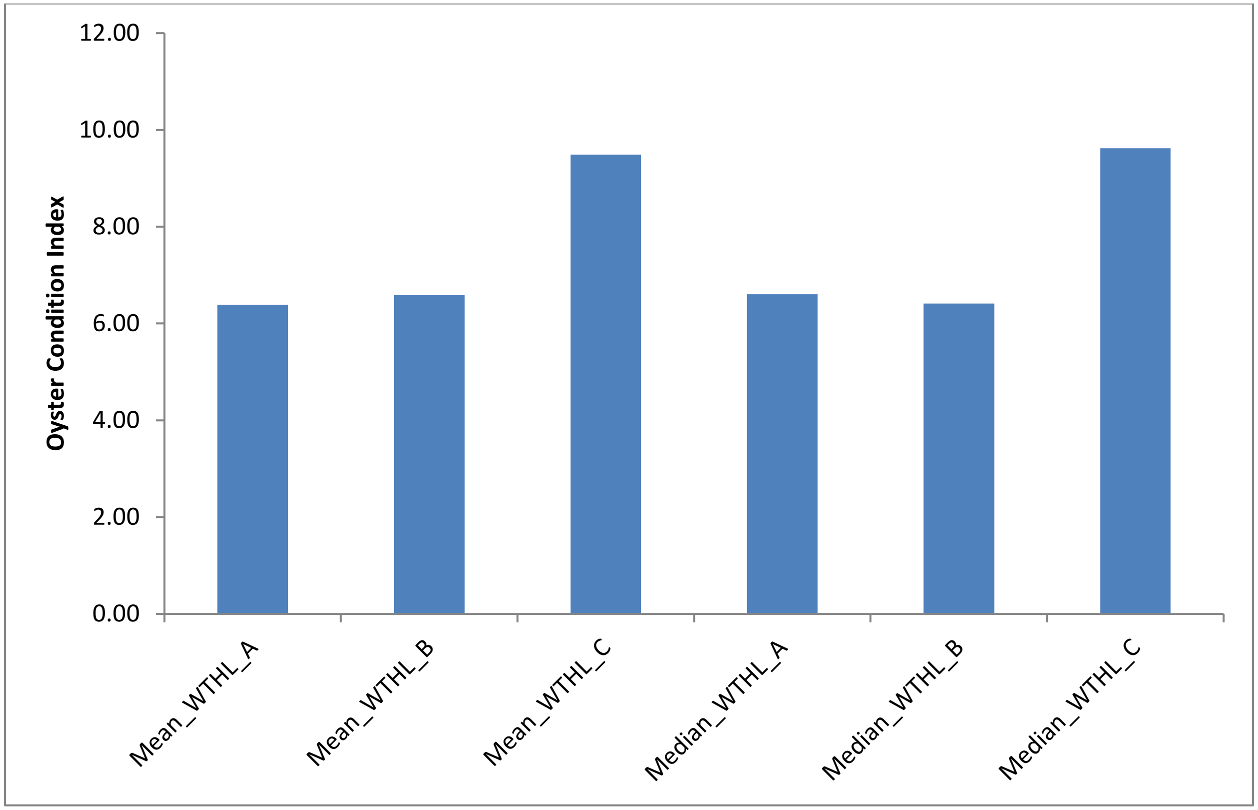


Figure H-5. Lower Withlacoochee River Means and Medians for the Oyster Condition Index.

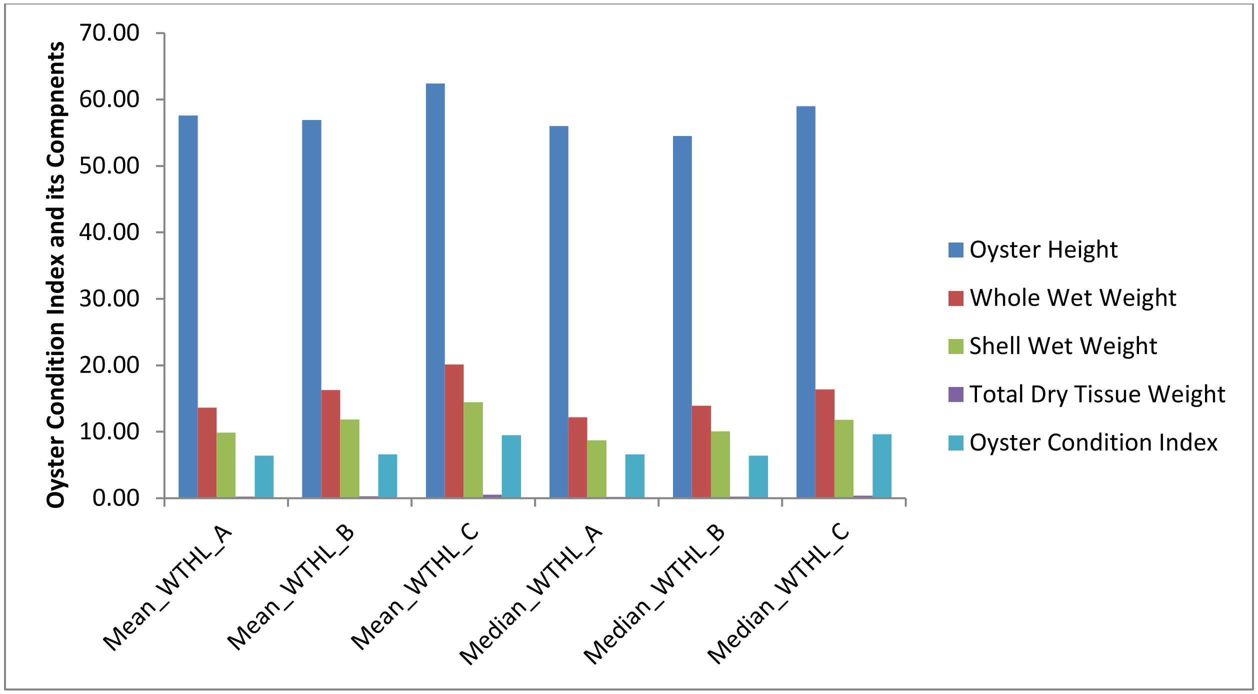


Figure H-6. Lower Withlacoochee River Means and Medians for the Oyster Condition Index and its Component Inputs.

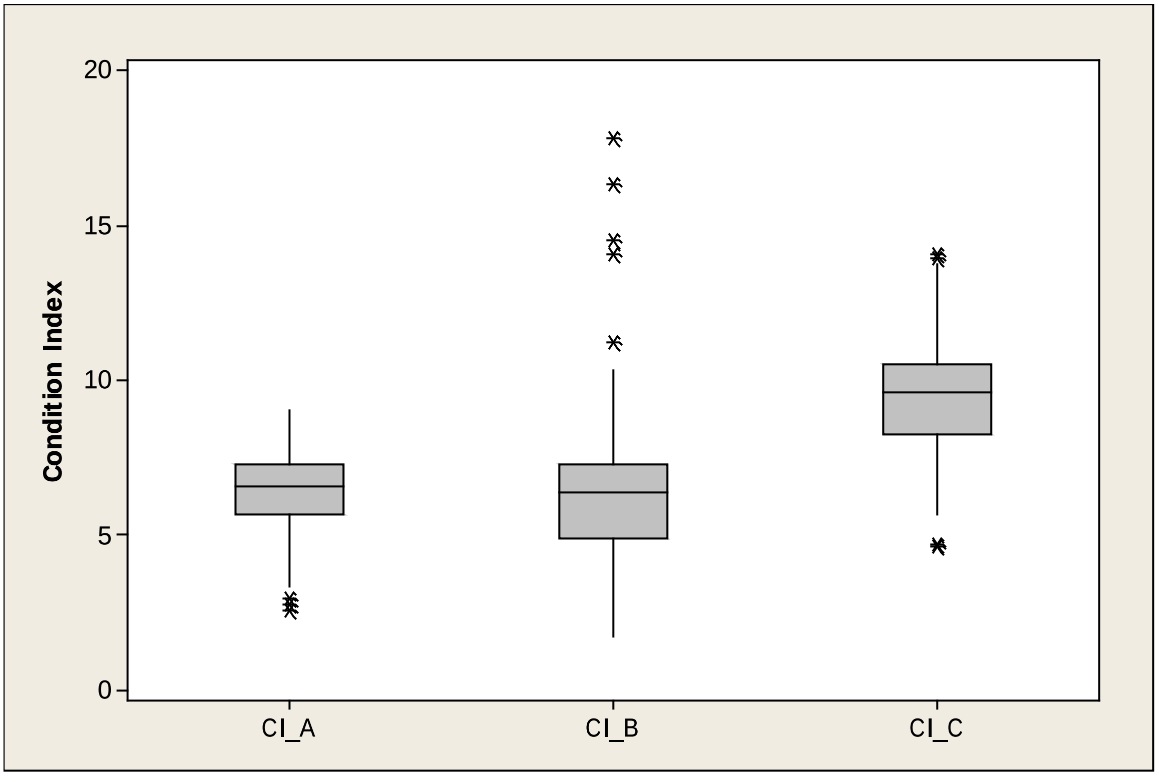


Figure H-6.2. Box and Whisker plot for Lower Withlacoochee River Condition Index by Salinity Group.

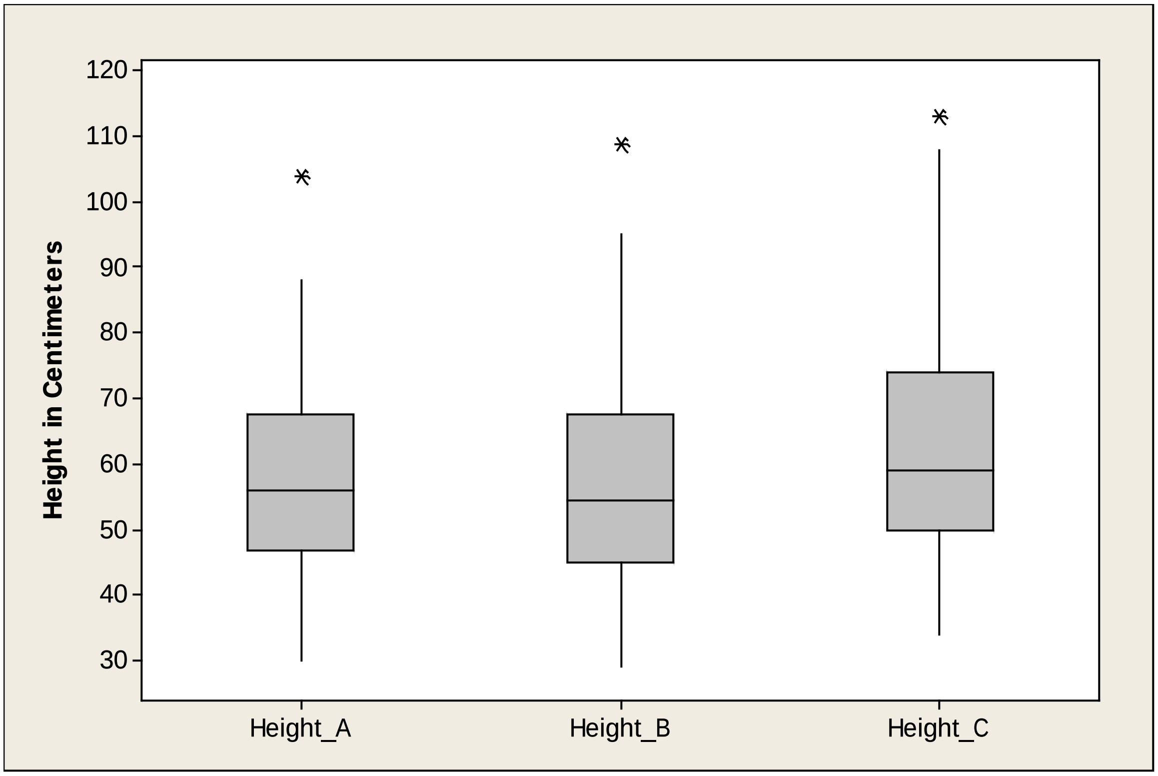


Figure H-6.3. Box and Whisker plot for Lower Withlacoochee River Oyster Height by Salinity Group.

APPENDIX I

STATISTICAL DOCUMENTATION

SWFWMD Oyster & Barnacle Project Conventional Statistical Documentation

Oysters

Chassahowitzka River Oyster Field Data

Descriptive Statistics for Chassahowitzka Oyster Field Data.

Descriptive Statistics: Est%Ba AreaA, NperQuadrant, PercentLive, TotalLive, ...

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Est%BaAreaAlive	5	68.0	22.8	40.0	45.0	70.0	90.0	90.0
NperQuadrant	5	561.2	218.2	279.0	325.5	700.0	727.5	741.0
PercentLive	5	86.40	6.69	76.00	80.00	88.00	92.00	92.00
TotalLive	5	21.600	1.673	19.000	20.000	22.000	23.000	23.000
TotalDead	5	3.400	1.673	2.000	2.000	3.000	5.000	6.000

Chassahowitzka River Oyster Field Data by Salinity Area.

Results for: CHAS Oyster Field Data for Salinity Area tests.MTW

Salinity Area B

Descriptive Statistics: Est%Ba AreaA, NperQuadrant, PercentLive_, ...

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Est%Ba AreaAlive_B	2	65.0	35.4	40.0	*	65.0	*	90.0
NperQuadrant_B	2	490	298	279	*	490	*	700
PercentLive_B	2	80.00	5.66	76.00	*	80.00	*	84.00
TotalLive_B	2	20.00	1.41	19.00	*	20.00	*	21.00
TotalDead_B	2	5.00	1.41	4.00	*	5.00	*	6.00

Salinity Area C

Descriptive Statistics: Est%Ba AreaA, NperQuadrant, PercentLive_, ...

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Est%Ba AreaAlive_C	3	70.0	20.0	50.0	50.0	70.0	90.0	90.0
NperQuadrant_C	3	609	206	372	372	714	741	741
PercentLive_C	3	90.67	2.31	88.00	88.00	92.00	92.00	92.00
TotalLive_C	3	22.667	0.577	22.000	22.000	23.000	23.000	23.000
TotalDead_C	3	2.333	0.577	2.000	2.000	2.000	3.000	3.00

Mann-Whitney tests between Salinity Areas B and C for Chassahowitzka River Oyster Field Data

Mann-Whitney Test and CI: Est%Ba AreaAlive_B, Est%Ba AreaAlive_C

```
                    N  Median
Est%Ba AreaAlive_B  2   65.00
Est%Ba AreaAlive_C  3   70.00


Point estimate for ETA1-ETA2 is -5.00
85.1 Percent CI for ETA1-ETA2 is (-50.02,40.02)
W = 5.5
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 1.0000
```

Mann-Whitney Test and CI: NperQuadrant_B, NperQuadrant_C

```
                N  Median
NperQuadrant_B  2   489.5
NperQuadrant_C  3   714.0


Point estimate for ETA1-ETA2 is -67.0
85.1 Percent CI for ETA1-ETA2 is (-462.1,328.1)
W = 4.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.3865
```

Mann-Whitney Test and CI: PercentLive_B, PercentLive_C

```
               N  Median
PercentLive_B  2   80.00
PercentLive_C  3   92.00


Point estimate for ETA1-ETA2 is -10.00
85.1 Percent CI for ETA1-ETA2 is (-16.00,-4.00)
W = 3.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.1489
```

Mann-Whitney Test and CI: TotalLive_B, TotalLive_C

```
             N  Median
TotalLive_B  2  20.000
TotalLive_C  3  23.000


Point estimate for ETA1-ETA2 is -2.500
85.1 Percent CI for ETA1-ETA2 is (-4.001,-0.999)
W = 3.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.1489
```

Mann-Whitney Test and CI: TotalDead_B, TotalDead_C

	N	Median
TotalDead_B	2	5.000
TotalDead_C	3	2.000

```
Point estimate for ETA1-ETA2 is 2.500
85.1 Percent CI for ETA1-ETA2 is (0.999,4.001)
W = 9.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.1489
The test is significant at 0.1386 (adjusted for ties)
```

None of the Nonparametric Mann-Whitney tests found significant difference for oyster field data at P≤0.05.

