Ambient Monitoring Program Annual Report

2003 - 2010

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Acknowledgments

Former and current staff of the Pinellas County Department of Environment and Infrastructure (formerly Department of Environmental Management) acknowledged for their contributions to the monitoring program include: Michele Bakacs, William Beattie, Geoff Duncan, Craig Dye, Eric Fehrmann, Dannielle Grimes, Natasha Dickrell, Michael Feldner, Rob Fricke, Carol Grynewicz, Melissa Harrison, Chip Heinz, Don Hicks, Brian Johns, Frank Kulpa, Stephanie Lawler, Alyssa Liadis, Fiona Lyons, Robert McWilliams, Cindy Meyer, Jim Meyer, Lindsey Parks, Karla Pedersen, Conor Petren, Shannon Ransom, Steve Robinson, Ryan Ryczek, K. Schanzle, Bill Sova, Joe Torok, Karen Walker, and Melanie Weed. Department staff is grateful for permission granted by numerous citizens to access their property for the purpose of sampling surface water quality monitoring sites throughout the County.

Executive Summary

Since October 1990, the Pinellas County Department of Environment and Infrastructure's Watershed Management Division (WMD) (formerly the Department of Environmental Management) has monitored surface water quality in the County's 52 drainage basins, four lakes, and nine receiving water bodies. In January 2003, a revised monitoring program (Janicki 2003) was implemented to provide better geographical coverage of County waters and to provide more statistically defensible results in comparison to the original (1991-2002) program.

In this report, water quality conditions are summarized by site, by basin, and for the entire County from 2006-2010. Spatial and temporal trends are summarized for County waters in Tampa Bay, from Tarpon Springs south to Ft. DeSoto, and two major lakes from 2003-2009. Parameters measured in situ included temperature, flow, salinity, specific conductance, pH, dissolved oxygen, water column depth, and Secchi depth. Analyses of grab samples collected from the field included chlorophyll (a, b, c), nutrients (total Kjeldahl nitrogen (TKN), ammonia nitrogen (NH_3), nitrate + nitrite nitrogen (NOX), total phosphorus (TP), and dissolved orthophosphorus (OP)), 5 day biological oxygen demand (BOD5), color, total suspended solids (TSS), transmissivity, Enterococcus, fecal coliform, and turbidity. In addition, temporal and seasonal trends in water quality are summarized by stratum for the years 2003-07 and 2004-2008 for the parameters dissolved oxygen, chlorophyll-a, total suspended solids, transmissivity, and turbidity.

The Pinellas water bodies designated as impaired by the Florida Department of Environmental Protection (FDEP) and United States Environmental Protection Agency (USEPA) are shown in Figure 1. The Pinellas County monitoring strata and fixed land stations that are within these waters are shown in Figures 2 - 4.

Based on the FDEP 2011 IWR verified lists and the original 1998 303(d) list (Figure 1), 67 of 72 fixed land stations, all 8 Tampa Bay strata, 4 of 8 western Intra-Coastal strata, and two lake strata are impaired. Sixty-two fixed land sites are impaired for low dissolved oxygen (Figure 2 and Appendix C); forty-nine fixed land sites are listed impaired for high chlorophyll-a due to nutrients (Figure 3 and Appendix C); and sixty-one fixed land sites are considered impaired for high bacteria counts (Figure 4 and Appendix C). The portion of Old Tampa Bay north of the Courtney Campbell Causeway and south of the Gandy Bridge; Riviera Bay; Clearwater Harbor and Boca Ciega Bay to the Central Avenue Causeway in St. Petersburg; and Lake Tarpon are listed impaired for low dissolved oxygen (Figure 2 and Appendix C). Old Tampa Bay north of the Howard Franklin Bridge; Riviera Bay; and Clearwater Harbor and Boca Ciega Bay to the Central Avenue Causeway in St. Petersburg are listed impaired for high chlorophyll-a (Figure 3 and Appendix C). Both Lake Tarpon and Lake Seminole are considered impaired for high chlorophyll-a and Trophic State Index. All strata in Tampa Bay are listed as impaired for bacteria either in the water column or in shellfish (Figure 4 and Appendix C).

The following statements can be made about water quality in Pinellas County based on analyses of PCDEM data from 2003-2010:

Water quality is better in open water strata compared to enclosed or semi-enclosed strata.

Water quality is typically better during the dry season compared to the wet season.

Water quality is better during years with lower rainfall though wet season phytoplankton blooms in 2008-2010, moderate rainfall years, tend to compromise this statement.

· Land sites (streams, creeks, and canals) with the highest flow were typically associated with the highest nitrogen loadings including the Lake Tarpon outfall canal, the Seminole Bypass Canal, Curlew Creek, Brooker Creek North and South, and Roosevelt Channel 5.

Land sites with the lowest flow were typically associated with the lowest nitrogen loadings including upper portions of Long Branch Creek, Bishop Creek North Branch, and Cedar Creek.

Nutrient loads for land sites varied with rainfall. Sites had lowest loads in 2007, the year with lowest rainfall. Nutrient loads were greater in 2006 and 2008-2010 periods of greater rainfall.

Nutrient load discharges from local watersheds contributed to high chlorophyll-a and low dissolve oxygen in Old Tampa Bay.

Discharges from three eutrophic systems; Lake Seminole, the Seminole Bypass Canal, and the Cross Bayou Canal contributed to high chlorophyll-a and low dissolved oxygen in Long Bayou and Cross Bayou (stratum W5).

Lake Tarpon and Lake Seminole did not meet the state water quality standard for nutrients and Lake Tarpon did not meet state criterion for dissolved oxygen.

Lake Seminole water quality improved from the end of 2009 through 2010. The lake's condition was still very poor at the end of 2010.

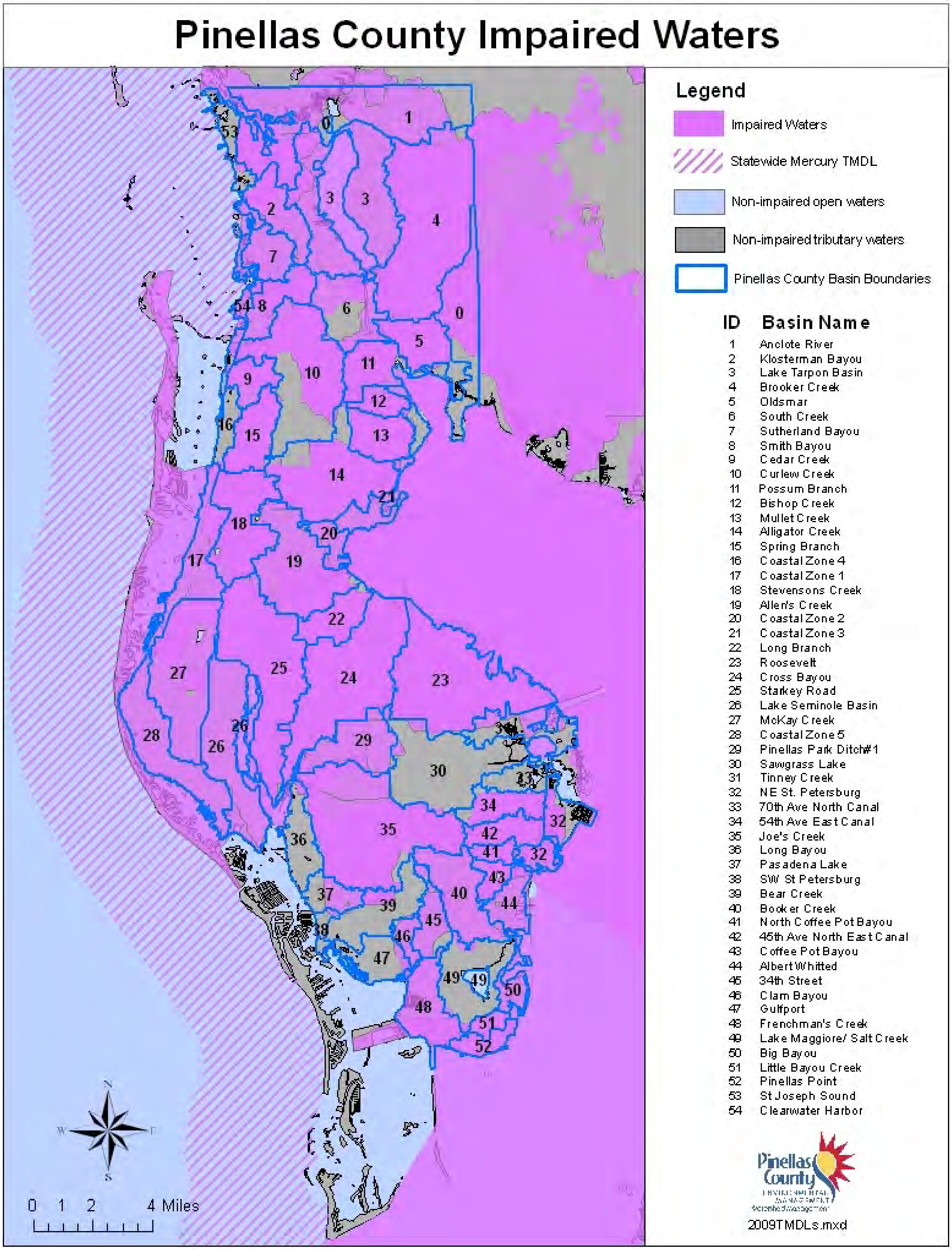

Figure 1. Pinellas County impaired waters based on FDEP 2011 verified lists and the 1998 303(d) list for Group 1 and Group 5 basins

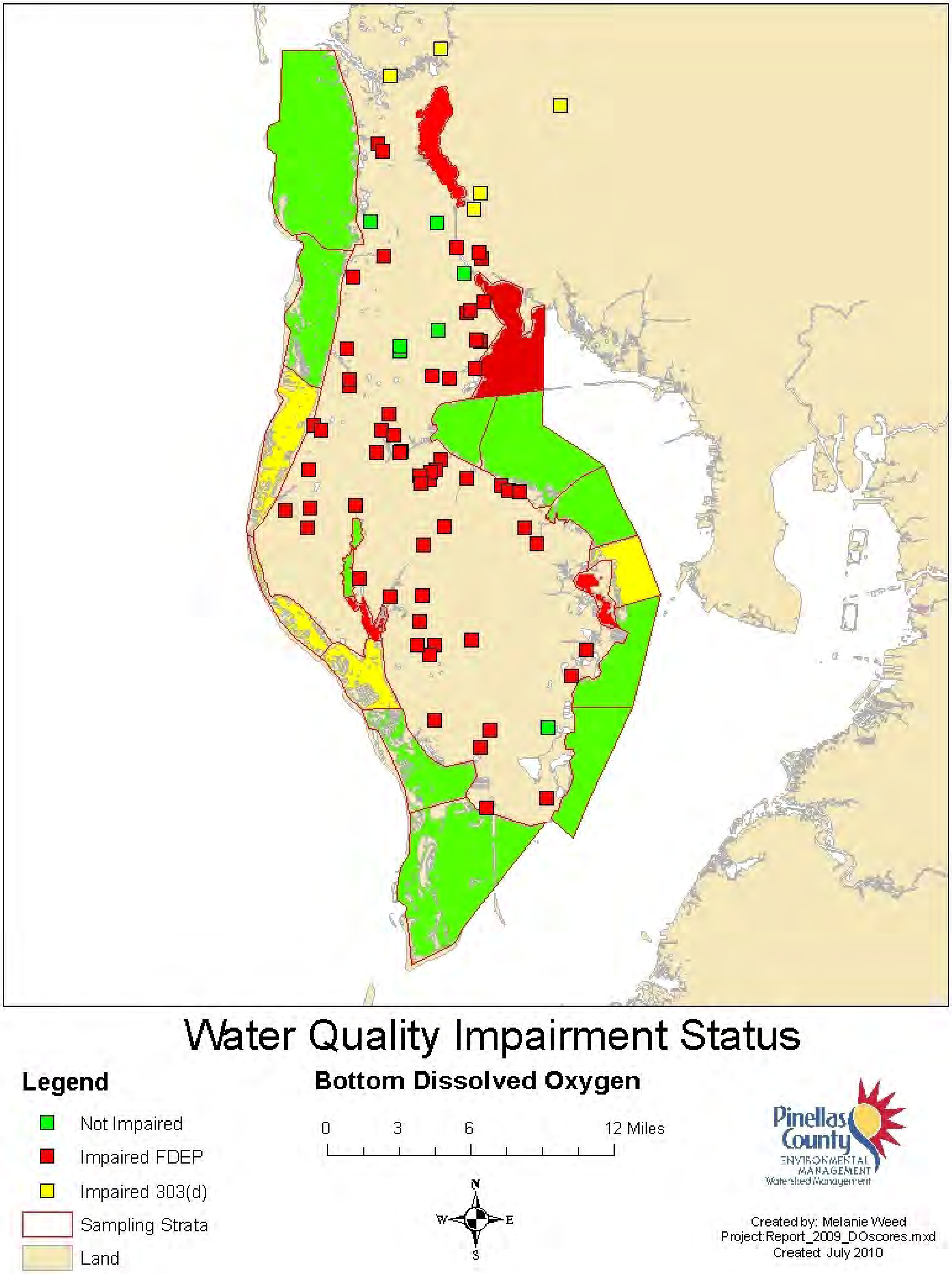

Figure 2. Pinellas County waters impaired for bottom dissolved oxygen based on FDEP 2011 verified lists and the 1998 303(d) list for Group 1 and Group 5 basins

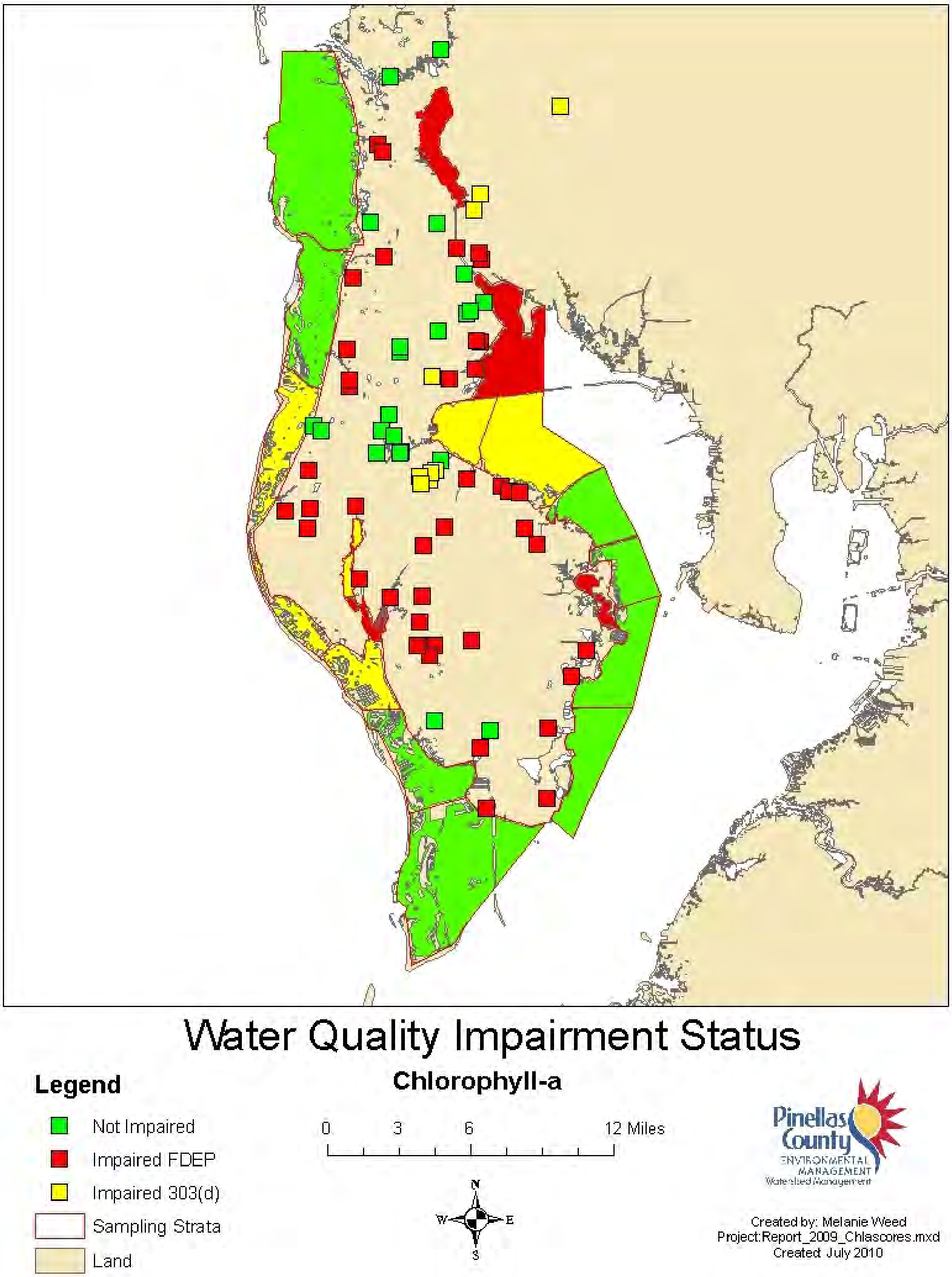

Figure 3. Pinellas County waters impaired for Chlorophyll-a and Trophic State Index based on FDEP 2011 verified lists and the 1998 303(d) list for Group 1 and Group 5 basins

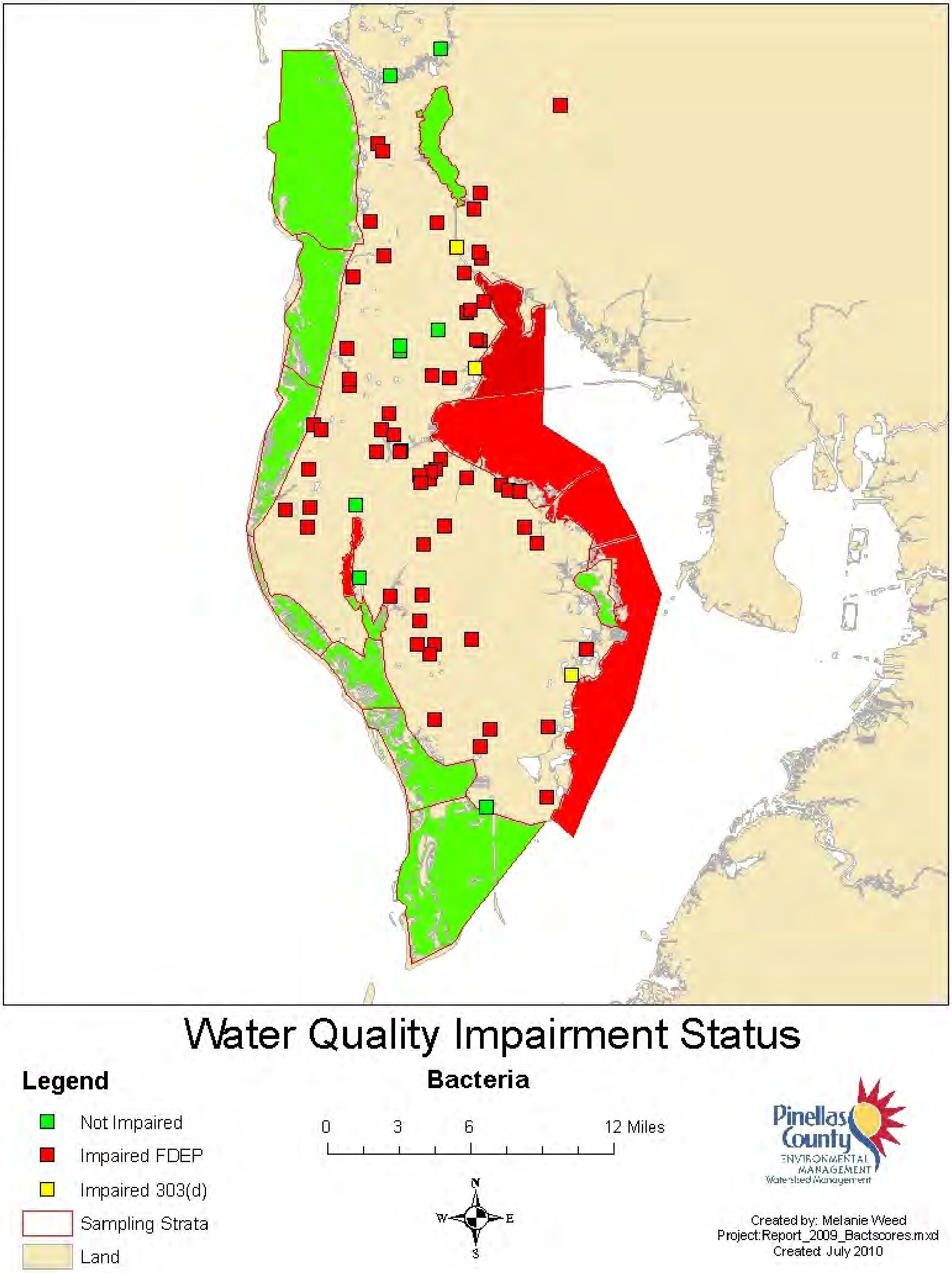

Figure 4. Pinellas County waters impaired for bacteria based on FDEP 2011 verified lists and the 1998 303(d) list for Group 1 and Group 5 basins

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1.0 Introduction

The Water Management Division (WMD) (formerly the Department of Environmental Management) of the Pinellas County Department of Environment and Infrastructure initiated a surface water monitoring program in October 1990 and began reporting results from samples collected in January 1991. The program monitors water quality in a variety of creeks, streams, lakes, and open marine water bodies. Much of the rationale behind the water quality monitoring program is associated with County watershed planning initiatives consistent with State Water Policy (Chapter 62-40, Florida Administrative Code (FAC)), and the County Comprehensive Plan. Pinellas County's existing watershed planning and water quality monitoring programs were originally developed largely in response to directives under Chapters 62-40.430 FAC (Water Quality) and 62-40.432 FAC (Surface Water Protection and Management) of State Water Policy. These activities serve to support the goals, objectives and policies of both the County Comprehensive Plan (hereafter referred to as the County CP) and the Tampa Bay Estuary Program Comprehensive Conservation and Management Plan (CCMP).

Previous reports summarized: the first two years (1990-1991); 1992 (Moores et al. 1992 and 1994); 1991-1997 (Myers et al. 2000); 1991-2002 (Squires et al. 2003), 2003-2005 (Hammer Levy et al. 2006), 2003-2006 (Hammer Levy et al. 2007), 2003-2007 (Hammer-Levy et al. 2008), 2004-2008 (Hammer-Levy et al. 2009) and 2005-2009 (Hammer-Levy et al. 2010). This report summarizes data collected in the 5 year reporting period 2006-2010, and presents analyses for both 2006-2010 data and 2003-2010 data.

PINELLAS COUNTY PROGRAM

The monitoring program was in part a result of the adoption of the County CP in 1989, which mandated implementation of ambient water quality monitoring under Goal 3 of the Conservation Element. The Plan was amended in 1998 and 2007 and provisions for water quality protection of the County's waters now appear in the Surface Water Management Element. Specifically Goal 1 of the Surface Water Management Element states:

"...SURFACE WATERS SHALL BE MANAGED TO PROVIDE FLOOD PROTECTION FOR THE CITIZENS OF PINELLAS COUNTY, TO PRESERVE AND ENHANCE THE WATER QUALITY OF RECEIVING WATER BODIES, AND FOR THE PURPOSES OF NATURAL RESOURCE PROTECTION, ENHANCEMENT AND RESTORATION, PLANT AND WILDLIFE DIVERSITY, AND ESTUARINE PRODUCTIVITY."

County Comprehensive Plan objectives and policies emphasize the critical link between watershed management planning and monitoring of the County's waters to prioritize planning efforts based on need as well as to evaluate the effect of implemented management activities on the quality of receiving water bodies. Furthermore, objectives and policies call for continued collaborative efforts with federal, state, regional, and local agencies and governments in assessing water pollution problems and evaluating management actions to remedy identified problems. Selected objectives and policies under Goal 1 in support of the County water quality monitoring program are listed below.

Objective 1.5: Pinellas County shall show measurable improvements in the quality of County waters as a result of management activities and the development and implementation of watershed management plans.

Policy 1.5.2: Comprehensive watershed and water body management plans shall be developed and implemented in a manner that is unique to the character and condition of each watershed or waterbody and shall address, as appropriate, the need for: (1) stormwater, water quality, water quantity, and habitat-related capital projects, (2) public education and citizen involvement, (3) specific management activities including, if necessary, additional regulation and/or incentive based programs, and (4) the necessary monitoring to evaluate the short and long-term successes of the overall management program, (5) the implementation of the Total Maximum Daily Load (TMDL) requirements, and (6) opportunities to incorporate recreational opportunities.

Objective 1.10: Pinellas County shall participate with federal, state, regional, and local agencies and governments in gathering and evaluating the data necessary to identify major pollution problems in the County's waters.

Policy 1.10.2: Pinellas County, in coordination with the municipalities, shall continue its program of surface water monitoring within the waters of the county as a means of evaluating the degree of the watershed/water body impairment, the overall effect of management activities, the quality of surface waters, and the overall health of dependent living resources.

Objective 1.12: The Surface Water Management Element shall continue to be coordinated with all affected jurisdictions and agencies, as well as federal, state and regional goals for surface water control, protection, enhancement, restoration, and management.

Policy 1.11.10: Pinellas County shall continue to support the Tampa Bay Estuary Program (TBEP) and its partnership approach to the protection and restoration of Tampa Bay.

The County water quality monitoring network was originally designed to carry out the goals of the County CP, specifically (1) to characterize the relative priority of each receiving water for development of management plans, (2) to identify those tributaries contributing the greatest contribution of pollutants, and (3) to provide a baseline for evaluating the impacts of management programs on receiving water quality. Further sampling site selection criteria are discussed in Section 3.0.

WATER QUALITY MONITORING IN TAMPA BAY

In addition to the County's intent to monitor freshwater creeks, streams, and lakes, Pinellas County has made special commitments to collaborate with local governments and public agencies for long-term water quality monitoring of Tampa Bay waters. These collaborative monitoring efforts were implemented as a Tampa Bay National Estuary Program initiative (TBNEP 1996) to better meet the goals of the CCMP. Upon signing of the CCMP in 1996, the TBNEP was renamed the Tampa Bay Estuary Program (TBEP). The signing represented a responsibility of local governments - the counties of Hillsborough, Pinellas, and Manatee; and the cities of Clearwater, St. Petersburg, and Tampa - to monitor Tampa Bay water quality.

The ongoing monitoring efforts in Tampa Bay are carried out by the Environmental Protection Commission of Hillsborough County, the Pinellas County Department of Environment and Infrasturcture's Watershed Management Division, the Manatee County Natural Resources Department (formerly Environmental Management Department), and the City of Tampa Bay Study Group. The coordinated efforts of these governmental entities have resulted in an on-going sampling program with coverage in each of seven Tampa Bay segments. These program representatives, and others from the region, formed the Southwest Florida Regional Ambient Monitoring Program that meet quarterly to split water samples for inter-laboratory comparisons and to discuss approaches to strengthen overall monitoring program compatibility.

Four reports and a CD-ROM (KEA 1992, Squires and Cardinale, 1996 and 1999; TBEP 2002, TBEP 2007) provide a bay-wide perspective of spatial and temporal water quality trends in Tampa Bay since 1974. These reports include water quality trends in Boca Ciega Bay since 1991 based on the PCDEM monitoring data and allow for water quality comparisons to other Tampa Bay segments.

DATA AVAILABILITY

To facilitate data sharing among local, regional, state, and federal agencies and governments, as well as the public at large, all county ambient monitoring data results are periodically uploaded into FDEP's STORET which then uploads the data to the United States Environmental Protection Agency's STORET database. Data can also be downloaded from the Pinellas County Water Atlas (http://www.pinellas.wateratlas.usf.edu/) or can be received by email or on CD-ROM by contacting the Department of Environment and Infrastructure's Watershed Management Division at (727) 464-4425.

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2.0 Methodology

Field sample collections and measurements were carried out according to Florida Department of Environmental Protection (FDEP) Standard Operating Procedures (FDEP, 2008a).

FIELD MEASUREMENTS AND SAMPLE COLLECTION

Physical parameters including temperature, pH, dissolved oxygen, conductivity, and salinity were measured using Hydrolab multiprobe units. Surface readings were taken at a depth of 0.2m from the surface. If the total water column depth was >0.5m but <1.0m, data were recorded at the surface and 0.2m from the bottom. For depths greater than 1.0m, data were also recorded at mid-depth.

From 2003-2006 for both fixed land sites and open water strata sites, water samples were collected at 0.2m using a horizontally-oriented Alpha bottle water sampler. Since 2007 for fixed land sites bottle immersion was used in lieu of an Alpha bottle if field staff could access the site.

Flow measurements were collected using a modification of the US Geological Survey's (USGS) stream flow methodology with a Marsh McBirney Model 2000 Flow-Mate or by using data collected at either real-time USGS continuous flow monitoring locations or data logging Hydrologic Data Collection, Inc (HDI) continuous flow monitoring locations. Water quality samples were not collected if flow was not detectable.

LABORATORY METHODS

All water samples were delivered to the Pinellas County Utilities Department, PACE labs, or Southern Analytical Labs, the same day and usually within six hours of sample collection at any given site. The Pinellas County Utilities Department Laboratory, a National Environmental Laboratory Accreditation Conference (NELAC) certified lab, performed most sample analyses. Pace Analytical (formerly E-lab), a NELAC certified laboratory, also provided analysis services for this program.

The laboratories follow analysis protocol from:

Methods for Chemical Analysis of Water and Wastes. EPA 600/4-79-020. Revised March 1983.

Standard Methods for the Examination of Water and Wastewater, 19th Edition. APHA, WEF, AWWA, 1998.

PHYTOPLANKTON TAXONOMY METHODS

From 2003-2010 phytoplankton samples were collected at randomly selected water quality sites in Lake Tarpon and Lake Seminole. Samples were collected from four sites in each lake during

each sample period. From 2003-2007 there were nine sampling period per year and from 2008-2010 eight sample periods per year. A total of 488 phytoplankton samples from 203-2009 were analyzed and data summarized in this report. Samples from 2010 are still being processed.

Sample collection was completed in accordance with FDEP SOP FS 7000 for General Biological Community Sampling. A PVC tube with a rubber stopper at one end was used to collect samples. The tube was lowered into the water column to twice the secchi depth for the site, capped, then raised and the contents released into a bucket. This process was repeated two more times. The bucket was agitated to mix the sample then 125 ml sample bottle was filled, capped and put on ice. Samples were preserved with approximately 0.5 ml of Lugol's solution and refrigerated until analysis was complete. Once samples were analyzed a seperate alloquoat was transferred to a 25ml glass scintillation vial and sealed for long-term storage.

Identification, enumeration, and volumetric calculation procedures for phytoplankton were based on procedures described in Standard Methods for Examination of Water and Waste Water 17th Ed. (APHA Washington DC. 1987).

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3.0 Open Water Sites

From 2003 to 2010, the ambient water quality program consisted of two types of sample sites distinguished by selection method. The first type are randomly selected sites in open water bodies (strata) including Tampa Bay, from Oldsmar south to Pinellas Point; along the western mainland shore, from the mouth of the Anclote River south to Ft. DeSoto; and the two largest lakes, Lake Tarpon and Lake Seminole. Samples collected at these sites are used to assess status and trends in County receiving water bodies. The second type is a set of fixed land-based sites along streams, ditches, canals, and the Anclote River. Water quality samples and flow data are collected each sample period and are used to assess the condition of the waterway and for estimation of nutrient and sediment loads from these waterways to receiving water bodies. Lake Chautauqua and Alligator Lake are monitored as fixed sites.

The stratified random monitoring program was designed for WMD by Janicki Environmental, Inc. WMD provided a set of goals and objectives as well as budgetary and logistic constraints for the program. The consultant designed a monitoring program with a probabilistic design consisting of an Environmental Protection Agency (EPA) Environmental Monitoring Assessment Program (EMAP)-based element and a stratified random element. The EMAP-based design element consists of overlaying hexagonal grids on strata (water body segments) and randomly selecting a sample location within each grid. This allows for estimating surface area for water quality conditions within each stratum. The stratified random element allows for statistical methods to be applied to estimate population means and confidence limits for water quality metrics. The stratified random element also has a temporal and spatial component.

Lake Tarpon, Lake Seminole, and the marine waters along the shores of Pinellas County were subdivided into 19 strata (Figure 5 and Appendix D). East and west coast reporting units were selected based on the location of causeways, bridges, and the Tampa Bay Estuary Program boundaries (Pribble et al., 1999).

The temporal unit is a daytime period of approximately four hours. There are two temporal units in each day representing morning and afternoon. The order of visitation (i.e., morning vs. afternoon) within each strata was randomized. The temporal population of interest was defined as a one-year set of all possible temporal units excluding Fridays, Saturdays, Sundays, holidays, and days before holidays.

From 2003 through the end of September 2007, the calendar year was divided into nine evenly spaced sample periods of 40.5 days. Primary and secondary sampling dates were randomly selected from the first 25 days of each of the nine sample periods. The remaining days were reserved as secondary sampling days if the primary dates were missed due to weather or scheduling conflicts. Starting in October 2007 the calendar year was divided into four dry season sample periods of 50.75 days and four wet season sample periods of 40.5 days. Primary and secondary sampling dates were randomly selected from the first 31 days in dry season periods and the first 25 days in the wet season periods.

Due to inherent Global Positioning System (GPS) errors and boat drift at sampling sites, a spatial unit representing each sampled site was defined as a 30-meter diameter circle. From 2003 to September 2007 for east coast strata, the spatial population of interest was the set of all spatial units from the Pinellas County shoreline to the 2-meter mean low water isobath in Tampa Bay. Starting in October 2007 the eastern strata spatial population of interest was expanded to include all waters from the shoreline to strata boundaries. For west coast strata, the spatial population of interest was the set of all spatial units from the shoreline of the peninsula mainland to the eastern shore of the barrier islands. Also, the populations of interest in the eastern and western coastal reporting units were defined so each reporting unit was not located within more than one Tampa Bay Estuary Program bay segment reporting unit. The Lake Seminole population of interest was stratified geographically into a northern and southern lobe. This stratification was imposed to ensure that an equal number of samples were collected in each lobe. Lake Tarpon comprises a single stratum.

From 2003-2007 in each calendar year, a total of 36 samples were selected for each stratum. At least one of these 36 sites was located in each hexagonal grid in the respective stratum. These 36 sites are called the primary sampling sites. Four sites are assigned to a sample period; there are nine sampling periods in the calendar year. In the event a primary sampling site could not be used, sets of randomly selected secondary and tertiary sites were available as alternates. Starting calendar year 2008 a total of 32 samples were selected for each stratum. There were 8 sample periods and four sites were assigned to a sample period. In eastern strata sample effort was further stratified with 6 sample sites randomly selected from waters greater than 2 meters and 26 sites randomly selected from waters less than 2 meters.