Descriptive Statistics for Chassahowitzka River Oyster Condition Index and its Components.

Descriptive Statistics: Height, WWW, SWW, TDW, CI

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3
Height	224	1	44.54	1.09	16.34	18.00	34.00	40.00	53.38
WWW	224	1	12.989	0.942	14.098	0.825	5.509	8.655	15.676
SWW	224	1	10.126	0.746	11.170	0.715	4.340	6.702	12.625
TDW	224	1	0.1921	0.0137	0.2047	0.0160	0.0742	0.1230	0.2138
CI	224	1	7.030	0.160	2.395	0.273	5.685	7.049	8.226

Variable	Maximum
Height	122.00
WWW	143.833
SWW	112.086
TDW	1.3120
CI	18.336

Descriptive Statistics for Chassahowitzka River Oyster Condition Index and its Components by Salinity Area.

Results for: CHAS Oyster Lab Data by Salinity Group.MTW

Descriptive Statistics: Height_A, WWW_A, SWW_A, TDW_A, CI_A

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Height_A	74	49.92	19.42	18.00	35.50	46.50	63.25	122.00
WWW_A	74	19.53	20.69	0.82	7.18	13.49	26.14	143.83
SWW_A	74	15.34	16.49	0.71	5.31	10.42	20.64	112.09
TDW_A	74	0.2792	0.2998	0.0160	0.0688	0.1450	0.4305	1.3120
CI_A	74	6.753	3.097	0.273	4.886	6.799	8.171	18.336

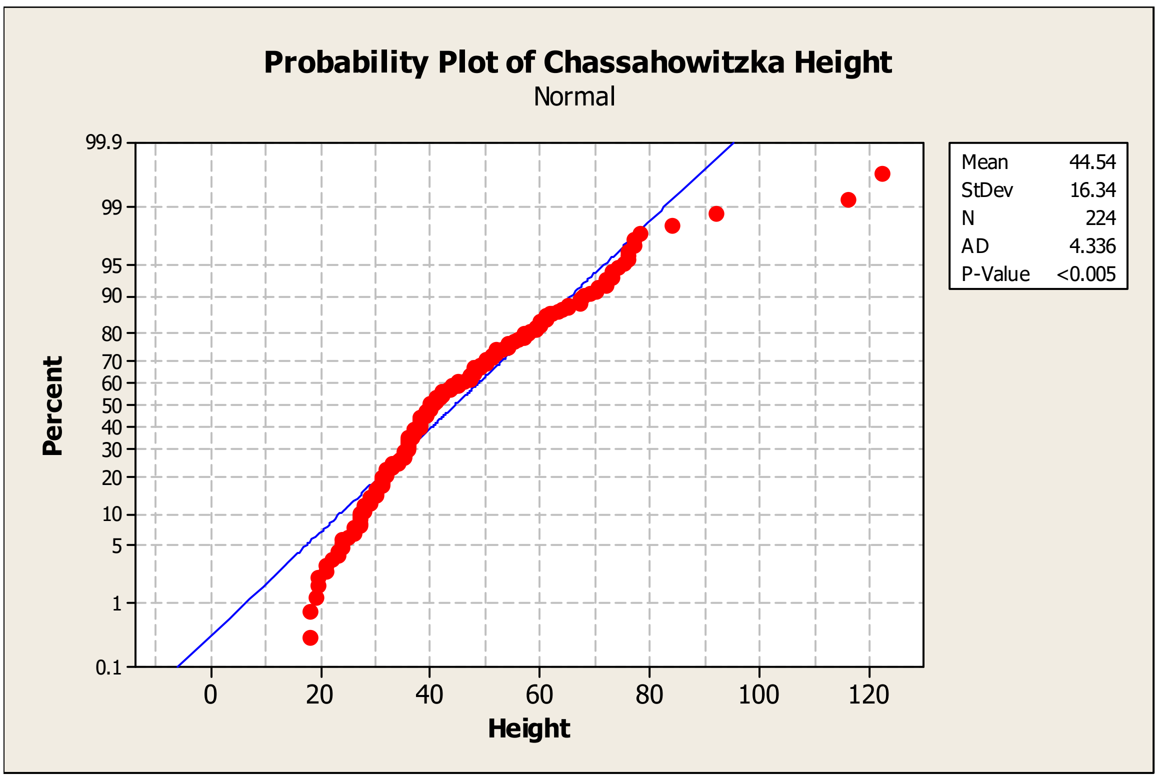
Descriptive Statistics: Height_B, WWW_B, SWW_B, TDW_B, CI_B

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Height_B	75	39.31	12.66	18.00	29.00	38.00	47.50	72.00
WWW_B	75	8.726	5.031	1.816	4.837	7.704	11.361	22.761
SWW_B	75	6.762	3.800	1.495	3.921	5.915	8.621	16.364
TDW_B	75	0.12016	0.06702	0.01900	0.07300	0.11200	0.15100	0.31900
CI_B	75	6.828	2.272	2.617	5.600	6.550	7.774	17.935

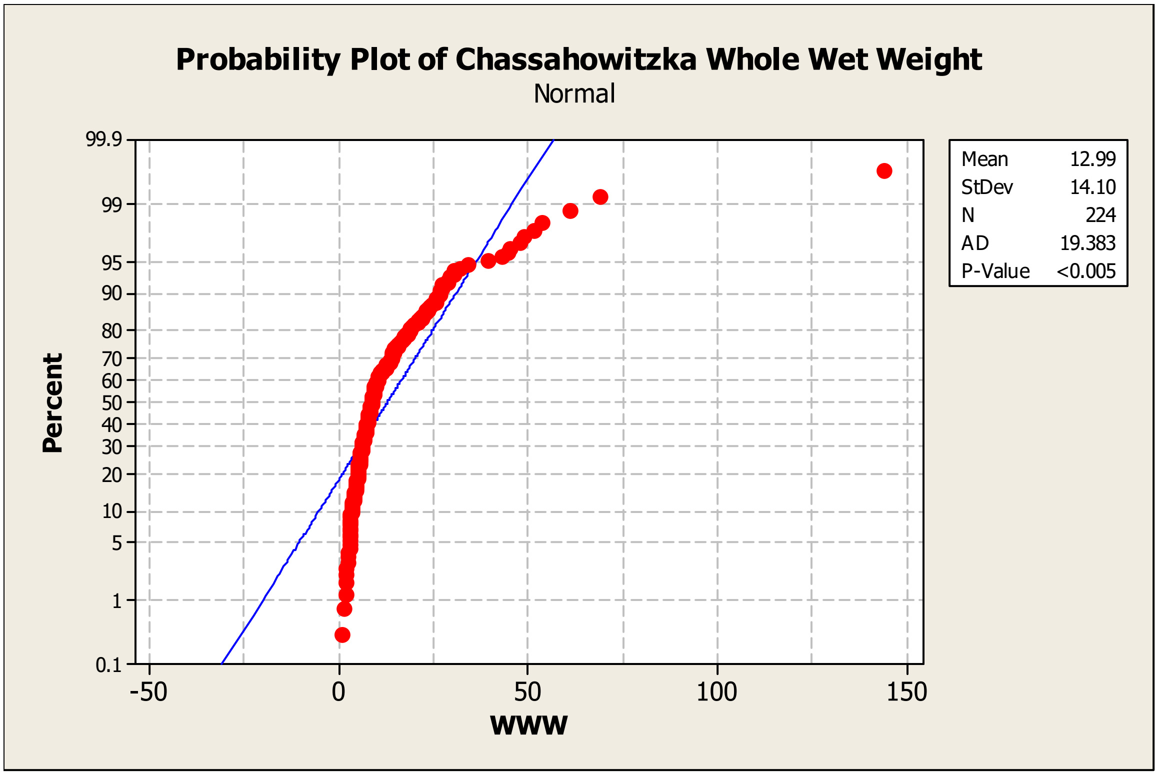
Descriptive Statistics: Height_C, WWW_C, SWW_C, TDW_C, CI_C

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Height_C	75	44.45	14.69	26.00	35.00	39.00	51.00	116.00
WWW_C	75	10.80	9.23	2.38	5.44	7.60	13.83	60.75
SWW_C	75	8.344	7.166	1.820	4.273	5.861	10.552	48.342
TDW_C	75	0.1780	0.1417	0.0330	0.0840	0.1270	0.2250	0.7630
CI_C	75	7.503	1.522	2.808	6.440	7.563	8.681	10.477

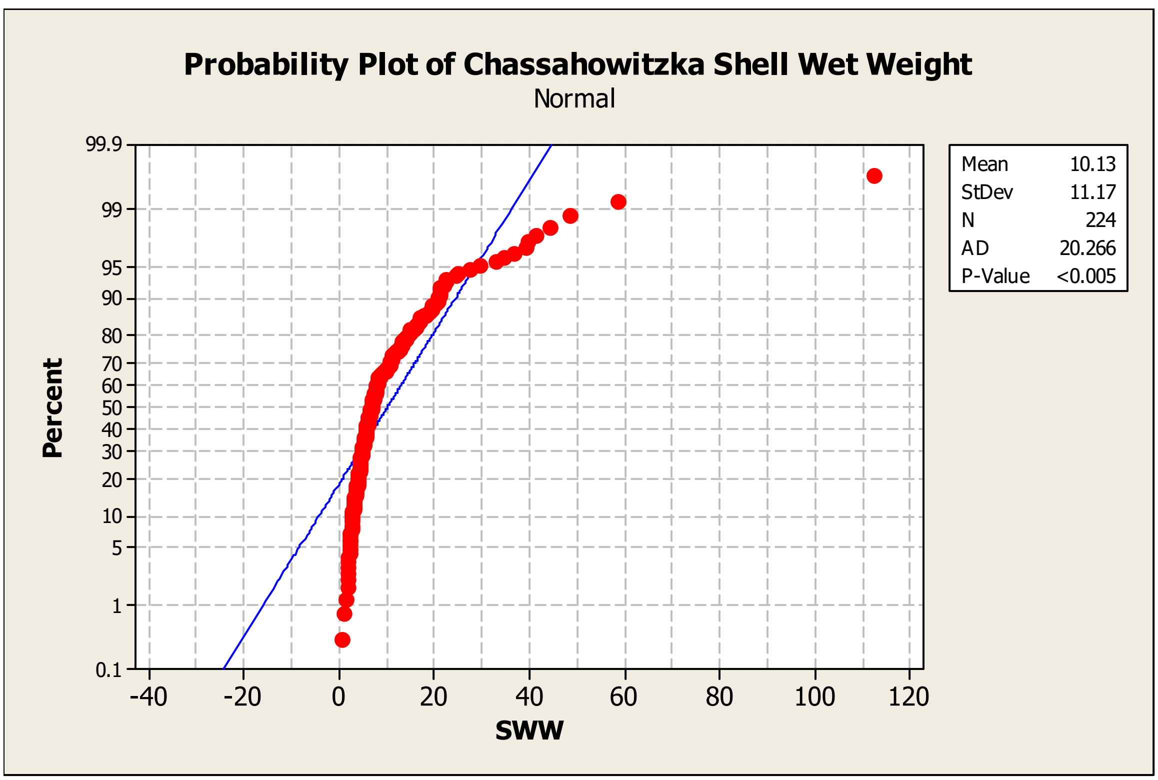
Tests for Normality for Chassahowitzka River Oyster Condition Index (CI) Data



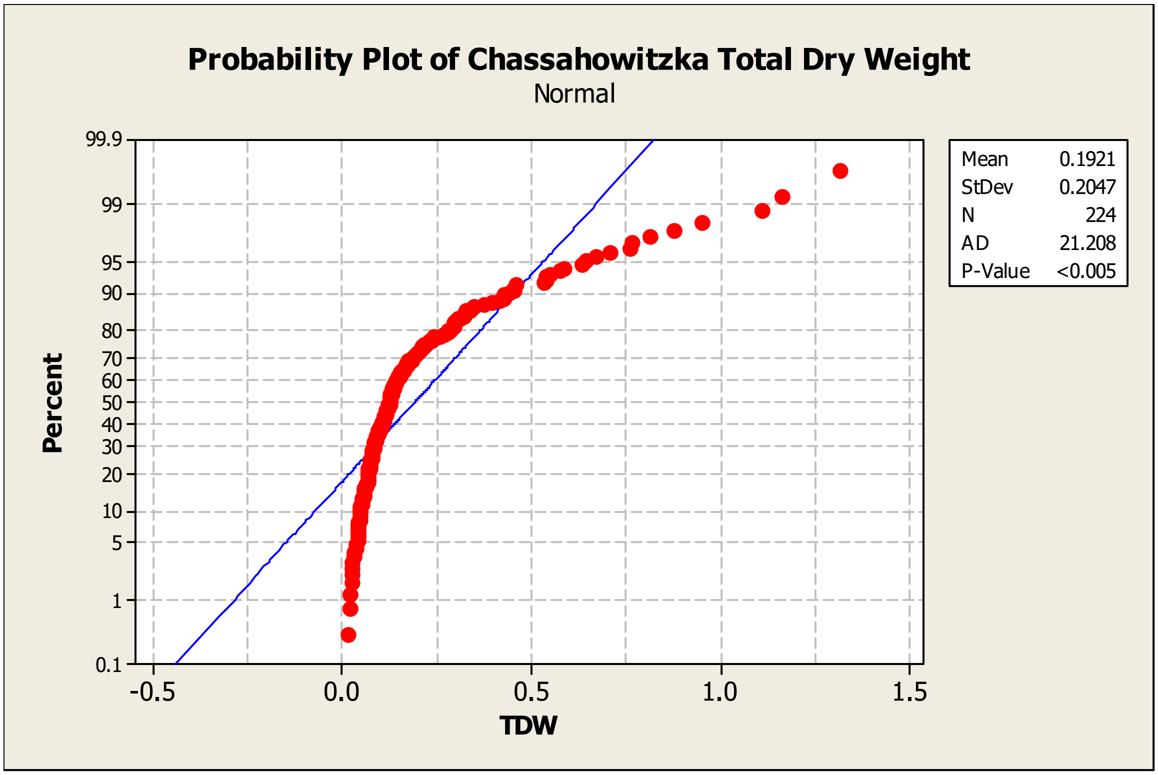
Chassahowitzka Oyster Height data were not normally distributed.



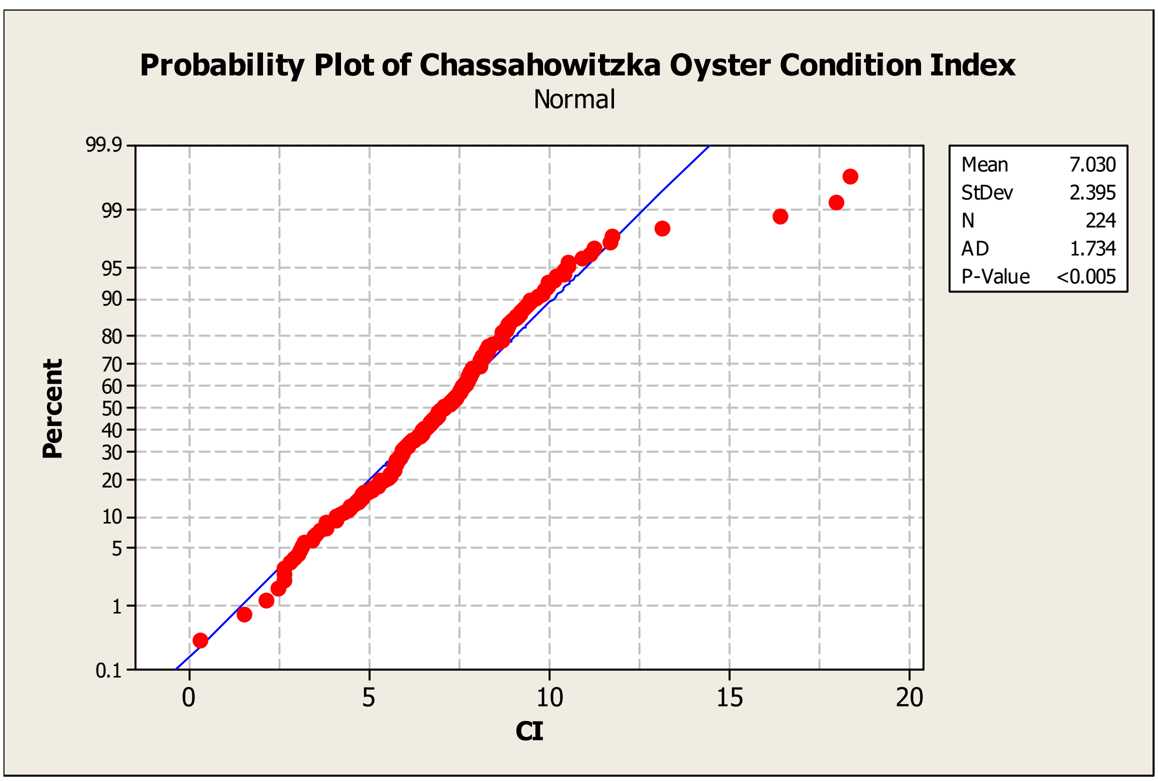
Chassahowitzka Oyster Whole Wet Weight data were not normally distributed.



Chassahowitzka Oyster Shell Wet Weight data were not normally distributed.



Chassahowitzka Oyster Total Dry Weight data were not normally distributed.



Chassahowitzka River Oyster Condition Index data were not normally distributed.

Chassahowitzka River Spearman's Rank Correlation Test Results

Correlations: Height_1, WWW_1, SWW_1, TDW_1, CI_1

```
          Height_1     WWW_1     SWW_1     TDW_1
WWW_1        0.887
             0.0001

SWW_1        0.893     0.990
             0.0001    0.0001

TDW_1        0.844     0.889     0.894
             0.0001     0.0001    0.0001

CI_1        -0.061    -0.133    -0.105     0.198
             0.367     0.047     0.119     0.003
```

With N=224, degrees of freedom is 222, so the Spearman's P-values at that large N will equal the Pearson values provided by MINITAB (see Snedecor and Cochran 1967). All correlations were highly significant, except for CI versus Height, P=0.367 (not a significant difference); CI versus SWW P=0.119 (not a significant difference); CI versus WWW P=0.047 (difference was significant); and CI versus WWW P=0.047 (difference was significant);

Nonparametric Mann-Whitney Test Results for the Chassahowitzka River

Results for: CHAS Oyster Lab Data by Salinity Group.MTW

Mann-Whitney Test and CI: Height_A, Height_B

```
           N  Median
Height_A  74  46.500
Height_B  75  38.000


Point estimate for ETA1-ETA2 is 9.000
95.0 Percent CI for ETA1-ETA2 is (4.000,13.999)
W = 6457.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.0006
The test is significant at 0.0006 (adjusted for ties)
```

Mann-Whitney Test and CI: Height_A, Height_C

```
           N  Median
Height_A  74  46.500
Height_C  75  39.000


Point estimate for ETA1-ETA2 is 4.000
95.0 Percent CI for ETA1-ETA2 is (-1.001,8.998)
W = 6013.5
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.0788
The test is significant at 0.0787 (adjusted for ties)
```

Mann-Whitney Test and CI: WWW_A, WWW_B

```
        N  Median
WWW_A  74  13.494
WWW_B  75   7.704


Point estimate for ETA1-ETA2 is 5.494
95.0 Percent CI for ETA1-ETA2 is (2.574,9.049)
W = 6626.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.00001
```

Mann-Whitney Test and CI: WWW_A, WWW_C

```
        N  Median
WWW_A  74  13.494
WWW_C  75   7.602


Point estimate for ETA1-ETA2 is 4.246
95.0 Percent CI for ETA1-ETA2 is (1.616,7.842)
W = 6423.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.0009
```

Mann-Whitney Test and CI: SWW_A, SWW_B

```
        N  Median
SWW_A  74  10.418
SWW_B  75   5.915


Point estimate for ETA1-ETA2 is 4.256
95.0 Percent CI for ETA1-ETA2 is (1.935,7.001)
W = 6589.5
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.0001
The test is significant at 0.0001 (adjusted for ties)
```

Mann-Whitney Test and CI: SWW_A, SWW_C

```
        N  Median
SWW_A  74  10.418
SWW_C  75   5.861


Point estimate for ETA1-ETA2 is 3.273
95.0 Percent CI for ETA1-ETA2 is (1.175,6.176)
W = 6402.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.0012
```

Mann-Whitney Test and CI: TDW_A, TDW_B

```
        N  Median
TDW_A  74  0.1450
TDW_B  75  0.1120


Point estimate for ETA1-ETA2 is 0.0390
95.0 Percent CI for ETA1-ETA2 is (0.0060,0.1000)
W = 6155.5
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.0216
The test is significant at 0.0216 (adjusted for ties)
```

Mann-Whitney Test and CI: TDW_A, TDW_C

```
        N  Median
TDW_A  74  0.1450
TDW_C  75  0.1270


Point estimate for ETA1-ETA2 is 0.0130
95.0 Percent CI for ETA1-ETA2 is (-0.0230,0.0600)
W = 5729.5
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.4968
The test is significant at 0.4967 (adjusted for ties)
```

Mann-Whitney Test and CI: CI_A, CI_B

```
       N  Median
CI_A  74   6.799
CI_B  75   6.550


Point estimate for ETA1-ETA2 is -0.117
95.0 Percent CI for ETA1-ETA2 is (-0.832,0.699)
W = 5471.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.7657
```

Mann-Whitney Test and CI: CI_A, CI_C

```
       N  Median
CI_A  74   6.799
CI_C  75   7.563


Point estimate for ETA1-ETA2 is -0.916
95.0 Percent CI for ETA1-ETA2 is (-1.631,-0.201)
W = 4884.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.0115
```

Mann-Whitney Test and CI: Height_B, Height_C

```
           N  Median
Height_B  75  38.000
Height_C  75  39.000


Point estimate for ETA1-ETA2 is -4.000
95.0 Percent CI for ETA1-ETA2 is (-8.001,0.001)
W = 5157.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.0577
The test is significant at 0.0576 (adjusted for ties)
```

Mann-Whitney Test and CI: WWW_B, WWW_C

```
        N  Median
WWW_B  75   7.704
WWW_C  75   7.602


Point estimate for ETA1-ETA2 is -0.486
95.0 Percent CI for ETA1-ETA2 is (-2.011,0.949)
W = 5486.5
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.5095
The test is significant at 0.5095 (adjusted for ties)
```

Mann-Whitney Test and CI: SWW_B, SWW_C

```
        N  Median
SWW_B  75   5.915
SWW_C  75   5.861


Point estimate for ETA1-ETA2 is -0.333
95.0 Percent CI for ETA1-ETA2 is (-1.541,0.746)
W = 5493.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.5253
```

Mann-Whitney Test and CI: TDW_B, TDW_C

```
        N   Median
TDW_B  75  0.11200
TDW_C  75  0.12700


Point estimate for ETA1-ETA2 is -0.02600
95.0 Percent CI for ETA1-ETA2 is (-0.05099,-0.00399)
W = 5059.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.0234
The test is significant at 0.0234 (adjusted for ties)
```

Mann-Whitney Test and CI: CI_B, CI_C

	N	Median
CI_B	75	6.5499
CI_C	75	7.5630

Point estimate for ETA1-ETA2 is -0.8897
95.0 Percent CI for ETA1-ETA2 is (-1.4222,-0.3107)
W = 4863.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.0027

Homosassa River Oyster Field Data

Results for: HOMO Oyster Field Data.MTW

Descriptive Statistics: Est%Ba AreaA, NperQuadrant, PercentLive, TotalLive, ...

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Est%Ba AreaAlive	8	71.88	12.52	50.00	62.50	72.50	80.00	90.00
NperQuadrant	9	301.3	111.7	116.0	207.5	317.0	396.5	448.0
PercentLive	9	84.58	11.35	68.00	70.62	92.00	92.00	96.00
TotalLive	9	21.222	2.728	17.000	18.000	23.000	23.000	24.000
TotalDead	9	3.889	2.892	1.000	2.000	2.000	7.500	8.000

Results for: HOMO Oyster Field Data for Salinity Area tests.MTW

Descriptive Statistics: Est%Ba AreaA, NperQuadrant, PercentLive_, ...

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Est%Ba AreaAlive_A	2	82.50	10.61	75.00	*	82.50	*	90.00
NperQuadrant_A	3	318.3	129.0	190.0	190.0	317.0	448.0	448.0
PercentLive_A	3	69.74	2.05	68.00	68.00	69.23	72.00	72.00
TotalLive_A	3	17.667	0.577	17.000	17.000	18.000	18.000	18.000
TotalDead_A	3	7.667	0.577	7.000	7.000	8.000	8.000	8.000

Descriptive Statistics: Est%Ba AreaA, NperQuadrant, PercentLive_, ...

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Est%Ba AreaAlive_B	3	73.33	5.77	70.00	70.00	70.00	80.00	80.00
NperQuadrant_B	3	268.7	156.6	116.0	116.0	261.0	429.0	429.0
PercentLive_B	3	90.67	2.31	88.00	88.00	92.00	92.00	92.00
TotalLive_B	3	22.667	0.577	22.000	22.000	23.000	23.000	23.000
TotalDead_B	3	2.333	0.577	2.000	2.000	2.000	3.000	3.000

Mann-Whitney tests between Salinity Areas for the Homosassa River Oyster Field Data

Mann-Whitney Test and CI: Est%Ba AreaAlive_A, Est%Ba AreaAlive_B

```
                    N  Median
Est%Ba AreaAlive_A  2   82.50
Est%Ba AreaAlive_B  3   70.00


Point estimate for ETA1-ETA2 is 7.50
85.1 Percent CI for ETA1-ETA2 is (-5.01,20.00)
W = 8.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.3865
The test is significant at 0.3743 (adjusted for ties)
```

Mann-Whitney Test and CI: NperQuadrant_A, NperQuadrant_B

```
                N  Median
NperQuadrant_A  3   317.0
NperQuadrant_B  3   261.0


Point estimate for ETA1-ETA2 is 56.0
91.9 Percent CI for ETA1-ETA2 is (-239.0,332.0)
W = 12.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.6625
```

Mann-Whitney Test and CI: PercentLive_A, PercentLive_B

```
               N  Median
PercentLive_A  3  69.231
PercentLive_B  3  92.000


Point estimate for ETA1-ETA2 is -20.000
91.9 Percent CI for ETA1-ETA2 is (-24.001,-15.999)
W = 6.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.0809
```

Mann-Whitney Test and CI: TotalLive_A, TotalLive_B

```
             N  Median
TotalLive_A  3  18.000
TotalLive_B  3  23.000


Point estimate for ETA1-ETA2 is -5.000
91.9 Percent CI for ETA1-ETA2 is (-6.000,-4.000)
W = 6.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.0809
The test is significant at 0.0722 (adjusted for ties)
```

Mann-Whitney Test and CI: TotalDead_A, TotalDead_B

```
             N  Median
TotalDead_A  3   8.000
TotalDead_B  3   2.000


Point estimate for ETA1-ETA2 is 5.000
91.9 Percent CI for ETA1-ETA2 is (4.000,6.000)
W = 15.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.0809
The test is significant at 0.0722 (adjusted for ties)
```

Mann-Whitney Test and CI: Est%Ba AreaAlive_A, Est%Ba AreaAlive_C

```
                    N  Median
Est%Ba AreaAlive_A  2   82.50
Est%Ba AreaAlive_C  3   60.00

Point estimate for ETA1-ETA2 is 20.00
85.1 Percent CI for ETA1-ETA2 is (-4.99,39.99)
W = 8.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.3865
```

Mann-Whitney Test and CI: NperQuadrant_A, NperQuadrant_C

```
                N  Median
NperQuadrant_A  3   317.0
NperQuadrant_C  3   362.0

Point estimate for ETA1-ETA2 is -35.0
91.9 Percent CI for ETA1-ETA2 is (-173.9,223.0)
W = 10.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 1.0000
```

Mann-Whitney Test and CI: PercentLive_A, PercentLive_C

```
               N  Median
PercentLive_A  3  69.231
PercentLive_C  3  92.000


Point estimate for ETA1-ETA2 is -24.000
91.9 Percent CI for ETA1-ETA2 is (-27.999,-20.001)
W = 6.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.0809
The test is significant at 0.0765 (adjusted for ties)
```

Mann-Whitney Test and CI: TotalLive_A, TotalLive_C

```
             N  Median
TotalLive_A  3  18.000
TotalLive_C  3  23.000


Point estimate for ETA1-ETA2 is -6.000
91.9 Percent CI for ETA1-ETA2 is (-7.000,-5.000)
W = 6.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.0809
The test is significant at 0.0722 (adjusted for ties)
```

Mann-Whitney Test and CI: TotalDead_A, TotalDead_C

```
             N  Median
TotalDead_A  3   8.000
TotalDead_C  3   2.000

Point estimate for ETA1-ETA2 is 6.000
91.9 Percent CI for ETA1-ETA2 is (5.000,7.000)
W = 15.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.0809
The test is significant at 0.0722 (adjusted for ties)
```

Mann-Whitney Test and CI: Est%Ba AreaAlive_B, Est%Ba AreaAlive_C

```
                    N  Median
Est%Ba AreaAlive_B  3   70.00
Est%Ba AreaAlive_C  3   60.00

Point estimate for ETA1-ETA2 is 10.00
91.9 Percent CI for ETA1-ETA2 is (-10.01,30.00)
W = 12.5
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.5127
The test is significant at 0.5002 (adjusted for ties)
```

Mann-Whitney Test and CI: NperQuadrant_B, NperQuadrant_C

```
                N  Median
NperQuadrant_B  3   261.0
NperQuadrant_C  3   362.0

Point estimate for ETA1-ETA2 is -101.0
91.9 Percent CI for ETA1-ETA2 is (-248.0,204.0)
W = 10.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 1.0000
```

Mann-Whitney Test and CI: PercentLive_B, PercentLive_C

```
               N  Median
PercentLive_B  3  92.000
PercentLive_C  3  92.000

nt estimate for ETA1-ETA2 is -4.000
91.9 Percent CI for ETA1-ETA2 is (-8.000,0.001)
W = 8.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.3827
The test is significant at 0.3017 (adjusted for ties)
```

Mann-Whitney Test and CI: TotalLive_B, TotalLive_C

```
             N  Median
TotalLive_B  3  23.000
TotalLive_C  3  23.000

Point estimate for ETA1-ETA2 is -1.000
91.9 Percent CI for ETA1-ETA2 is (-2.000,0.000)
W = 8.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.3827
The test is significant at 0.3017 (adjusted for ties)
```

Mann-Whitney Test and CI: TotalDead_B, TotalDead_C

	N	Median
TotalDead_B	3	2.000
TotalDead_C	3	2.000

```
Point estimate for ETA1-ETA2 is 1.000
91.9 Percent CI for ETA1-ETA2 is (-0.000,2.000)
W = 13.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.3827
The test is significant at 0.3017 (adjusted for ties)
```

None of the Nonparametric Mann-Whitney tests found significant difference for oyster field data at P≤0.05.