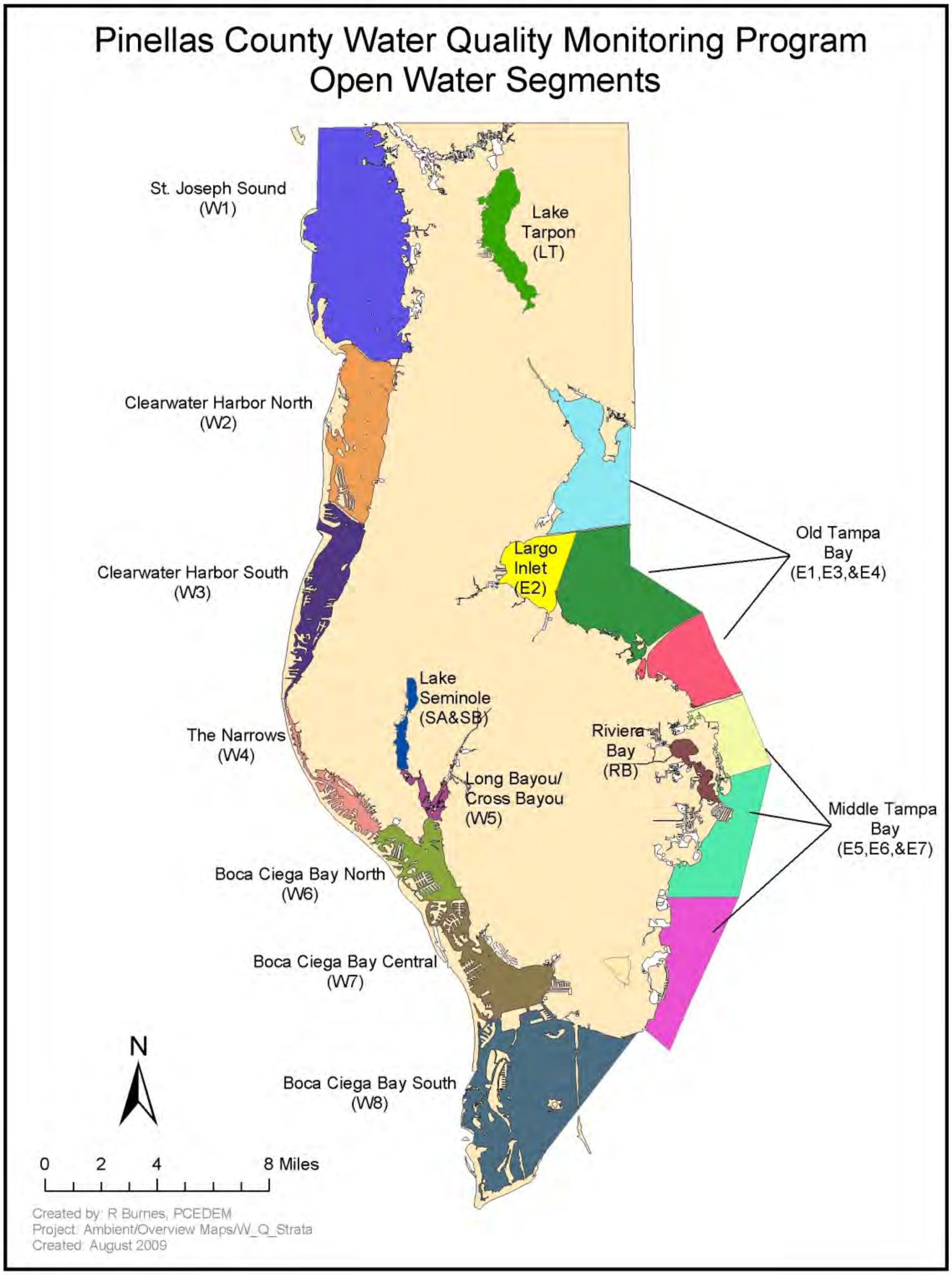

Figure 5. Open water strata

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4.0 Land Basins and Site Locations

The county is composed of fifty-two land basins (Basins 1-52, Figure 6). Most of the basins contain at least one fixed monitoring station near the final discharge point from the basin and just upstream of tidal influence. Sampling at these sites allowed for estimates of nutrient loads discharged from the basin into the recieving water body.

A total of 73 fixed monitoring stations were sampled from 2005 to 2009. Forty-eight fixed monitoring sites were sampled in 2004, and 2006, 50 sites in 2005 and 2007, 60 sites in 2008, 61 sites in 2009, and 59 sites in 2010. Eight sites were in tidally influenced areas or lakes and only water quality data were collected. At all other sites both water quality data and flow data were collected. For six of these sites, USGS discharge flow data were available. For eight sites HDI discharge flow data were available in 2006-2010. County staff measured flow at the time of sample collection at all remaining sites.

From 2004-2007 fixed sites were visited nine times per year except two stations in 2007 that were visited quarterly. In 2008 fixed sites were visited eight time except two stations that were visited quarterly. Fixed sites were grouped geographically into five sets from 2004-2007 and six sets in 2008-2010. A set of fixed sites was sampled on the same day. Sampling took place during the same random schedule determined for the open water program.

Sampling site descriptions are found in Appendix D.

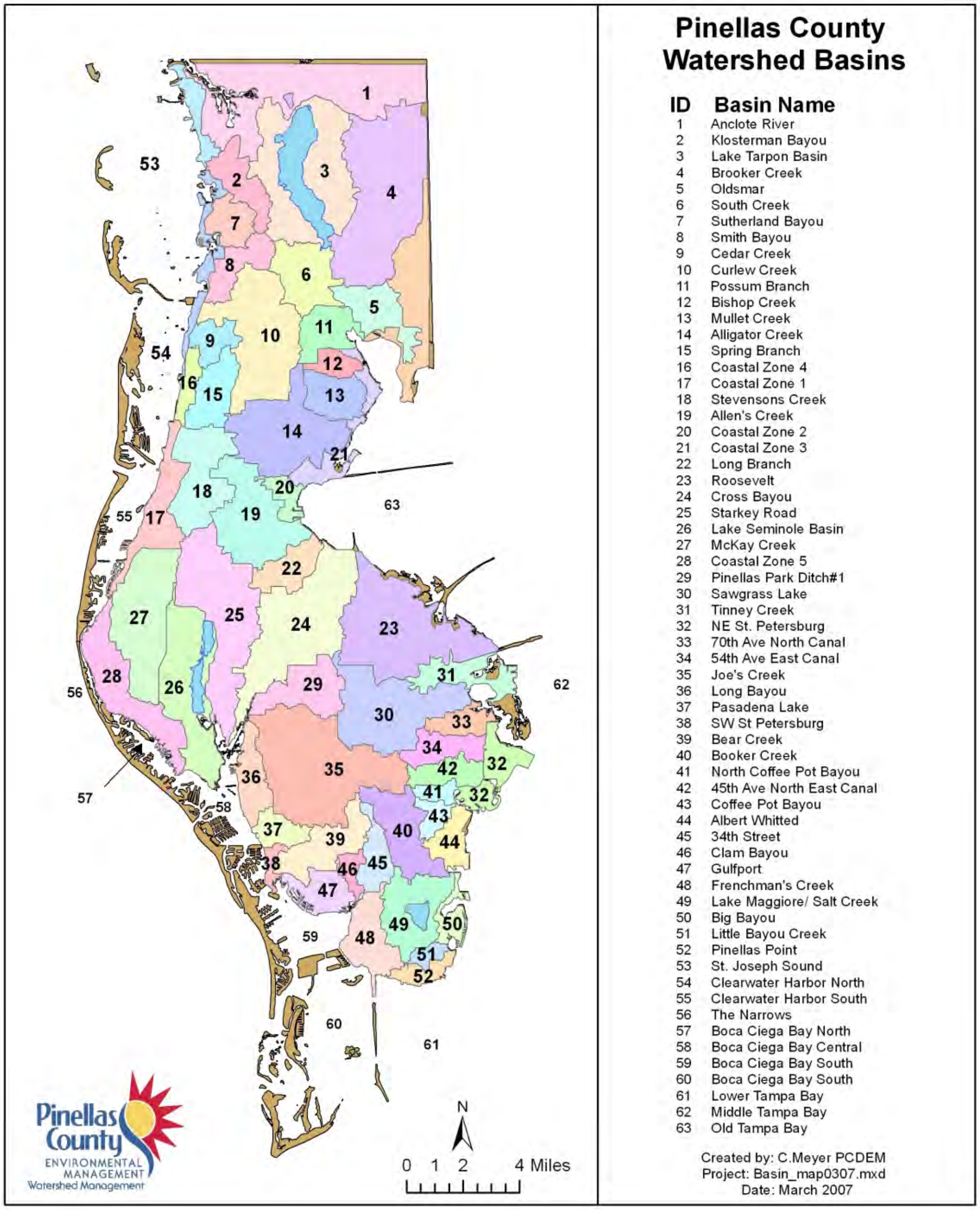

Figure 6. Pinellas County basins

5.0 Parameter Descriptions

Water quality indicators covered in this report are salinity, total suspended solids, total phosphorus, total nitrogen, bottom and surface dissolved oxygen, transmissivity, trophic state index (TSI), flow, and chlorophyll-a.

BOD5: Biochemical oxygen demand is the quantity of dissolved oxygen utilized in the biochemical oxidation of organic matter under standard laboratory procedure in five days at twenty degrees Centigrade, expressed in milligrams per liter (mg/L).

Color: Color is a measure of dissolved inorganic and organic substances in a water sample. Color is measured in platinum-cobalt units.

Chlorophyll-a: Water column chlorophyll-a (Chl-a) concentrations are a measure of the quantity or biomass of planktonic algae or phytoplankton in a water body. Excessive nutrient loadings into a water body can result in high phytoplankton biomass conditions known as algae blooms. High algal biomass can greatly reduce water clarity, which in turn may limit the growth and distribution of desirable bottom vegetation such as seagrasses and can seriously degrade the aesthetic quality of a water body. In addition, persistent conditions of high algae biomass often result in die-off, sinking, and decay of the algae in water bodies. Decaying matter consumes oxygen and often results in fish kills.

Dissolved Oxygen: Dissolved oxygen (DO), measured in mg/L, strongly influences where organisms live. Oxygen enters the aquatic environment from the atmosphere (wind, waves, direct diffusion), plant photosynthesis, and mixing and diffusion from more oxygenated water masses. A physical property of water is that the solubility of oxygen is greater in cold water than in warm water therefore, less oxygen can be dissolved in water as water temperature increases. Biological factors such as increased metabolic rates and oxygen uptake rates of aquatic organisms may further reduce dissolved oxygen levels. Since biological oxygen uptake is often the greatest in bottom waters compared to surface waters, the first signs of an oxygen stressed water body are usually observed as low bottom water dissolved oxygen levels. Such conditions often result in isolated or widespread fish kills.

Enterococcus: Enterococci, indicators of water column pathogens, are found in intestinal tracts of animals and humans. Its presence can be natural or from a man-made source like a sewage spill.

Fecal Coliform: Fecal coliforms, indicators of water column pathogens, are found in the intestinal tracts of animals and humans. Its presence can be natural or from a man-made source like a sewage spill.

Flow: Flow was measured at fixed land sites. Width and depth data was collected to estimate cross sectional areas of channels. Water velocity was measured on-site using a flowmeter. The flow was then calculated in cubic feet per second (cfs).

Flow volume was combined with water quality parameter concentrations to estimate loading for total nitrogen, total phosphorus, and total suspended solids.

Nutrients: This report presents two nutrient values, total phosphorus (TP) and total nitrogen (TN). Nutrients are chemical elements such as nitrogen and phosphorus that sustain life and promote growth. The amount of nutrients available in a water body is one of the controlling factors for plant growth. Waters containing few nutrients cannot support a large plant community and will not attract animal life, as there won't be a source of food. Nutrients cause problems when they are overabundant. In particular, microscopic plants or algae, when under bloom conditions, may appear as green "clouds" in the water. The poor water clarity from such nutrient-induced algae blooms can limit water column light transparency, which in turn, will often limit available light necessary for desirable types of bottom vegetation, such as seagrasses, to grow. Data on specific phosphorus and nitrogen components are available on request from PCDEM.

Salinity: Salinity is a measure of the total amount of dissolved solids in seawater and is measured in parts per thousand (ppt). Sodium and chloride make up 86% of sea salts, with sulfur, magnesium, potassium, and calcium accounting for 13%. Salinities in Pinellas County generally vary between 0 ppt (freshwater) and 33 ppt. Salinity is affected by precipitation, evaporation, freshwater inputs, springs, and mixing with other water masses such as the Gulf or streams. At sites with minimal or no salinity (i.e. 0.05 ppt or less), salinity sampling was either discontinued during the program or is not reported for the basin.

Total Coliform: Total coliform measures the presence of a group of bacteria used to indicate contamination of water sources from the intestines of warm- and cold-blooded animals.

Total Suspended Solids: Totals suspended solids (TSS) are the amount of particulate material in the water including algae, sediments, and microorganisms. TSS affects the amount of light that can penetrate the water column and thus is part of what determines where plants grow. Increases in TSS can be caused by algae blooms, increased runoff into a system, erosion, and by resuspension of bottom sediments in shallow areas.

Transmissivity: Transmissivity is the measurement of the percent transmittance of a 660nm light over a 10cm pathlength and is useful in determining total concentrations of matter in the water and as a measure of water clarity (Wet Labs, 2001).

Trophic State Index: The trophic state index (TSI) is a method to classify lakes based on total nitrogen, total phosphorus, and chlorophyll-a concentrations. Based on 2005-2006 color data from January to August all of our lakes are classified as colored. For colored lakes, a TSI scale from 1 to 100 is used. A lake with a TSI below 59 is considered to have good water quality, 60 to 69 is fair water quality, and a TSI of over 70 is considered poor water quality.

Turbidity: Turbidity is an expression of the optical property that causes light to be scattered and absorbed rather than transmitted. Turbidity is measured in nephelometric turbidity units (NTU).

6.0 Analysis Methodology

Data analyses focused on water quality metrics used by the Florida Department of Environmental Protection to determine impairment of water bodies and on water quality metrics related to water clarity.

DETERMINATION OF WET AND DRY SEASONS

Annual rainfall and wet and dry seasons for 2003-2010 were determined using rainfall data from the Southwest Florida Water Management District (Southwest Florida Water Management District, 2008). The data were plotted (Figure 7) and wet and dry seasons were visually assessed.

Annual rainfall by year was: 2003-55.5 inches; 2004-64.0 inches; 2005-46.4 inches; 2006-46.7 inches; 2007-38.2 inches; 2008-46.3 inches; 2009-48.0 inches; and 2010-51.1 inches. The dry season was from January through May and from October through December. The wet season was from June through September. Average annual rainfall for the period 1915-2010 is 51.60 inches.

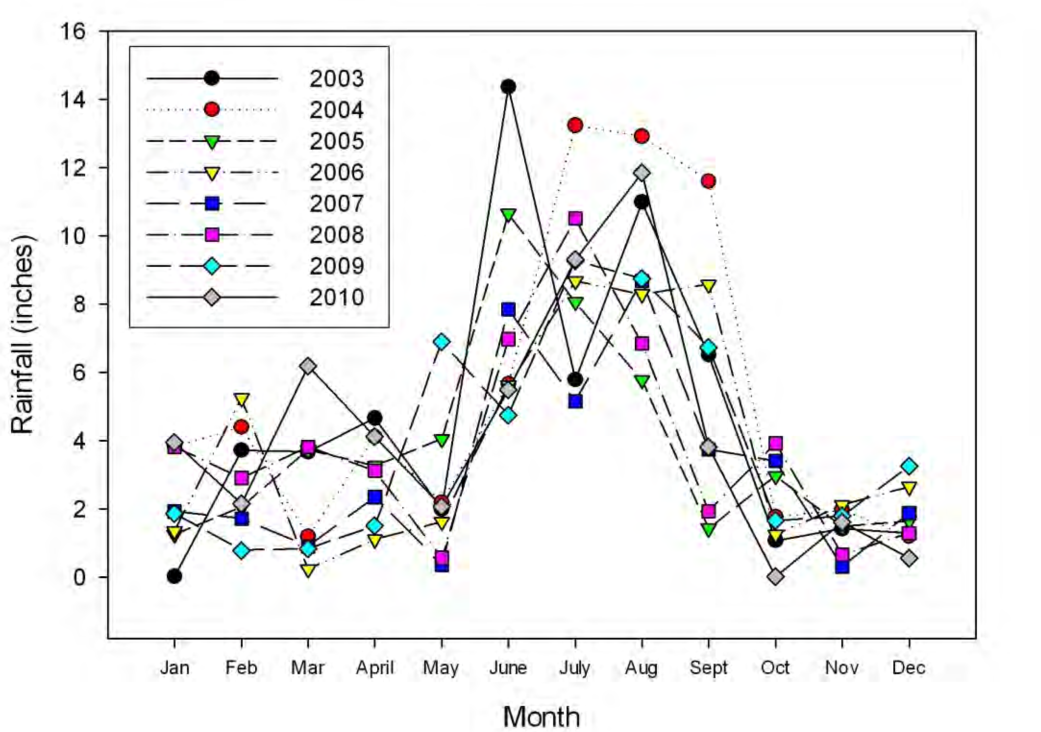

Figure 7. Monthly weighted rainfall sums from SWFWMD data (2003 - 2010)

DESCRIPTIVE STATISTICS FOR STRATA AND FIXED LAND SITES

For 2006-2010 strata data, the descriptive statistics mean, median, minimum, and maximum values are summarized in Appendix A. Water quality metrics include bottom dissolved oxygen, chlorophyll-a, total suspended solids, turbidity, and transmissivity. Descriptive statistics for fixed land sites are summarized in Appendix A. Water quality metrics include discharge volume, bottom dissolved oxygen, total nitrogen, total phosphorus, and chlorophyll-a.

For 2006-2010 data descriptive statistics comparing strata for wet and dry seasons are summarized in Appendix B. Descriptive statistics for strata include mean, median, minimum, and maximum values, 5th, 25th, 75th, and 95th percentiles. Statistical comparisons of water quality metrics were made among east strata, among west strata, and within each strata between wet and dry seasons. For each analysis data were tested for normal distribution. If data were normally distributed, a general linear model (GLM) was used to calculate least square means, their standard errors, t-statistics, and their associated means. Otherwise, the non-parametric Wilcoxon two-sample test and Kruskal-Wallis test were used to test for differences between sets of data. Water quality metrics used in analyses include bottom dissolved oxygen, chlorophyll-a, total suspended solids, turbidity, and transmissivity. TSI for lake sites were calculated and summarized in Appendix B. Spatial analysis plots for wet and dry season data were made for 2003-2006 and 2007-2010 to visually compare to plots of seasonal data for both sets of years (see section 7.0).

ANNUAL LOAD CALCULATIONS FOR STREAM AND CREEK SITES

Estimated annual loads for total nitrogen, total phosphorus, total suspended solids and volume discharge were calculated for 2006 through 2010 for all land sites where both water quality and flow data were collected. When there was flow, water quality data were collected at all sites in each of nine sampling periods (2006-2007) or eight sampling periods (2008-2010). The frequency of flow measurements varied among the sites and among years. To estimate flow, the cross sectional area of the stream was measured and velocity was measured with a Marsh McBirney Model 2000 Flow-Mate flow meter. At six sites (2003 and 2007), seven sites (2004-2006) and nine sites (2008-2010), daily mean flow measured at nearby United States Geological Survey (USGS) stream flow stations was used for flow estimates. In 2006-2010 daily mean flow was measured at 7 fixed stations (8 in 2007-2008) with HDI stream flow stations and was used for flow and load estimates. At eight remaining sites only water quality samples were collected because the sites were either tidally influenced or located in lakes. Since no flow data were collected, loading estimates were not calculated for these eight sites.

Additional flow data were collected in the wet season from 2004-2007 at sites where the total annual nitrogen load exceeded five tons. Additional flow data were collected at 14 sites from 2004-2005, 6 sites in 2006, and a single site in 2007.

For sites with one water quality and flow measurement per period, annual loads were estimated by first calculating an instantaneous load in tons/second. Instantaneous load was calculated by multiplying the concentration of the water quality metric by flow in cubic feet per second.

The instantaneous load was assumed to be the same through the period of time associated with the load. The load was multiplied by the number of seconds in the period to estimate the load per period. Loads for all periods were summed for each year to get the estimated annual load.

For sites with nine regular ambient sampling events and eight additional flow measures, estimated annual loads were calculated as follows. In the dry season, loads were calculated as described above for sites with nine water quality and flow measures. In the wet season, water quality metrics from the most recent regular ambient trip were assumed to represent water quality for each extra flow measure. The time period associated with a flow measure was one half the time between the current and previous date of flow measure plus one half the time between current and future date of flow measure. Estimated loads associated with the flows were calculated by determining the instantaneous load in tons/second. The instantaneous load was calculated by multiplying the concentration of the water quality metric by flow in cubic feet per second. The instantaneous load was assumed to be the same through the period of time associated with the load. The load was multiplied by the number of seconds in the sample period.

For the stream and ditch sites located close to USGS or HDI flow stations, water quality metrics were assumed to be the same throughout the sample period (40.5 days for all periods 2003-wet season of 2007; 40.5 days for wet season periods and 50.75 days for dry season periods from the last two periods of 2007-2010). Daily loads at these sites were estimated using the water quality data from the same sample period and daily mean stream flow data calculated by the USGS. Daily loads are summed to estimate annual loads.

Horizontal bar charts depicting annual loads for total nitrogen, total phosphorus, and total suspended solids in tons; flow in millions of gallons; annual loads per acre, in pounds; and annual flow per acre, in millions of gallons, are in Appendix B, Figures B-11 to B-18.

CUMULATIVE FREQUENCY DISTRIBUTION PLOTS FOR STRATA

Data analyses included cumulative frequency distribution (CDF) plots which show annual estimates of surface areas for water quality conditions within each stratum (Appendix B, Figures B-28 to B-122). The CDF plots can be used to estimate the percent area by year of strata that meet IWR criteria. Janicki Environmental provided SAS Institute statistical analysis programs to produce CDF plots (programs available upon request). Confidence limits were not included in each plot but are available upon request.

COMPARISON OF 2003-2007 AND 2007-2010 DATA FOR STRATA

Comparisons of water quality metrics were made for each strata among 2003-2007 and 2007-2010 data. Each set of three years of data and subsets of wet season and dry season data were tested for normal distribution. If data sets were normally distributed, a general linear model (GLM) was used to calculate least square means, their standard errors, t-statistics, and their associated means. Otherwise, the non-parametric Wilcoxon two-sample test and Kruskal-Wallis test were used to test for differences between sets of data. Water quality metrics used in analyses include bottom dissolved oxygen, chlorophyll-a, total suspended solids, turbidity, and

transmissivity. Spatial analysis plots were made for each set of three years of data and subsets of wet season and dry season data to visually compare trends (see section 7.0).

STATE OF FLORIDA WATER QUALITY COMPARISONS AND TAMPA BAY ESTUARY WATER QUALITY TARGET COMPARISONS

Section 303(d) of the Federal Clean Water Act (CWA) requires the State of Florida to identify impaired water bodies and the pollutants causing impairment. A water body is considered impaired if it does not meet minimum water quality criteria. Water bodies requiring a TMDL are placed on the Florida Department of Environmental Protection's verified list of impaired water bodies. The state is then required to develop a Total Maximum Daily Load (TMDL) that estimates the load reductions required to eliminate the impairment.

Pinellas County basins and sample site locations were compared to the FDEP's 2011 verified lists for Tampa Bay (group 1 basins) and Spring Coast (group 5 basins), and the 1998 303(d) list (see Figure 1). Sample sites within water bodies on these lists for dissolved oxygen, chlorophyll-a, and bacteria are summarized in Figures 2-4 and Appendix C.

Pinellas County data from 2006 through 2010 were also compared to chlorophyll-a criteria of TBEP for Old and Middle Tampa to determine if bay strata would be impaired for these criteria. The TBEP criteria for Tampa Bay are:

- Annual mean chlorophyll values in Old Tampa Bay, Strata E1- E4, were greater than TBEP chlorophyll-a target of 9.3 g/L for Old Tampa Bay;

- Annual mean chlorophyll values in Middle Tampa Bay, strata E5-E7, were greater then TBEP chlorophyll-a target of 8.5 g/L for Middle Tampa Bay.

Fixed land run sites and strata assessed as potentially impaired are summarized in Figures 2-4 and Appendix C.

7.0 Spatial Analysis Graphs

The spatial interpolation methods used in this analysis (Figures 8a, 8b, 8c, 9a, 9b, 9c, 10a, 10b, and 10c) included Inverse Distance Weighting (IDW) and Ordinary Kriging (OKRG). The Inverse Distance Weighting method performs well with a limited sample size and random data points. The data does not need to meet the assumption of normality for IDW. The IDW is a deterministic and exact interpolation method and robust when dealing with limited datasets. IDW uses the neighboring points to interpolate the area between the points based on a weighted distance function. Kriging is based on the concept of random functions requiring the data to be from a stationary stochastic process and in most cases a normal distribution. This interpolation method is based on statistical methods. This model is stochastic and can be exact or inexact depending on the error associated with the data measures. The flexibility of the model relies on the parameter settings. It also assesses autocorrelation and errors of the prediction surface making OKRG the preferred analysis method.

The variables analyzed included chlorophyll-a, bottom dissolved oxygen, and transmissivity. The data were checked for location, qualifiers, and normality prior to interpolation. The normality of the data was analyzed using the normality histogram plot, Q-Q normal plot, skewness, and kurtosis. If the data met the assumption of normality OKRG was used. If the data were not normally distributed IDW was applied.

Prior to interpolation the data was broken down into several geographic regions. Each region was interpolated separately and then added to the figure. This was done to ensure that freshwater systems did not unduly influence salt water systems and vice versa. The ESRI® ArcMap Geographic Information System (GIS) software was used for the construction and creation of the interpolation surfaces. The ESRI® Geostatistical Analyst Extension was used to calculate the interpolation surfaces.

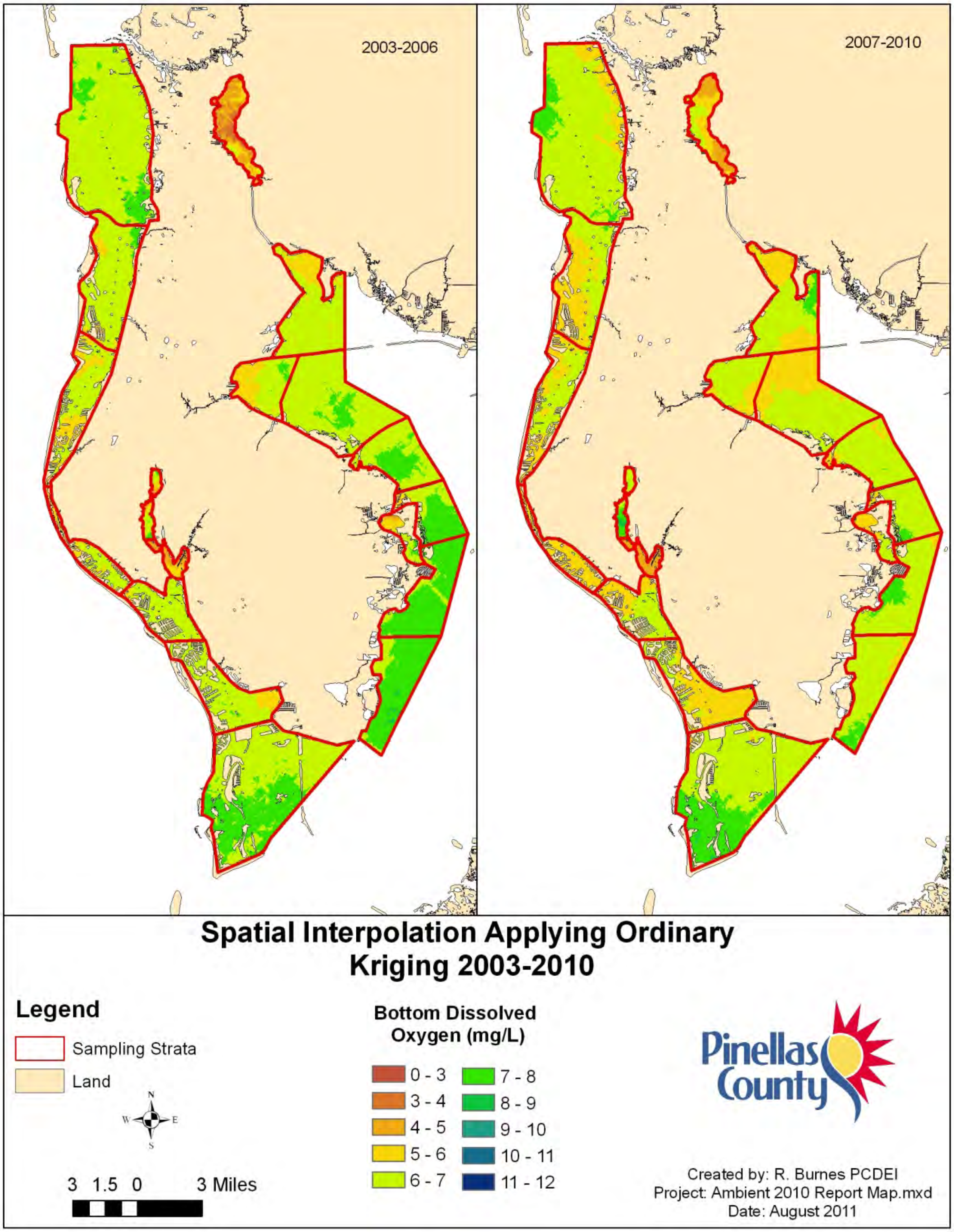

Figure 8a: Spatial analysis of bottom dissolved oxygen data (2003-2006 and 2007-2010)

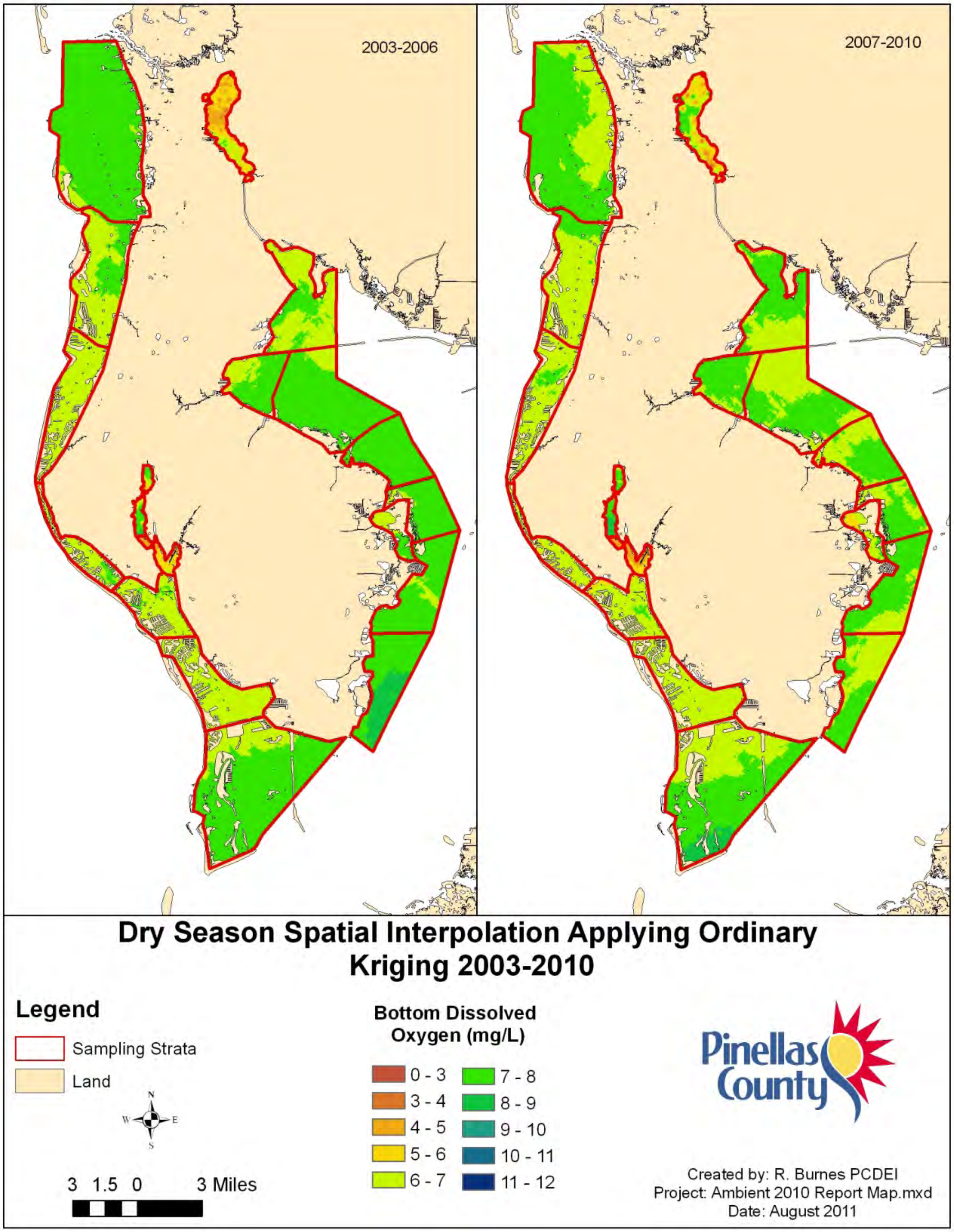

Figure 8b: Spatial analysis of bottom dissolved oxygen data for dry seasons (2003-2006 and 2007-2010)