Results for: All HOMO Oyster CI & Height Data.MTW

Descriptive Statistics: Height, WWW, SWW, TDW, CI

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Height	220	60.44	17.26	21.00	49.00	58.25	70.00	112.00
WWW	220	23.91	15.59	0.99	13.83	20.23	29.63	104.38
SWW	220	18.240	11.934	0.840	10.342	15.330	22.598	75.109
TDW	220	0.4024	0.3041	0.0090	0.2140	0.3475	0.4950	2.6220
CI	220	7.897	2.726	1.633	6.115	7.637	8.944	17.763

Results for: HOMO Oyster Lab Data by Salinity Group.MTW

Descriptive Statistics: Height_A, WWW_A, SWW_A, TDW_A, CI_A

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Height_A	70	59.74	20.31	21.00	46.75	57.00	74.00	108.00
WWW_A	70	20.15	14.10	0.99	8.88	16.68	25.58	70.27
SWW_A	70	16.54	11.72	0.84	7.57	14.07	21.26	52.37
TDW_A	70	0.2869	0.1974	0.0090	0.1263	0.2560	0.4043	0.9660
CI_A	70	9.312	3.592	2.498	6.440	9.238	11.798	17.763

Results for: HOMO Oyster Lab Data by Salinity Group.MTW

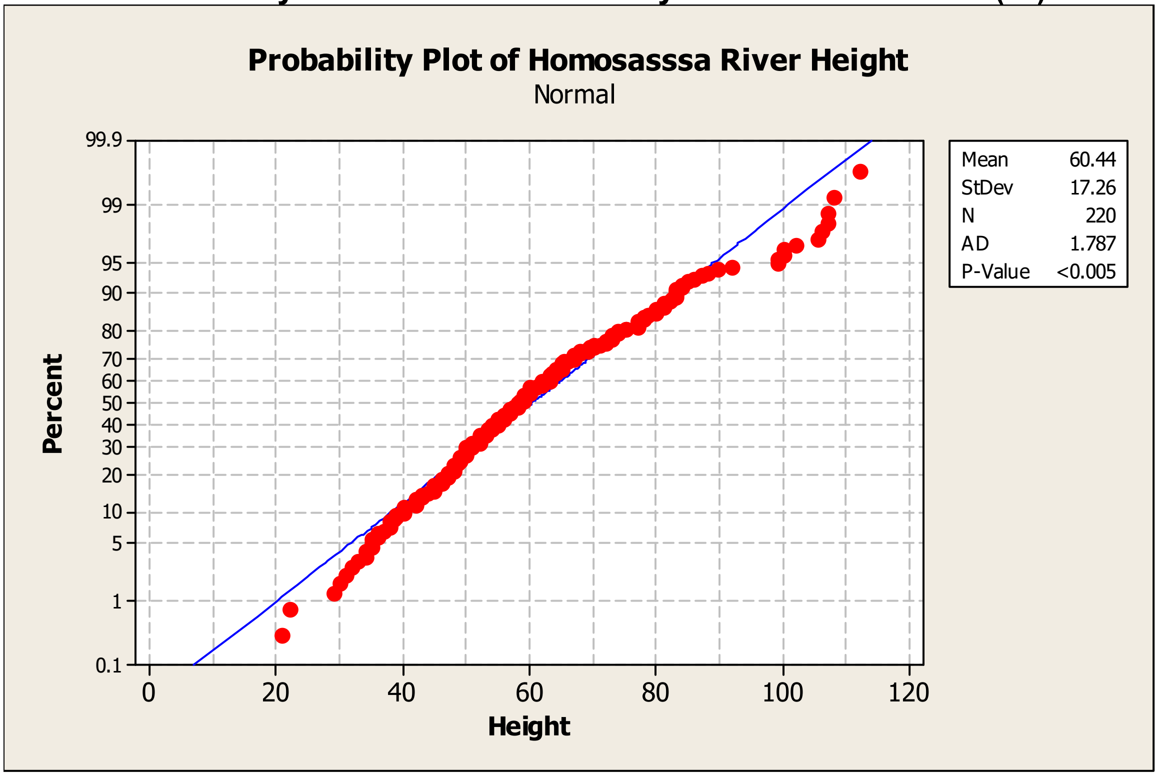
Descriptive Statistics: Height_B, WWW_B, SWW_B, TDW_B, CI_B

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Height_B	75	66.45	16.80	35.00	56.00	65.00	78.00	112.00
WWW_B	75	30.92	18.78	6.30	18.90	24.80	42.49	104.38
SWW_B	75	22.65	14.06	3.71	14.07	17.73	31.24	75.11
TDW_B	75	0.5561	0.3966	0.1140	0.3100	0.4610	0.6540	2.6220
CI_B	75	7.184	1.730	1.633	6.080	7.608	8.160	12.014

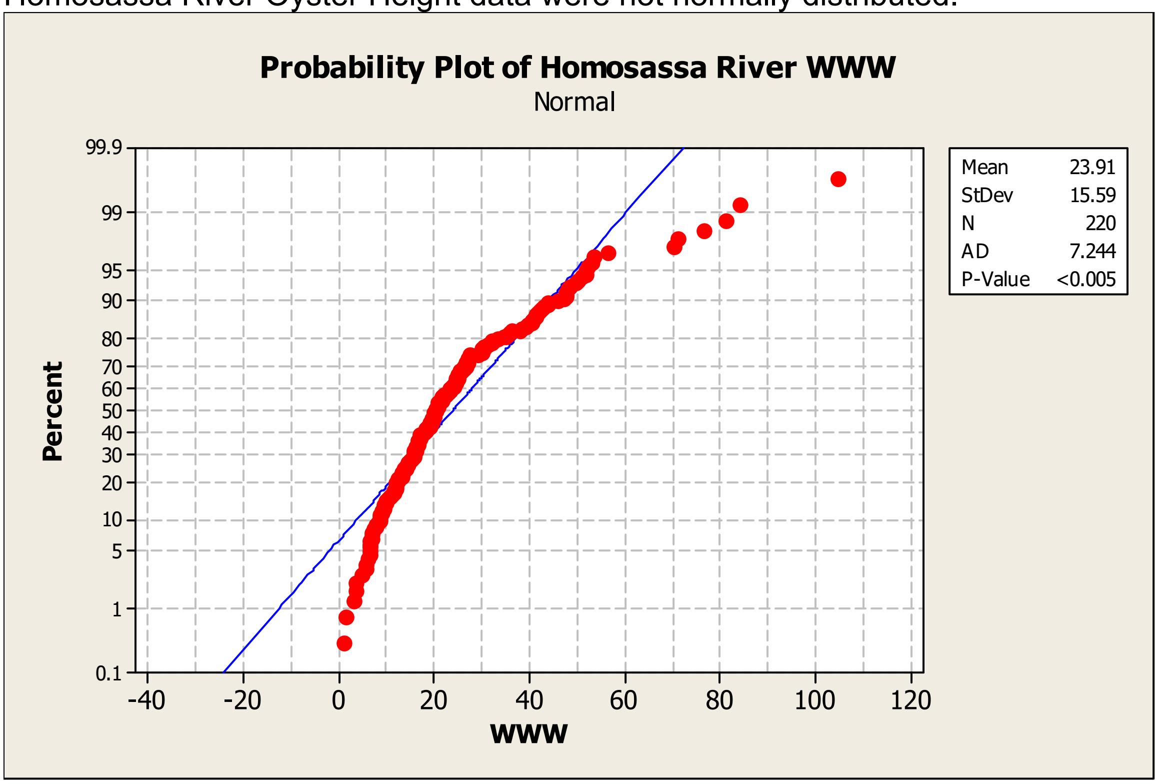
Descriptive Statistics: Height_C, WWW_C, SWW_C, TDW_C, CI_C

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Height_C	75	55.08	12.19	30.00	48.00	54.00	63.00	88.00
WWW_C	75	20.40	10.25	5.71	13.84	18.25	25.07	70.84
SWW_C	75	15.410	8.068	4.475	10.214	13.437	19.163	54.948
TDW_C	75	0.3565	0.2034	0.0640	0.2140	0.3200	0.4180	1.2420
CI_C	75	7.288	2.044	2.835	6.083	7.245	8.242	16.514

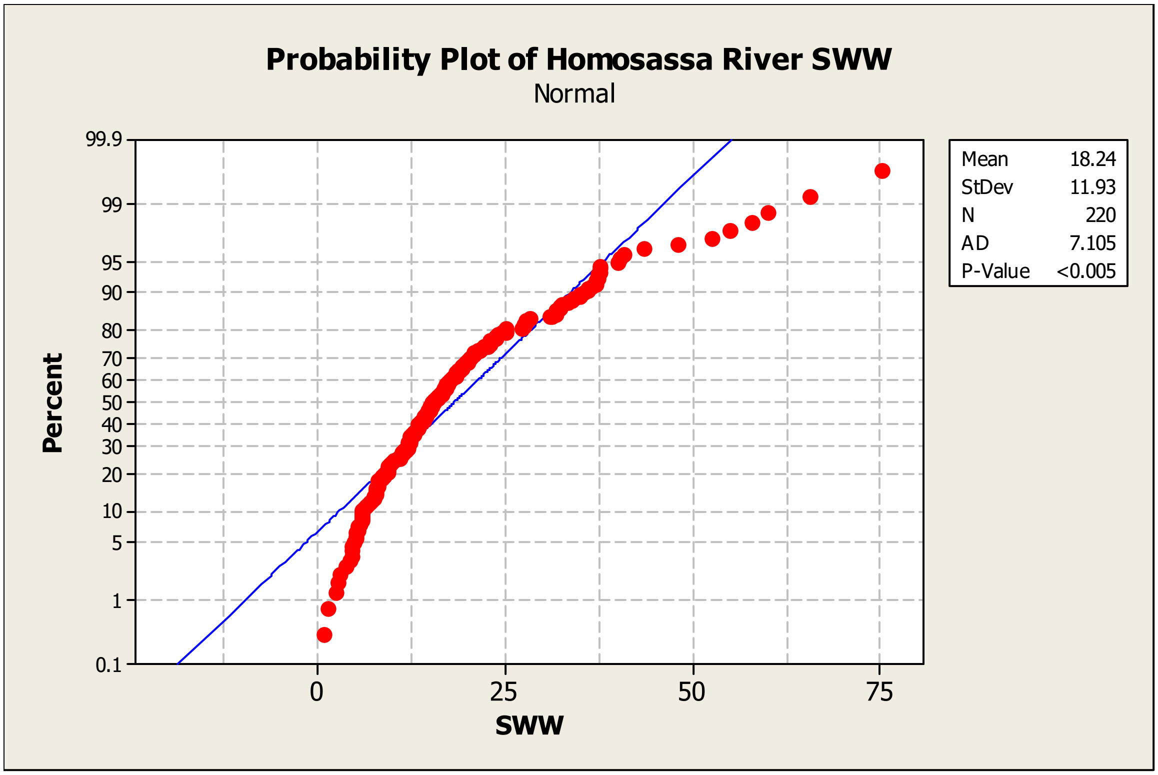
Tests for Normality for Homosassa River Oyster Condition Index (CI) Data



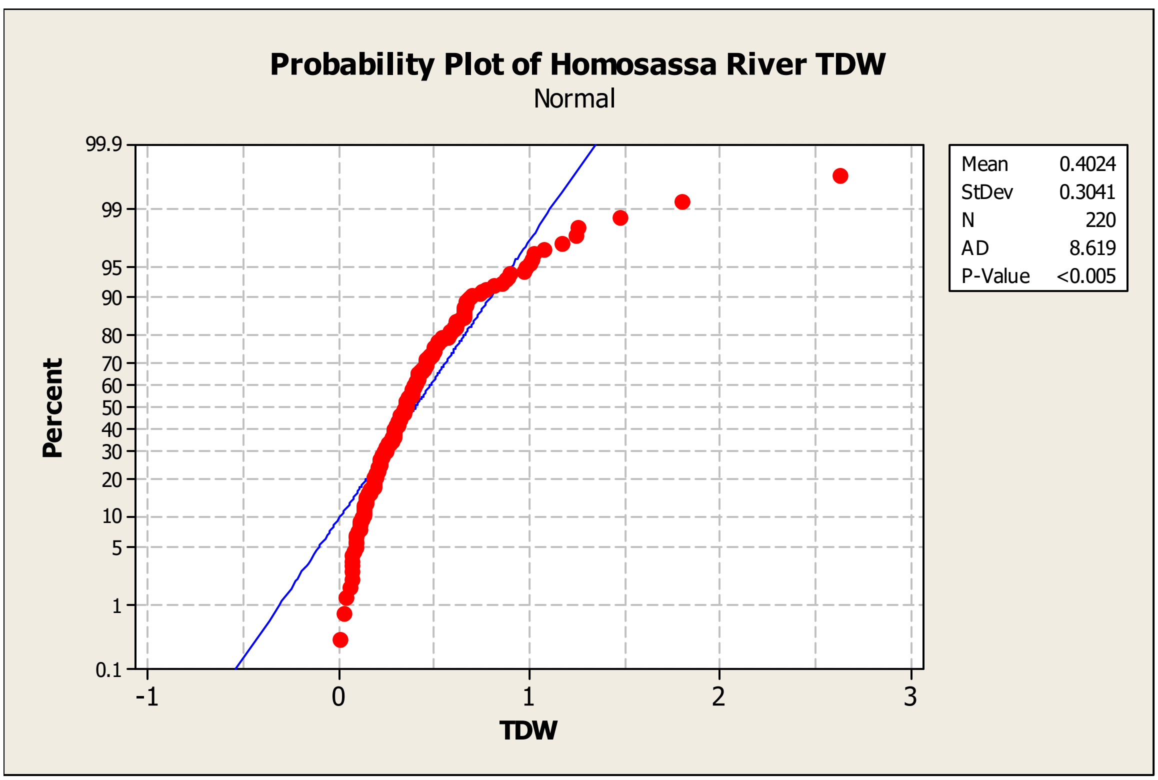
Homosassa River Oyster Height data were not normally distributed.



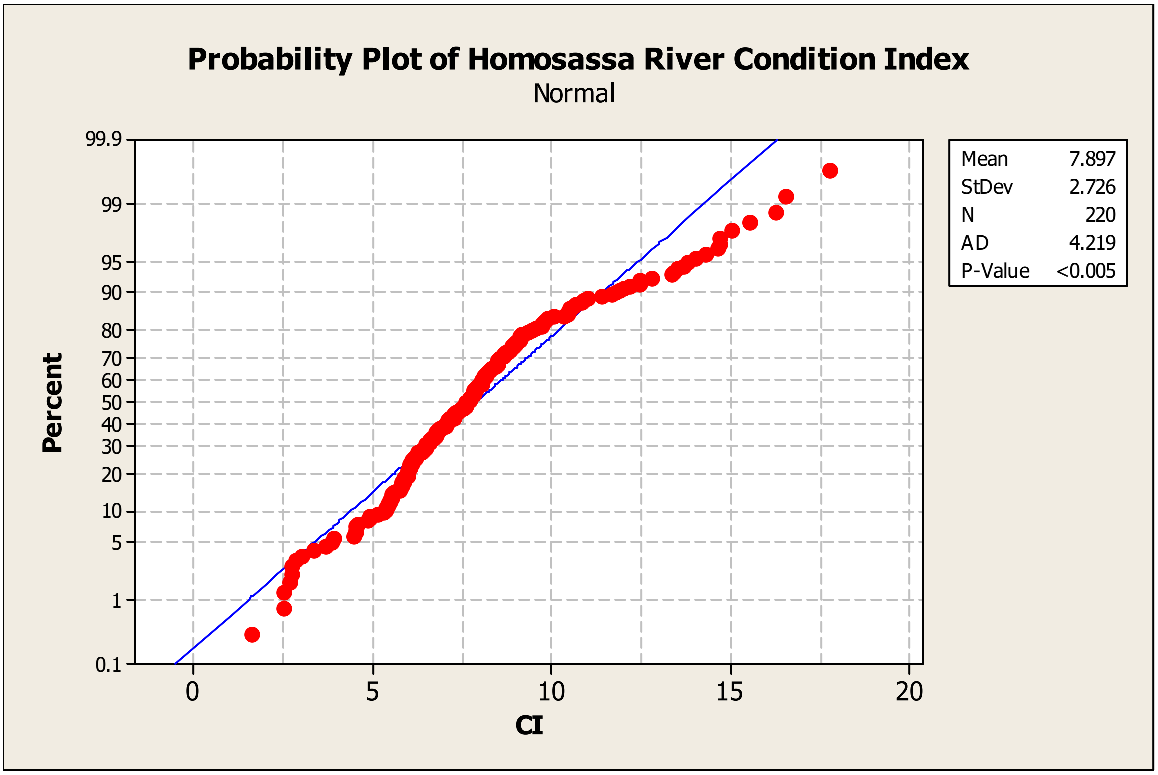
Homosassa River Oyster Whole Wet Weight data were not normally distributed.



Homosassa River Oyster Shell Wet Weight data were not normally distributed.



Homosassa River Oyster Shell Wet Weight data were not normally distributed.



Homosassa River Oyster Condition Index data were not normally distributed.

Homosassa River Spearman's Rank Correlation Test Results

Results for: HOMO Oyster CI & Height Data.MTW

Correlations: Height_1, WWW_1, SWW_1, TDW_1, CI_1

	Height_1	WWW_1	SWW_1	TDW_1
WWW_1	0.877			
	0.0001			
SWW_1	0.865	0.966		
	0.0001	0.0001		
TDW_1	0.800	0.897	0.841	
	0.0001	0.0001	0.0001	
CI_1	0.039	-0.071	0.034	0.099
	0.560	0.295	0.620	0.143

Cell Contents: Pearson correlation
P-Value

Mann-Whitney tests between Salinity Areas for the Homosassa River Oyster Condition Index Data

Results for: HOMO Oyster Lab Data by Salinity Group.MTW

Mann-Whitney Test and CI: Height_A, Height_B

```
           N  Median
Height_A  70   57.00
Height_B  75   65.00


Point estimate for ETA1-ETA2 is -7.50
95.0 Percent CI for ETA1-ETA2 is (-13.00,-1.00)
W = 4512.5
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.0182
The test is significant at 0.0181 (adjusted for ties)
```

Mann-Whitney Test and CI: WWW_A, WWW_B

```
        N  Median
WWW_A  70  16.684
WWW_B  75  24.797


Point estimate for ETA1-ETA2 is -8.835
95.0 Percent CI for ETA1-ETA2 is (-13.325,-4.813)
W = 4077.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.00001
```

Mann-Whitney Test and CI: SWW_A, SWW_B

```
        N  Median
SWW_A  70  14.073
SWW_B  75  17.734


Point estimate for ETA1-ETA2 is -5.211
95.0 Percent CI for ETA1-ETA2 is (-8.837,-1.929)
W = 4350.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.0027
```

Mann-Whitney Test and CI: TDW_A, TDW_B

```
        N  Median
TDW_A  70  0.2560
TDW_B  75  0.4610


Point estimate for ETA1-ETA2 is -0.2070
95.0 Percent CI for ETA1-ETA2 is (-0.2800,-0.1350)
W = 3747.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.00001
The test is significant at 0.0000 (adjusted for ties)
```

Mann-Whitney Test and CI: CI_A, CI_B

```
       N  Median
CI_A  70   9.238
CI_B  75   7.608


Point estimate for ETA1-ETA2 is 2.035
95.0 Percent CI for ETA1-ETA2 is (1.058,2.969)
W = 6119.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.0001
```

Mann-Whitney Test and CI: Height_A, Height_C

```
           N  Median
Height_A  70  57.000
Height_C  75  54.000


Point estimate for ETA1-ETA2 is 3.000
95.0 Percent CI for ETA1-ETA2 is (-1.997,8.001)
W = 5390.5
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.2679
The test is significant at 0.2678 (adjusted for ties)
```

Mann-Whitney Test and CI: WWW_A, WWW_C

```
        N  Median
WWW_A  70  16.684
WWW_C  75  18.248


Point estimate for ETA1-ETA2 is -1.656
95.0 Percent CI for ETA1-ETA2 is (-5.074,1.782)
W = 4855.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.3139
```

Mann-Whitney Test and CI: SWW_A, SWW_C

```
        N  Median
SWW_A  70  14.073
SWW_C  75  13.437


Point estimate for ETA1-ETA2 is -0.305
95.0 Percent CI for ETA1-ETA2 is (-3.171,2.691)
W = 5066.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.8633
```

Mann-Whitney Test and CI: TDW_A, TDW_C

```
        N  Median
TDW_A  70  0.2560
TDW_C  75  0.3200


Point estimate for ETA1-ETA2 is -0.0700
95.0 Percent CI for ETA1-ETA2 is (-0.1260,-0.0100)
W = 4530.5
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.0220
The test is significant at 0.0220 (adjusted for ties)
```

Results for: HOMO Oyster Lab Data by Salinity Group.MTW

Mann-Whitney Test and CI: CI_A, CI_C

```
       N  Median
CI_A  70   9.238
CI_C  75   7.245


Point estimate for ETA1-ETA2 is 2.036
95.0 Percent CI for ETA1-ETA2 is (1.026,3.014)
W = 6079.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.0001
```

Mann-Whitney Test and CI: Height_B, Height_C

```
           N  Median
Height_B  75  65.000
Height_C  75  54.000


Point estimate for ETA1-ETA2 is 10.000
95.0 Percent CI for ETA1-ETA2 is (6.001,14.999)
W = 6806.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.00001
The test is significant at 0.0000 (adjusted for ties)
```

Mann-Whitney Test and CI: WWW_B, WWW_C

```
        N  Median
WWW_B  75  24.797
WWW_C  75  18.248


Point estimate for ETA1-ETA2 is 7.292
95.0 Percent CI for ETA1-ETA2 is (3.695,11.039)
W = 6721.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.0001
```

Mann-Whitney Test and CI: SWW_B, SWW_C

```
        N  Median
SWW_B  75  17.734
SWW_C  75  13.437

Point estimate for ETA1-ETA2 is 4.928
95.0 Percent CI for ETA1-ETA2 is (2.361,7.864)
W = 6644.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.0002
```

Mann-Whitney Test and CI: TDW_B, TDW_C

```
        N  Median
TDW_B  75  0.4610
TDW_C  75  0.3200

Point estimate for ETA1-ETA2 is 0.1380
95.0 Percent CI for ETA1-ETA2 is (0.0680,0.2100)
W = 6701.5
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.0001
The test is significant at 0.0001 (adjusted for ties)
```

Mann-Whitney Test and CI: CI_B, CI_C

```
       N  Median
CI_B  75  7.6082
CI_C  75  7.2445


Point estimate for ETA1-ETA2 is 0.1192
95.0 Percent CI for ETA1-ETA2 is (-0.4086,0.6010)
W = 5783.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.6520
```

Withlacoochee River Oyster Field Data

Descriptive Statistics for Chassahowitzka Oyster Field Data.

Results for: WTHL Oyster Field Data.MTW

Descriptive Statistics: Est%Ba AreaA, NperQuadrant, PercentLive, TotalLive, ...

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Est%Ba AreaAlive	1	60.000	*	60.000	*	60.000	*	60.000
NperQuadrant	5	608	331	35	321	784	807	823
PercentLive	5	89.72	9.67	76.00	80.00	92.60	98.00	100.00
TotalLive	5	22.80	2.68	19.00	20.00	24.00	25.00	25.00
TotalDead	5	3.60	2.61	0.00	1.00	4.00	6.00	6.00

Results for: WTHL Oyster Field Data for Salinity Area tests.MTW

Descriptive Statistics: NperQuadrant_B, PercentLive_B, TotalLive_B, TotalDead_B

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
NperQuadrant_B	2	695.5	125.2	607.0	*	695.5	*	784.0
PercentLive_B	2	80.00	5.66	76.00	*	80.00	*	84.00
TotalLive_B	2	20.00	1.41	19.00	*	20.00	*	21.00
TotalDead_B	2	5.00	1.41	4.00	*	5.00	*	6.00

Descriptive Statistics: Est%Ba AreaA, NperQuadrant, PercentLive_, ...

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Est%Ba AreaAlive_C	1	60.000	*	60.000	*	60.000	*	60.000
NperQuadrant_C	3	549	446	35	35	790	823	823
PercentLive_C	3	96.20	3.70	92.60	92.60	96.00	100.00	100.00
TotalLive_C	3	24.667	0.577	24.000	24.000	25.000	25.000	25.000
TotalDead_C	3	2.67	3.06	0.00	0.00	2.00	6.00	6.00

Mann-Whitney Test and CI: NperQuadrant_B, NperQuadrant_C

	N	Median
NperQuadrant_B	2	695.5
NperQuadrant_C	3	790.0

```
Point estimate for ETA1-ETA2 is -22.5
85.1 Percent CI for ETA1-ETA2 is (-216.1,748.8)
W = 5.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.7728
```

Mann-Whitney Test and CI: PercentLive_B, PercentLive_C

	N	Median
PercentLive_B	2	80.00
PercentLive_C	3	96.00

```
Point estimate for ETA1-ETA2 is -16.30
85.1 Percent CI for ETA1-ETA2 is (-24.00,-8.60)
W = 3.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.1489
```

Mann-Whitney Test and CI: TotalLive_B, TotalLive_C

```
             N  Median
TotalLive_B  2  20.000
TotalLive_C  3  25.000


Point estimate for ETA1-ETA2 is -4.500
85.1 Percent CI for ETA1-ETA2 is (-6.001,-2.999)
W = 3.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.1489
```

Mann-Whitney Test and CI: TotalDead_B, TotalDead_C

```
             N  Median
TotalDead_B  2   5.000
TotalDead_C  3   2.000


Point estimate for ETA1-ETA2 is 3.000
85.1 Percent CI for ETA1-ETA2 is (-2.001,6.000)
W = 7.5
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.5637
```

Descriptive Statistics for Withlacoochee River Oyster Condition Index and its Components.

Results for: WTHL Oyster CI & Height Data.MTW

Descriptive Statistics: Height, WWW, SWW, TDW, CI

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Height	325	59.245	15.463	29.000	47.000	57.000	68.750	113.000
WWW	325	16.952	11.105	3.277	9.067	14.033	20.495	73.037
SWW	325	12.240	7.872	2.321	6.681	10.107	14.830	51.057
TDW	325	0.3677	0.3170	0.0400	0.1625	0.2740	0.4400	2.2520
CI	325	7.642	2.486	1.723	6.044	7.331	9.150	17.804

Descriptive Statistics for Withlacoochee River Oyster Condition Index and its Components by Salinity Area.

Results for: WTHL Oyster Lab Data by Salinity Group.MTW

Descriptive Statistics: Height_A, WWW_A, SWW_A, TDW_A, CI_A

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Height_A	100	57.60	13.81	30.00	46.88	56.00	67.75	104.00
WWW_A	100	13.643	7.764	3.604	8.379	12.191	16.462	55.893
SWW_A	100	9.850	5.471	2.694	6.181	8.738	11.807	37.554
TDW_A	100	0.2411	0.1597	0.0590	0.1373	0.1935	0.3048	1.0990
CI_A	100	6.388	1.380	2.559	5.669	6.607	7.322	9.000

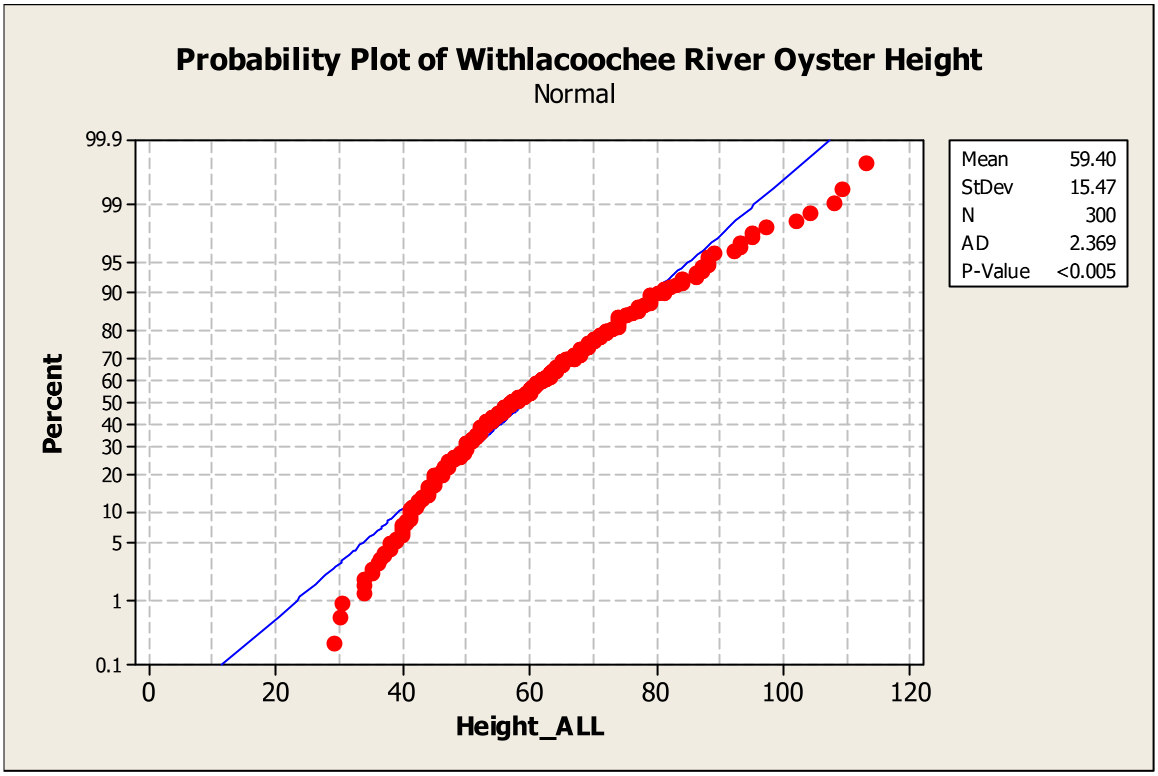
Descriptive Statistics: Height_B, WWW_B, SWW_B, TDW_B, CI_B