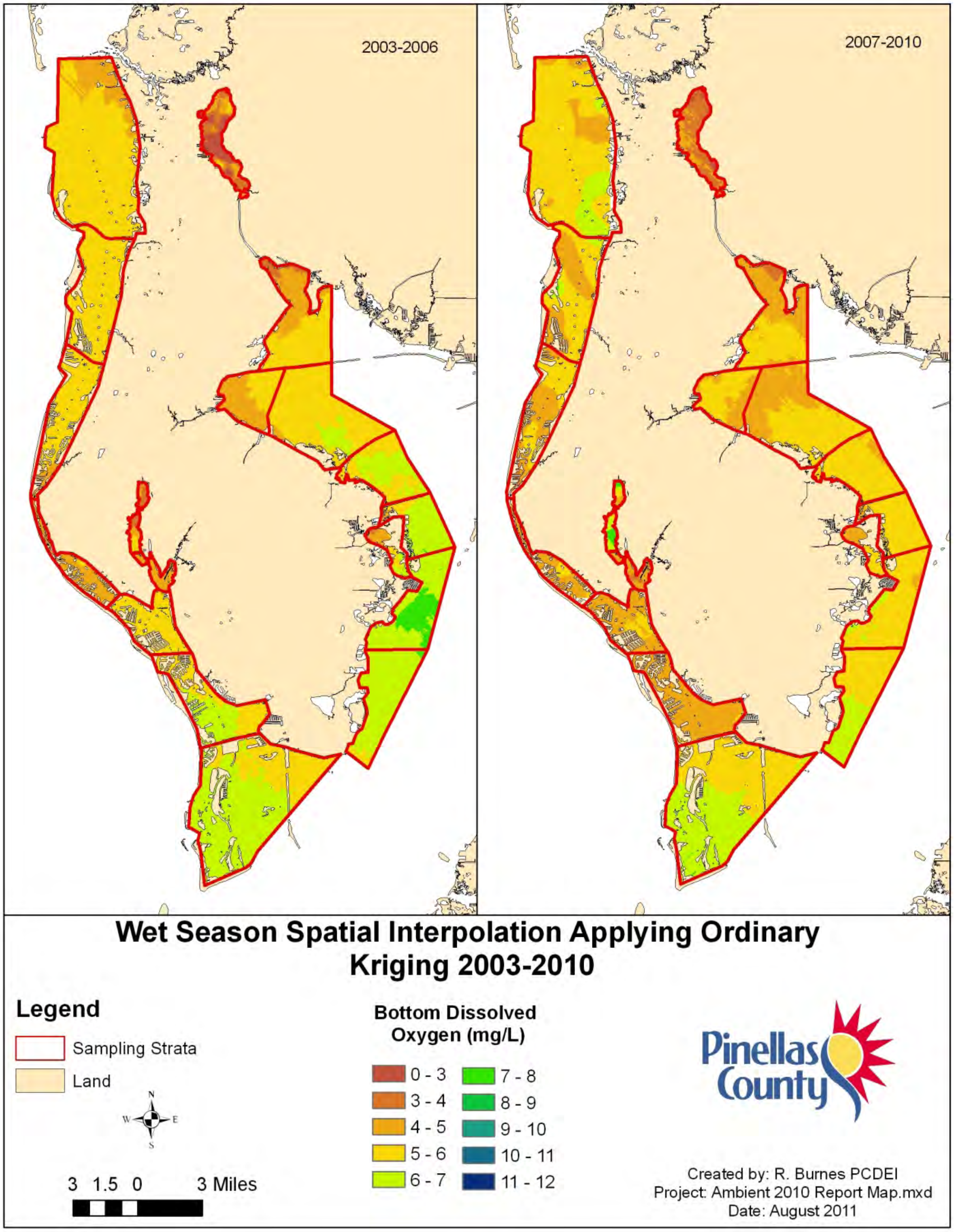

Figure 8c: Spatial analysis of bottom dissolved oxygen data for wet seasons (2003-2006 and 2007-2010)

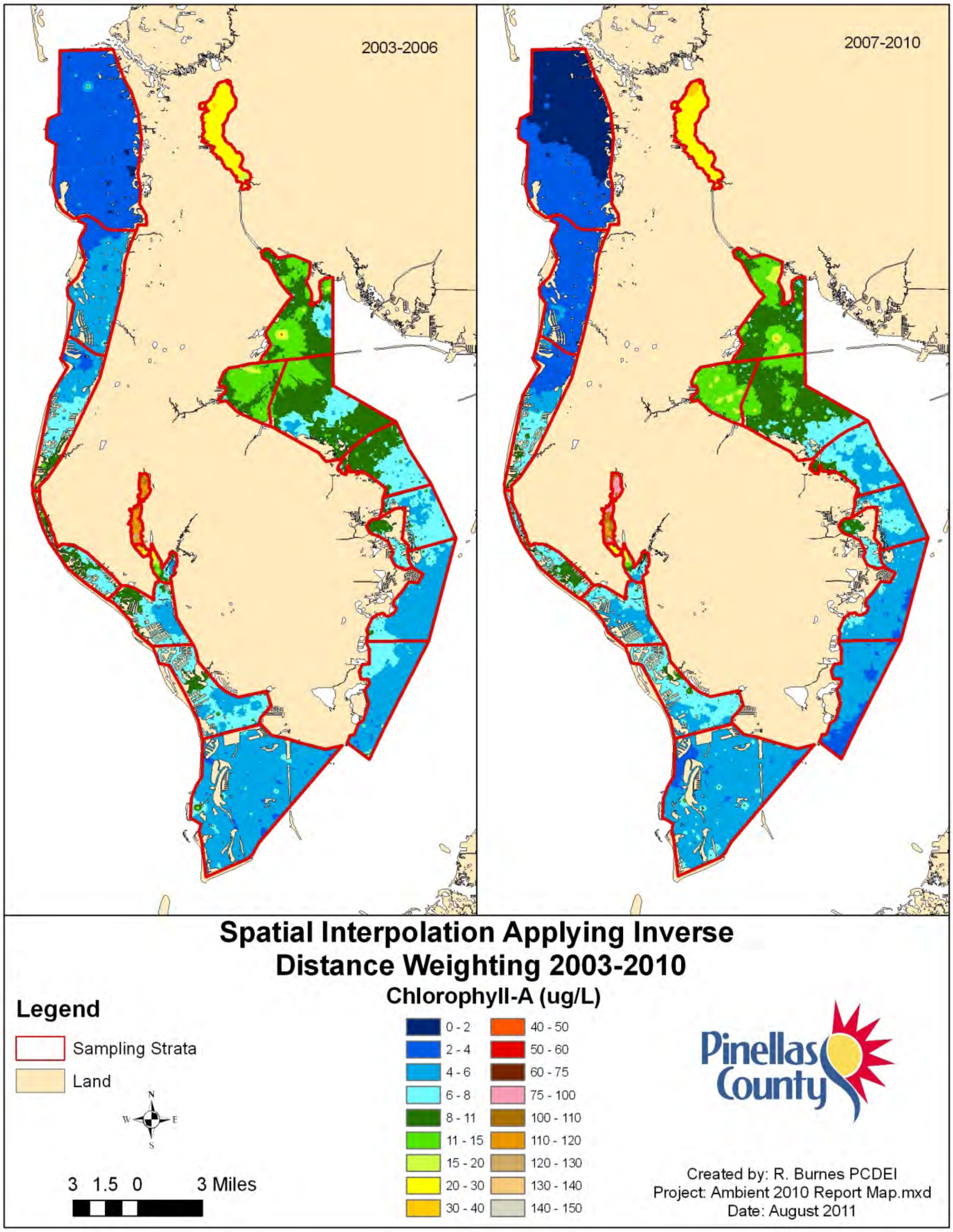

Figure 9a: Spatial analysis of chlorophyll-a data (2003-2006 and 2007-2010)

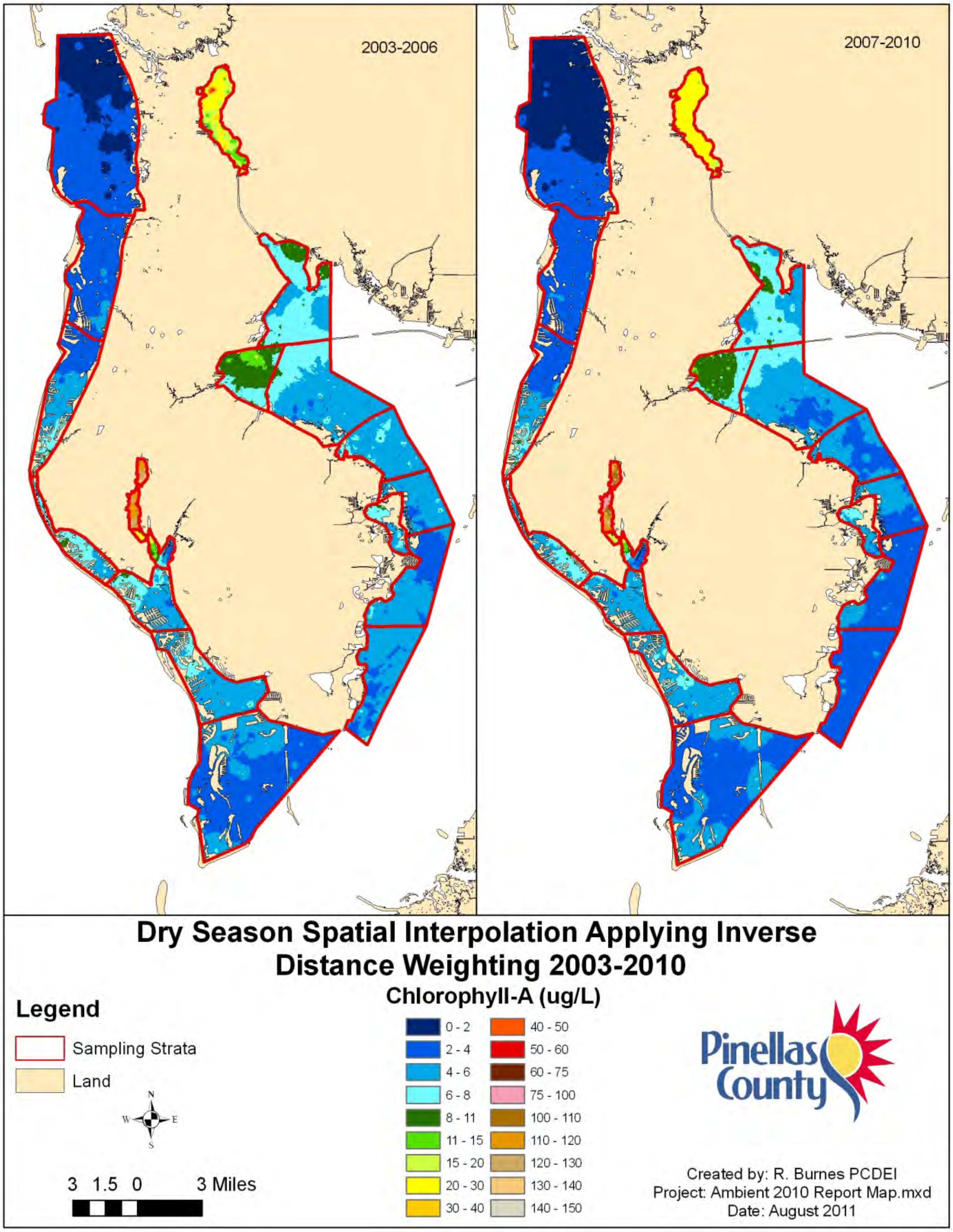

Figure 9b: Spatial analysis of chlorophyll-a data for dry seasons (2003-2006 and 2007-2009)

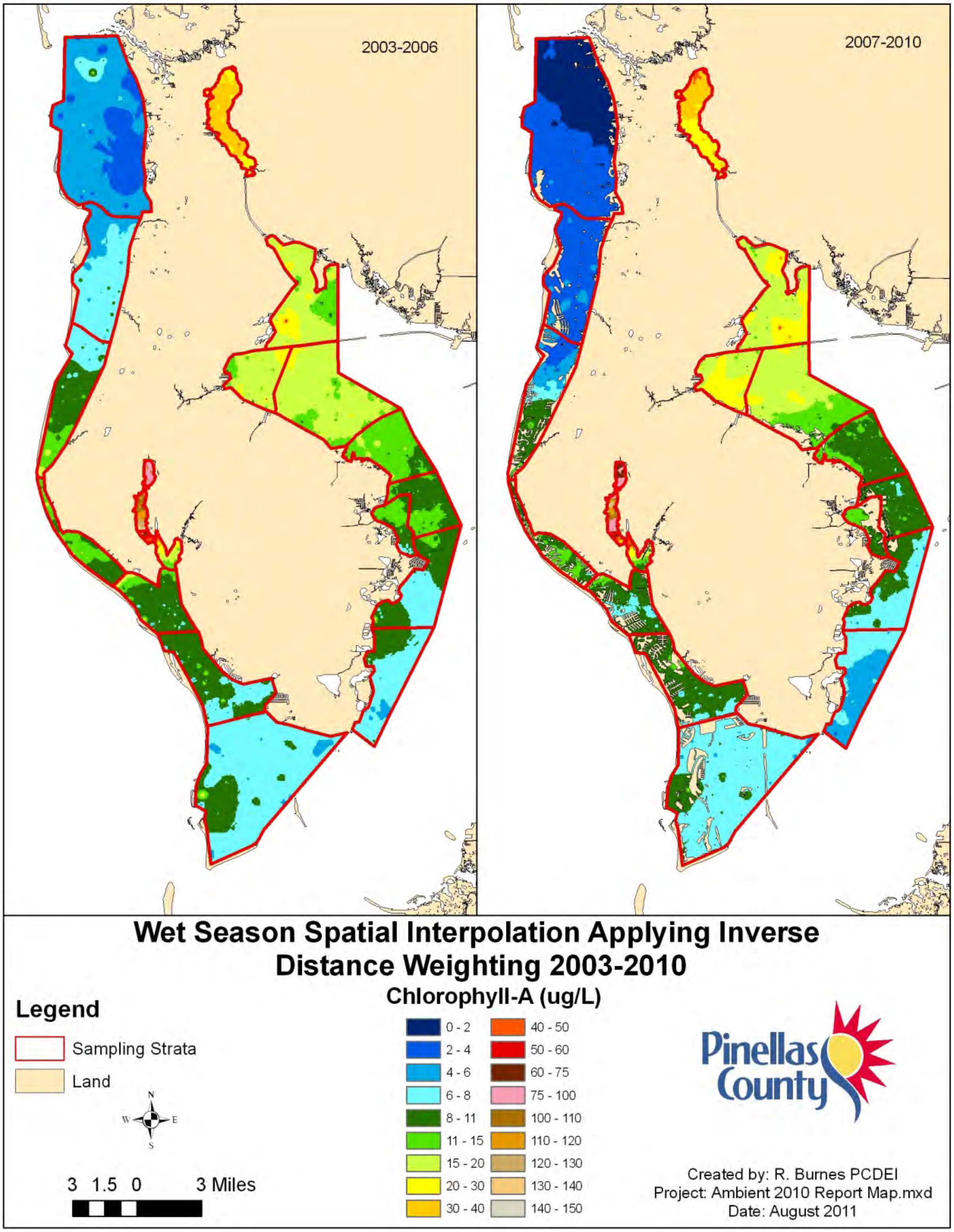

Figure 9c: Spatial analysis of chlorophyll-a data for wet seasons (2003-2006 and 2007-2010)

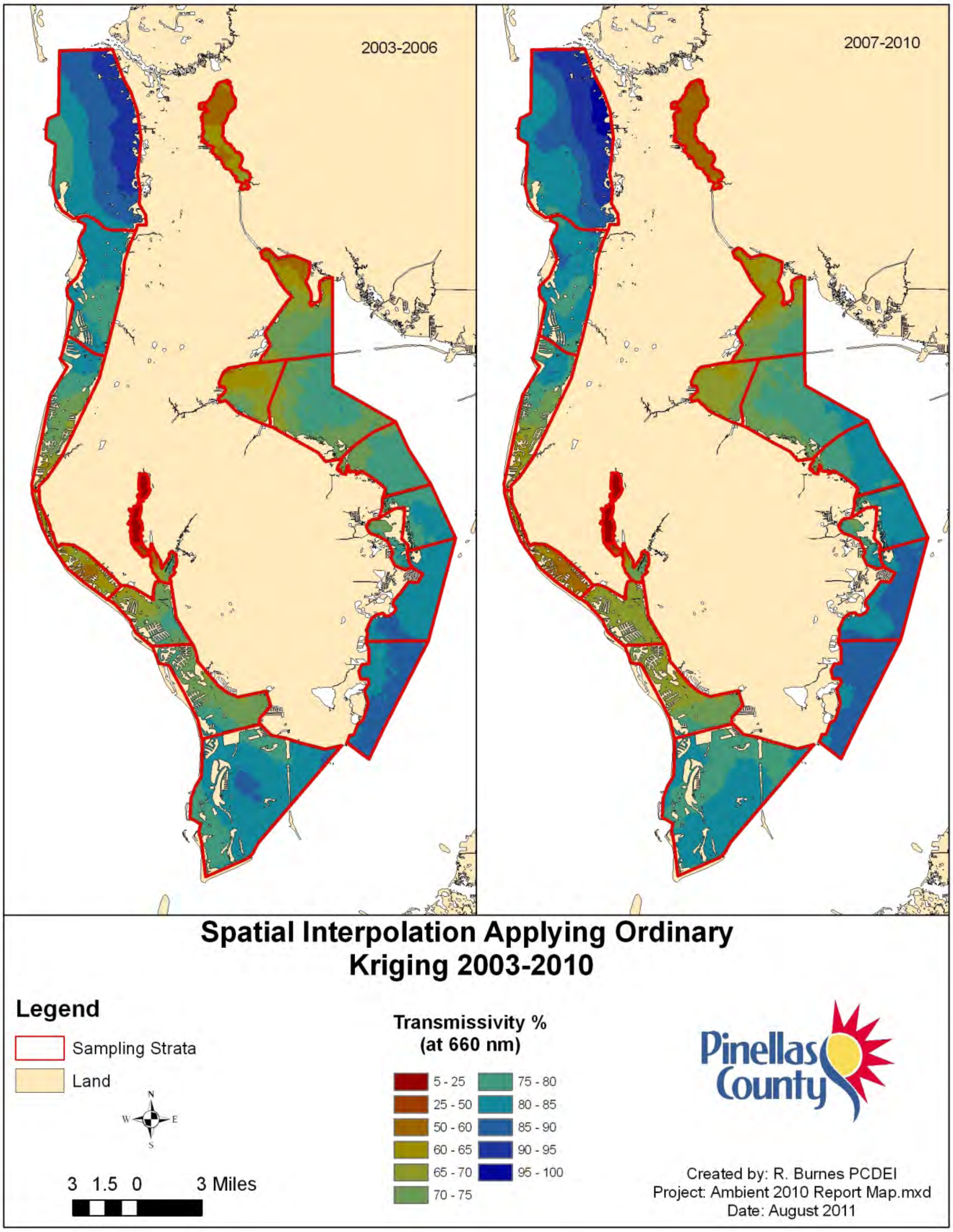

Figure 10a: Spatial analysis of transmissivity data (2003-2006 and 2007-2010)

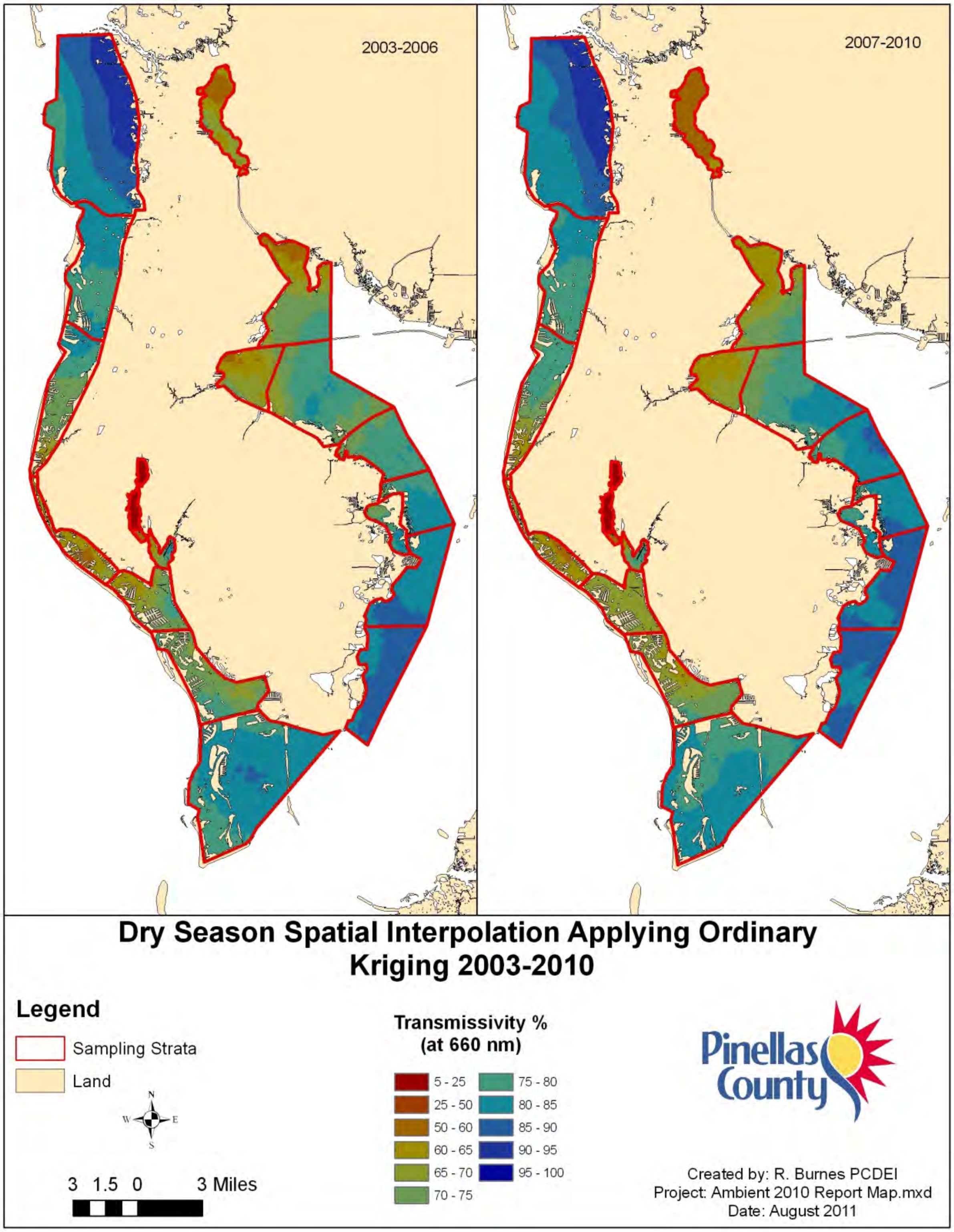

Figure10b: Spatial analysis of transmissivity data for dry seasons (2003-2006 and 2007-2010)

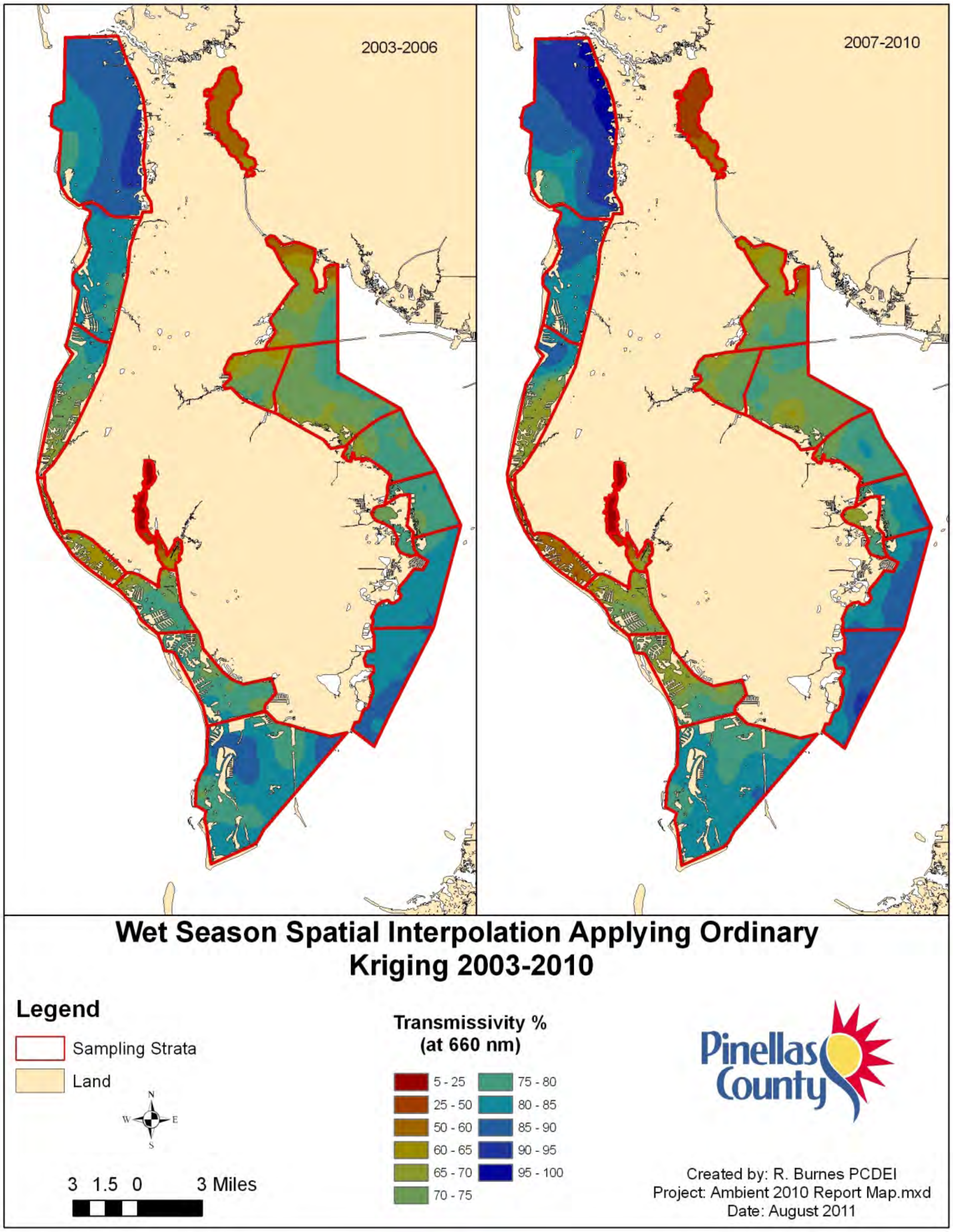

Figure10c: Spatial analysis of transmissivity data for wet seasons (2003-2006 and 2007-2010)

8.0 Results and Discussion

EASTERN AND WESTERN STRATA:

Geographic Trends in Spatial Analysis and Data Distribution Plots

Geographic water quality trends in Pinellas County coastal waters for 2003-2010 are shown in spatial interpolation plots (Figures 8a, 8b, 8c, 9a, 9b, 9c, 10a, 10b, and 10c), and data distribution plots by strata from 2006-2010 (Appendix B, Section 1). Geographical trends were apparent along both east and west coasts of the county.

Water quality along the east coast of the county generally improved from north to south with poorer conditions from Oldsmar to Weedon Island and better conditions in the mid and southern bay off St. Petersburg. Spatial interpolation plots show both bottom dissolved oxygen (DO) and transmissivity increasing and chlorophyll-a (Chl-a) decreasing from north to south along the east coast of the county in the plots of combined wet and dry season data (Figures 8a, 9a,and 10a) and in separate plots of wet and dry season data (Figures 8b,8c, 9b, 9c, 10b, and 10c).

Summary statistics (Appendix A) and data distribution plots for data from 2006-2010 (Appendix B, Figures B1-B10) show geographic trends similar to the above spatial analysis for the wet season and to a lesser degree the dry season . In these plots the distribution of DO and transmissivity data generally increased from north to south while Chl-a, total suspended solids (TSS), and turbidity decreased from north to south (Appendix B, Section 1). Annual mean and median values for DO, Chl-a, TSS, turbidity, and transmissivity showed similar geographic trends as shown in data distribution plots (Appendix A and Appendix B, Section 1). GLM tests for DO and transmissivity and non-parametric tests for Chl-a, TSS, and turbidity show there were significant differences among strata.

The north-south geographic trend is due in part to the much larger drainage area contributing nutrient laden runoff to Old Tampa Bay compared to Middle Tampa Bay. The land area contributing runoff through Pinellas County basins to Tampa Bay waters north of the Courtney Campbell Causeway is 47,745 acres; between the Courtney Campbell Causeway and Gandy Bridge 19,254 acres; and south of the Gandy Bridge 17,539 acres. In addition circulation models have shown parts of Old Tampa Bay have slower circulation and longer residence times than the rest of the bay, particularly in the two strata between the Courtney Campbell Causeway and Howard Franklin Bridge (Cross, 2007). Poorer water quality in Old Tampa Bay is most likely caused by the combination of increased nutrient loads and increased residence times.

Water quality along the west coast was relatively poor in the mid-county regions from Gulfport northward to Belleair compared to better water quality conditions observed both north and south of this mid-county region. This trend is depicted in spatial interpolation plots for both wet and dry seasons combined (Figures 8a, 9a, and 10a) and separate (Figures 8b, 8c, 9b, 9c, 10b, and 10c).

Summary statistics (Appendix A) and data distribution plots (Appendix B, Figures B1-B10) for data from 2006-2010 show geographic trends similar to the above spatial analysis trends for the wet season but to a lesser degree for the dry season. Data distribution plots showed DO and transmissivity data generally increased from the mid-county region to the north and south while Chl-a, TSS, and turbidity decreased. Annual mean and median values for DO, Chl-a, TSS, turbidity, and transmissivity showed similar geographic trends as seen in spatial distribution and data distribution plots (Appendix A and Appendix B, Section 1). GLM tests show there were significant differences among strata for DO and transmissivity. Non-parametric tests show there were significant differences among strata for Chl-a, TSS, and turbidity.

The trend of poor mid-county water quality is due in part to large drainage areas contributing nutrient laden runoff to waters from the Clearwater Beach Causeway to the Madiera Beach Causeway, to Long Bayou, and to Boca Ceiga Bay between Madiera Beach Causeway and Gulfport. Strata from the Clearwater Beach Causeway south to the Madiera Beach Causeway receive runoff from 12,714 acres. Five watersheds comprising 28,825 acres contribute runoff to Long Bayou/Cross Bayou. Strata from the Madiera Beach Causeway south to Gulfport receive runoff from 11,437 acres. Numerous causeway constrictions probably limit water circulation in the mid-county waters and contribute to the poorer water quality. Circulation models are not available to confirm this for strata W4-W8. A circulation model for W1-W3 will be completed as part of the Clearwater Harbor St. Joseph Sound Comprehensive Conservation Plan. The model confirm the impact of causeways on circulation in these strata..

<u>Annual and Seasonal Trends in Spatial Analysis Plots and Data Distribution Plots</u>

There were clear seasonal water quality differences in county waters during 2003-2010 as shown in spatial interpolation plots (Figures 8b, 8c, 9b, 9c, 10b, and 10c) and in 2006-2010 as shown in data distribution plots (Appendix B, Section 1). Spatial interpolation plots show that conditions in both the east and west strata improve in the dry season for transmissivity, Chl-a, and DO.

As in spatial distribution analyses, 2006-2010 data distribution plots for both east and west strata show conditions improved for bottom DO and Chl-a in the dry season. (Appendix B, Section 1). Transmissivity was better in the dry season from the Feather Sound area south to Pinellas Point and in Riviera Bay. In western strata transmissivity was better in the dry season except in stata W7 and W8 where there was little apparent variation in transmissivity between seasons (Appendix B, Section 1). There were no apparent differences in the mean and median values of TSS between the wet and dry seasons for all east strata. There were no apparent differences in the mean and median values of TSS between the wet and dry seasons for west strata except north of the Clearwater Causeway and in the Gulfport area (Appendix B, Section 1). During the wet season mean and median values for turbidity in Tampa Bay were higher from Oldsmar down to Pinellas Point and in Riviera Bay, and in Long Bayou on the west coast, though the overall change in the value ranges were small (Appendix B, Section 1). GLM test results confirmed seasonal differences within stratum for DO and transmissivity. Non-parametric test results confirmed seasonal differences seen within strata for Chl-a, TSS, and turbidity.

The observed seasonal trends in east and west strata for DO and Chl-a during were consistent with the expectation that water quality should be better in the dry season. There was either a lack

of seasonal trends (TSS) or inconsistent seasonal trends (turbidity and transmissivity) in east and west strata. This could be due to seasonal differences in the contribution of wind generated sediment resuspension to TSS, turbidity, and transmissivity levels. Wind associated with weather fronts in the dry season may be higher.

Geographic, Annual, and Seasonal Trends in Cumulative Frequency Distribution Plots

Annual CDF graphs for 2006-2010 data were developed to estimate the percentage area for each stratum that exceeds or was below given values for each water quality metric (Appendix B, Section 4). The set of five annual graphs for each stratum and water quality metric were grouped together in a CDF plot (Appendix B, Section 4). A CDF plot displaying five years of data for bottom DO, Chl-a, transmissivity, TSS, and turbidity was created for each stratum. For Chl-a annual trends information from 2003-2010 will be included.

Factors that can contribute to observed annual trends in eastern strata CDF plots include annual variation in rainfall, annual variation in the volume of water released from the Lake Tarpon Outfall Canal, land area contributing runoff, and circulation patterns. Rainfall from 2003 to 2010, in inches, was 55.5, 64.0, 46.4, 46.7, 38.2, 46.3, 48.0, and 51.1, respectively. Estimated volume discharge from the outfall canal from 2003 to 2010 in millions of gallons was: 22,730; 27,745; 18,724; 9,814; 5,352; 20,128; 13,019 and 21,092, respectively. Old Tampa Bay north of the Gandy Bridge receives runoff from 66,999 acres and has areas of low water exchange. Mid Tampa Bay receives runoff from 17,539 acres and has good circulation. Factors that may contribute to annual trends shown in west coast strata CDF plots include annual variation in rainfall, land area contributing runoff, and circulation patterns. The area from Clearwater to Gulfport receives runoff from 53,000 acres and has restricted circulation due to four causeways, numerous finger islands, and the Narrows. North of Clearwater Causeway, waters receive runoff from 32,000 acres, has a single causeway, and better circulation. Waters south of the Pinellas Bayway receives runoff from 2,100 acres and has open circulation.

Annual and geographic trends were apparent in CDF plots and CDF data for eastern strata. For example along the eastern side of the County, the area estimates of strata meeting TBEP Chl-a criterion increased from 2003-04 to 2005-06 (Figure 11a) as annual rainfall decreased and Lake Tarpon Outfall Canal discharge decreased. Area estimates ranged from 55-70% in 2004 to 65-90% in 2006. Areas meeting the TBEP criterion unexpectedly dropped in strata from Oldsmar to the Gandy Bridge in 2007, the year of lowest rainfall and discharge from Lake Tarpon outfall canal. Areas meeting the TBEP criterion increased in 2008, except in waters west of the Bayside Bridge, and reached levels similar to 2005-06. In 2009 areas estimates dropped to 2003 levels ranging from 45-100% then rose close to 2008 levels even though annual rainfall in 2008-2010 were similar ranging from 46.3 to 51.1 inches. The percentage of areas south of the Gandy Bridge that met TBEP criterion appeared to be related to annual rainfall variation. Area estimates of strata south of the Gandy that met TBEP Chl-a criterion generally increased from 60-80% in 2003-04 to 80-100% in 2005-2007 when annual rainfall decreased. Response of these 3 southern strata was mixed in 2008-2010 when annual rainfall increased. Geographic trends show from year to year, the three southern-most strata usually have higher area percentages meeting the TBEP Chl-a criterion.

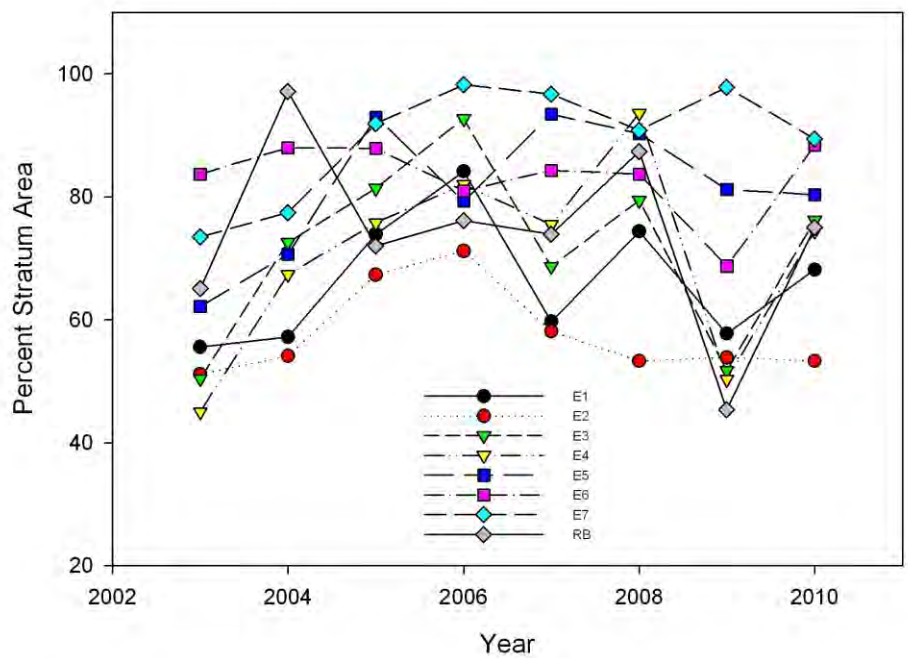

Figure 11a. Percent Area of Eastern Strata Meeting TBEP Chl-a Criteria

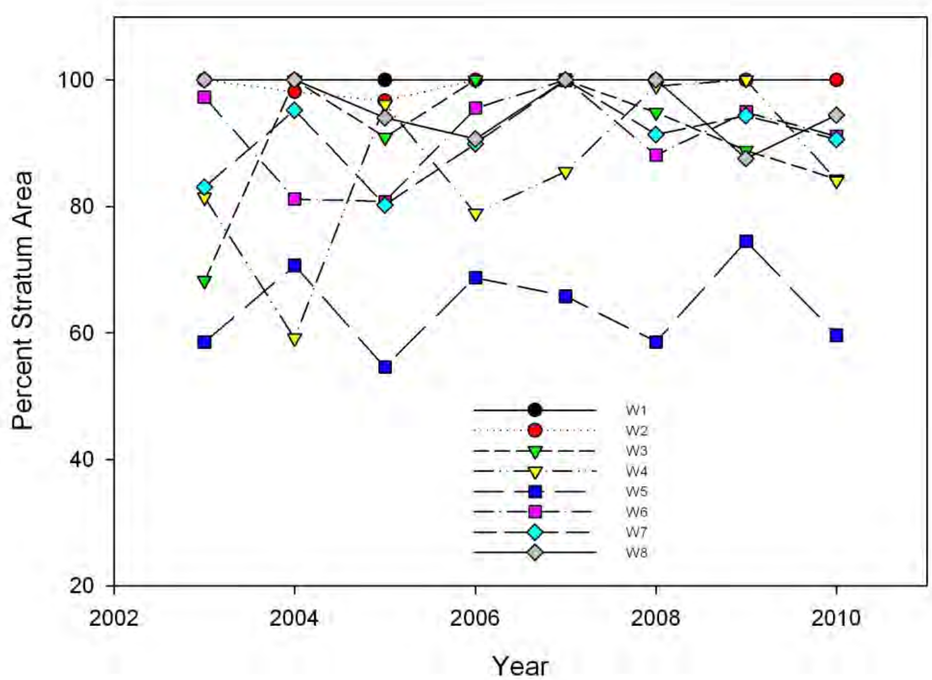

Figure 11b. Percent Area of Western Strata Meeting FDEP Chl-a Criteria

In western strata, there were no clear trends in CDF plots that reflected inter-annual rainfall variation. The only indication of rainfall related changes in percent areas meeting FDEP Chl-a criterion was in 2007 when all strata except W4 and W5 had nearly 100% of the area exceeding the criterion (Figure11b). The geographic trend in area meeting Chl-a targets varies with the amount of land area contributing runoff and circulation patterns. The most northern strata from Anclote to Clearwater Harbor and the most southern stratum around Ft DeSoto had consistently good water quality from 2003-10 with areas that met targets ranging from 90-100%. These areas have fewer acres contributing runoff and better circulation than the central areas of the west coast. Percent areas meeting FDEP Chl-a targets in strata in the central part of the county were lower than in the northern and southern areas. The area of Long Bayou that met FDEP targets ranged from 50-70% from 2003-10. Long Bayou receives discharges from three eutrophic systems, Lake Seminole, the Seminole Bypass Canal, and Cross Bayou. It has a fairly narrow opening that connects it to adjacent strata in the Intra-Coastal Waterway. Percent areas of waters from Clearwater Harbor down to Gulfport that met FDEP Chl-a targets ranged from 60-100% from 2003-10. These waters receive runoff water from 53,000 acres including Long Bayou.

There are no TBEP or FDEP targets established for transmissivity. The relative position of graphs within each CDF plot was used to assess inter-annual transmissity conditions for each stratum (Appendix B, Section 4). CDF plots for northern strata in Tampa Bay and western strata from the Belleair Causeway south generally show reduced transmissivity (plot shifted to the left) in 2008-2010 compared to 2006-2007.

The transmissivity trends shown in CDF plots from northern Tampa Bay strata could be explained by annual variation in rainfall and discharges from the Lake Tarpon Outfall Canal. Rainfall was higher in 2005, 2008, 2009, and 2010 and lowest in 2007. Additionally, 2007 was the year of lowest discharge from the Lake Tarpon Outfall Canal. Similarly, transmissivity trends shown in CDF plots of western strata could be explained by annual variation in rainfall.

There are no TBEP or FDEP targets established for TSS. The relative position of graphs within each CDF plot was used to compare inter-annual TSS conditions for each stratum. CDF plots for all strata in Tampa Bay and the west coast generally show reduced TSS (plots shifted to the left) in 2006 and 2007 which are years with lowest rainfall for the period 2005 to 2010. Lower TSS condition in these strata is probably due in part to low rainfall in these two years. Additionally, lower TSS condition in northern Tampa Bay strata in 2006 and 2007 could be due to lower discharges from the Lake Tarpon Outfall Canal.

Area estimates of strata meeting FDEP DO criterion of 5.0 mg/L did not show inter-annual or geographic trends. The exception was for Long Bayou on the west coast that had much lower percent areas (12-61%) that met FDEP DO criterion compared to other west strata (66-96%) for all years from 2003-2010. As previously mentioned, this area receives discharges from three eutrophic systems which may contribute to low DO conditions.

Area estimates of strata meeting FDEP turbidity crierion, 29 NTU above natural background, showed all east and west strata except for two met the criterion. In 2008 the stratum north of the Courtney Campbell Causeway and the stratum bounded by the Clearwater Causeway and Belleair Causeway exceeded the State criterion. The estimated area exceeding the criterion in

both strata was small, less than 5%. For all other strata and years, turbidity was less than 29 NTU's. Eastern and western strata had higher percentage area with increased turbidity in 2007-2010. Lake Tarpon turbidity was low in all years and ranged from 1-6 NTU's. Lake Seminole turbidity was higher and ranged from 5-35 NTU's. Lake Tarpon also had higher percentage area with increased turbidity in 2007-2009 compared to 2006-07 and 2010.

Trends for 2003-2007 and 2007-2010

Annual and seasonal geographical trends were similar along both east and west coasts of the county for each 4 year data set. Spatial interpolation plots show bottom DO, Chl-a, and transmissivity improved from north to south along the east coast of the county in the plots of combined wet and dry season data (Figures 8a, 9a,and 10a) and in separate plots of wet and dry season data (Figures 8b, 8c, 9b, 9c, 10b, and 10c). On the west coast of the county, water quality was relatively poor in the mid-county regions from Gulfport northward to Clearwater compared to the good water quality conditions observed both north and south of the mid-county region. This trend is shown in spatial interpolation plots for both wet and dry seasons combined (Figures 8a, 9a, and 10a) and separate (Figures 8b, 8c, 9b, 9c, 10b, and 10c).

A comparison of 2003-06 and 2007-10 sets of data showed small scale differences for combined wet and dry season data. In 2003-2006 DO values were higher than the other periods in Tampa Bay from Feathersound to Pinellas Point, and in west coast waters north of the Clearwater Causeway and from Redington Shores south to St. Pete Beach (Figure 8a). Chl-a values in Old Tampa Bay from Courtney Campbell Causeway to the Howard Franklin Bridge and in the west coast waters north of the Clearwater Causeway were higher during 2007-2010 compared to 2003-2006 (Figure 9a). This was likely due to extensive wet season phytoplankton blooms in 2008-2010 in Old Tampa Bay (Figure 9c). The cause of the wet season blooms is not yet determined. Transmissivity values were lower in waters just south of the Courtney Campbell Causeway, to Pinellas Point during the 2003-2006 time period (Figure 10a). This is likely a function of precipitation and subsequent runoff that occurred, as the period of 2007-2010 was drier than 2003-2006.

There were clear seasonal water quality differences in county waters during each time period shown in spatial interpolation plots (Figures 8b, 8c, 9b, 9c, 10b, and 10c). Spatial interpolation plots showed that, in general, conditions in both the east and west strata improved in the dry season for transmissivity, Chl-a, and DO. DO values were higher in the dry season during the 2003-2006 study period in nearly all the strata, Lake Tarpon being the exception, compared to the other time period (Figures 8b and 8c). During the wet season DO values were comparable throughout all the strata with the exceptions being Lake Tarpon and St. Joseph Sound which were lower in 2003-2006 (Figures 8b and 8c). Chl-a values were higher in nearly all the strata during 2003-2006 in the dry season compared the other time period (Figures 9b and 9c). During the wet season chl-a values did not appear to change between the time periods for most strata, the few exceptions were Lake Tarpon and Old Tampa Bay which had lower values during the 2003-2006 time period and Clearwater Harbor and St. Joseph Sound which had higher values during 2003-2006 time period (Figures 9b and 9c). Transmissivity values exhibited changes between time periods during both the wet and dry periods. The values for the wet and dry seasons were higher in waters throughout the east and west coast of Pinellas County for

2007-2010 (Figures 10b and 10c). This is most likely due to a drier wet season during this period which led to less run-off and subsequently greater transmissivity values.

Trends in spatial analyses were also compared with statistical tests. Results of general linear model (GLM) and non-parametric statistical analyses generally followed conclusions of spatial analyses for between year groups for DO and transmissivity. Results of GLM analyses for DO from eastern strata comparing year periods 2003-2006 and 2007-2010 also generally follow the conclusions from spatial analyses. Significant differences in DO occurred among year groups in strata E4 and E7 with higher mean DO in 2003-2006. In western strata GLM results indicate significant differences in DO between year groups from the Narrows to the Pinellas Bayway Causeway with lower mean DO values in 2007-2010. For both eastern and western strata, GLM statistical analyses showed significant differences in transmissivity between year groups for some strata. Mean transmissivity was slightly lower in 2003-2006 for strata E4-E6 and W6-W7. Results for non-parametric statistical analyses for Chl-a from eastern strata were different from to spatial analyses interpetations. There were no significant differences in Chl-a between year groups except from Courtney Campbell Causeway to the Howard Franklin Bridge in the dry season where mean Chl-a values were lower in 2007-2010.

Seasonal differences seen in spatial analyses for year groups for DO and Chl-a were confirmed by GLM (DO) and non-parametric (Chl-a) statistical tests. Conditions for both DO and Chl-a improved in the dry season for all east and west strata. Results for GLM statistical tests for seasonal differences in transmissivity within year groups were different from spatial analyses conclusions. Statistical test results indicate tranmissivity conditions improve in the dry season from the Madeira Beach Causeway to the Pinellas Bayway in 2003-2006, from the Howard Franklin Bridge to Riviera Bay in 2003-2006, and from Courtney Campbell Causeway to the Howard Franklin Bridge in 2007-2010.

State Water Quality Standards and TBEP Target Comparisons

Comparison of county waters (Figure 5) and state impaired water bodies (Figure 1) showed all eastern strata in Tampa Bay and Riviera Bay (RB) did not meet State water standards. Old Tampa Bay above the Courtney Campbell Causeway and Riviera Bay did not meet DO and Chl-a standards (Figures 2-3 and Appendix C). None of the Tampa Bay strata met State bacteria criteria, either in the water column or in shellfish (Figure 4 and Appendix C).

Western strata from Clearwater Causeway south to the Central Avenue Causeway in St. Petersburg did not meet DO and Chl-a standards (Figures 2-3 and Appendix C).

LAND SITES:

Impaired Waters Rule

Comparisons of fixed land station locations and impaired state water bodies (Figure 1) show 67 monitoring sites were located within impaired water bodies as designated by the State. Sixty-two fixed land sites were within water bodies considered impaired for dissolved oxygen (Figure 2 and Appendix C). Forty-nine fixed land sites were within water bodies that did not meet Chl-a

targets (Figure 3 and Appendix C). Sixty-one fixed land sites did not meet bacteria standards (Figure 4 and Appendix C).

Two sites in Brooker Creek, 04-02 and 04-03, also exceeded the pH criterion (Appendix C).

Estimated Annual Flow and Loadings and Annual Area-Based Flow and Loadings

In addition to comparisons to State water quality standards, calculations were made to estimate annual flow volumes in millions of gallons and nutrient loadings in tons and in pounds per acre. As expected, sites with the highest estimated annual flow generally had the highest annual estimated TN loads and, to a lesser degree, TP loads and TSS loads. Sites with the highest estimated annual flow and TN loads from 2006-2010 were: Lake Tarpon outfall canal (06-04), Lake Seminole Bypass Canal (25-07), Curlew Creek (10-02), Brooker Creek North (04-03), Brooker Creek South (04-04), (Joe's Creek (35-10), and Roosevelt channel H (23-08) (Appendix B, Section 2). The five sites with the highest estimated annual flow per acre included three of the five highest estimated TN loads per acre, the two highest TP loads per acre, and two of the five of the highest TSS loads per acre (Appendix B, Section 2). In general, estimated annual flow and loads were lower in 2007 than other years and was directly related to rainfall (Figure 7). This included the Lake Tarpon outfall canal site (06-04) where flow through the structure was managed to maintain lake levels and prevent flooding. Estimated flows, in millions of gallons, from the Lake Tarpon outfall canal were: 2003-22,730, 2004-27,745; 2005-18,724; 2006-9,814; 2007-5,352; 2008-20,128; 2009-13,019; and 2010-21,092. The only exception is in Basin 35 where highest flows and load are in 2007. This was associated with an extreme flow event in August.

LAKES:

Wet and Dry Season Variation

Seasonal differences were observed for both Lake Seminole and Lake Tarpon in spatial interpolation plots (Figures 8b, 8c, 9b, 9c, 10b, and 10c) and data distribution plots (Appendix B, Section 3). In the north lobe of Lake Seminole mean and median DO, Chl-a, TSS, and turbidity were higher in the dry season. Transmissivity was lower in the dry season. In the southern lobe of Lake Seminole DO and TSS were higher in the dry season. There were no apparent seasonal differences for Chl-a, transmissivity, or turbidity in the southern lobe. For Lake Tarpon, mean and median values for DO and transmissivity were higher in the dry season, while Chl-a was higher in the wet season. Values for TSS and turbidity were similar between seasons.

GLM and non-parametric tests for seasonal differences confirm the seasonal trends shown in data distribution plots for each lake strata. Most of the observed seasonal trends were expected differences in water quality that would occur between seasons. The exception are the higher dry season Chl-a and TSS in the north lobe of Lake Seminole. These results are not unexpected as there is an increased residence time during the dry season.

Trophic State Index (TSI)

The TSI for each sample period was calculated and plotted by date for Alligator Lake, Lake Chautauqua, Lake Tarpon, and Lake Seminole (Appendix B, Section 3). In clear lakes a TSI 40 is good and in colored lakes a TSI of <59 is good (FDEP, 2008b). A lake with color less than or equal to 40 platinum cobalt units (PCU) called a color lake while lakes with color greater than 40 PCU are called a colored lake. Using annual average color as a criterion, PCWMD data show for most years Pinellas County lakes are colored lakes. Exceptions when average color characterized lakes as clear: Alligator lake from mid 2007 to 2010; Lake Chautauqua in 2008 and 2009. Lake Tarpon in 2007; and Lake Seminole in 2010.

From 2005 to mid 2009 TSI values from Alligator Lake were below 60 (Figure B-24). From 2008 to mid 2009 TSI values trended down between 50-55, indicating water quality was gradually improving. In the latter half of 2009 TSI values trended up to almost 70. In 2010 TSI dropped to about 55-58. In previous years high Chl-a and TSI values in this lake were due to Hydrilla spp. removal (personal communication with County Mosquito Control) but there was only regular small-scale maintenance activity during this time. The reason for this 6 month spike has not been determined. In Lake Chautauqua, a clear lake which had the best water quality of all sampled lakes, all TSI values were below 45 (Figure B-25). There were no seasonal or annual trends in TSI values for Lake Chautaqua. Lake Tarpon, a colored lake, TSI values varied from 42 to 68 and showed strong seasonal variability from 2004-2006 with higher TSI values in the wet season (Figure B-26). In 2007 and 2008 seasonal variability diminished and TSI gradually increased exceeding 60 in four of the last five monitoring periods from March to December 2008. In 2009 and 2010 seasonality returned to Lake Tarpon TSI trends and TSI values dropped to 50 in dry seasons. Lake Seminole, a colored lake, had the poorest water quality of all sampled lakes (Figure B-27). With the exception of three sample periods in the fall of 2005, 2007, 2008, and 2009 all TSI values were greater than 70. There was an apparent seasonal trend from 2004-2009 with the lowest observed TSI values occurring in mid to late summer.Since the end of 2009, TSI has trended downward from values around 80 down to 70. This coincided with a decrease in Chl-a down to 50-60 g/L by the end of 2010.

Inter-annual Trends in Cumulative Frequency Distribution Plots

Cumulative Frequency Distribution (CDF) plots of Lake Tarpon for transmissivity, total suspended solids, and turbidity showed water quality declined in 2008-2010 compared to 2006-2007 (Appendix B, Section 4). Comparisons of the CDF plots for the lakes reflected better water quality for Lake Tarpon compared to Lake Seminole (Appendix B, Section 4). The Lake Seminole plots of Chl-a, TSS, and turbidity covered a range of water quality measurements greater than similar plots for Lake Tarpon. The transmissivity data showed extremely poor light penetration in Lake Seminole. The Lake Seminole 2010 Chl-a CDF plot was shifted left reflecting the decrease in Chl-a in 2010.

State Water Quality Standards

Both Lake Seminole and Lake Tarpon are considered impaired water bodies by the State (Figure 1). Lake Tarpon is listed as impaired for dissolved oxygen (Figure 2 and Appendix C). Both

lakes did not meet standards for Chl-a and TSI (Figure 3 and Appendix C). Lake Seminole and Lake Tarpon 2003-2008 water quality data were compared to state water quality standards. Based on these comparisons, Lake Tarpon is potentially impaired for bacteria (Figure 4 and Appendix C). Lake Tarpon and Lake Seminole were potentially impaired for pH (Appendix C).

Phytoplankton Taxonomy

Due to staffing shortages 2010 phytoplanktons were not all processed. Results from 2003-2009 are presented. Phytoplankton community structure was similar in both Lake Tarpon and Lake Seminole (Appendix B, Section3). Phytoplankton densities; however were over 4 times greater in Lake Seminole, with an annual mean of 1,592,743 cells/ml, compared to Lake Tarpon, with an annual mean of 386,607 cells/ml from 2003-2009. The most abundant divisions of phytoplankton were Cyanophyta, Chlorophyta, and Crysophyta. The division Cyanophyta was the most abundant throughout the study and comprised approximately 97% of the abundance of Lake Seminole and 81% of the abundance in Lake Tarpon. The genus *Planktothrix sp.*, division Cyanophyta, was the most dominant organism in a majority of the samples.

CONCLUSIONS BASED ON THE ANALYSIS OF PINELLAS COUNTY WATER QUALITY DATA FROM 2004-2008:

- Water quality improves from north to south in Tampa Bay while along the west coast water quality improves from mid county both north and south.
- Water quality is typically better during the dry season than wet season in both east and west strata.
- For east and west strata chl-a, transmissivity, and TSS appeared to improve in years with lower rainfall, although wet season blooms in Old Tampa Bay occurred in 2008-2010, moderate rainfall years.
- Land sites (streams, creeks, and canals) with the highest flow were typically associated with the highest nitrogen loadings including the Lake Tarpon outfall canal, the Seminole Bypass Canal, Curlew Creek, Brooker Creek North and South, and Roosevelt Channel 5.
- Land sites with the lowest flow were typically associated with the lowest nitrogen loadings including upper Long Branch Creek, Bishop Creek North Branch, and Cedar Creek.
- Land site loadings were lower in 2007 in most basins due to the lower rainfall in this year and the reduced discharge from the Lake Tarpon Outfall Canal.
- Water quality in Long Bayou and Cross Bayou (stratum W5) is poor most likely due to discharges from three eutrophic systems: Lake Seminole, the Seminole Bypass Canal, and the Cross Bayou Canal.
- Lake Tarpon and Lake Seminole did not meet state water quality standards for four different criteria: DO, Chl-a, TSI, and pH.

- Lake Seminole TSI and Chl-a improved through 2010 though the lake is still far from meeting state water quality standards.

- Alligator Lake and Lake Tarpon TSI values vary seasonally with lower values in the dry season. Only Alligator Lake showed annual variation in TSI values which decreased from 2005 to mid 2009, increased through the second half of 2009, then returned to close to early 2009 values. The reason has not been determined.

- Phytoplankton taxonomy results for Lake Tarpon and Lake Seminole show both lakes are dominated by Cyanophyta. During 2003-2009 cell concentrations on Lake Seminole were up to 4 times that of Lake Tarpon.

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APPENDIX A: Summary Statistics (2006-2010)

Mean / Median Summary Statistics for all open water strata.

Site	Bottom DO	Chl-a	TSS	Turb	Trans
E1	6.05 / 6.22	10.7 / 6.2	18 / 14	4.7 / 3.5	68.52 / 70.12
E2	6.33 / 6.58	13.2 / 7.5	17 / 13	4.2 / 3.1	68.82 / 72.74
E3	6.45 / 6.66	7.5 / 5.3	14 / 12	2.8 / 2.2	78.10 / 80.52
E4	6.65 / 6.76	6.4 / 4.5	13 / 12	2.3 / 1.8	80.35 / 81.78
E5	6.74 / 6.75	5.7 / 4.3	11 / 9	1.9 / 1.6	83.14 / 83.56
E6	6.78 / 6.69	5.4 / 4.1	12 / 10	1.6 / 1.4	85.28 / 86.57
E7	6.95 / 6.85	3.9 / 3.4	12 / 11	1.6 / 1.2	87.43 / 89.10
LT	5.28 / 5.61	24.9 / 24.9	8 / 8	3.6 / 3.4	54.85 / 52.64
RB	5.93 / 6.28	7.5 / 6.7	12 / 11	2.4 / 2.1	77.53 / 79.19
SA	6.40 / 7.62	101.4 / 93.4	39 / 37	19.3 / 17.0	8.76 / 7.85
SB	7.50 / 8.12	111.3 / 92.5	39 / 36	19.8 / 17.0	8.06 / 7.58
W1	6.48 / 6.59	1.9 / 1.3	13 / 12	2.0 / 1.3	88.39 / 92.29
W2	6.04 / 5.93	3.1 / 2.8	14 / 13	3.3 / 2.6	82.07 / 83.89
W3	5.97 / 5.79	4.7 / 3.4	16 / 14	4.3 / 3.2	75.75 / 79.22
W4	5.68 / 5.53	7.6 / 6.3	20 / 17	7.2 / 6.4	61.82 / 61.25
W5	4.93 / 4.54	13.0 / 8.4	16 / 13	5.1 / 4.2	65.28 / 69.90
W6	6.11 / 5.92	5.7 / 5.3	17 / 14	5.2 / 4.5	71.01 / 71.63
W7	5.87 / 6.01	6.5 / 5.9	17 / 16	4.6 / 4.5	72.38 / 73.15
W8	6.79 / 6.44	5.0 / 4.0	15 / 13	3.0 / 2.6	81.84 / 83.56

Maximum / Minimum Summary Statistics for all open water strata.

Site	Bottom DO	Chl-a	TSS	Turb	Trans
E1	27.89 / 0.25	91.7 / 0.3	73 / 2	64.0 / 0.5	97.06 / 3.47
E2	14.52 / 0.08	65.8 / 0.9	68 / 3	24.0 / 0.6	94.54 / 14.50
E3	12.03 / 0.25	57.6 / 0.3	48 / 1	15.0 / 0.5	97.25 / 38.11
E4	15.54 / 2.87	28.1 / 0.6	47 / 1	8.8 / 0.2	95.35 / 45.38
E5	15.33 / 2.49	28.4 / 0.3	46 / 1	8.7 / 0.4	97.25 / 50.99
E6	12.35 / 1.05	27.3 / 0.3	48 / 1	7.0 / 0.3	99.67 / 56.53
E7	14.30 / 3.56	9.9 / 0.3	62 / 1	9.1 / 0.3	98.97 / 56.74
LT	11.26 / 0.09	49.0 / 2.3	15 / 1	8.6 / 0.4	84.73 / 35.98
RB	14.38 / 0.19	22.7 / 0.3	48 / 2	9.6 / 0.5	94.48 / 47.66
SA	11.17 / 0.11	318.0 / 50.7	92 / 16	50.0 / 8.4	24.11 / 2.35
SB	13.09 / 0.41	332.0 / 53.9	76 / 16	62.0 / 9.3	24.30 / 2.51
W1	13.28 / 2.83	10.3 / 0.3	61 / 1	17.0 / 0.2	99.46 / 44.17
W2	10.20 / 1.78	7.9 / 0.3	64 / 1	15.0 / 0.7	97.02 / 55.98
W3	9.12 / 1.51	16.3 / 0.6	68 / 2	54.0 / 0.6	97.66 / 14.31
W4	11.49 / 0.51	24.6 / 0.5	63 / 1	27.0 / 1.0	91.52 / 20.70
W5	12.10 / 1.42	141.0 / 0.8	52 / 2	26.0 / 0.1	93.07 / 3.21
W6	10.69 / 2.28	16.7 / 0.3	60 / 3	19.0 / 1.0	94.54 / 22.95
W7	12.42 / 0.77	45.9 / 0.5	62 / 2	15.0 / 0.6	92.45 / 42.36
W8	13.70 / 2.86	20.9 / 0.3	64 / 1	18.0 / 0.4	97.06 / 45.63

Mean / Median Summary Statistics for fixed land sites. NC = Not Collected

Site	Flow	Bottom DO	TN	TP	Chl-a
01-01	NC	5.24 / 5.09	0.66 / 0.60	0.06 / 0.06	3.0 / 2.7
01-03	NC	5.23 / 5.91	0.95 / 1.01	0.07 / 0.06	3.3 / 1.2
01-08	NC	4.00 / 3.87	0.68 / 0.62	0.08 / 0.08	9.4 / 5.6
02-07	2.80 / 0.54	4.18 / 3.62	2.66 / 2.42	0.64 / 0.57	29.2 / 20.3
02-09	1.20 / 0.65	3.29 / 3.16	2.36 / 2.39	1.05 / 1.05	36.9 / 29.9
04-02	9.83 / 0.56	2.81 / 1.80	1.14 / 1.07	0.06 / 0.06	6.8 / 2.8
04-03	13.45 / 1.10	3.26 / 3.08	1.32 / 1.35	0.07 / 0.06	3.6 / 1.6
04-04	6.94 / 0.23	3.74 / 3.54	1.38 / 1.25	0.07 / 0.08	2.8 / 2.2
05-05	3.90 / 4.38	1.42 / 1.42	1.55 / 1.53	0.35 / 0.30	27.5 / 37.6
05-07	2.35 / 0.01	5.44 / 5.29	1.38 / 1.37	0.14 / 0.14	65.9 / 68.4
06-03	1.00 / 0.33	7.79 / 7.53	0.64 / 0.61	0.11 / 0.11	1.8 / 0.9
06-04	54.84 / 0.62	4.52 / 5.37	0.96 / 0.96	0.05 / 0.05	18.8 / 14.9
08-03	0.62 / 0.39	8.61 / 8.29	1.32 / 1.32	0.11 / 0.11	2.8 / 1.4
09-02	0.44 / 0.44	3.59 / 3.59	0.72 / 0.72	0.14 / 0.14	2.1 / 2.1
09-03	0.33 / 0.17	6.82 / 6.59	1.06 / 0.98	0.10 / 0.09	2.4 / 1.4
10-02	14.86 / 7.80	7.21 / 6.95	1.21 / 1.01	0.20 / 0.18	2.1 / 1.4
11-05	1.71 / 0.73	7.32 / 7.25	0.90 / 0.87	0.20 / 0.19	3.1 / 2.6
12-02	0.51 / 0.39	6.87 / 6.82	0.82 / 0.78	0.22 / 0.22	8.9 / 2.0
12-03	0.51 / 0.24	7.52 / 7.48	0.74 / 0.73	0.08 / 0.09	0.9 / 0.9
12-04	1.73 / 0.69	7.16 / 6.75	0.69 / 0.68	0.09 / 0.09	1.7 / 1.5
13-02	1.37 / 1.44	5.76 / 5.48	0.87 / 0.82	0.12 / 0.11	4.7 / 2.4
13-05	2.85 / 0.80	4.91 / 5.15	0.83 / 0.80	0.14 / 0.13	8.6 / 4.1
14-02	NC	6.83 / 6.88	0.77 / 0.78	0.02 / 0.01	2.8 / 2.5
14-07	NC	6.19 / 6.40	0.77 / 0.75	0.14 / 0.14	14.5 / 11.5

Mean / Median Summary Statistics for fixed land sites-cont. NC = Not Collected

Site	Flow	Bottom DO	TN	TP	Chl-a
14-09	0.74 / 0.74	6.41 / 6.37	0.95 / 0.96	0.04 / 0.04	16.9 / 14.4
14-10	12.34 / 6.00	5.52 / 5.54	0.69 / 0.70	0.11 / 0.11	5.8 / 4.6
14-11	7.09 / 2.90	4.33 / 4.48	1.04 / 1.01	0.16 / 0.13	5.7 / 4.6
14-12	NC	5.68 / 5.84	0.69 / 0.69	0.04 / 0.03	10.2 / 11.4
15-04	2.92 / 0.66	3.18 / 3.10	1.32 / 1.23	0.31 / 0.25	2.5 / 1.9
17-01	0.94 / 0.54	7.77 / 7.51	2.44 / 2.32	0.20 / 0.18	6.6 / 4.1
17-03	0.83 / 0.41	5.02 / 4.98	1.17 / 1.14	0.22 / 0.21	6.9 / 2.6
18-03	2.90 / 2.29	6.20 / 6.43	0.78 / 0.81	0.12 / 0.12	9.2 / 8.1
18-06	5.49 / 2.93	4.81 / 4.44	0.93 / 0.87	0.13 / 0.11	8.0 / 3.6
19-02	NC	4.24 / 4.05	0.82 / 0.81	0.20 / 0.18	17.1 / 14.1
19-07	1.26 / 0.47	6.93 / 6.93	0.78 / 0.71	0.14 / 0.11	3.5 / 2.8
19-08	0.57 / 0.26	6.18 / 6.12	1.39 / 1.43	0.20 / 0.18	2.9 / 1.6
19-09	2.34 / 0.74	5.59 / 5.67	0.89 / 0.88	0.21 / 0.19	4.5 / 1.5
19-10	1.86 / 0.63	4.11 / 4.11	0.85 / 0.80	0.23 / 0.22	2.5 / 1.4
22-01	4.85 / 3.55	2.72 / 2.54	0.85 / 0.83	0.11 / 0.10	3.1 / 1.7
22-05	1.65 / 1.23	2.89 / 3.02	0.87 / 0.86	0.12 / 0.11	2.7 / 2.4
22-07	2.48 / 1.00	2.50 / 1.90	1.02 / 0.98	0.20 / 0.15	6.0 / 4.5
22-08	0.15 / 0.08	4.16 / 3.96	0.73 / 0.69	0.06 / 0.05	4.4 / 2.5
22-12	2.62 / 1.10	3.71 / 2.17	0.97 / 0.96	0.14 / 0.14	6.5 / 4.2
22-14	0.17 / 0.04	4.41 / 4.31	1.04 / 1.04	0.13 / 0.13	4.1 / 1.3
22-15	0.48 / 0.46	3.23 / 1.98	0.98 / 1.01	0.18 / 0.15	8.3 / 4.0
23-05	1.22 / 0.74	3.30 / 2.98	0.93 / 0.81	0.09 / 0.05	15.3 / 13.0
23-07	1.75 / 1.05	3.78 / 3.95	1.13 / 1.03	0.07 / 0.06	10.3 / 6.8
23-08	7.74 / 2.90	8.27 / 8.39	1.44 / 1.37	0.09 / 0.08	23.0 / 14.4