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Height_B	100	56.92	15.63	29.00	45.00	54.50	67.75	109.00
WWW_B	100	16.26	10.31	3.28	8.67	13.92	20.04	53.54
SWW_B	100	11.862	7.324	2.321	6.505	10.056	14.854	38.015
TDW_B	100	0.2768	0.2003	0.0400	0.1280	0.2240	0.3657	0.9640
CI_B	100	6.584	2.643	1.723	4.934	6.416	7.284	17.804

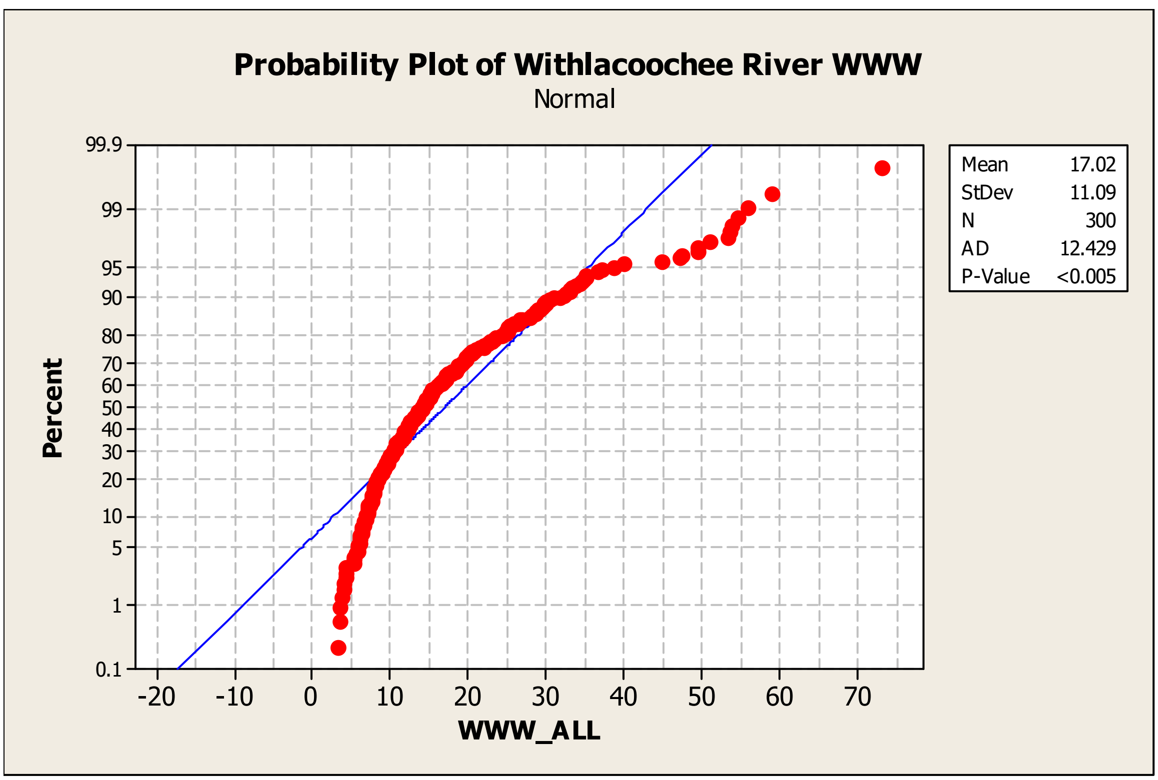
Descriptive Statistics: Height_C, WWW_C, SWW_C, TDW_C, CI_C

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Height_C	125	62.42	16.15	34.00	50.00	59.00	74.00	113.00
WWW_C	125	20.15	13.03	5.80	10.58	16.38	26.57	73.04
SWW_C	125	14.455	9.248	3.889	7.497	11.819	19.133	51.057
TDW_C	125	0.5418	0.4001	0.1280	0.2760	0.4010	0.7385	2.2520
CI_C	125	9.491	1.855	4.658	8.239	9.625	10.516	14.060

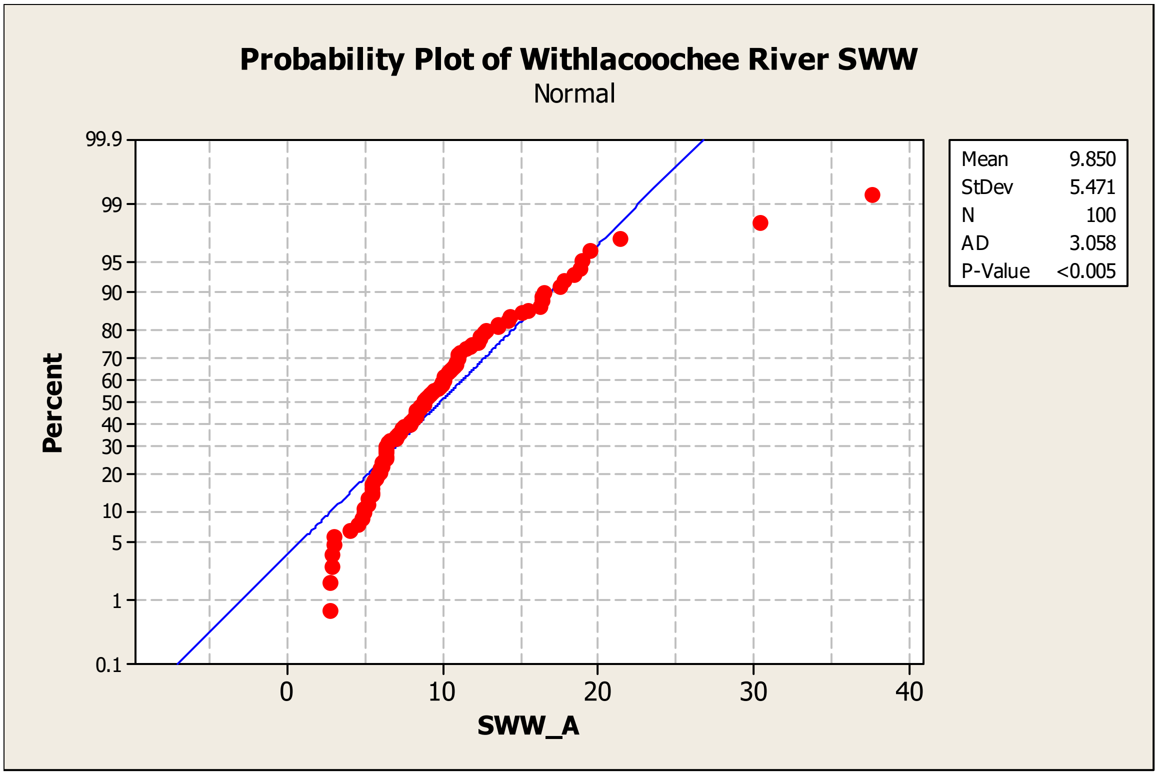
Tests for Normality for Withlacoochee River Oyster Condition Index (CI) Data



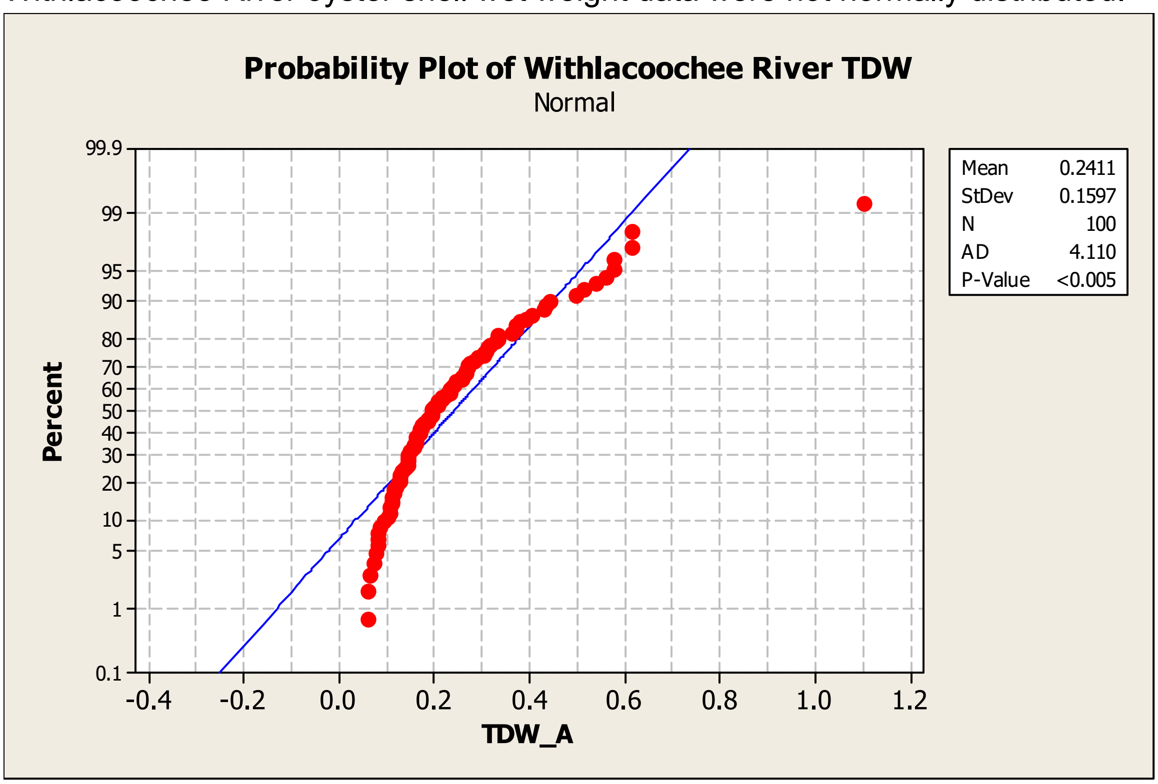
Withlacoochee River oyster Height data were not normally distributed.



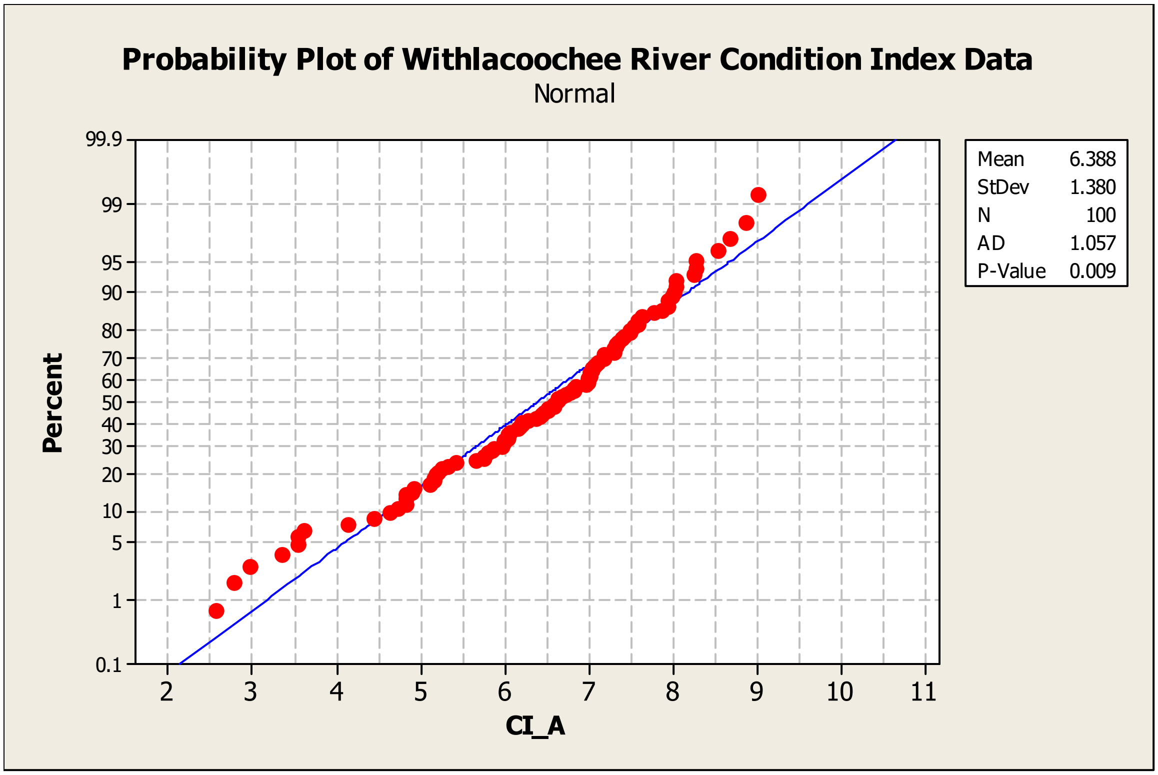
Withlacoochee River oyster whole wet weight data were not normally distributed.



Withlacoochee River oyster shell wet weight data were not normally distributed.



Withlacoochee River oyster total dry weight data were not normally distributed.