Mean / Median Summary Statistics for fixed land sites-cont. NC = Not Collected

Site	Flow	Bottom DO	TN	TP	Chl-a
24-01	NC	4.40 / 3.93	0.92 / 0.87	0.21 / 0.20	17.3 / 11.6
24-02	NC	3.90 / 3.80	0.92 / 0.92	0.18 / 0.18	8.7 / 6.9
24-03	NC	3.43 / 3.18	1.16 / 1.20	0.13 / 0.12	12.5 / 6.1
24-07	NC	5.70 / 4.07	1.07 / 1.14	0.09 / 0.09	9.4 / 3.6
25-02	14.99 / 9.89	4.38 / 3.56	1.03 / 1.01	0.11 / 0.10	24.8 / 23.6
25-07	17.49 / 9.07	4.49 / 4.52	0.87 / 0.84	0.07 / 0.06	24.1 / 17.0
27-03	2.69 / 0.75	3.25 / 3.68	0.95 / 0.92	0.03 / 0.03	8.6 / 6.3
27-08	2.25 / 0.61	7.20 / 7.02	2.17 / 1.59	0.12 / 0.08	5.1 / 2.7
27-09	4.00 / 0.81	6.13 / 6.23	0.87 / 0.84	0.18 / 0.18	4.7 / 1.6
27-10	2.88 / 0.98	7.76 / 7.95	0.70 / 0.71	0.02 / 0.01	4.5 / 3.8
32-03	NC	5.50 / 5.48	0.66 / 0.66	0.14 / 0.13	10.5 / 12.3
35-01	0.33 / 0.18	7.38 / 7.24	0.59 / 0.55	0.04 / 0.03	2.4 / 1.8
35-09	2.99 / 1.31	5.94 / 5.88	0.92 / 0.87	0.07 / 0.06	4.8 / 3.2
35-10	10.70 / 2.34	6.07 / 6.12	0.70 / 0.68	0.06 / 0.05	7.7 / 3.6
35-11	4.13 / 2.10	5.95 / 5.52	0.74 / 0.77	0.06 / 0.06	12.9 / 6.4
35-12	5.19 / 1.23	6.01 / 6.07	1.09 / 1.09	0.10 / 0.08	6.2 / 4.0
35-14	5.20 / 4.80	6.53 / 5.58	0.99 / 0.91	0.13 / 0.13	8.6 / 5.0
39-02	1.72 / 1.36	2.48 / 2.58	1.06 / 0.99	0.09 / 0.08	5.2 / 4.8
40-02	4.29 / 3.04	5.57 / 5.32	1.01 / 1.07	0.08 / 0.08	6.6 / 5.0
44-02	NC	5.10 / 5.22	0.67 / 0.71	0.14 / 0.15	9.9 / 9.5
45-03	0.66 / 0.54	4.93 / 4.92	1.21 / 1.28	0.05 / 0.05	3.6 / 2.8
46-03	0.55 / 0.32	4.85 / 4.51	0.51 / 0.51	0.10 / 0.09	6.9 / 3.3
48-03	NC	4.75 / 4.45	0.64 / 0.65	0.08 / 0.08	5.9 / 5.0
51-02	0.56 / 0.33	3.64 / 3.01	1.31 / 1.31	0.39 / 0.37	17.1 / 12.0

Maximum / Minimum Statistics for fixed land sites. NC = Not Collected

Site	Flow	Bottom DO	TN	TP	Chl-a
01-01	NC	7.43 / 3.07	1.67 / 0.12	0.15 / 0.03	8.3 / 0.7
01-03	NC	6.46 / 3.31	1.12 / 0.71	0.09 / 0.05	7.7 / 0.9
01-08	NC	6.79 / 1.73	1.67 / 0.30	0.24 / 0.03	89.6 / 0.5
02-07	19.04 / -2.96	8.03 / 1.44	4.38 / 1.40	1.13 / 0.28	62.6 / 13.6
02-09	38.74 / 0.00	6.40 / 0.18	3.22 / 1.43	2.02 / 0.34	113.0 / 0.6
04-02	122.00 / 0.00	6.63 / 0.88	2.35 / 0.75	0.09 / 0.03	31.1 / 1.2
04-03	575.00 / 0.00	5.90 / 0.45	2.34 / 0.71	0.18 / 0.01	21.8 / 0.5
04-04	122.00 / 0.00	6.19 / 0.96	2.16 / 1.01	0.12 / 0.03	6.2 / 0.8
05-05	4.75 / 2.57	1.54 / 1.30	1.68 / 1.45	0.46 / 0.28	38.6 / 6.2
05-07	96.28 / 0.00	7.68 / 3.76	1.82 / 1.03	0.22 / 0.07	92.8 / 40.8
06-03	7.51 / 0.01	10.21 / 2.65	1.06 / 0.36	0.16 / 0.05	6.5 / 0.3
06-04	1880.0 / 0.00	8.15 / 0.45	1.26 / 0.54	0.07 / 0.04	60.7 / 4.4
08-03	2.53 / 0.03	12.16 / 6.02	2.05 / 0.80	0.17 / 0.06	21.2 / 0.8
09-02	0.77 / 0.10	4.11 / 3.06	0.99 / 0.45	0.19 / 0.09	3.7 / 0.5
09-03	2.46 / 0.05	10.97 / 2.21	2.02 / 0.57	0.26 / 0.03	13.1 / 0.3
10-02	454.00 / 1.70	9.55 / 4.33	3.25 / 0.50	0.44 / 0.12	7.1 / 0.3
11-05	11.70 / 0.07	10.12 / 3.53	1.37 / 0.58	0.44 / 0.06	11.8 / 0.3
12-02	2.21 / 0.03	10.32 / 2.48	1.44 / 0.44	0.36 / 0.10	119.0 / 0.5
12-03	1.67 / 0.11	9.48 / 6.34	0.99 / 0.56	0.11 / 0.05	2.0 / 0.3
12-04	54.77 / 0.07	10.82 / 4.50	1.09 / 0.35	0.15 / 0.05	6.5 / 0.3
13-02	3.21 / 0.13	9.28 / 3.92	1.07 / 0.76	0.18 / 0.07	18.4 / 0.3
13-05	135.18 / 0.00	7.96 / 0.32	1.54 / 0.45	0.42 / 0.07	52.2 / 0.9
14-02	NC	9.59 / 4.15	0.94 / 0.39	0.05 / 0.00	9.1 / 1.2
14-07	NC	10.18 / 2.40	1.42 / 0.43	0.26 / 0.07	45.9 / 5.3

Maximum / Minimum Statistics for fixed land sites-cont. NC = Not Collected

Site	Flow	Bottom DO	TN	TP	Chl-a
14-09	0.74 / 0.74	13.34 / 1.18	1.90 / 0.34	0.18 / 0.01	38.2 / 0.8
14-10	157.00 / 0.69	9.59 / 0.61	0.92 / 0.44	0.24 / 0.02	17.2 / 1.1
14-11	197.00 / 0.03	8.90 / 1.22	2.26 / 0.76	0.94 / 0.06	19.2 / 1.7
14-12	NC	8.76 / 0.91	1.02 / 0.38	0.07 / 0.01	18.8 / 0.8
15-04	108.91 / 0.01	6.57 / 0.62	2.74 / 0.73	0.84 / 0.17	10.5 / 0.3
17-01	6.16 / 0.17	10.19 / 5.18	4.69 / 1.61	0.59 / 0.11	81.5 / 0.3
17-03	7.68 / 0.05	7.91 / 2.05	1.95 / 0.78	0.74 / 0.11	105.0 / 0.3
18-03	5.92 / 1.20	8.51 / 2.33	0.90 / 0.55	0.18 / 0.09	25.3 / 0.7
18-06	87.34 / 0.01	9.56 / 0.53	2.09 / 0.56	0.46 / 0.05	54.9 / 0.5
19-02	NC	8.22 / 0.10	1.14 / 0.51	0.40 / 0.11	48.3 / 0.3
19-07	10.69 / 0.08	9.17 / 4.56	1.45 / 0.43	0.45 / 0.07	15.8 / 0.3
19-08	4.73 / 0.04	8.49 / 3.95	2.68 / 0.58	0.43 / 0.13	13.9 / 0.3
19-09	87.00 / 0.15	8.81 / 0.46	1.50 / 0.25	0.48 / 0.12	34.9 / 0.3
19-10	40.20 / 0.17	6.45 / 1.12	1.36 / 0.60	0.65 / 0.12	13.0 / 0.3
22-01	14.20 / 0.72	7.28 / 0.15	1.33 / 0.38	0.21 / 0.06	16.2 / 0.3
22-05	6.23 / 0.20	6.24 / 0.35	1.30 / 0.50	0.21 / 0.04	7.6 / 0.5
22-07	152.00 / 0.00	6.96 / 0.78	1.70 / 0.74	0.62 / 0.05	22.0 / 0.5
22-08	0.69 / 0.01	7.71 / 0.37	1.10 / 0.46	0.18 / 0.01	22.3 / 0.8
22-12	76.00 / 0.09	12.84 / 0.56	1.58 / 0.37	0.29 / 0.04	25.1 / 0.9
22-14	1.08 / 0.01	6.41 / 1.54	1.60 / 0.53	0.29 / 0.07	15.9 / 0.3
22-15	0.81 / 0.14	8.04 / 1.23	1.52 / 0.40	0.36 / 0.07	33.6 / 0.5
23-05	3.71 / 0.00	7.28 / 0.83	2.06 / 0.50	0.39 / 0.03	51.4 / 4.1
23-07	7.43 / 0.01	9.15 / 0.22	2.54 / 0.63	0.26 / 0.01	62.5 / 0.6
23-08	336.00 / 0.00	15.86 / 0.72	2.83 / 0.72	0.22 / 0.03	111.0 / 1.2

Maximum / Minimum Statistics for fixed land sites-cont. NC = Not Collected

Site	Flow	Bottom DO	TN	TP	Chl-a
24-01	NC	12.01 / 1.71	2.19 / 0.52	0.38 / 0.08	122.0 / 0.3
24-02	NC	12.97 / 0.26	1.28 / 0.50	0.29 / 0.08	30.8 / 0.3
24-03	NC	7.33 / 0.40	1.42 / 0.56	0.23 / 0.07	43.7 / 1.0
24-07	NC	10.92 / 2.30	1.34 / 0.75	0.19 / 0.03	24.4 / 0.7
25-02	42.20 / 1.76	10.02 / 0.13	1.56 / 0.77	0.16 / 0.06	76.3 / 2.8
25-07	330.70 / 0.00	10.68 / 0.26	1.27 / 0.58	0.15 / 0.01	72.1 / 1.3
27-03	28.70 / 0.03	5.65 / 1.46	1.82 / 0.42	0.06 / 0.01	22.4 / 0.8
27-08	50.00 / 0.12	9.54 / 5.31	5.82 / 0.73	0.92 / 0.04	36.9 / 0.3
27-09	45.10 / 0.08	10.32 / 1.92	1.31 / 0.36	0.50 / 0.06	39.9 / 0.3
27-10	15.15 / 0.26	10.01 / 3.64	1.13 / 0.34	0.05 / 0.01	12.6 / 1.6
32-03	NC	8.66 / 3.46	1.04 / 0.28	0.21 / 0.08	20.5 / 2.5
35-01	0.85 / 0.01	12.27 / 3.98	0.80 / 0.37	0.12 / 0.01	3.9 / 0.5
35-09	28.30 / 0.31	9.19 / 2.38	1.72 / 0.62	0.11 / 0.02	33.0 / 0.6
35-10	298.00 / 0.32	12.00 / 2.55	1.24 / 0.41	0.15 / 0.01	63.1 / 0.3
35-11	104.00 / 0.00	13.53 / 1.94	1.08 / 0.33	0.11 / 0.01	36.9 / 0.5
35-12	151.00 / 0.36	13.79 / 1.22	2.14 / 0.45	0.38 / 0.03	23.6 / 0.6
35-14	12.70 / -2.43	12.75 / 2.31	1.45 / 0.45	0.21 / 0.06	31.9 / 1.2
39-02	6.88 / 0.11	4.95 / 0.61	1.52 / 0.67	0.30 / 0.03	12.5 / 0.3
40-02	17.50 / 0.33	9.74 / 2.55	1.25 / 0.48	0.13 / 0.01	27.9 / 0.8
44-02	NC	8.13 / 2.60	0.86 / 0.29	0.24 / 0.06	19.1 / 0.3
45-03	1.97 / 0.13	8.53 / 1.74	1.67 / 0.68	0.13 / 0.01	19.5 / 0.6
46-03	2.11 / 0.08	8.30 / 1.98	1.18 / 0.12	0.22 / 0.04	59.3 / 1.1
48-03	NC	7.00 / 2.93	1.22 / 0.33	0.15 / 0.01	16.1 / 1.1
51-02	2.99 / 0.10	7.08 / 0.97	1.99 / 0.94	0.59 / 0.22	47.5 / 1.0

APPENDIX B: Water Quality Graphs (2006-2010)

1. Open Water Graphs

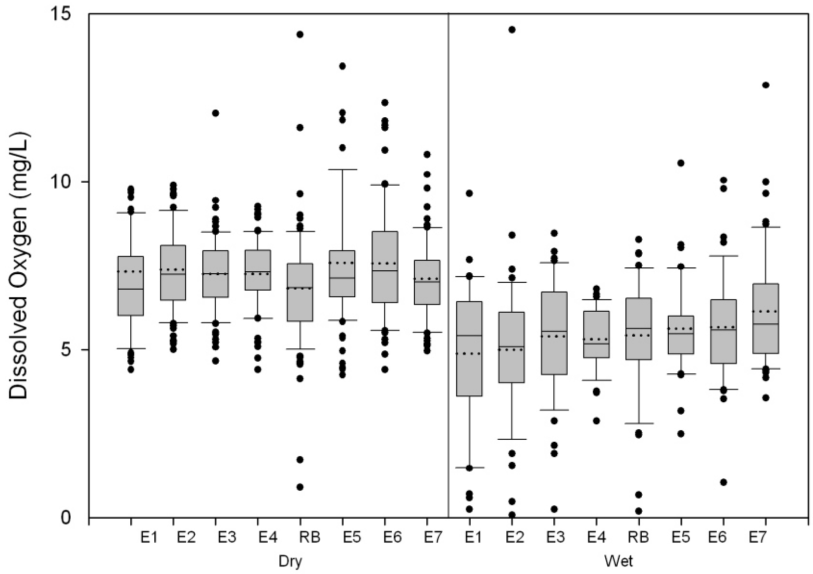

Figure B-1. Distribution of bottom dissolved oxygen for eastern strata for wet and dry seasons (2006-2010)

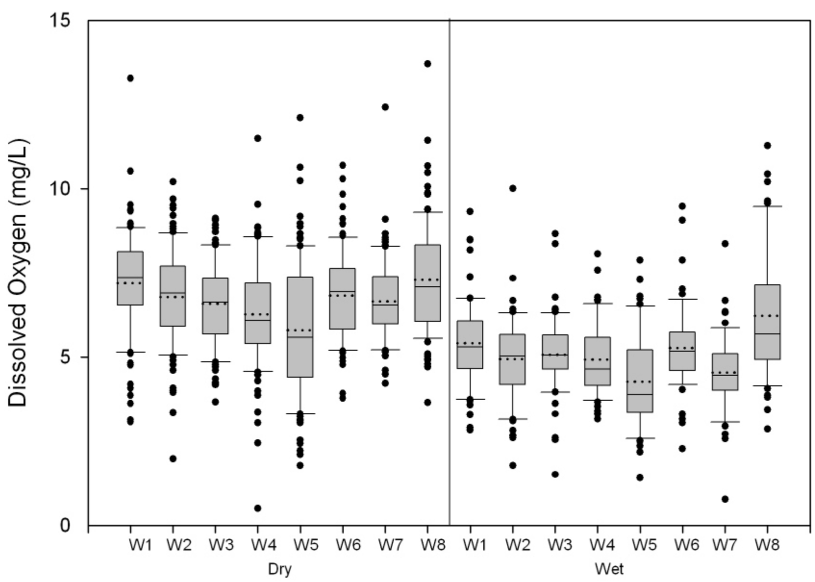

Figure B-2. Distribution of bottom dissolved oxygen for western strata for wet and dry seasons (2006-2010)

Box and whisker plot legend: median - solid line in box; mean - dotted line in box; 25th and 75th percentiles - lower and upper box lines; 10th and 90th percentiles - lower and upper whisker lines.

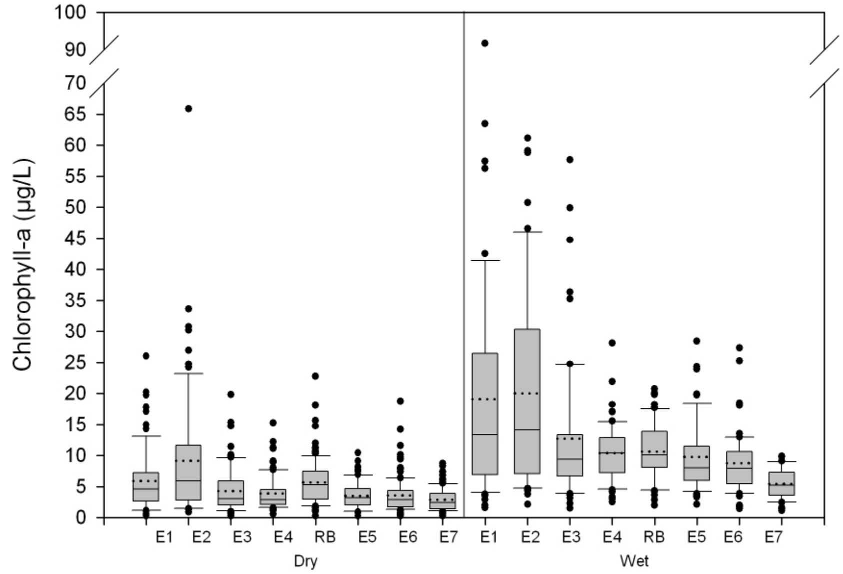

Figure B-3. Distribution of Chlorophyll-a for eastern strata for wet and dry seasons (2006-2010)

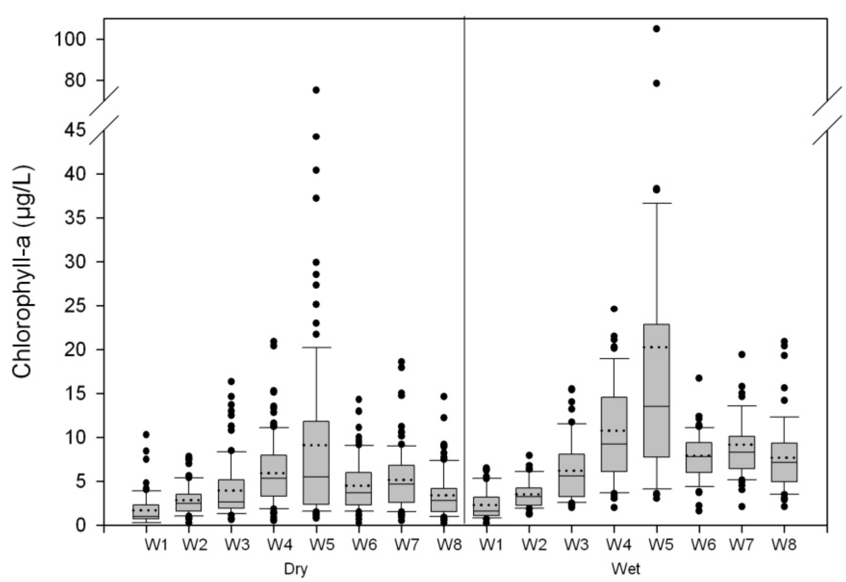

Figure B-4. Distribution of Chlorophyll-a for western strata for wet and dry seasons (2006-2010)

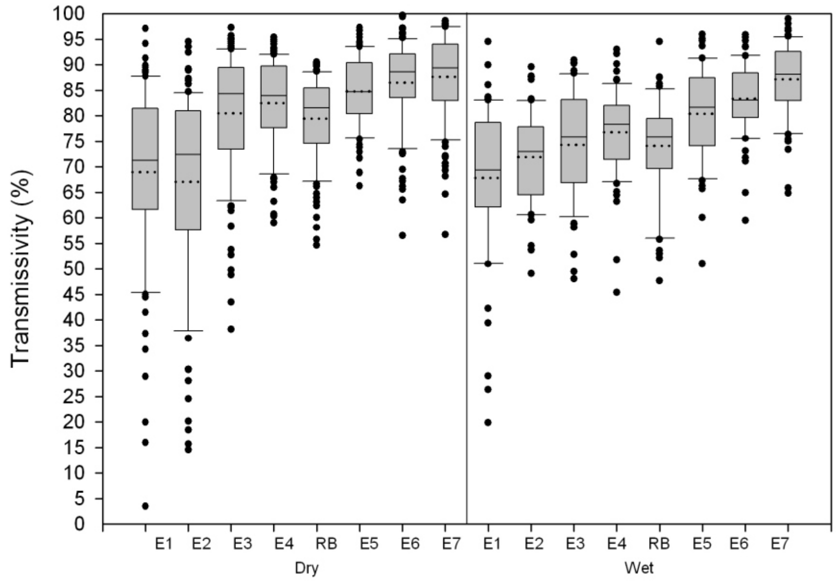

Figure B-5. Distribution of transmissivity for eastern strata for wet and dry seasons (2006-2010)

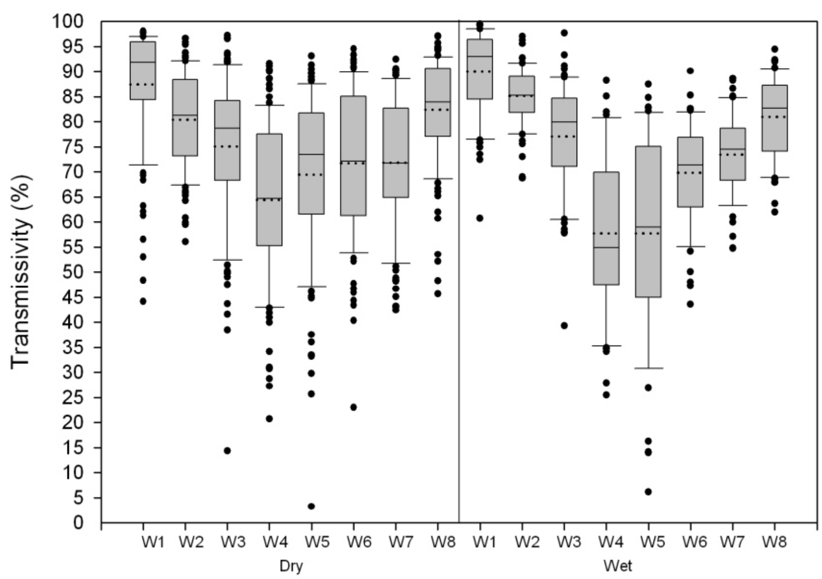

Figure B-6. Distribution of transmissivity for western strata for wet and dry seasons (2006-2010)

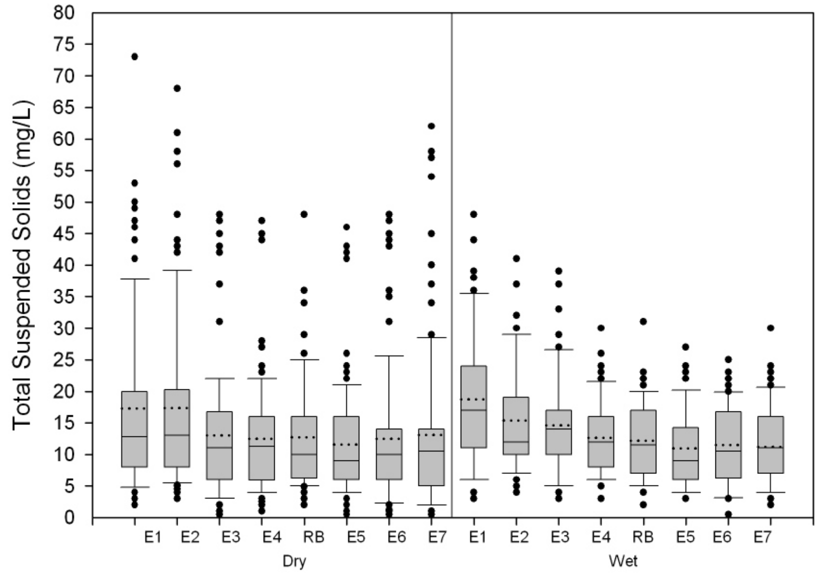

Figure B-7. Distribution of total suspended solids for eastern strata for wet and dry seasons (2006-2010)

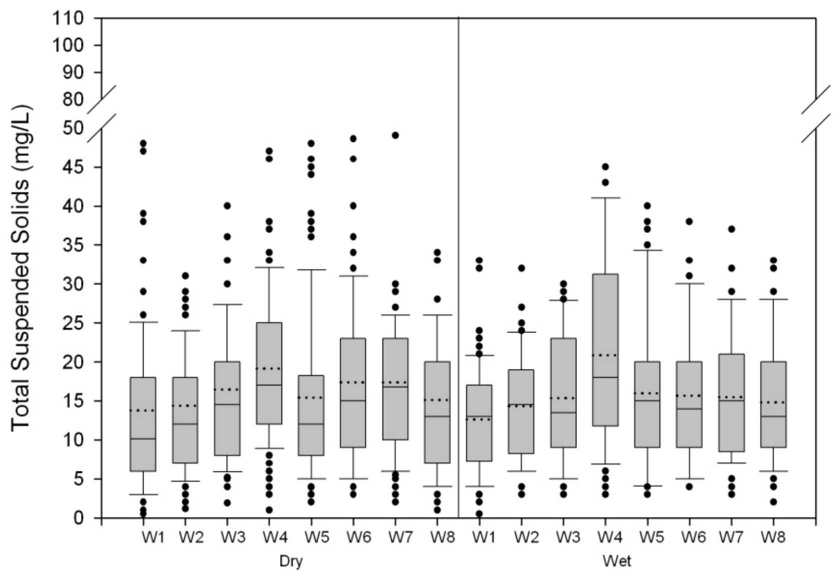

Figure B-8. Distribution of total suspended solids for western strata for wet and dry seasons (2006-2010)

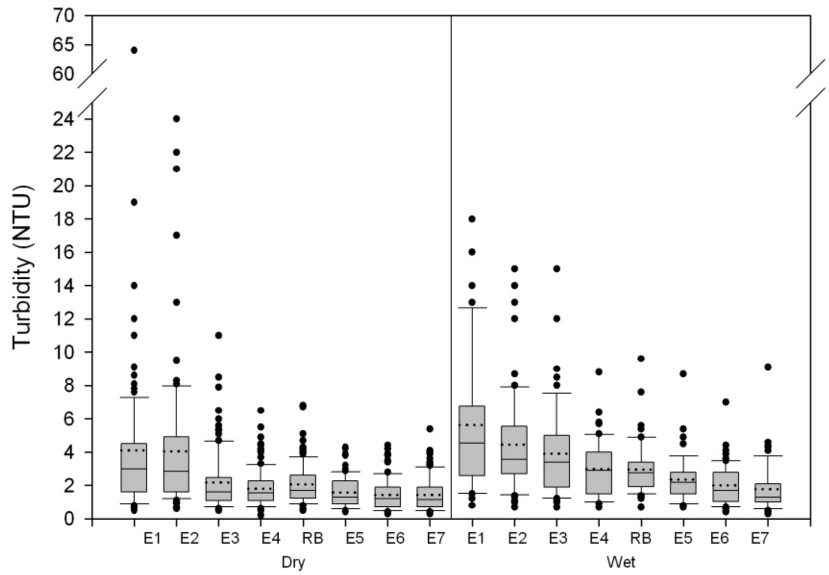

Figure B-9. Distribution of turbidity for eastern strata for wet and dry seasons (2006-2010)

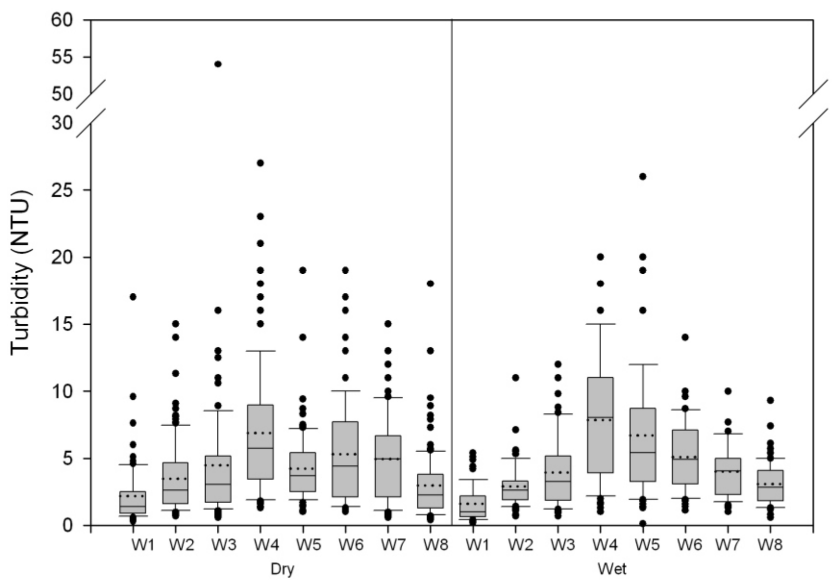

Figure B-10. Distribution of turbidity for western strata for wet and dry seasons (2006-2010)

2. <u>Land Site Graphs</u>

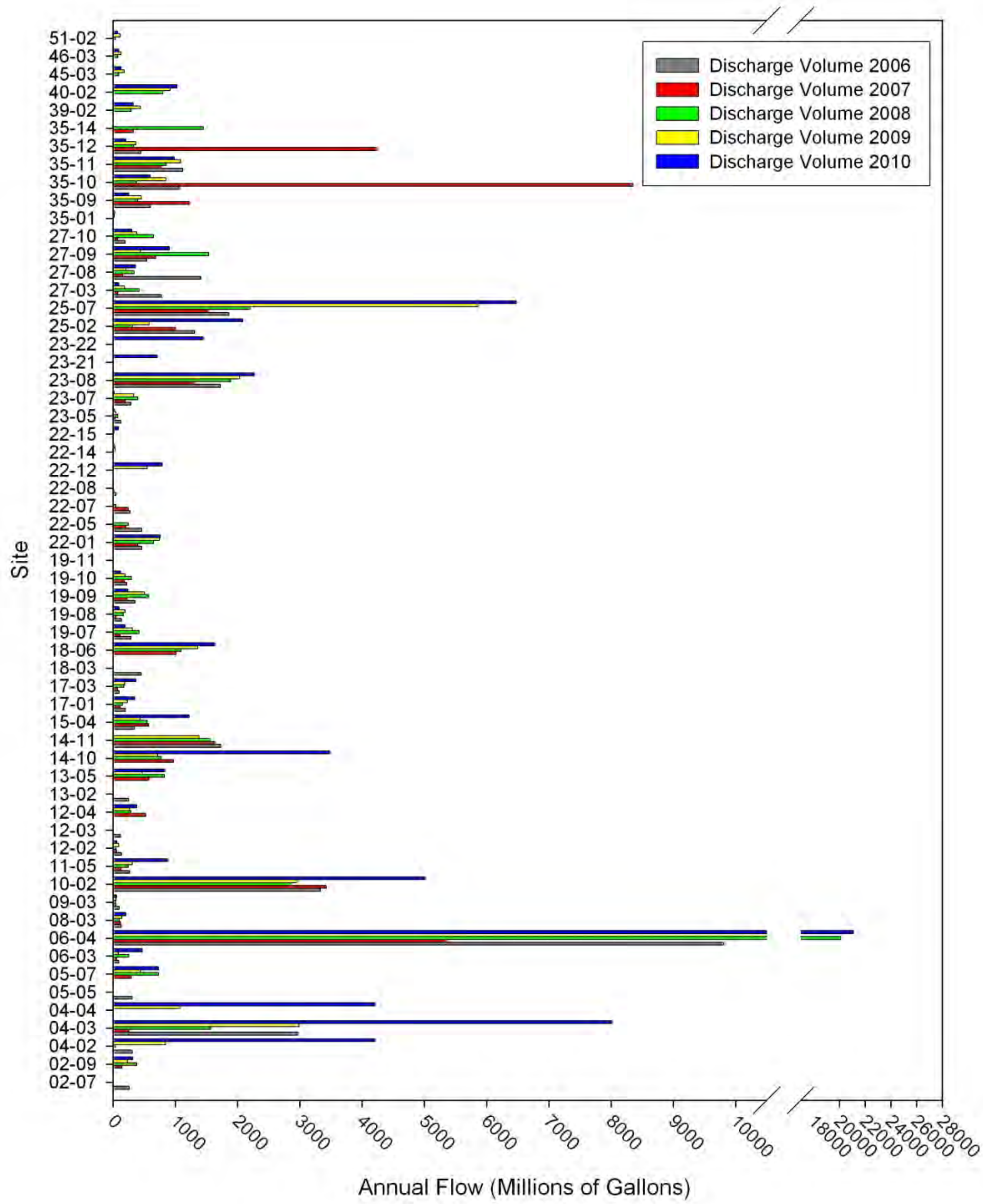

Figure B-11. Estimated annual discharge volume (2006-2010)

Note: Flow methodologies varied per year. See Section 6.0 for methods used for volume and loading calculations.

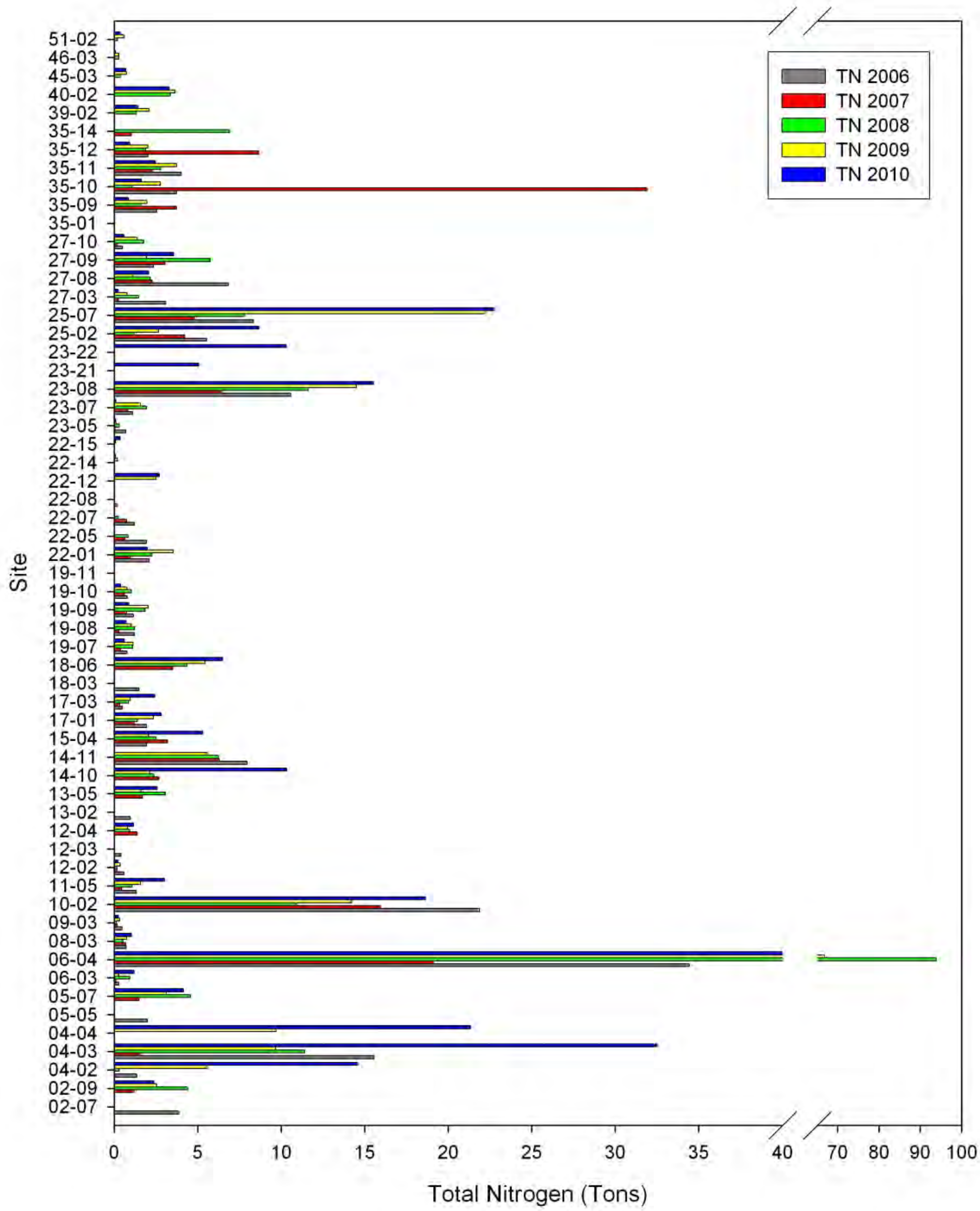

Figure B-12. Estimated total nitrogen annual loads (2006-2010)

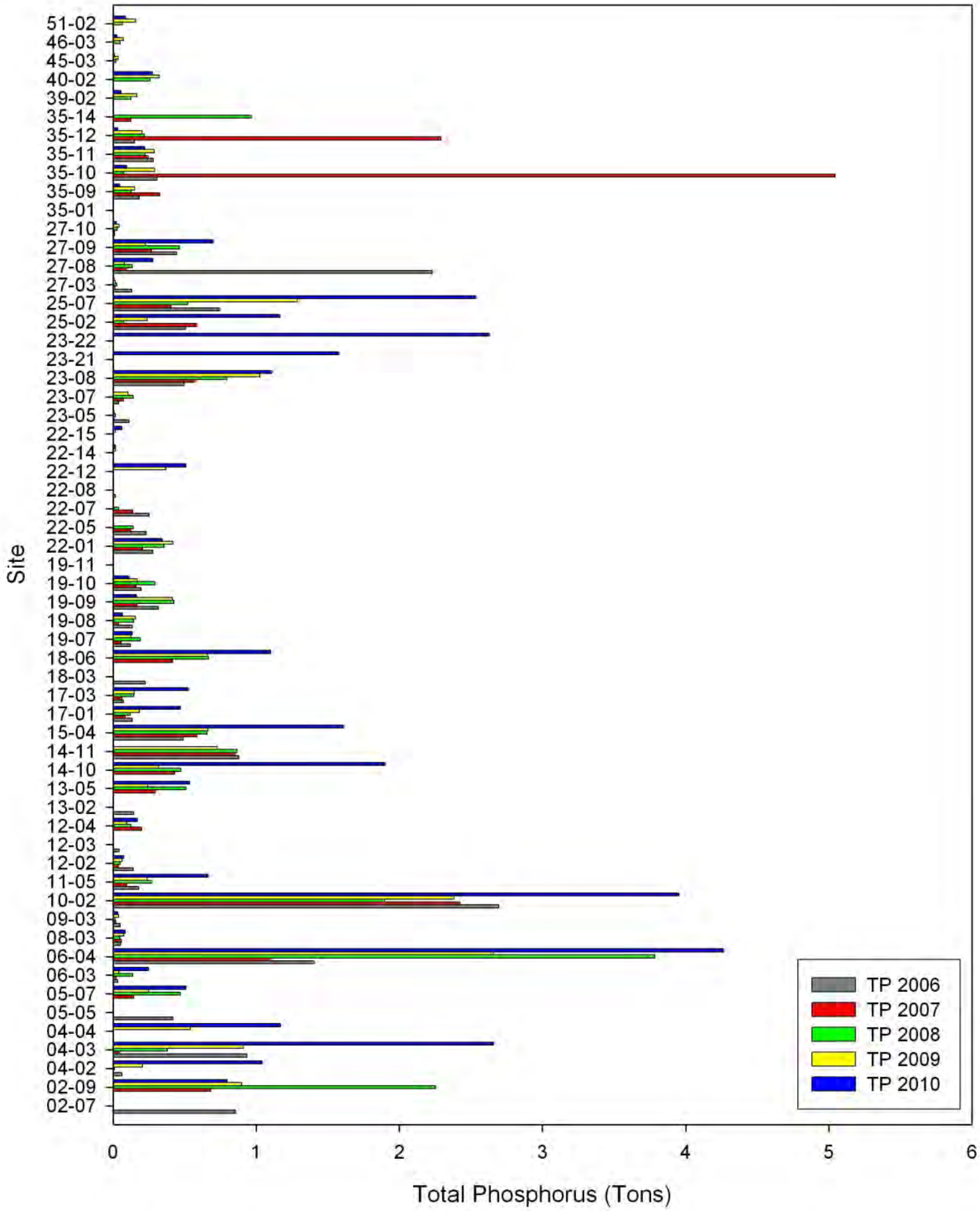

Figure B-13. Estimated total phosphorus annual loads (2006-2010)

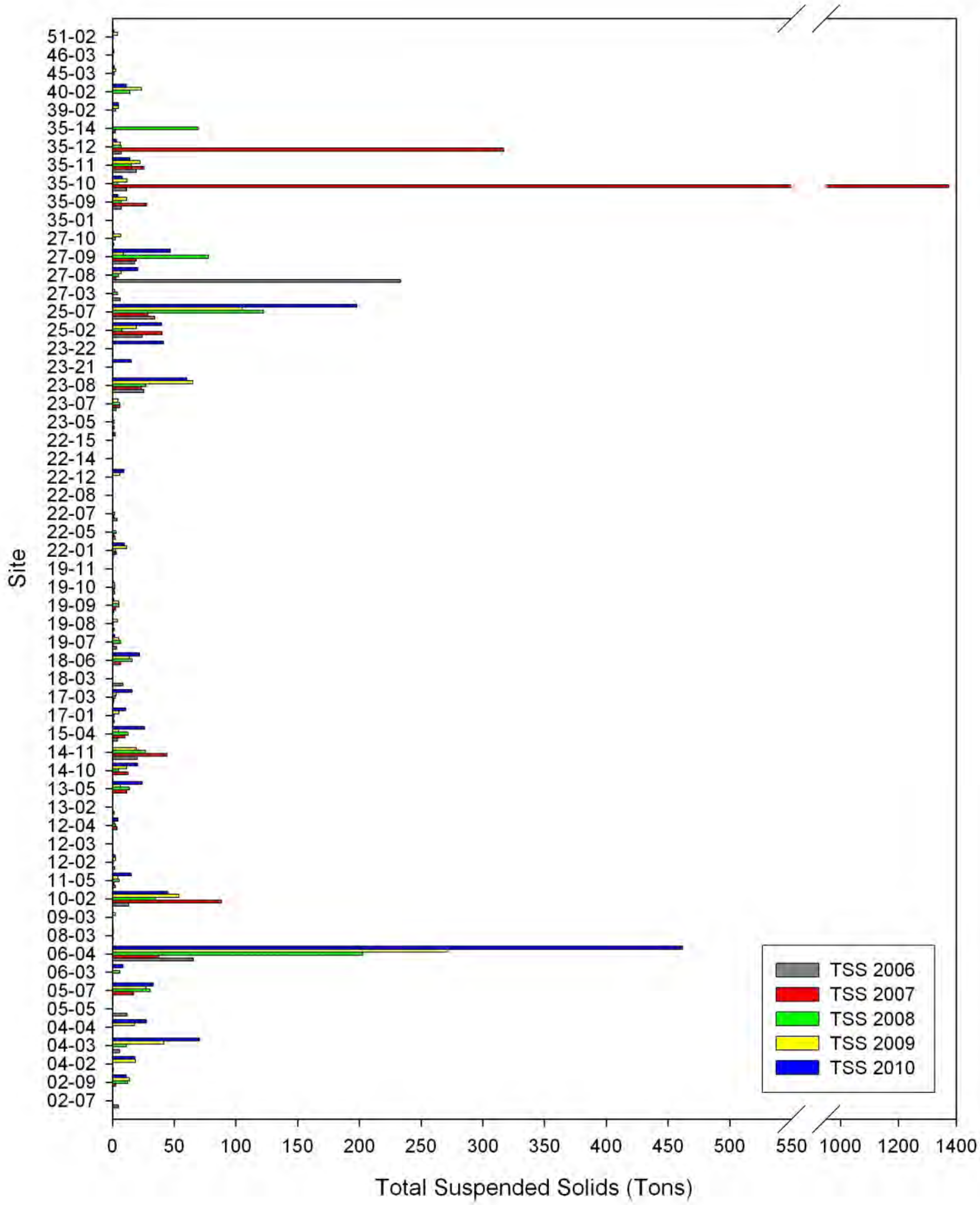

Figure B-14. Estimated total suspended solids annual loads (2006-2010)

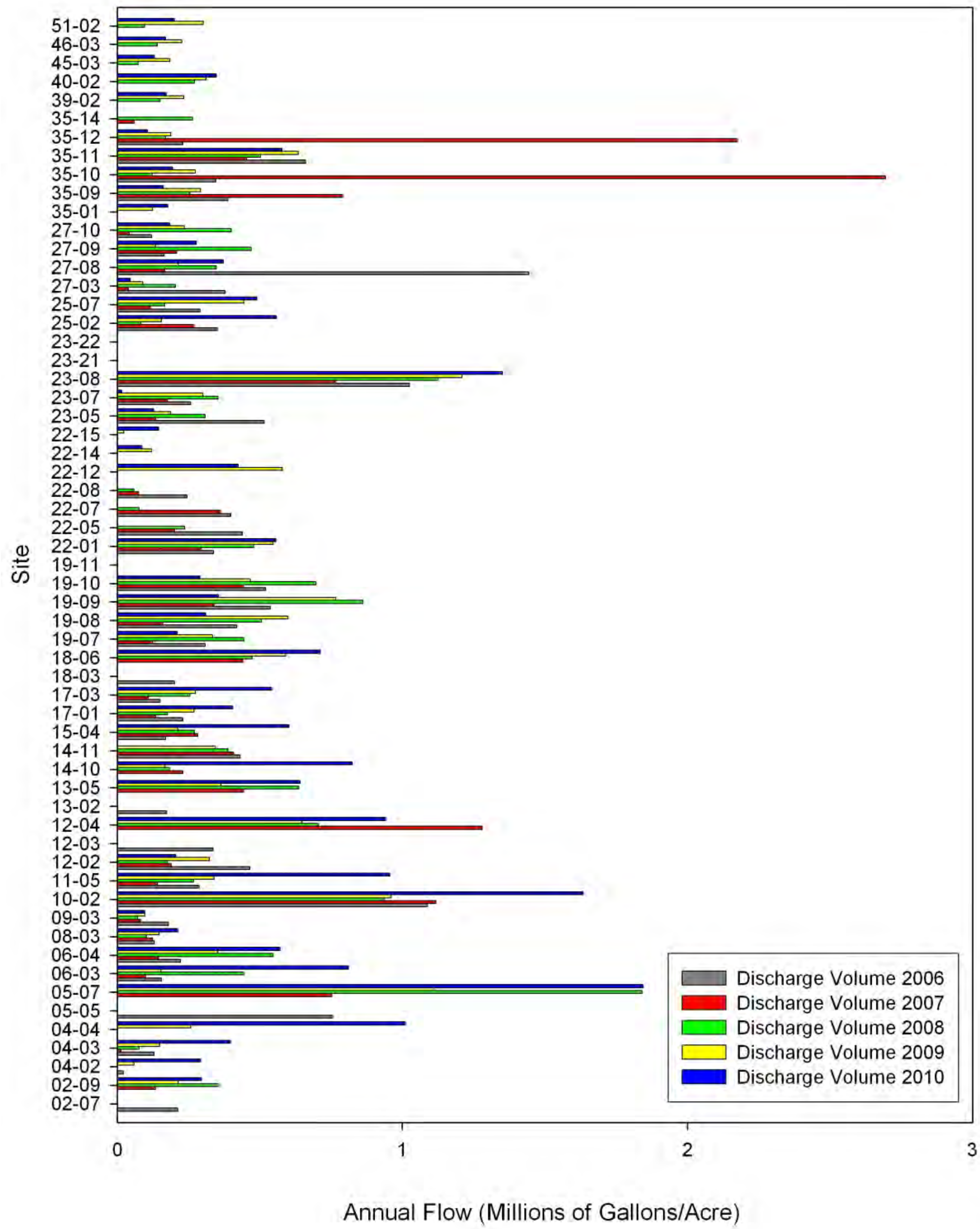

Figure B-15. Estimated total annual discharge volume per acre (2006-2010)

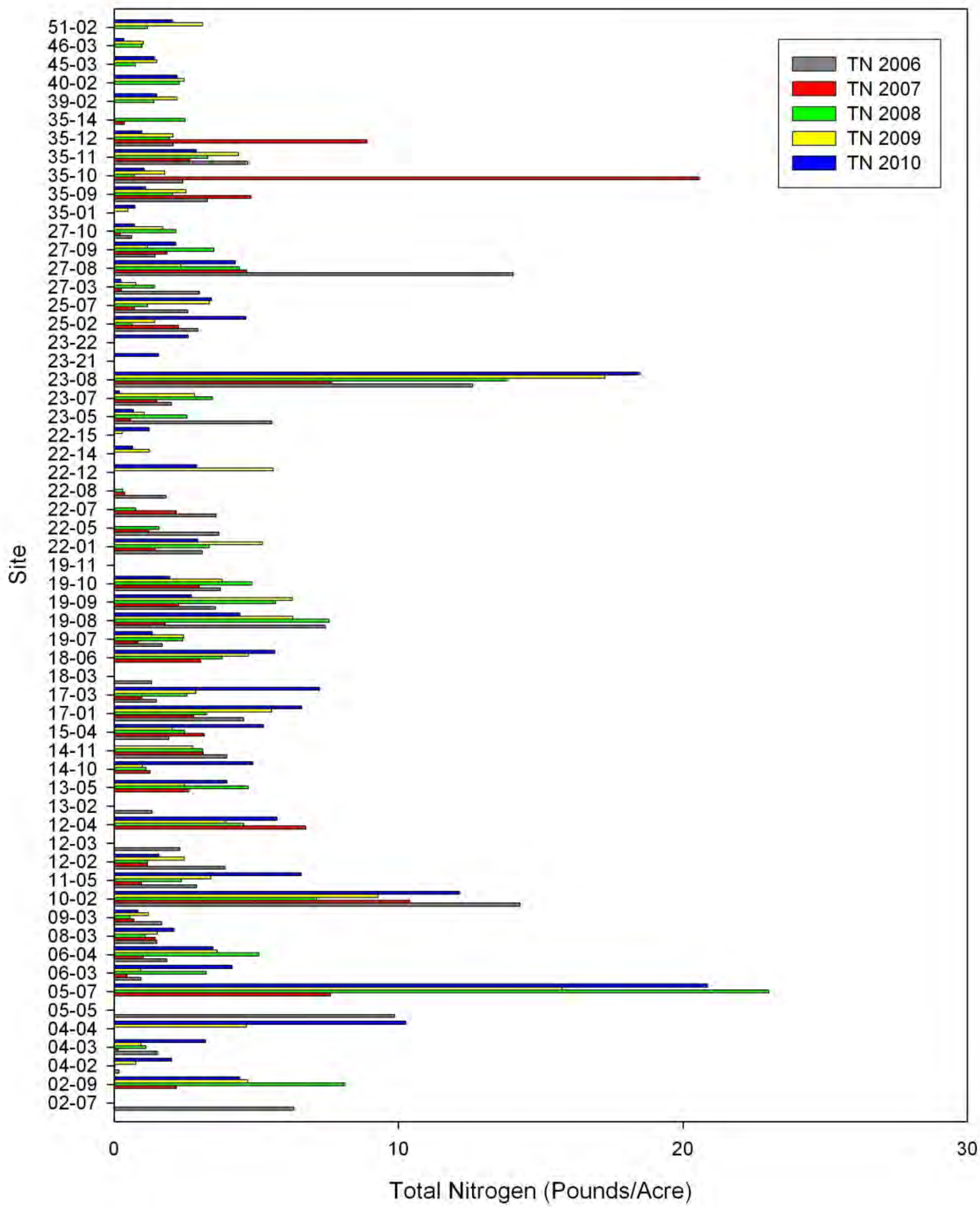

Figure B-16. Estimated total nitrogen load per acre (2006-2010)

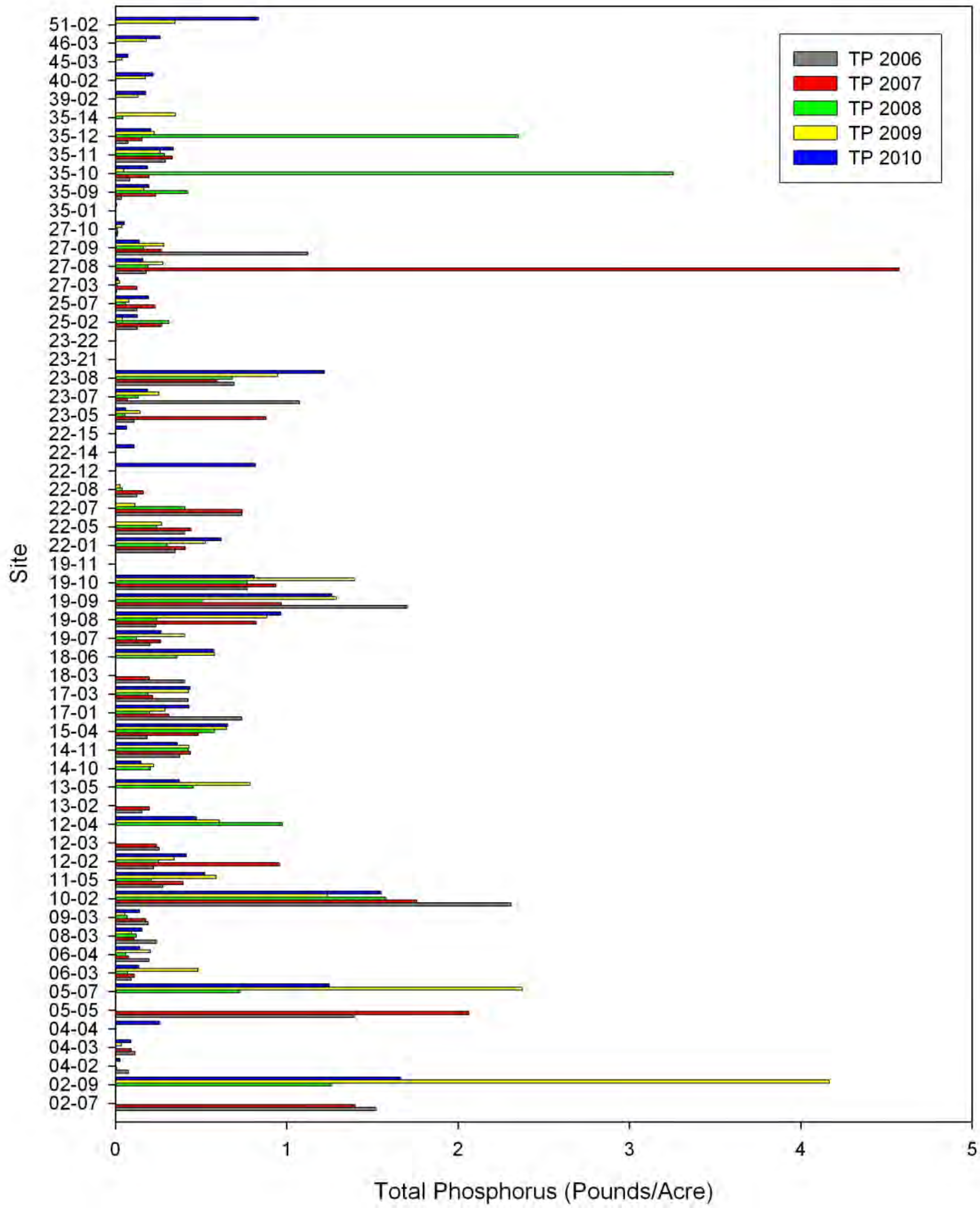

Figure B-17. Estimated total phosphorus load per acre (2006-2010)

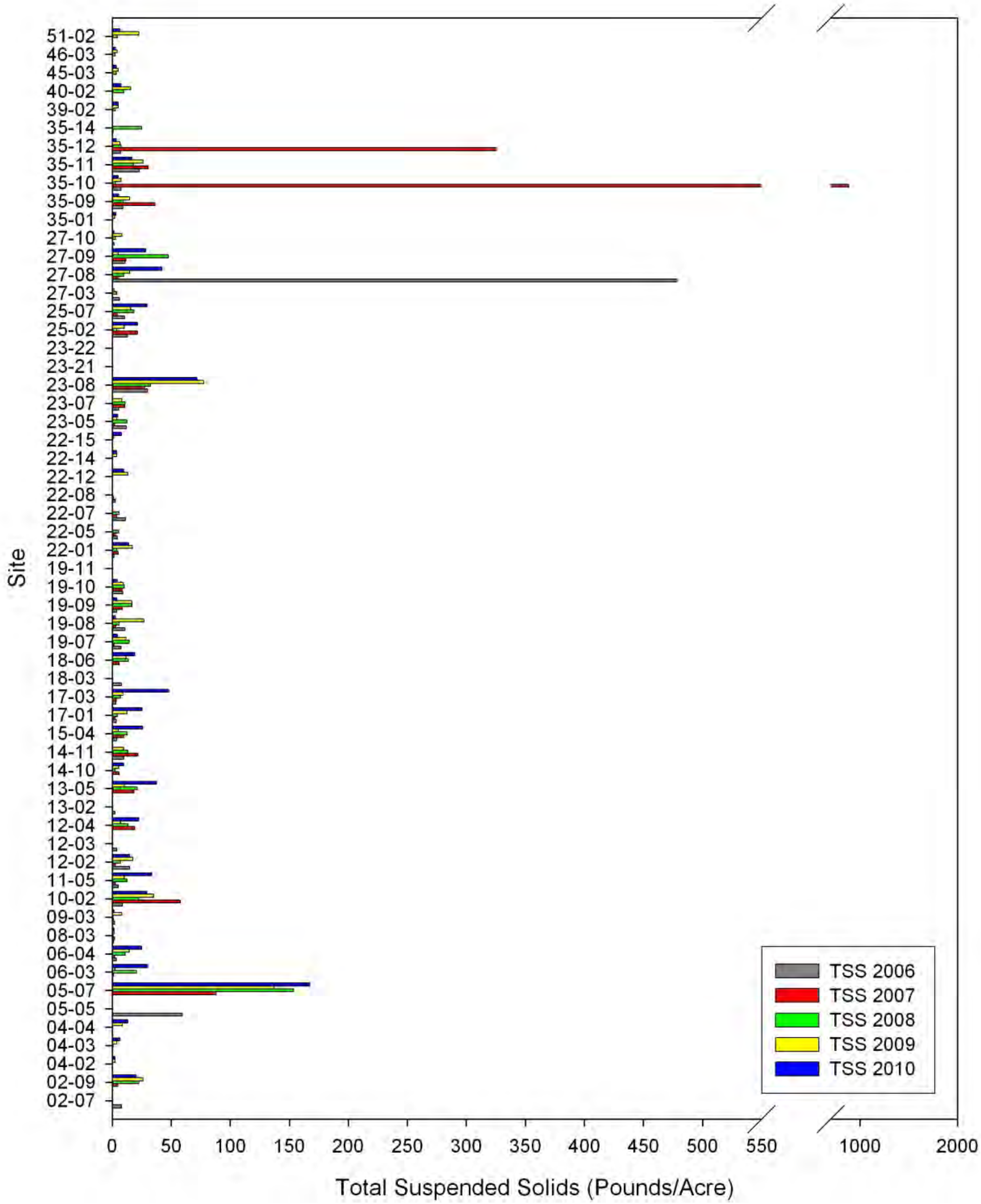

Figure B-18. Estimated total suspended solids load per acre (2006-2010)

3. Lake Graphs

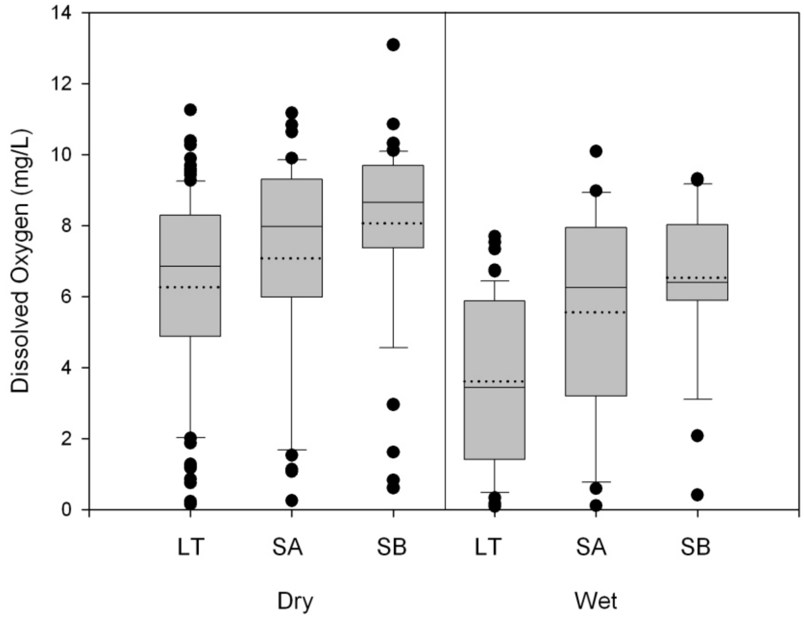

Figure B-19. Distribution of Bottom Dissolved Oxygen Data for Pinellas County Lake Strata During 2006-2010 Wet and Dry Seasons

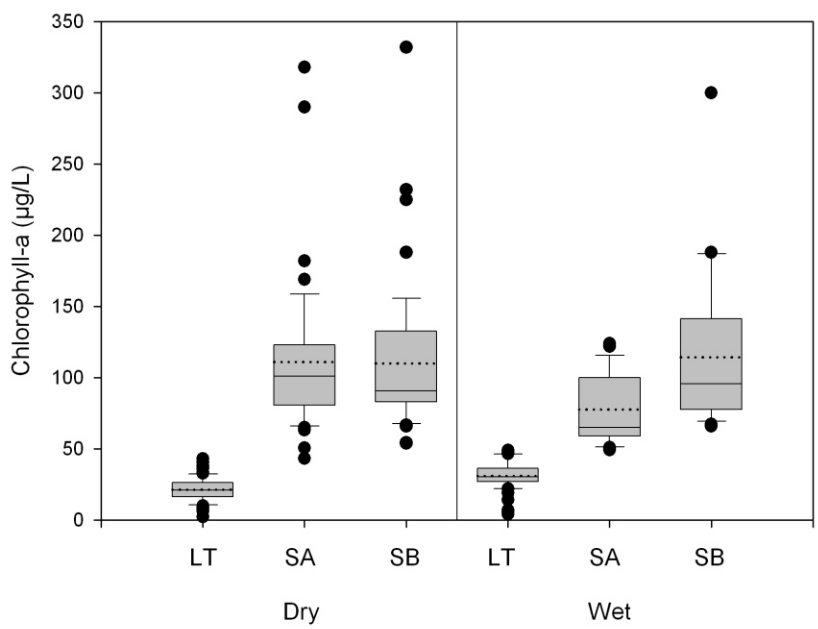

Figure B-20. Distribution of Chlorophyll-a Data for Pinellas County Lake Strata During 2006-2010 Wet and Dry Seasons

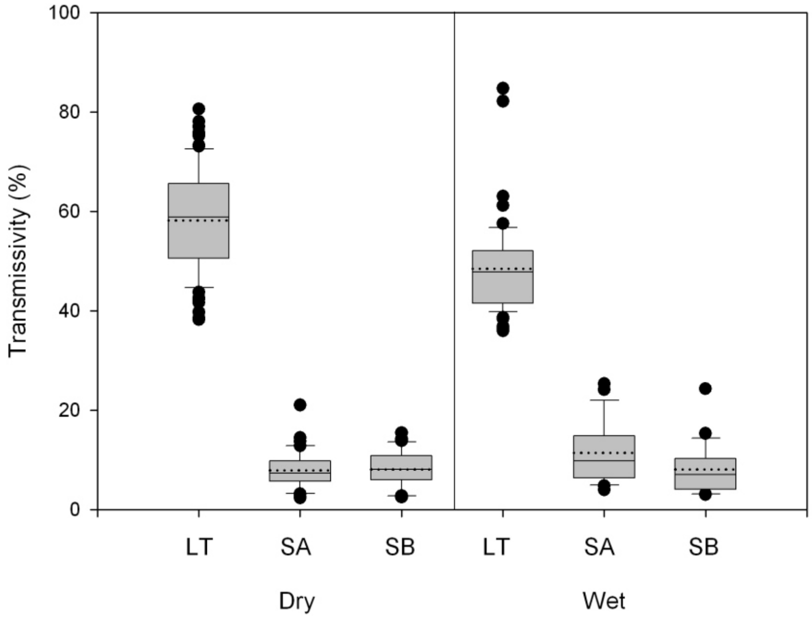

Figure B-21. Distribution of Transmissivity Data for Pinellas County Lake Strata During 2006-2010 Wet and Dry Seasons

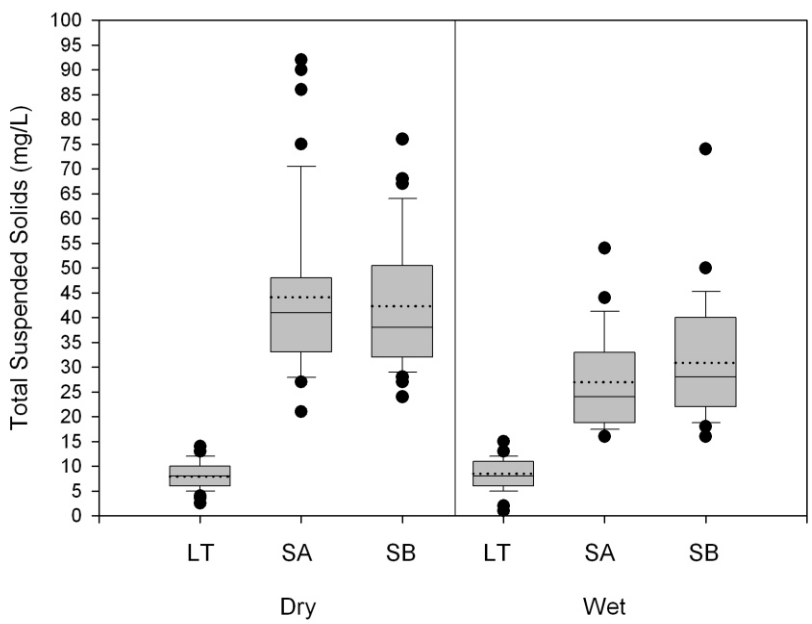

Figure B-22. Distribution of Total Suspended Solids Data for Pinellas County Lake Strata During 2006-2010 Wet and Dry Seasons

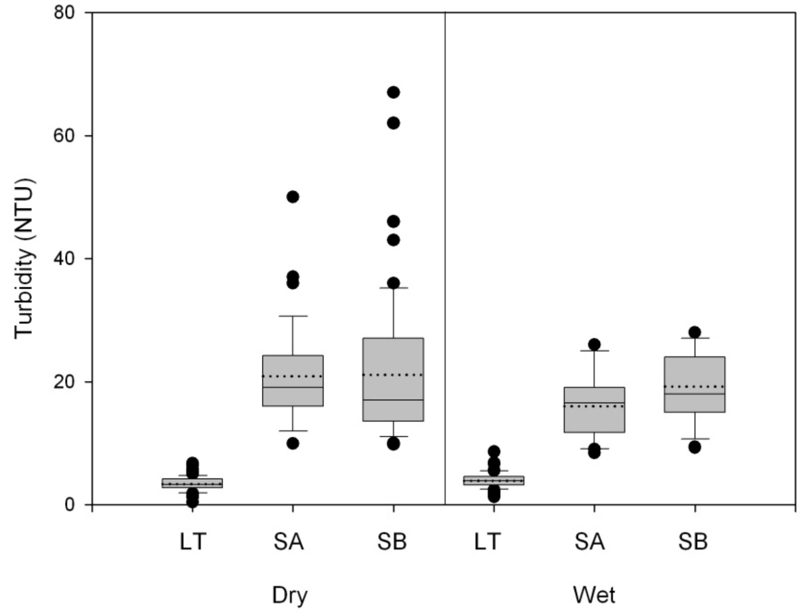

Figure B-23. Distribution of Turbidity Data for Pinellas County Lake Strata During 2006-2010 Wet and Dry Seasons

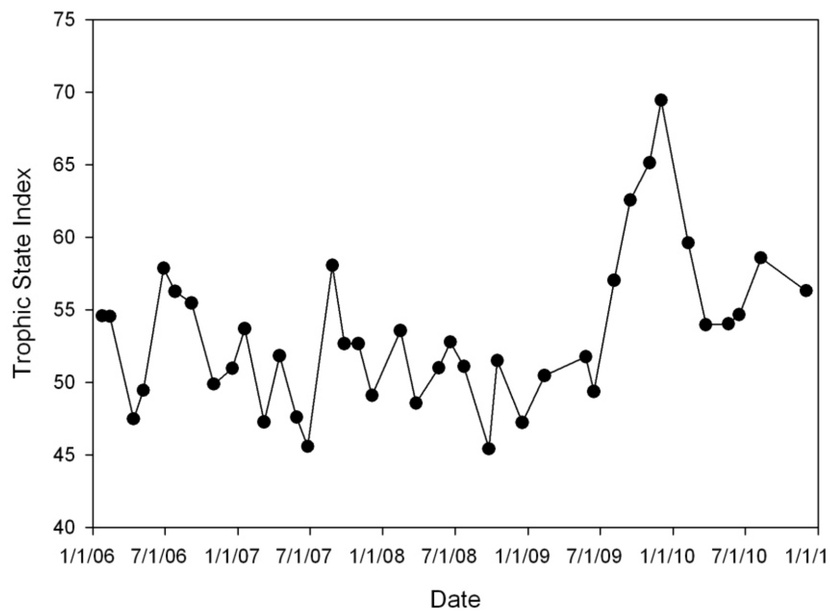

Figure B-24. Alligator Lake Trophic State Index (2006-2010)

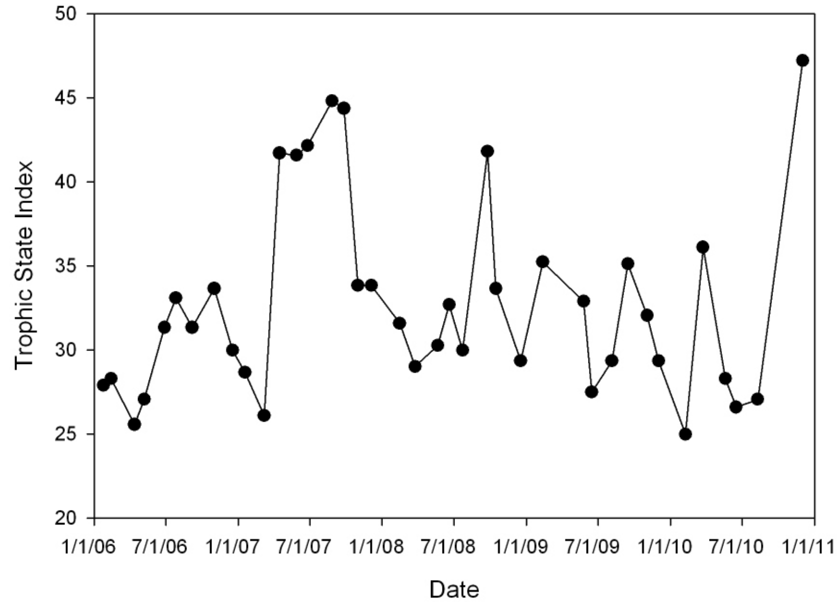

Figure B-25. Lake Chautauqua Trophic State Index (2006-2010)

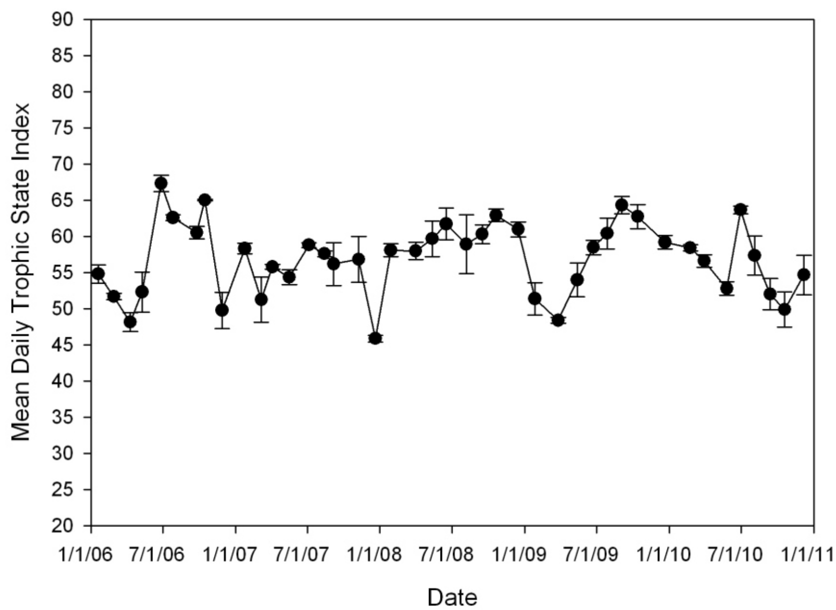

Figure B-26. Lake Tarpon Trophic State Index (2006-2010)

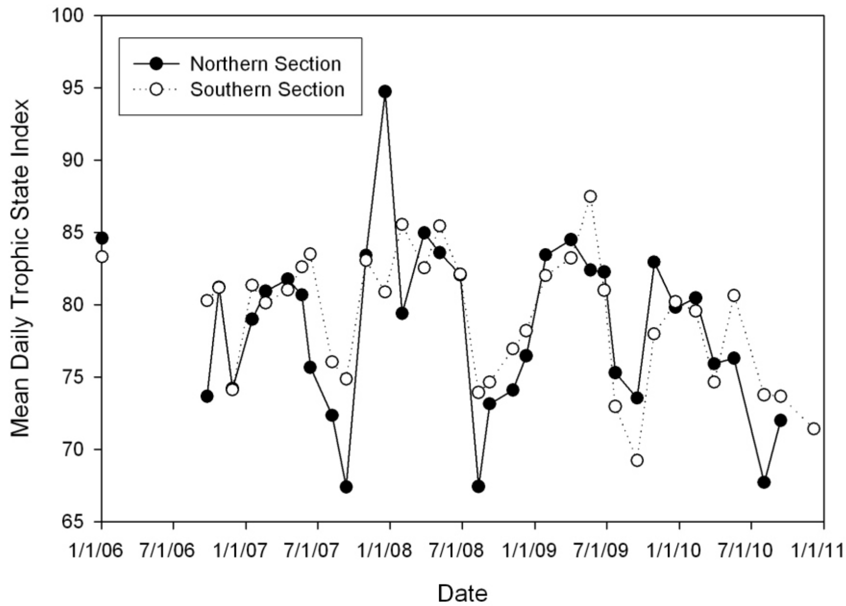

Figure B-27. Lake Seminole north and south (A and B) Trophic State Index (2006-2010) * Samples were not collected from February -- August 2006 due to low lake level.