Withlacoochee River Spearman's Rank Correlation Test Results

Results for: WTHL Oyster CI & Height Data.MTW

Correlations: Height_1, WWW_1, SWW_1, TDW_1, CI_1

	Height_1	WWW_1	SWW_1	TDW_1
WWW_1	0.862 0.000			
SWW_1	0.858 0.000	0.997 0.0001		
TDW_1	0.723 0.000	0.851 0.0001	0.835 0.0001	
CI_1	0.049 0.374	0.094 0.090	0.092 0.099	0.530 0.000

```
Cell Contents: Pearson correlation
               P-Value
```

Mann-Whitney tests between Salinity Areas for the Withlacoochee River Oyster Field Data

Results for: WTHL Oyster Lab Data by Salinity Group.MTW

Mann-Whitney Test and CI: Height_A, Height_B

```
            N  Median
Height_A  100  56.000
Height_B  100  54.500


Point estimate for ETA1-ETA2 is 1.500
95.0 Percent CI for ETA1-ETA2 is (-3.000,5.499)
W = 10307.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.5308
The test is significant at 0.5307 (adjusted for ties)
```

Mann-Whitney Test and CI: WWW_A, WWW_B

```
         N  Median
WWW_A  100  12.191
WWW_B  100  13.924


Point estimate for ETA1-ETA2 is -1.475
95.0 Percent CI for ETA1-ETA2 is (-3.503,0.489)
W = 9457.5
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.1480
The test is significant at 0.1480 (adjusted for ties)
```

Mann-Whitney Test and CI: SWW_A, SWW_B

```
         N  Median
SWW_A  100   8.738
SWW_B  100  10.056


Point estimate for ETA1-ETA2 is -1.206
95.0 Percent CI for ETA1-ETA2 is (-2.695,0.262)
W = 9376.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.0998
The test is significant at 0.0998 (adjusted for ties)
```

Mann-Whitney Test and CI: TDW_A, TDW_B

```
         N   Median
TDW_A  100  0.19350
TDW_B  100  0.22400

Point estimate for ETA1-ETA2 is -0.01500
95.0 Percent CI for ETA1-ETA2 is (-0.05302,0.01900)
W = 9689.5
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.3791
The test is significant at 0.3791 (adjusted for ties)
```

Mann-Whitney Test and CI: CI_A, CI_B

```
        N  Median
CI_A  100  6.6067
```

```
CI_B  100  6.4165

Point estimate for ETA1-ETA2 is 0.1577
95.0 Percent CI for ETA1-ETA2 is (-0.3152,0.5956)
W = 10316.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.5165
```

Mann-Whitney Test and CI: Height_A, Height_C

```
            N  Median
Height_A  100  56.000
Height_C  125  59.000

Point estimate for ETA1-ETA2 is -4.000
95.0 Percent CI for ETA1-ETA2 is (-7.999,-0.002)
W = 10338.5
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.0476
The test is significant at 0.0476 (adjusted for ties)
```

Mann-Whitney Test and CI: WWW_A, WWW_C

```
         N  Median
WWW_A  100  12.191
WWW_C  125  16.381

Point estimate for ETA1-ETA2 is -4.136
95.0 Percent CI for ETA1-ETA2 is (-6.315,-2.123)
W = 9324.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.00001
The test is significant at 0.0000 (adjusted for ties)
```

Mann-Whitney Test and CI: SWW_A, SWW_C

```
         N  Median
SWW_A  100   8.738
SWW_C  125  11.819

Point estimate for ETA1-ETA2 is -2.926
95.0 Percent CI for ETA1-ETA2 is (-4.542,-1.490)
W = 9328.5
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.00001
The test is significant at 0.0000 (adjusted for ties)
```

Mann-Whitney Test and CI: TDW_A, TDW_C

```
         N  Median
TDW_A  100  0.1935
TDW_C  125  0.4010

Point estimate for ETA1-ETA2 is -0.2030
95.0 Percent CI for ETA1-ETA2 is (-0.2570,-0.1540)
W = 7444.5
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.00001
The test is significant at 0.0000 (adjusted for ties)
```

Mann-Whitney Test and CI: CI_A, CI_C

```
        N  Median
CI_A  100  6.6067
CI_C  125  9.6246
```

```
Point estimate for ETA1-ETA2 is -3.0090
95.0 Percent CI for ETA1-ETA2 is (-3.4431,-2.5769)
W = 6044.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.00001
```

Mann-Whitney Test and CI: Height_B, Height_C

```
            N  Median
Height_B  100  54.500
Height_C  125  59.000

Point estimate for ETA1-ETA2 is -5.000
95.0 Percent CI for ETA1-ETA2 is (-9.002,-0.998)
W = 10028.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.0088
The test is significant at 0.0088 (adjusted for ties)
```

Mann-Whitney Test and CI: WWW_B, WWW_C

```
         N  Median
WWW_B  100  13.924
WWW_C  125  16.381


Point estimate for ETA1-ETA2 is -2.662
95.0 Percent CI for ETA1-ETA2 is (-4.978,-0.501)
W = 10142.5
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.0171
The test is significant at 0.0171 (adjusted for ties)
```

Mann-Whitney Test and CI: SWW_B, SWW_C

```
         N  Median
SWW_B  100  10.056
SWW_C  125  11.819


Point estimate for ETA1-ETA2 is -1.709
95.0 Percent CI for ETA1-ETA2 is (-3.403,-0.155)
W = 10243.5
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.0295
The test is significant at 0.0295 (adjusted for ties)
```

Mann-Whitney Test and CI: TDW_B, TDW_C

```
         N  Median
TDW_B  100  0.2240
TDW_C  125  0.4010


Point estimate for ETA1-ETA2 is -0.1850
95.0 Percent CI for ETA1-ETA2 is (-0.2420,-0.1310)
W = 8040.5
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.00001
The test is significant at 0.0000 (adjusted for ties)
```

Mann-Whitney Test and CI: CI_B, CI_C

```
        N  Median
```

CI_B	100	6.4165
CI_C	125	9.6246

```
Point estimate for ETA1-ETA2 is -3.1466
95.0 Percent CI for ETA1-ETA2 is (-3.6398,-2.6226)
W = 6766.0
Test of ETA1 = ETA2 vs. ETA1 not = ETA2 is significant at 0.00001
```

Barnacles

Chassahowitzka River Barnacles Laboratory and Field Data

Descriptive Statistics for all Chassahowitzka Barnacle Lab &Field Data.

Results for: CHAS Barnacle Lab & Field Data.MTW

Descriptive Statistics: NperQuadrant, Total Live, Total Dead, %Live, ...

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
NperQuadrant	6	19.83	11.69	9.00	9.75	17.50	28.75	40.00
Total Live	6	13.83	5.67	6.00	9.00	13.50	19.00	22.00
Total Dead	6	6.00	8.37	0.00	0.00	3.00	11.50	22.00
%Live	6	76.93	22.53	45.00	57.68	77.33	100.00	100.00
Meandiameter	6	6.534	2.223	3.643	4.736	6.216	8.563	9.920
DryWeight	6	0.4935	0.1574	0.2629	0.3286	0.5278	0.6343	0.6693
%OrganicMatter	6	7.90	4.20	5.10	5.25	6.80	9.40	16.30

Descriptive Statistics for oligohaline versus mesohaline Sites for Chassahowitzka River Barnacle Lab &Field Data.

Results for: CHAS Barnacle Lab & Field Data_oligohaline.MTW

Descriptive Statistics: NperQuadrant, Total Live_o, Total Dead_o, %Live_o, ...

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
NperQuadrant_o	3	26.33	13.05	14.00	14.00	25.00	40.00	40.00
Total Live_o	3	18.00	4.00	14.00	14.00	18.00	22.00	22.00
Total Dead_o	3	8.33	11.93	0.00	0.00	3.00	22.00	22.00
%Live_o	3	77.7	28.9	45.0	45.0	88.0	100.0	100.0
Meandiameter_o	3	6.68	3.14	3.64	3.64	6.48	9.92	9.92
DryWeight_o	3	0.518	0.222	0.263	0.263	0.623	0.669	0.669
%OrganicMatter_o	3	9.53	5.92	5.30	5.30	7.00	16.30	16.30

Descriptive Statistics: NperQuadrant, Total Live_m, Total Dead_m, %Live_m, ...

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
NperQuadrant_m	3	13.33	6.66	9.00	9.00	10.00	21.00	21.00
Total Live_m	3	9.67	3.51	6.00	6.00	10.00	13.00	13.00
Total Dead_m	3	3.67	4.04	0.00	0.00	3.00	8.00	8.00
%Live_m	3	76.2	20.8	61.9	61.9	66.7	100.0	100.0
Meandiameter_m	3	6.388	1.552	5.100	5.100	5.952	8.111	8.111
DryWeight_m	3	0.4687	0.1033	0.3505	0.3505	0.5137	0.5419	0.5419
%OrganicMatter_m	3	6.267	1.041	5.100	5.100	6.600	7.100	7.100

Mann-Whiney Tests for Chassahowitzka River Barnacles – Oligohaline versus Mesohaline Sites

Mann-Whitney Test and CI: NperQuadrant_o, NperQuadrant_m

```
                N  Median
NperQuadrant_o  3   25.00
NperQuadrant_m  3   10.00


Point estimate for ETA1-ETA2 is 15.00
91.9 Percent CI for ETA1-ETA2 is (-7.01,31.01)
W = 14.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.1904
```

Mann-Whitney Test and CI: Total Live_o, Total Live_m

```
              N  Median
Total Live_o  3   18.00
Total Live_m  3   10.00


Point estimate for ETA1-ETA2 is 8.00
91.9 Percent CI for ETA1-ETA2 is (1.00,16.00)
W = 15.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0809
```

Mann-Whitney Test and CI: Total Dead_o, Total Dead_m

```
              N  Median
Total Dead_o  3    3.00
Total Dead_m  3    3.00


Point estimate for ETA1-ETA2 is 0.00
91.9 Percent CI for ETA1-ETA2 is (-8.00,21.99)
W = 11.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 1.0000
The test is significant at 1.0000 (adjusted for ties)
```

Mann-Whitney Test and CI: %Live_o, %Live_m

```
         N  Median
%Live_o  3   88.00
%Live_m  3   66.67


Point estimate for ETA1-ETA2 is 0.00
91.9 Percent CI for ETA1-ETA2 is (-55.02,38.08)
W = 10.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 1.0000
```

Mann-Whitney Test and CI: Meandiameter_o, Meandiameter_m

```
                N  Median
Meandiameter_o  3   6.480
Meandiameter_m  3   5.952


Point estimate for ETA1-ETA2 is 0.528
91.9 Percent CI for ETA1-ETA2 is (-4.467,4.821)
W = 11.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 1.0000
```

Mann-Whitney Test and CI: DryWeight_o, DryWeight_m

```
             N  Median
DryWeight_o  3  0.6226
DryWeight_m  3  0.5137


Point estimate for ETA1-ETA2 is 0.1089
91.9 Percent CI for ETA1-ETA2 is (-0.2790,0.3189)
W = 12.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.6625
```

Mann-Whitney Test and CI: %OrganicMatter_o, %OrganicMatter_m

```
                  N  Median
%OrganicMatter_o  3    7.00
%OrganicMatter_m  3    6.60


Point estimate for ETA1-ETA2 is 0.40
91.9 Percent CI for ETA1-ETA2 is (-1.80,11.20)
W = 12.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.6625
```

Spearman's Rank Correlation Tests for Variables versus River Kilometer

Results for: CHAS Barnacle Lab & Field Data.MTW

Correlations: River km, NperQuadrant, Total Live, Total Dead, %Live, ...

	River km	NperQuadrant	Total Live	Total Dead
NperQuadrant	0.459			
	0.360			
Total Live	0.705	0.745		
	0.118	0.089		
Total Dead	0.163	0.892	0.362	
	0.758	0.017	0.480	
%Live	0.011	-0.649	-0.054	-0.870
	0.983	0.163	0.920	0.024
Meandiameter	-0.151	0.625	0.108	0.800
	0.775	0.184	0.839	0.056
DryWeight	0.112	0.663	0.512	0.579
	0.833	0.151	0.299	0.228
%OrganicMatter	0.500	-0.254	-0.084	-0.298
	0.312	0.627	0.874	0.566

	%Live	Meandiameter	DryWeight
Meandiameter	-0.862		
	0.027		
DryWeight	-0.661	0.745	
	0.153	0.089	
%OrganicMatter	0.452	-0.534	-0.748
	0.368	0.275	0.087

Cell Contents: Pearson correlation
P-Value

Homosassa River Barnacles Laboratory and Field Data

Results for: HOMO Barnacle Lab & Field Data.MTW

Descriptive Statistics: NperQuadrant, Total Live, Total Dead, %Live, ...

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
NperQuadrant	8	73.13	26.15	19.00	58.50	79.00	95.00	98.00
Total Live	8	42.13	26.82	7.00	14.00	49.00	62.00	80.00
Total Dead	8	31.00	23.70	9.00	12.50	26.00	41.25	80.00
%Live	8	55.21	27.09	17.53	26.94	57.67	79.47	89.89
Meandiameter	8	5.813	1.873	4.440	4.620	5.420	5.800	10.263
DryWeight	8	0.4467	0.0865	0.3617	0.3676	0.4278	0.5394	0.5741
%OrganicMatter	8	7.40	3.57	5.10	5.53	6.20	7.35	16.00

Descriptive Statistics for oligohaline versus mesohaline Sites for Homosassa River Barnacle Lab &Field Data.

Results for: HOMO Barnacle Lab & Field Data_oligohaline.MTW

Descriptive Statistics: NperQuadrant, Total Live_O, Total Dead_O, %Live_O, ...

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
NperQuadrant_O	4	88.25	10.72	78.00	78.50	88.50	97.75	98.00
Total Live_O	4	45.5	20.9	17.0	23.5	51.0	62.0	63.0
Total Dead_O	4	42.8	26.6	17.0	21.5	37.0	69.8	80.0
%Live_O	4	52.9	25.7	17.5	26.9	57.7	74.1	78.8
Meandiameter_O	4	5.590	0.254	5.240	5.330	5.640	5.800	5.840
DryWeight_O	4	0.4682	0.0785	0.3668	0.3903	0.4750	0.5394	0.5560
%OrganicMatter_O	4	6.025	0.793	5.500	5.525	5.700	6.850	7.200

Mann-Whiney Tests for Homosassa River Barnacles – Oligohaline versus Mesohaline Sites

Mann-Whitney Test and CI: NperQuadrant_O, NperQuadrant_m

	N	Median
NperQuadrant_O	4	88.50
NperQuadrant_m	4	62.00

```
Point estimate for ETA1-ETA2 is 26.50
97.0 Percent CI for ETA1-ETA2 is (-10.99,78.99)
W = 24.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.1124
```

Mann-Whitney Test and CI: Total Live_O, Total Live_m

	N	Median
Total Live_O	4	51.00
Total Live_m	4	34.00

```
Point estimate for ETA1-ETA2 is 6.00
97.0 Percent CI for ETA1-ETA2 is (-63.00,56.01)
W = 20.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.6650
```

Mann-Whitney Test and CI: Total Dead_O, Total Dead_m

	N	Median
Total Dead_O	4	37.00
Total Dead_m	4	13.00

```
Point estimate for ETA1-ETA2 is 24.00
97.0 Percent CI for ETA1-ETA2 is (-24.99,71.01)
W = 23.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.1939
```

Mann-Whitney Test and CI: %Live_O, %Live_m

```
         N  Median
%Live_O  4   57.67
%Live_m  4   58.28


Point estimate for ETA1-ETA2 is -8.63
97.0 Percent CI for ETA1-ETA2 is (-72.35,55.10)
W = 16.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.6650
```

Mann-Whitney Test and CI: Meandiameter_O, Meandiameter_m

```
                N  Median
Meandiameter_O  4   5.640
Meandiameter_m  4   4.720


Point estimate for ETA1-ETA2 is 0.780
97.0 Percent CI for ETA1-ETA2 is (-5.023,1.399)
W = 22.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.3123
```

Mann-Whitney Test and CI: DryWeight_O, DryWeight_m

```
             N  Median
DryWeight_O  4  0.4750
DryWeight_m  4  0.3823


Point estimate for ETA1-ETA2 is 0.0784
97.0 Percent CI for ETA1-ETA2 is (-0.2073,0.1943)
W = 20.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.6650
```

Mann-Whitney Test and CI: %OrganicMatter_O, %OrganicMatter_m

```
                  N  Median
%OrganicMatter_O  4   5.700
%OrganicMatter_m  4   7.000


Point estimate for ETA1-ETA2 is -1.050
97.0 Percent CI for ETA1-ETA2 is (-10.500,2.102)
W = 15.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.4705
```

Spearman's Rank Correlation Tests for Variables versus River Kilometer

Results for: HOMO Barnacle Lab & Field Data.MTW

Correlations: River km_1, NperQuadrant, Total Live_1, Total Dead_1, ...