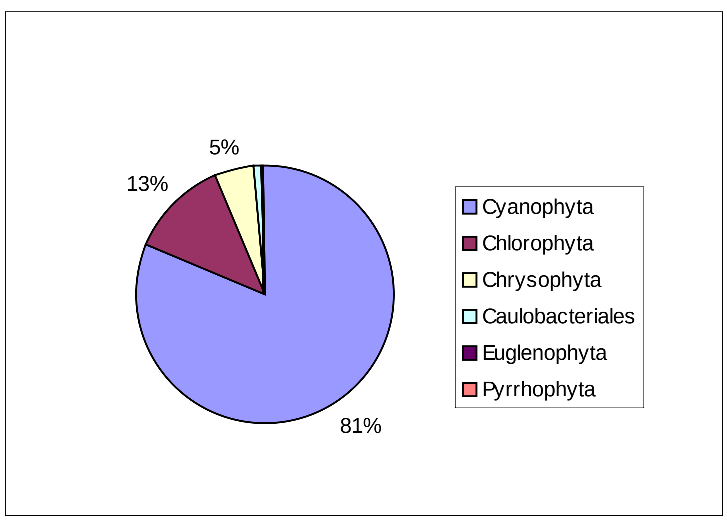

Figure B-28. Lake Tarpon Distribution of Phytoplankton Taxa (2003-2009)

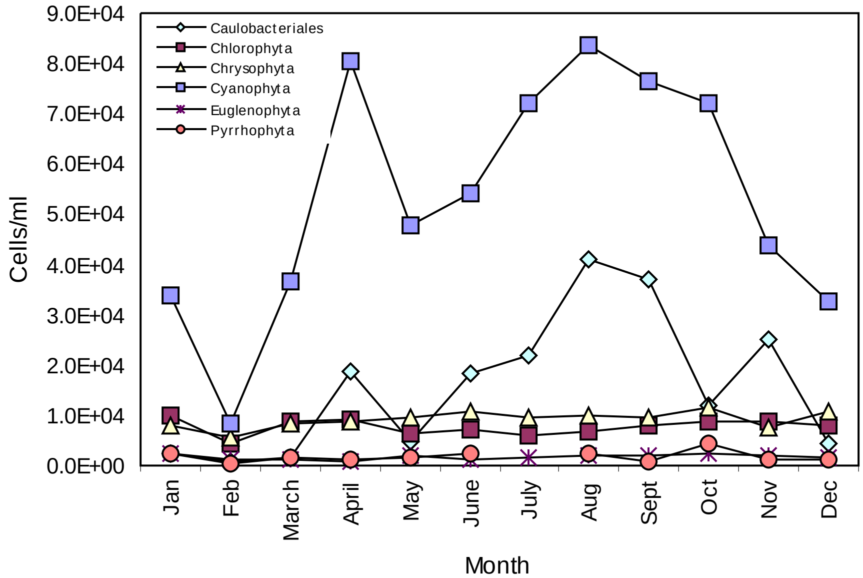

Figure B-29. Lake Tarpon Phytoplankton Taxa Average Cell Concentration by Month (2003-2009)

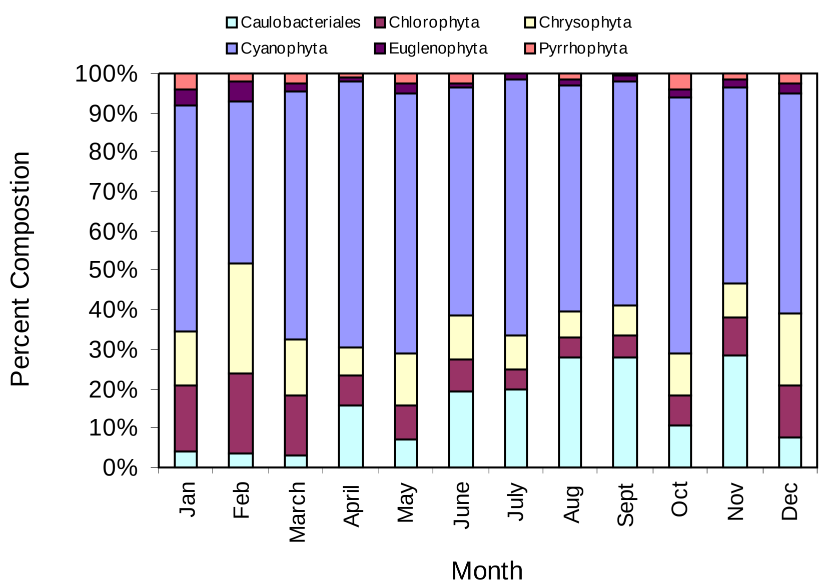

Figure B-30. Lake Tarpon Percent Composition of Phytoplankton Taxa by Month (2003-2009)

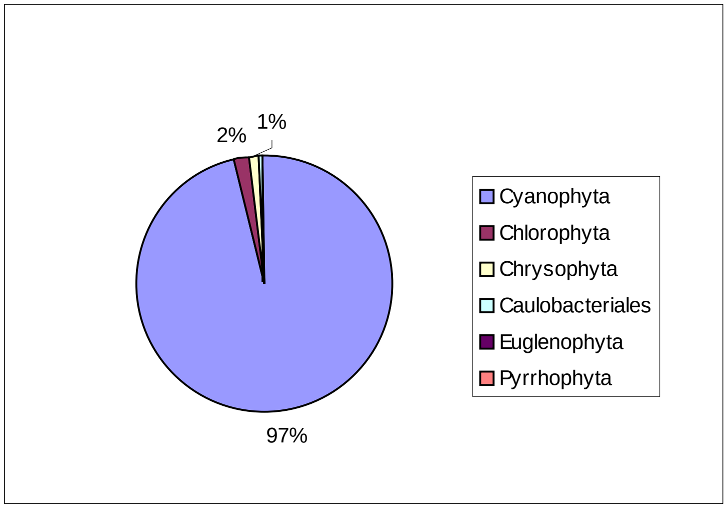

Figure B-31. Lake Seminole Distribution of Phytoplankton Taxa (2003-2009)

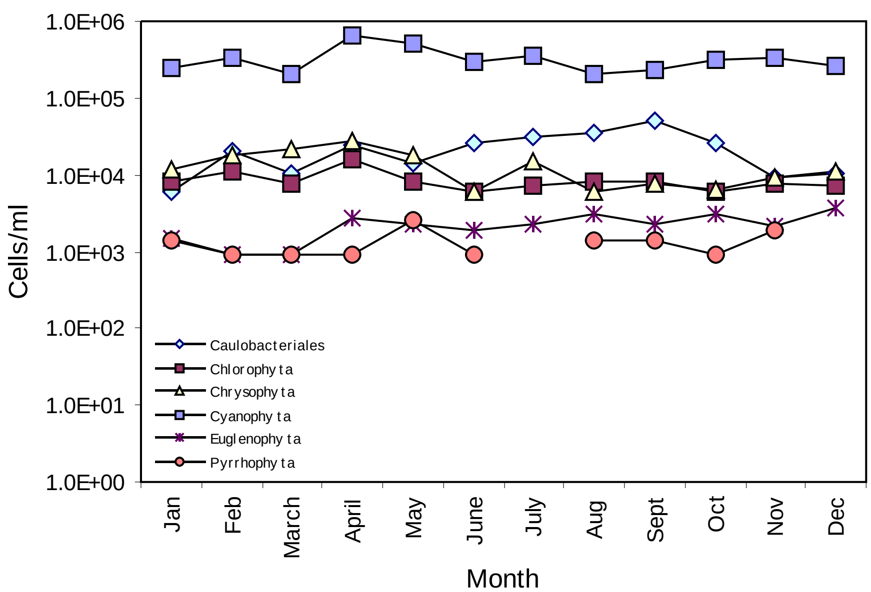

Figure B-32. Lake Seminole Phytoplankton Taxa Average Cell Concentration by Month (2003-2009)

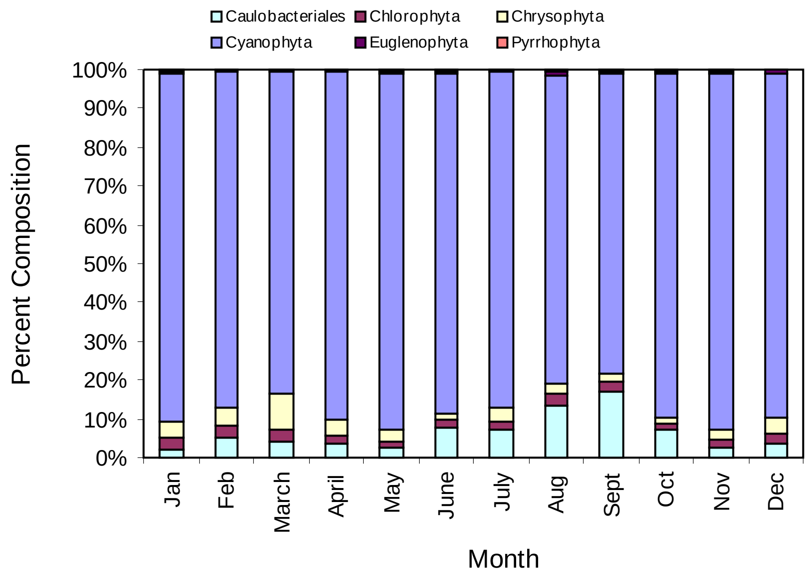

Figure B-33. Lake Seminole Percent Composition of Phytoplankton Taxa by Month (2003-2009)

4. CDF Plots

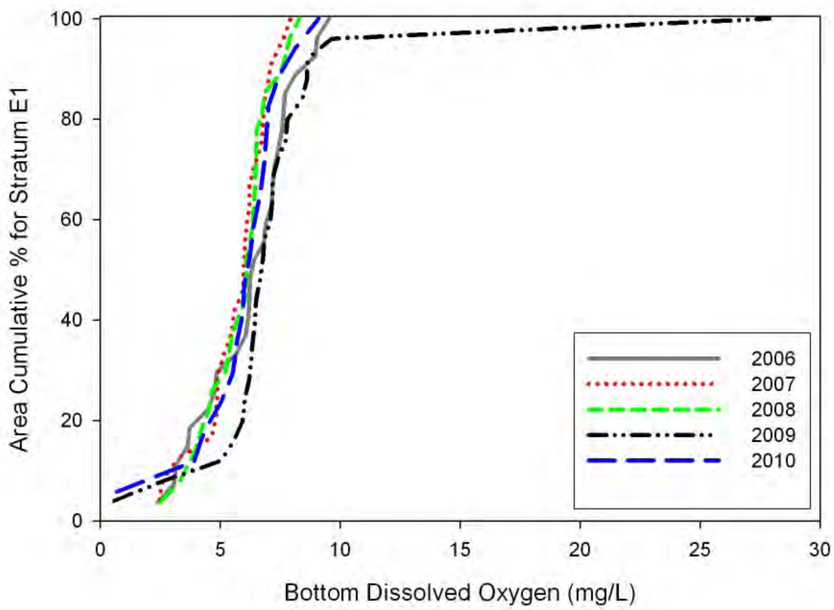

Figure B-34. Estimates of areal extent of bottom DO in stratum E1 (2006-2010)

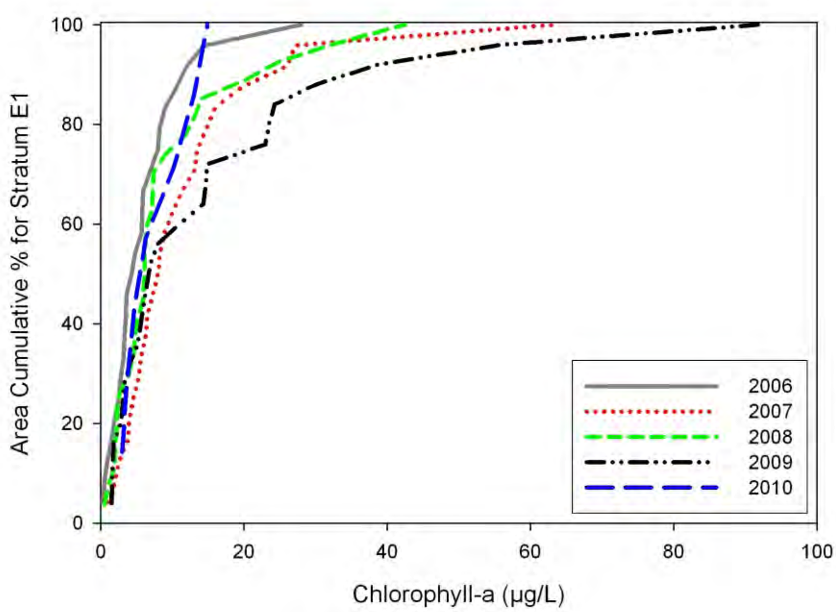

Figure B-35. Estimates of areal extent of chlorophyll-a in stratum E1 (2006-2010)

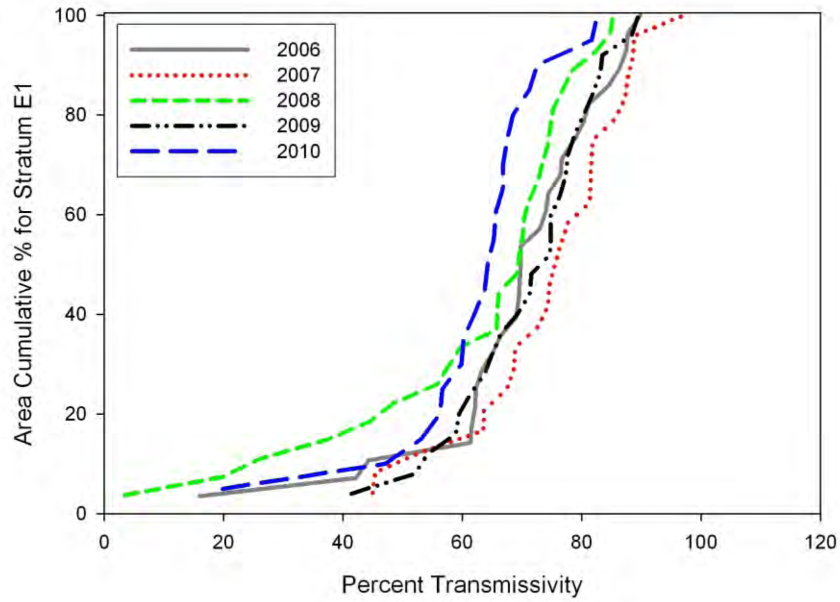

Figure B-36. Estimates of areal extent of transmissivity in stratum E1 (2006-2010)

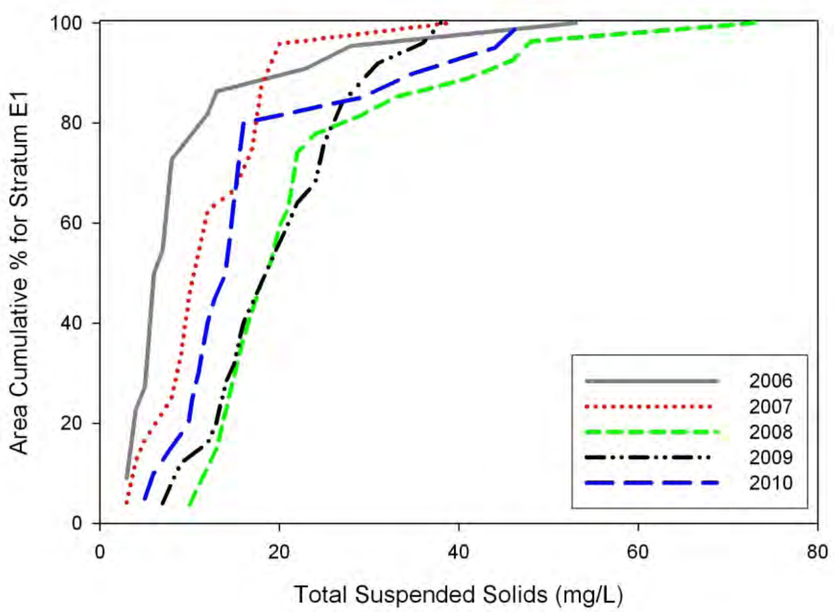

Figure B-37. Estimates of areal extent of total suspended solids in stratum E1 (2006-2010)

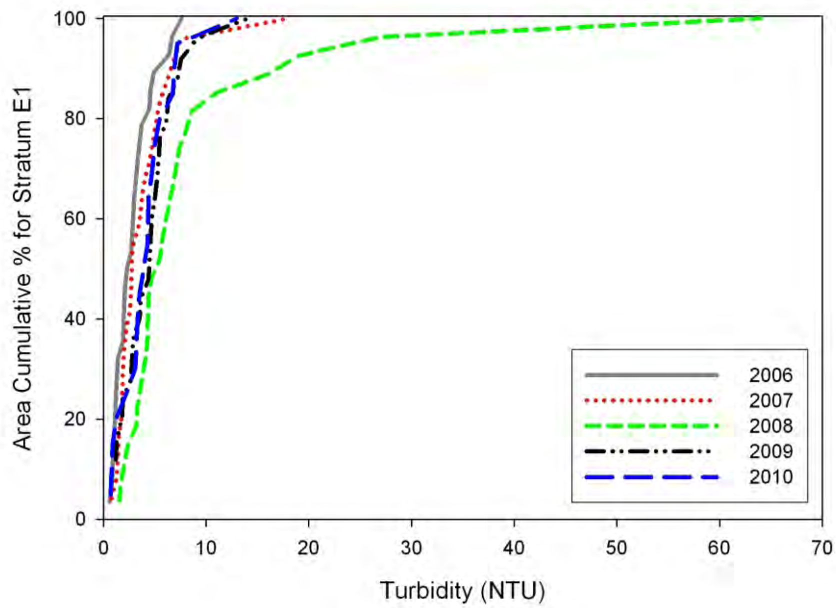

Figure B-38. Estimates of areal extent of turbidity in stratum E1 (2006-2010)

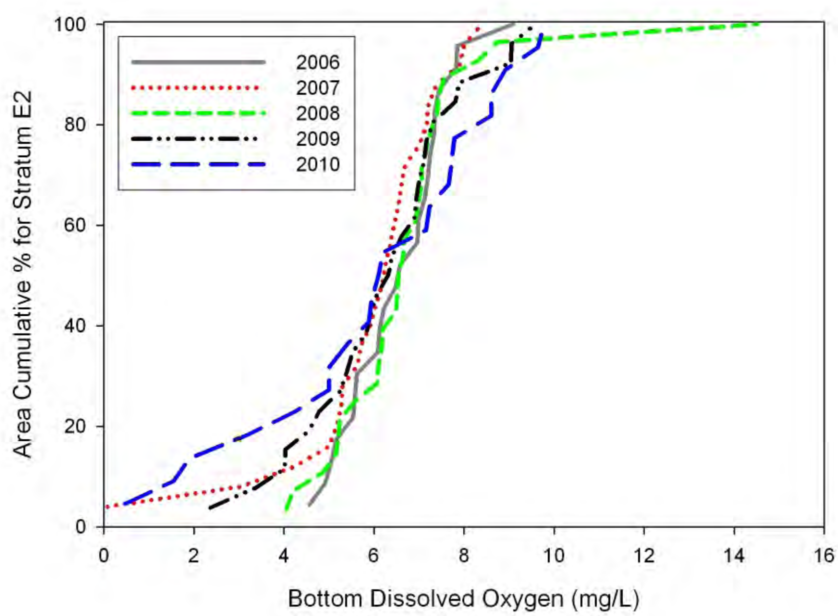

Figure B-39. Estimates of areal extent of bottom dissolved oxygen in stratum E2 (2006-2010)

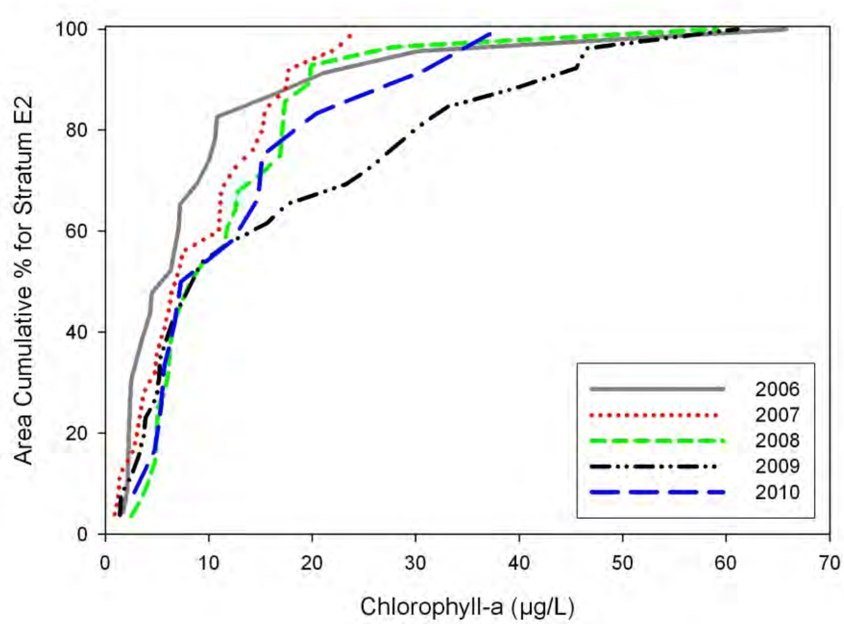

Figure B-40. Estimates of areal extent of chlorophyll-a in stratum E2 (2006-2010)

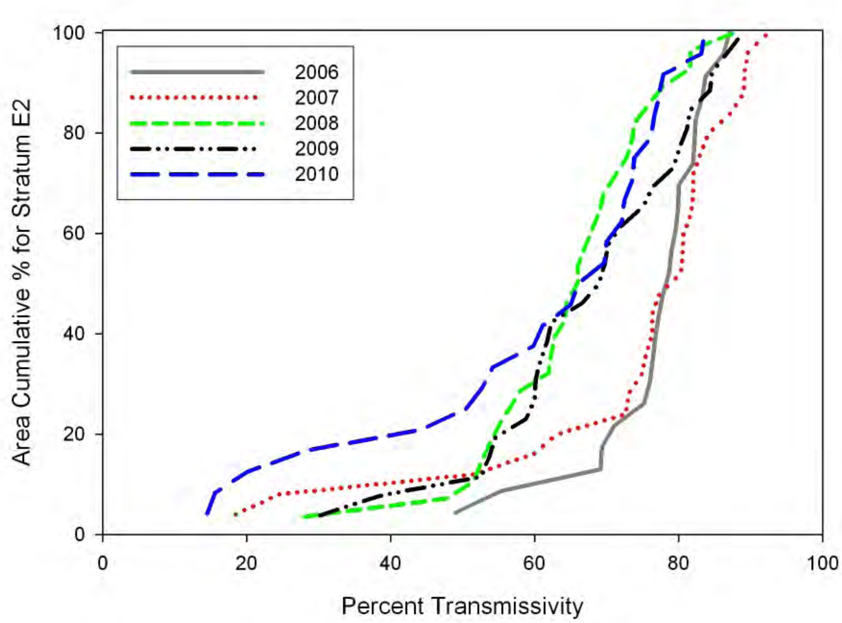

Figure B-41. Estimates of areal extent of transmissivity in stratum E2 (2006-2010)

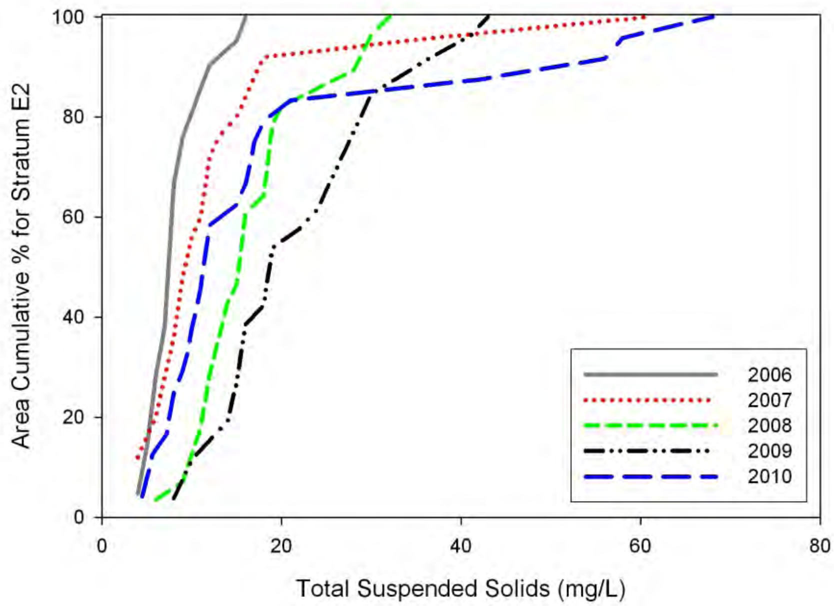

Figure B-42. Estimates of areal extent of total suspended solids in stratum E2 (2006-2010)

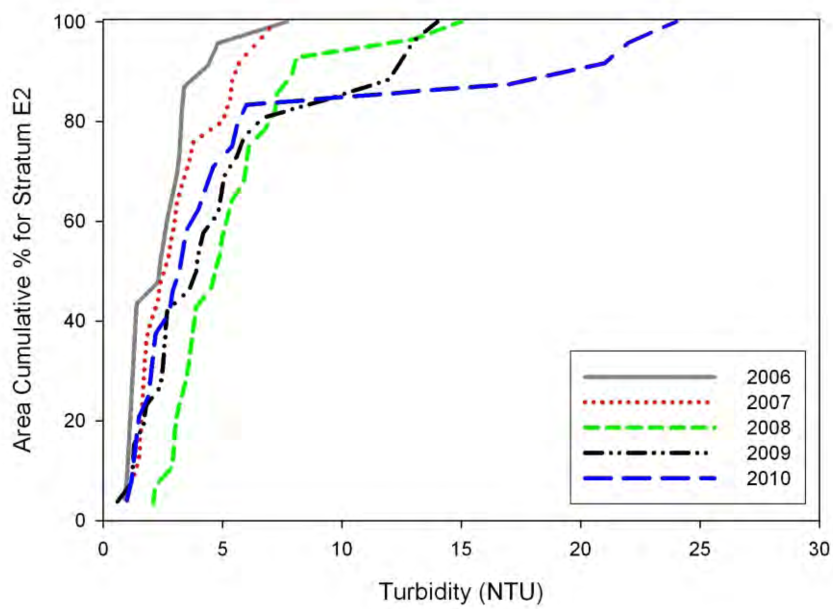

Figure B-43. Estimates of areal extent of turbidity in stratum E2 (2006-2010)

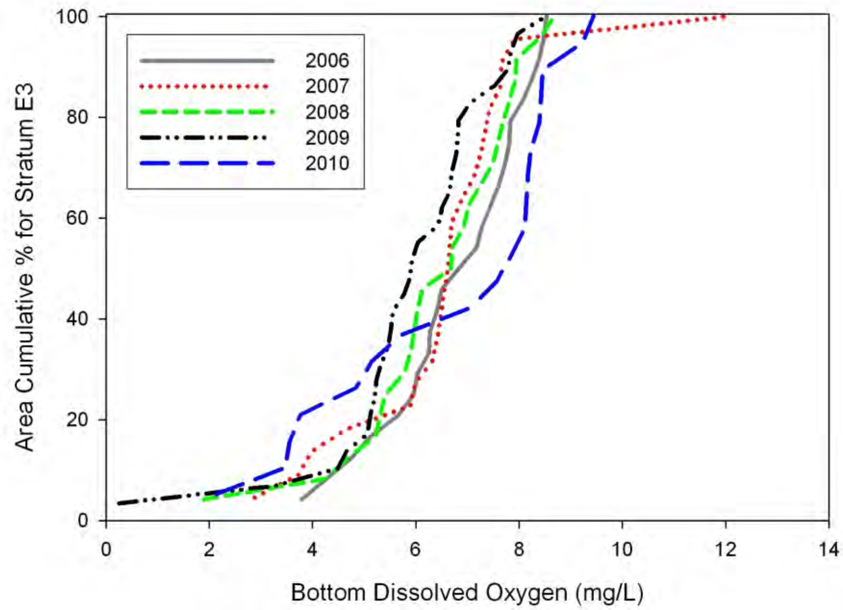

Figure B-44. Estimates of areal extent of bottom dissolved oxygen in stratum E3 (2006-2010)

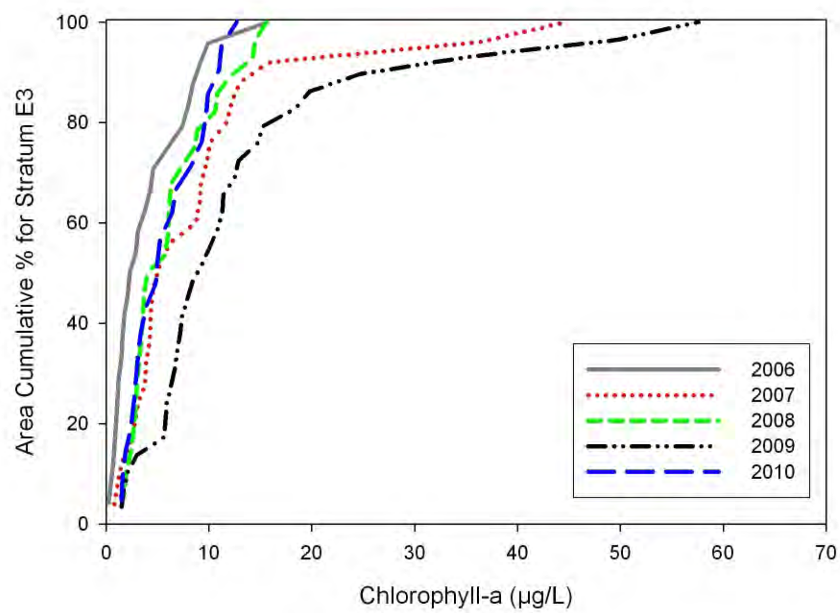

Figure B-45. Estimates of areal extent of chlorophyll-a in stratum E3 (2006-2010)