	River km_1	NperQuadrant_1	Total Live_1
NperQuadrant_1	0.667 0.071		
Total Live_1	0.333 0.420	0.619 0.102	
Total Dead_1	0.452 0.260	0.310 0.456	-0.357 0.385
%Live_1	0.000 1.000	0.167 0.693	0.833 0.010
Meandiameter_1	0.310 0.456	0.071 0.867	-0.262 0.531
DryWeight_1	0.357 0.385	0.690 0.058	0.405 0.320
%OrganicMatter_1	-0.619 0.102	-0.690 0.058	-0.643 0.086

	Total Dead_1	%Live_1	Meandiameter_1
%Live_1	-0.738 0.037		
Meandiameter_1	-0.071 0.867	-0.262 0.531	
DryWeight_1	-0.167 0.693	0.238 0.570	0.381 0.352
%OrganicMatter_1	0.071 0.867	-0.429 0.289	-0.048 0.911

	DryWeight_1
%OrganicMatter_1	-0.786 0.021

Cell Contents: Pearson correlation
P-Value

Halls River Barnacles Laboratory and Field Data

Results for: HALLS Barnacle Lab & Field Data.MTW

Descriptive Statistics: NperQuadrant, Total Live, Total Dead, %Live, ...

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
NperQuadrant	5	70.40	20.49	51.00	53.00	61.00	92.50	93.00
Total Live	5	59.00	20.88	33.00	41.00	53.00	80.00	85.00
Total Dead	5	11.40	5.64	6.00	7.00	8.00	17.50	18.00
%Live	5	82.72	10.71	64.71	73.11	86.89	90.24	91.40
Meandiameter	5	8.032	1.850	5.240	6.220	8.640	9.540	9.920
DryWeight	5	0.4429	0.1167	0.3520	0.3655	0.3871	0.5481	0.6401
%OrganicMatter	5	5.780	0.912	4.900	5.000	5.500	6.700	7.100

Spearman's Rank Correlation Tests for Variables versus River Kilometer

Correlations: River km_1, NperQuadrant, Total Live_1, Total Dead_1, ...

	River km_1	NperQuadrant_1	Total Live_1	
NperQuadrant_1	0.200			
	0.747			
Total Live_1	0.200	1.000		
	0.747	0.0001		(replaced an asterisk – DGS)
Total Dead_1	-0.308	-0.205	-0.205	
	0.614	0.741	0.741	
%Live_1	0.600	0.600	0.600	
	0.285	0.285	0.285	
Meandiameter_1	0.000	-0.200	-0.200	
	1.000	0.747	0.747	
DryWeight_1	0.900	0.500	0.500	
	0.037	0.391	0.391	
%OrganicMatter_1	0.300	0.300	0.300	
	0.624	0.624	0.624	

	Total Dead_1	%Live_1	Meandiameter_1
%Live_1	-0.821		
	0.089		
Meandiameter_1	0.564	-0.600	
	0.322	0.285	
DryWeight_1	-0.410	0.700	0.100
	0.493	0.188	0.873
%OrganicMatter_1	0.410	0.100	-0.300
	0.493	0.873	0.624

	DryWeight_1
%OrganicMatter_1	0.100
	0.873

Cell Contents: Pearson correlation
P-Value

Withlacoochee River Barnacles Laboratory and Field Data

Results for: WTHL Barnacle Lab & Field Data.MTW

Descriptive Statistics: NperQuadrant, Total Live, Total Dead, %Live, ...

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
NperQuadrant	8	30.1	39.4	4.0	10.5	16.5	35.0	124.0
Total Live	8	21.1	38.0	0.0	0.8	7.0	21.3	113.0
Total Dead	8	9.00	5.35	1.00	4.75	9.00	12.00	18.00
%Live	8	44.4	36.9	0.0	6.3	43.0	83.1	94.1
Meandiameter	8	9.544	2.736	6.640	7.492	8.779	11.578	14.750
DryWeight	8	0.5570	0.1416	0.4002	0.4370	0.5375	0.6612	0.8225
%OrganicMatter	8	8.98	5.95	4.40	4.88	6.05	11.92	21.70

Spearman's Rank Correlation Tests for Variables versus River Kilometer

Correlations: River km_1, NperQuadrant, Total Live_1, Total Dead_1, ...

	River km_1	NperQuadrant_1	Total Live_1
NperQuadrant_1	-0.826 0.011		
Total Live_1	-0.802 0.017	0.952 0.000	
Total Dead_1	-0.036 0.932	0.321 0.438	0.164 0.699
%Live_1	-0.659 0.076	0.771 0.025	0.855 0.007
Meandiameter_1	0.833 0.010	-0.970 0.000	-0.874 0.005
DryWeight_1	0.143 0.736	-0.084 0.844	-0.144 0.734
%OrganicMatter_1	-0.575 0.136	0.247 0.555	0.193 0.647

	Total Dead_1	%Live_1	Meandiameter_1
%Live_1	-0.285 0.494		
Meandiameter_1	-0.349 0.396	-0.707 0.050	
DryWeight_1	0.133 0.754	-0.096 0.821	-0.095 0.823
%OrganicMatter_1	0.370 0.367	-0.181 0.668	-0.263 0.528

	DryWeight_1
%OrganicMatter_1	-0.228 0.588

Cell Contents: Pearson correlation
P-Value

Results for: With Barnacle Data_meso.MTW

Descriptive Statistics: NperQuadrant, Total Live_O, Total Dead_O, ...

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3
NperQuadrant_Oligo	7	16.71	11.69	4.00	10.00	16.00	17.00
Total Live_Oligo	7	8.00	8.77	0.00	0.00	4.00	16.00
Total Dead_Oligo	7	8.71	5.71	1.00	4.00	7.00	12.00
%Live_Oligo	7	37.7	34.2	0.0	0.0	30.0	58.8
Meandiameter_Oligo	7	9.96	2.67	7.44	7.65	9.50	12.00
DryWeight_Oligo	7	0.5522	0.1523	0.4002	0.4326	0.5251	0.6845
%OrganicMatter_Oligo	7	8.63	6.34	4.40	4.70	5.40	12.10

Variable	Maximum
NperQuadrant_Oligo	41.00
Total Live_Oligo	23.00
Total Dead_Oligo	18.00
%Live_Oligo	94.1
Meandiameter_Oligo	14.75
DryWeight_Oligo	0.8225
%OrganicMatter_Oligo	21.70

Barnacle stat checks

Results for: Worksheet 23

Descriptive Statistics: b

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
b	6	19.83	11.69	9.00	9.75	17.50	28.75	40.00

Results for: Ho0mosassa Barnacles standard deviations.MTW
Descriptive Statistics: Number per Quadrat

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Number per Quadrat	9	75.33	25.34	19.00	62.00	80.00	95.00	98.00

Results for: Ho0mosassa Barnacles standard deviations.MTW

Descriptive Statistics: Live Barnacles per Quadrat

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3
Live Barnacles per Quadr	9	46.89	28.87	7.00	15.00	55.00	71.50

Variable	Maximum
Live Barnacles per Quadr	85.00

Descriptive Statistics: Live Barnacles per Quadrat = fixed removed one Halls River value

Variable	N	Mean	StDev	Minimum	Q1	Median	Q3
Live Barnacles per Quadr	8	42.13	26.82	7.00	14.00	49.00	62.00

Variable	Maximum
Live Barnacles per Quadr	80.00

APPENDIX J

SWFWMD SALINITY MODELS

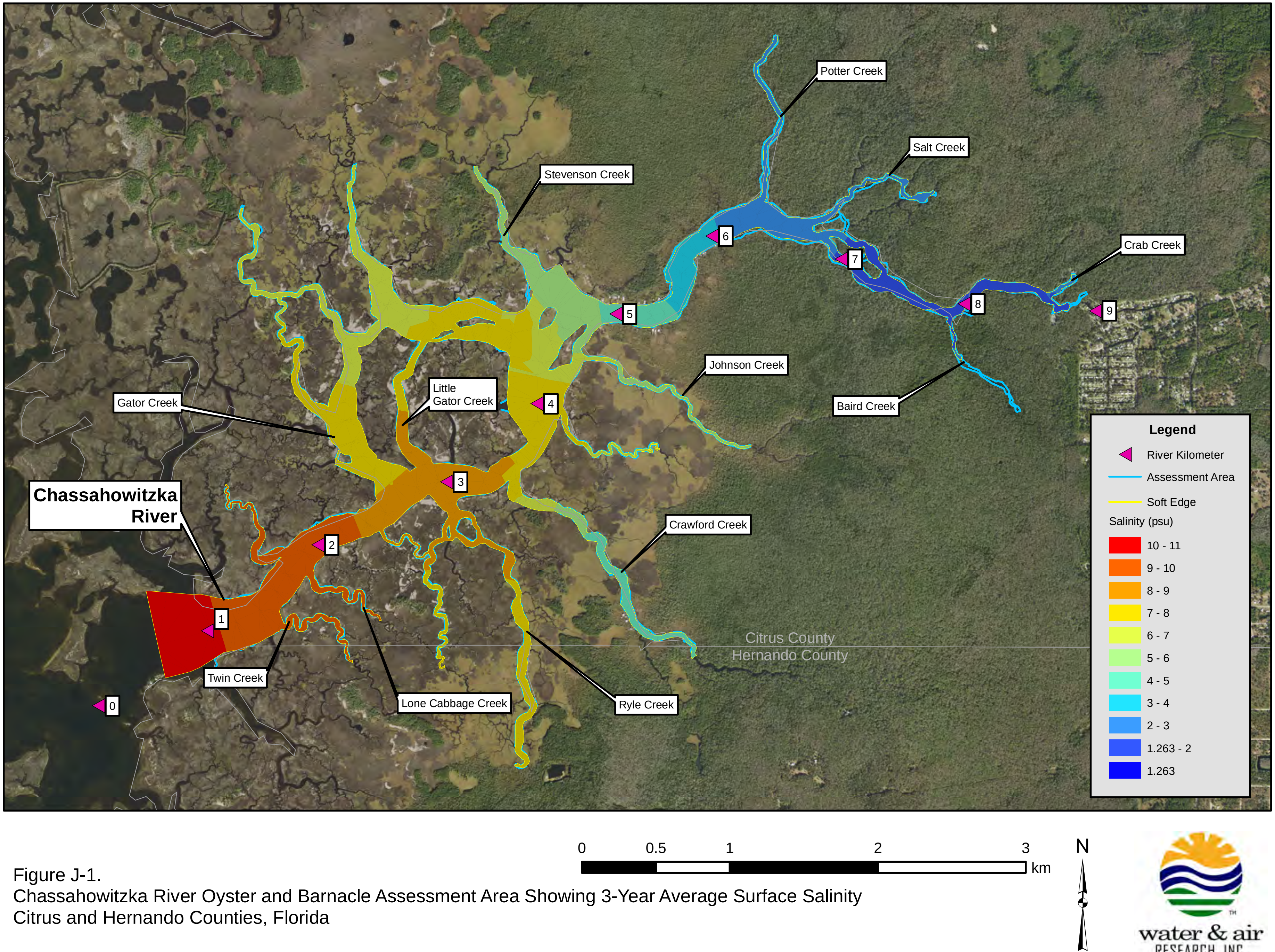


Figure J-1.
Chassahowitzka River Oyster and Barnacle Assessment Area Showing 3-Year Average Surface Salinity
Citrus and Hernando Counties, Florida

Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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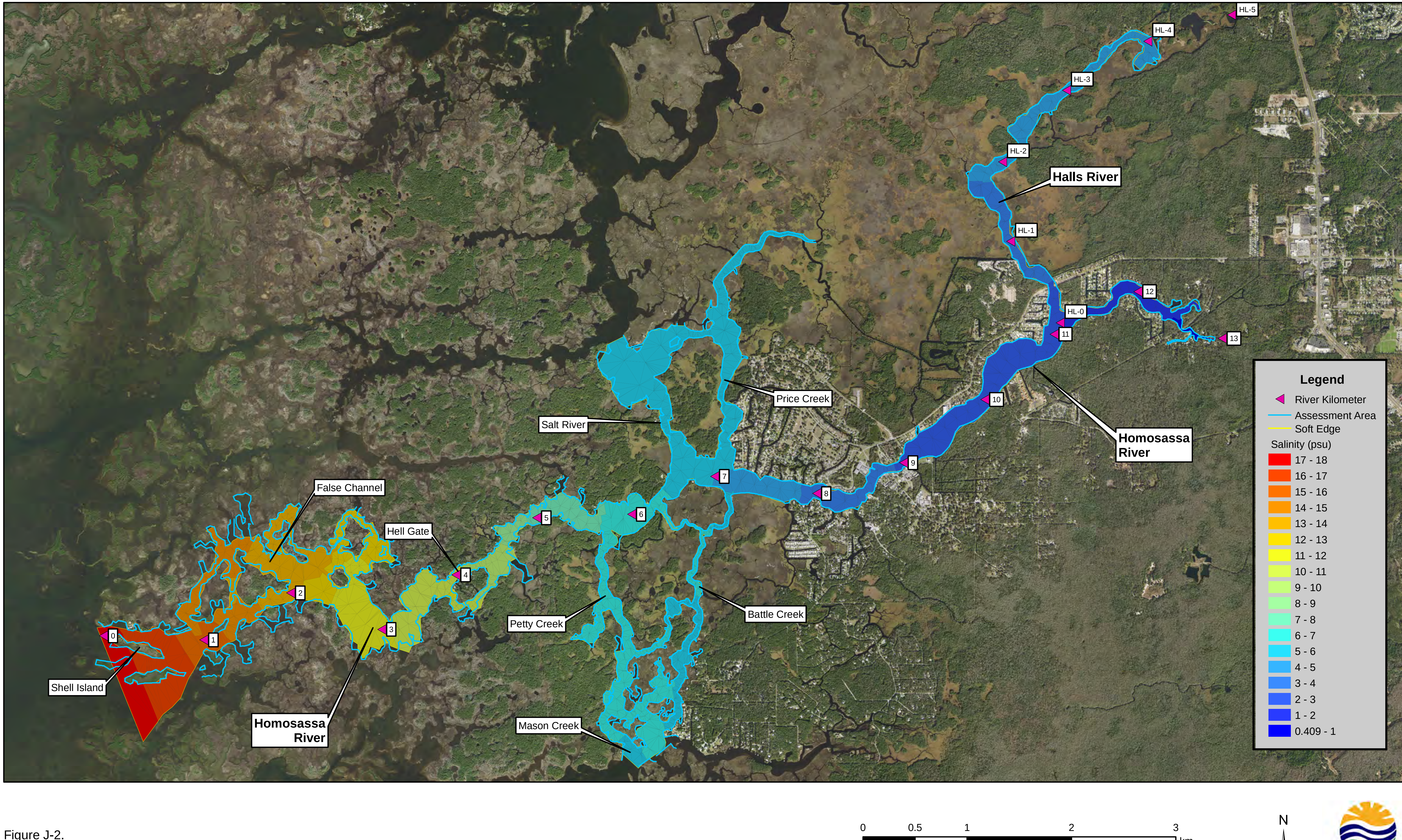

Figure J-2.
Homosassa and Halls River Oyster and Barnacle Assessment Area Showing 3-Year Average Surface Salinity
Citrus County, Florida

Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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