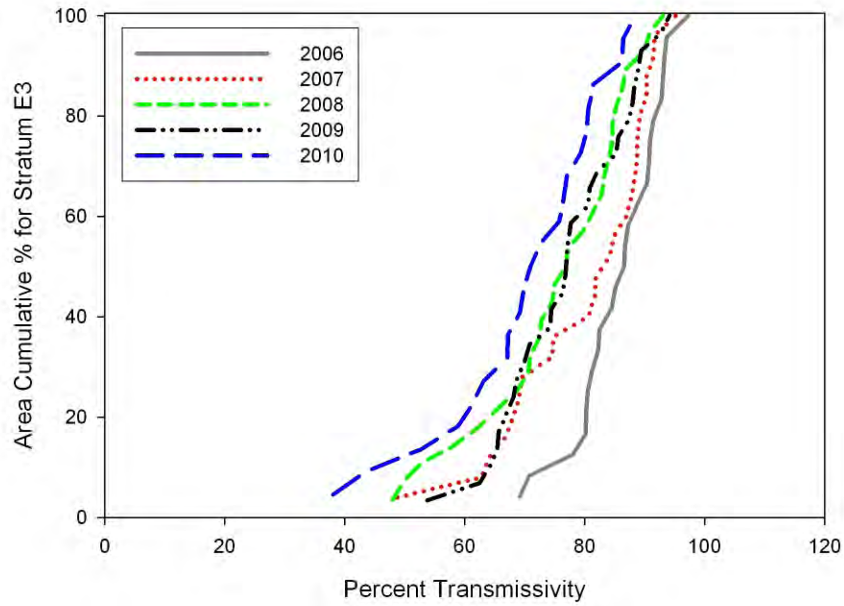

Figure B-46 Estimates of areal extent of transmissivity in stratum E3 (2006-2010)

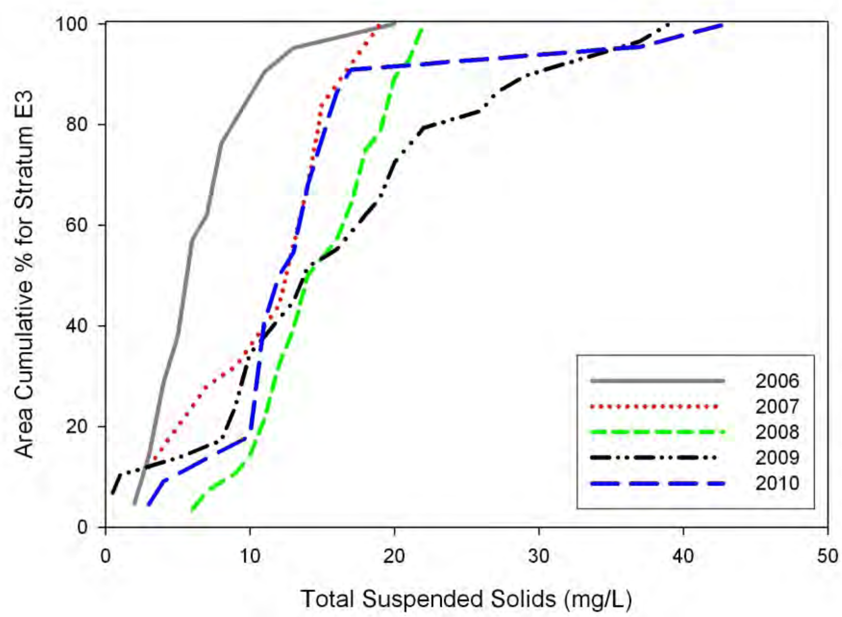

Figure B-47. Estimates of areal extent of total suspended solids in stratum E3 (2006-2010)

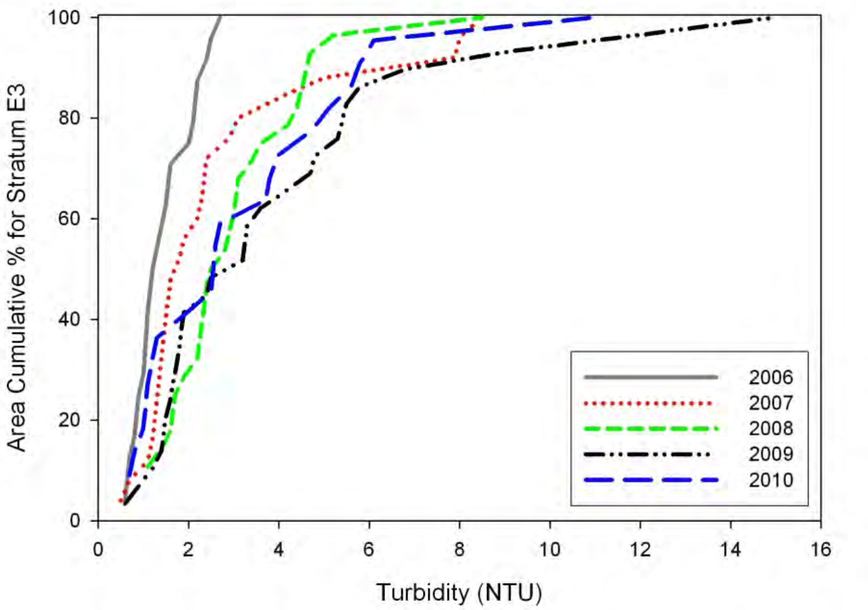

Figure B-48. Estimates of areal extent of turbidity in stratum E3 (2006-2010)

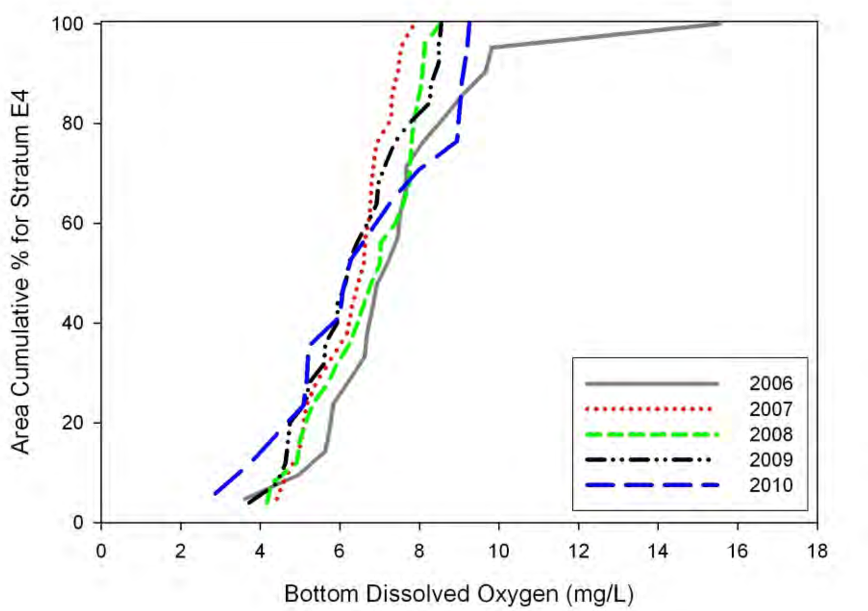

Figure B-49. Estimates of areal extent of bottom dissolved oxygen in stratum E4 (2006-2010)

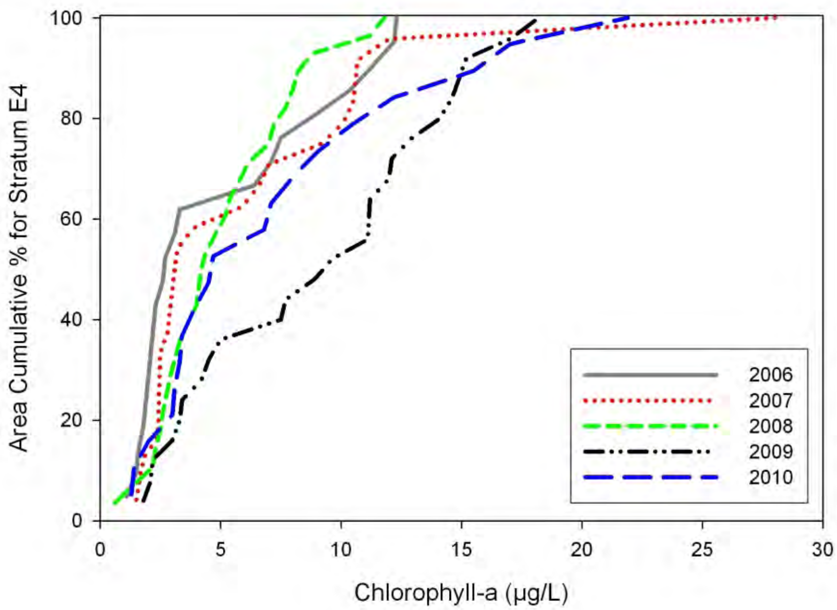

Figure B-50. Estimates of areal extent of chlorophyll-a in stratum E4 (2006-2010)

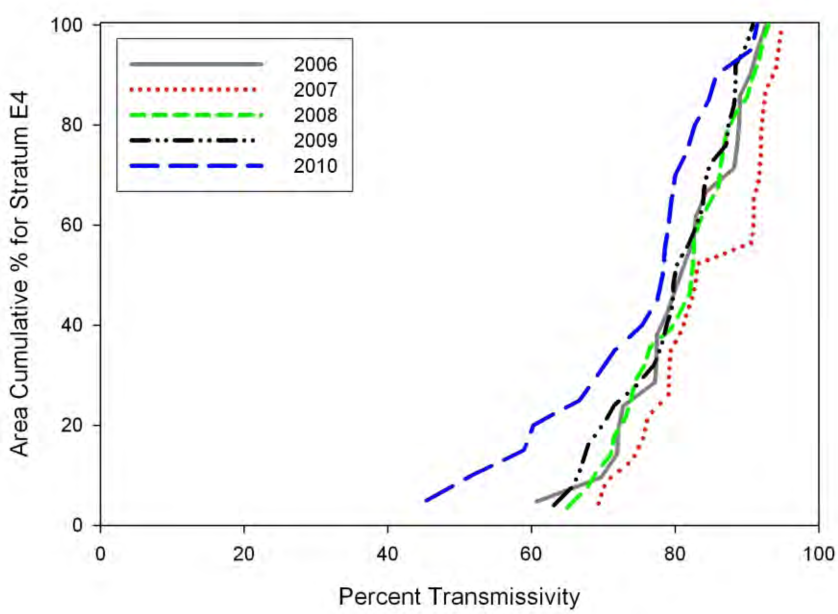

Figure B-51. Estimates of areal extent of transmissivity in stratum E4 (2006-2010)

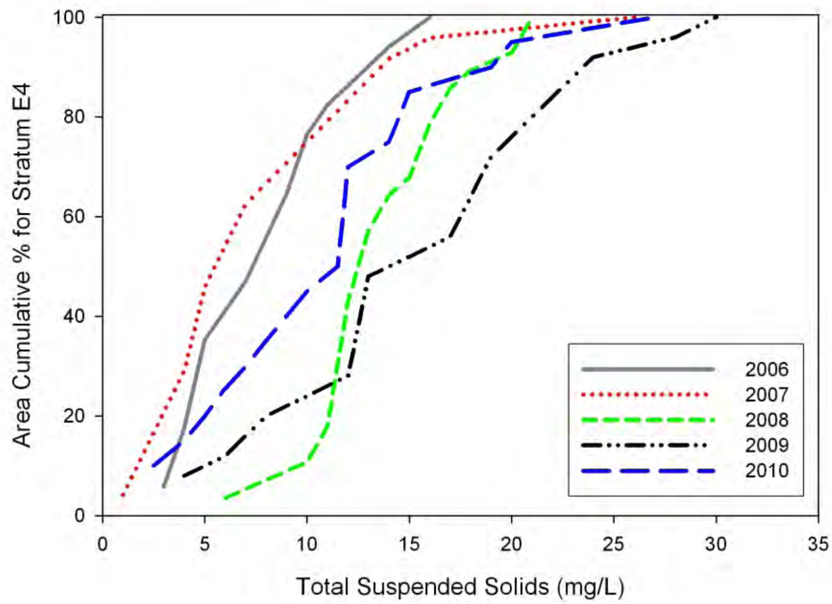

Figure B-52. Estimates of areal extent of total suspended solids in stratum E4 (2006-2010)

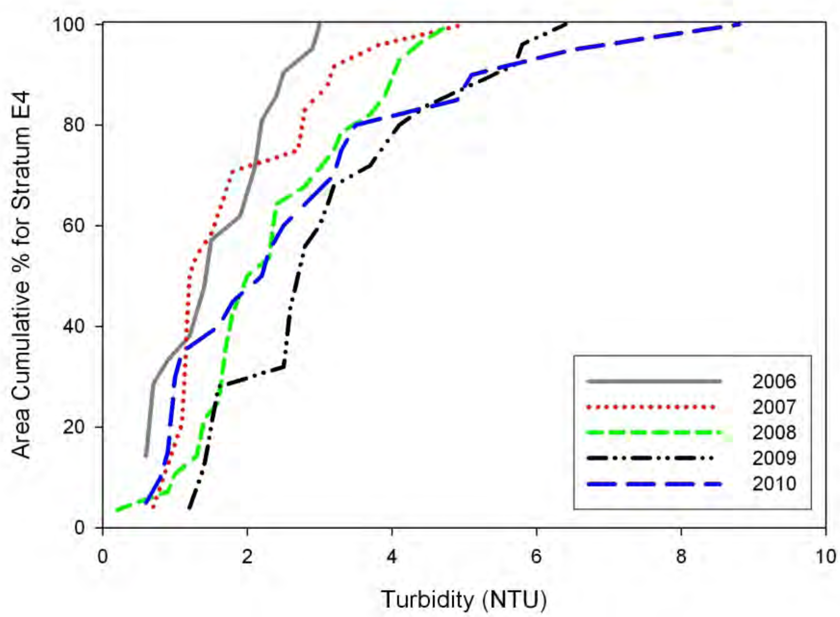

Figure B-53. Estimates of areal extent of turbidity in stratum E4 (2006-2010)

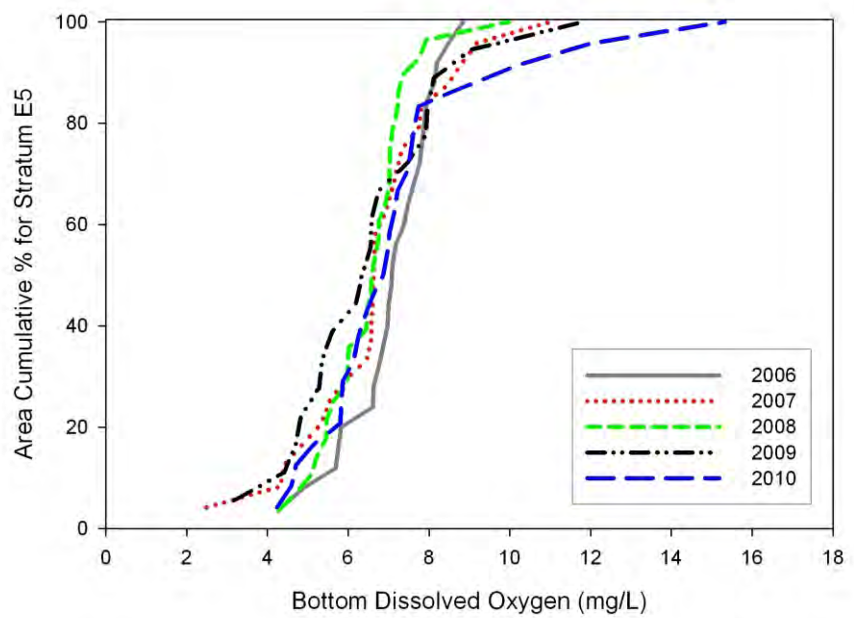

Figure B-54. Estimates of areal extent of bottom dissolved oxygen in stratum E5 (2006-2010)

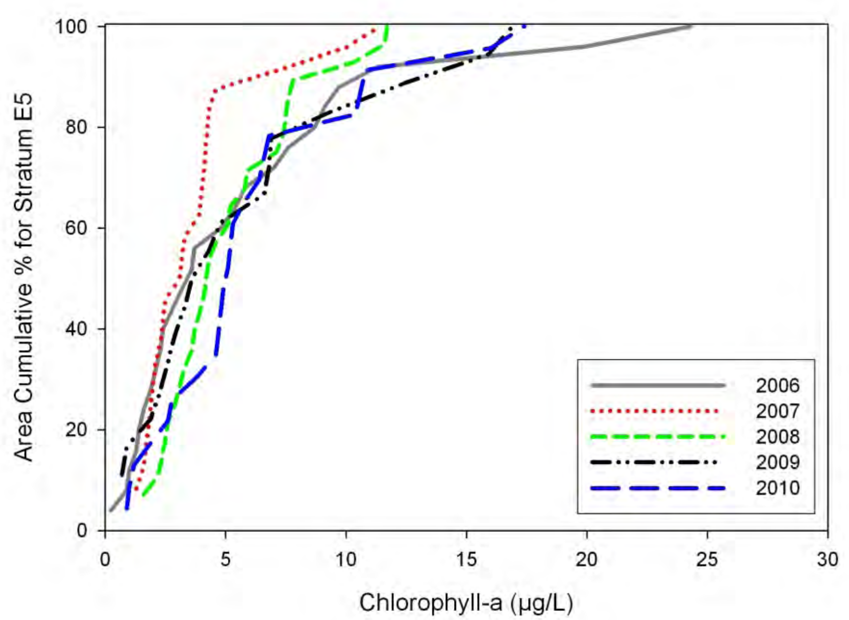

Figure B-55. Estimates of areal extent of chlorophyll-a in stratum E5 (2006-2010)

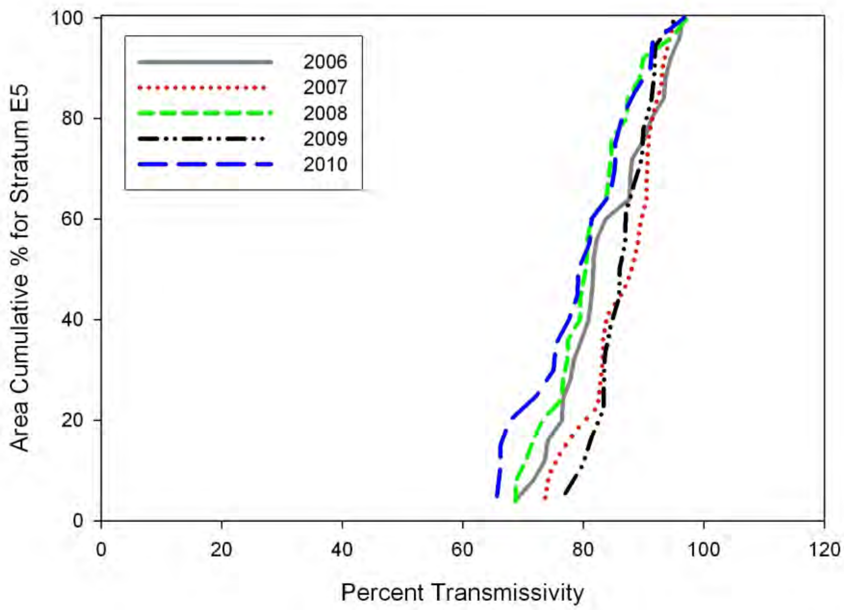

Figure B-56. Estimates of areal extent of transmissivity in stratum E5 (2006-2010)

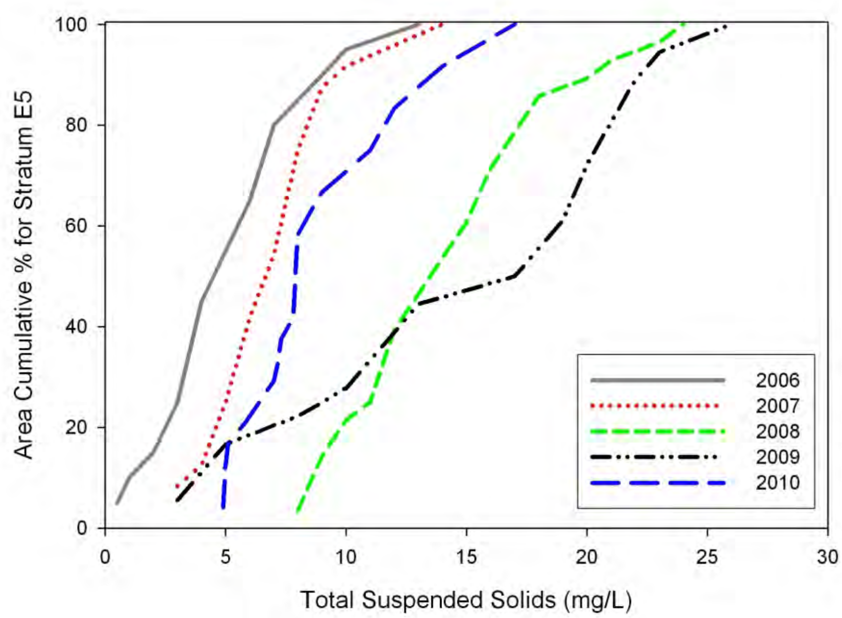

Figure B-57. Estimates of areal extent of total suspended solids in stratum E5 (2006-2010)

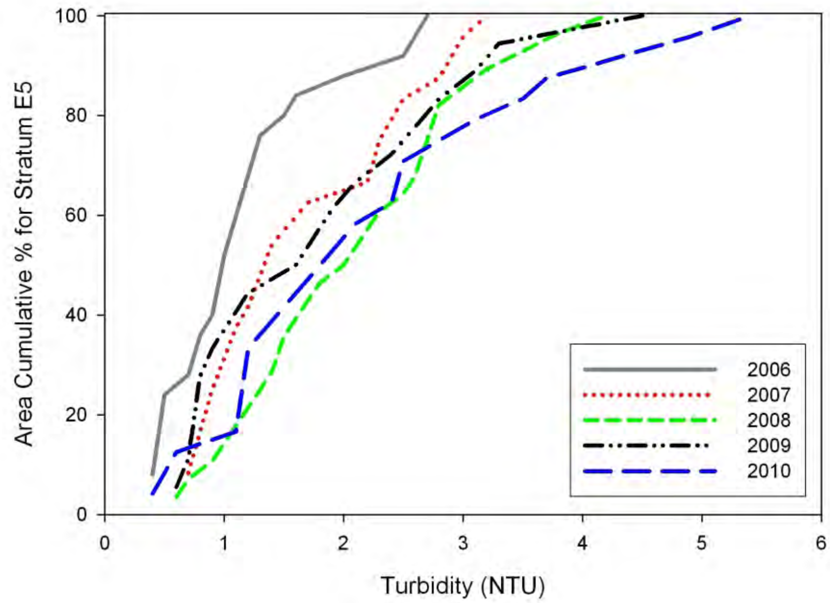

Figure B-58. Estimates of areal extent of turbidity in stratum E5 (2006-2010)

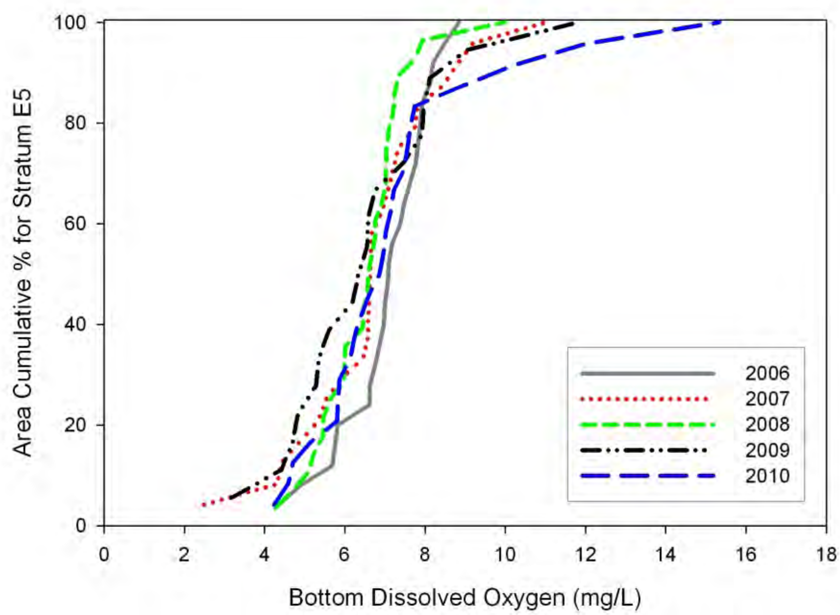

Figure B-59. Estimates of areal extent of bottom dissolved oxygen in stratum E6 (2006-2010)

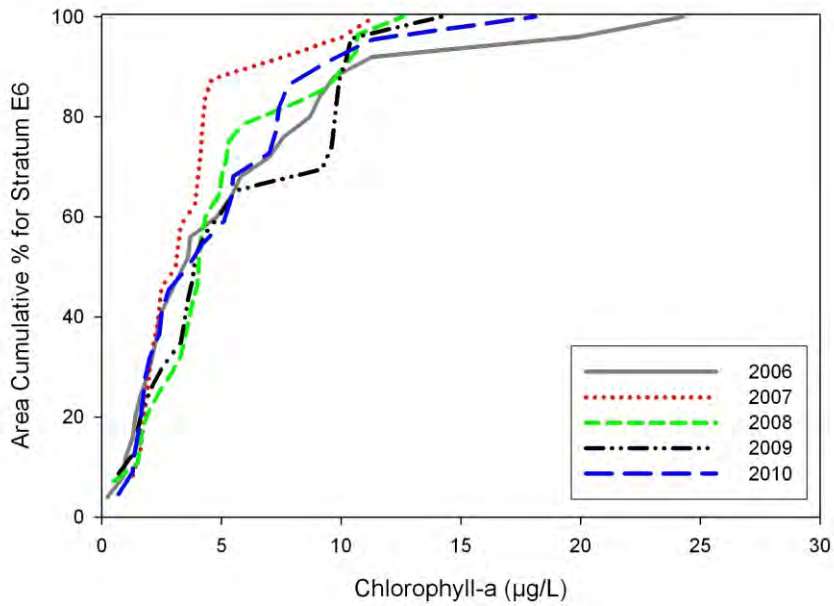

Figure B-60. Estimates of areal extent of chlorophyll-a in stratum E6 (2006-2010)

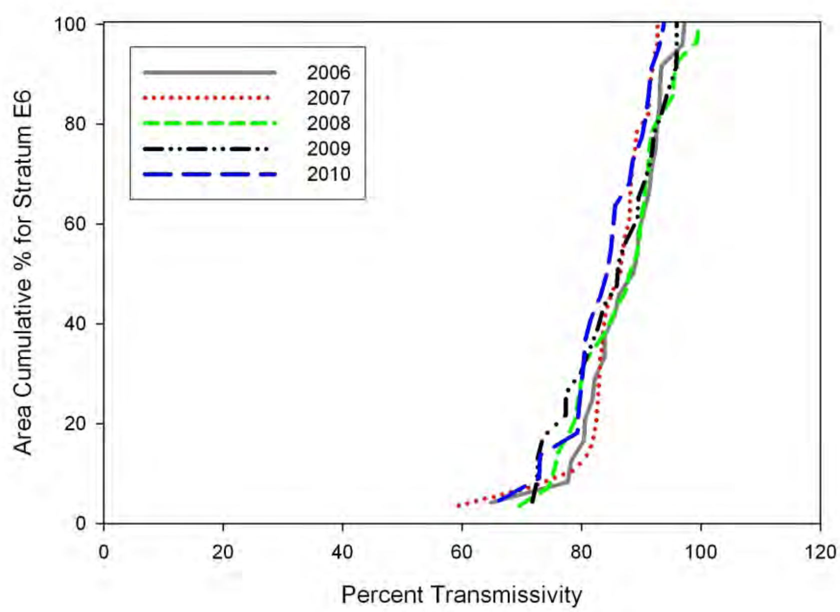

Figure B-61. Estimates of areal extent of transmissivity in stratum E6 (2006-2010)

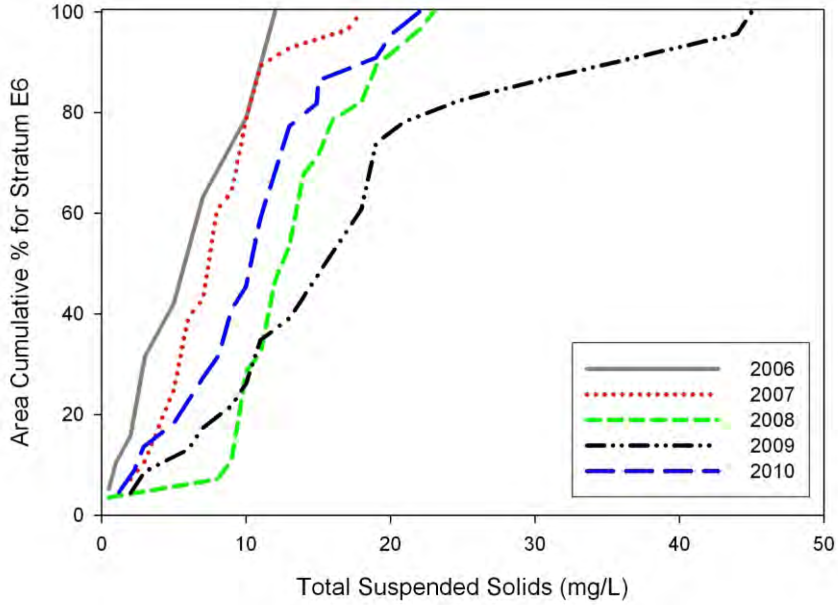

Figure B-62. Estimates of areal extent of total suspended solids in stratum E6 (2006-2010)

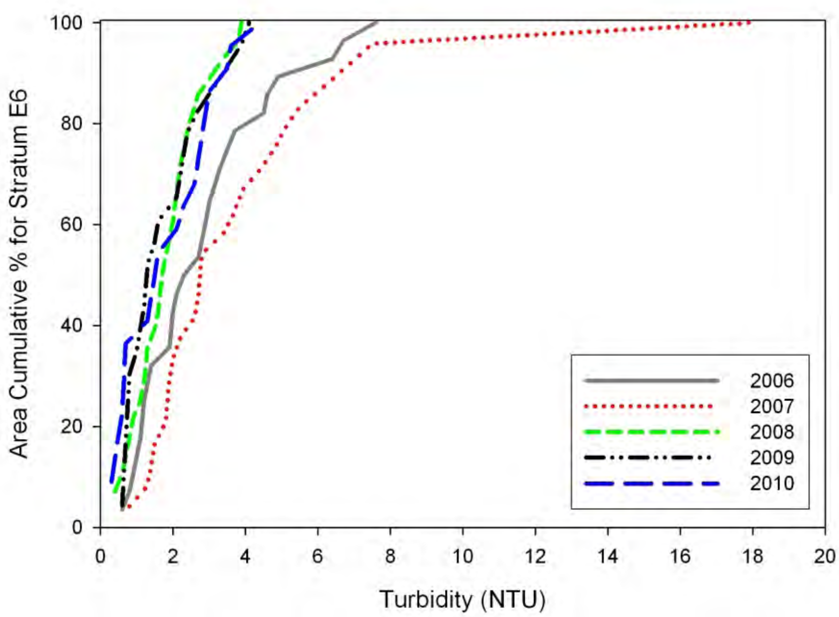

Figure B-63. Estimates of areal extent of turbidity in stratum E6 (2006-2010)

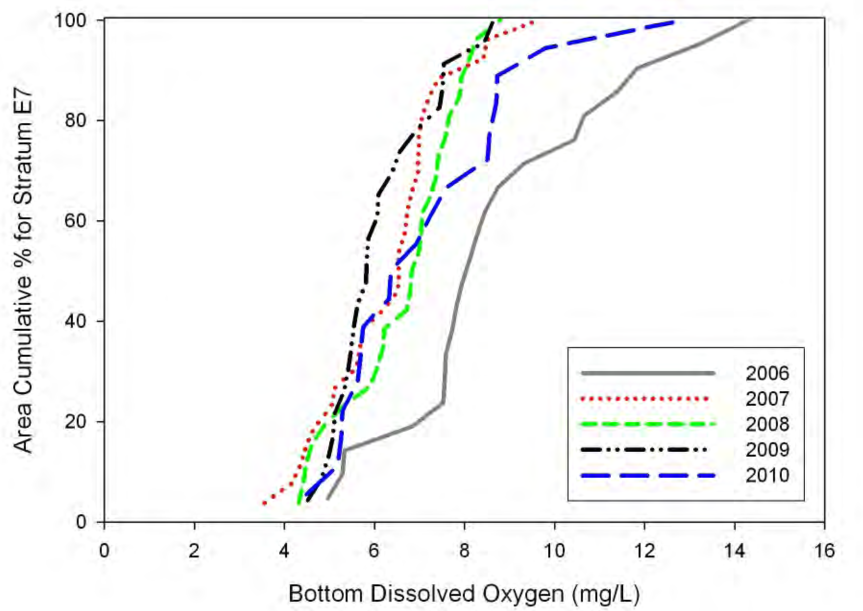

Figure B-64. Estimates of areal extent of bottom dissolved oxygen in stratum E7 (2006-2010)

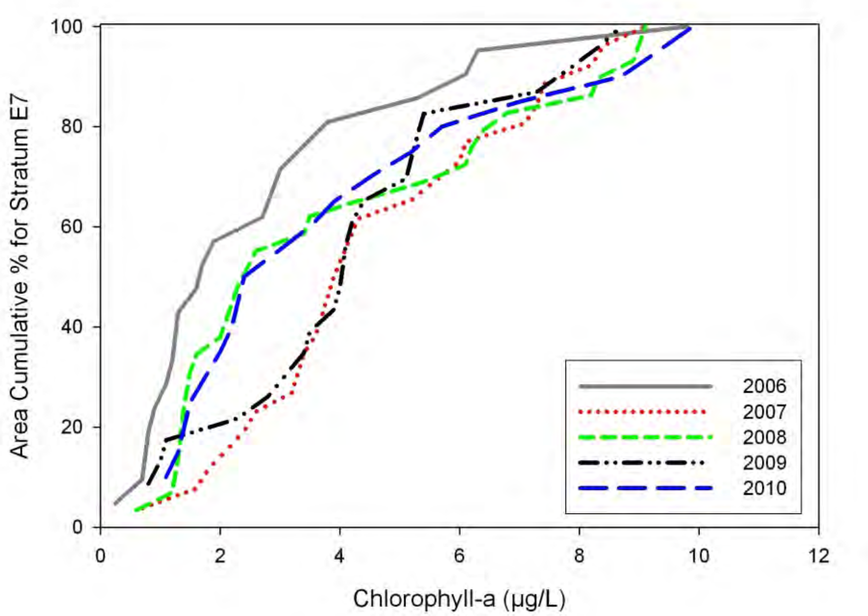

Figure B-65. Estimates of areal extent of chlorophyll-a in stratum E7 (2006-2010)

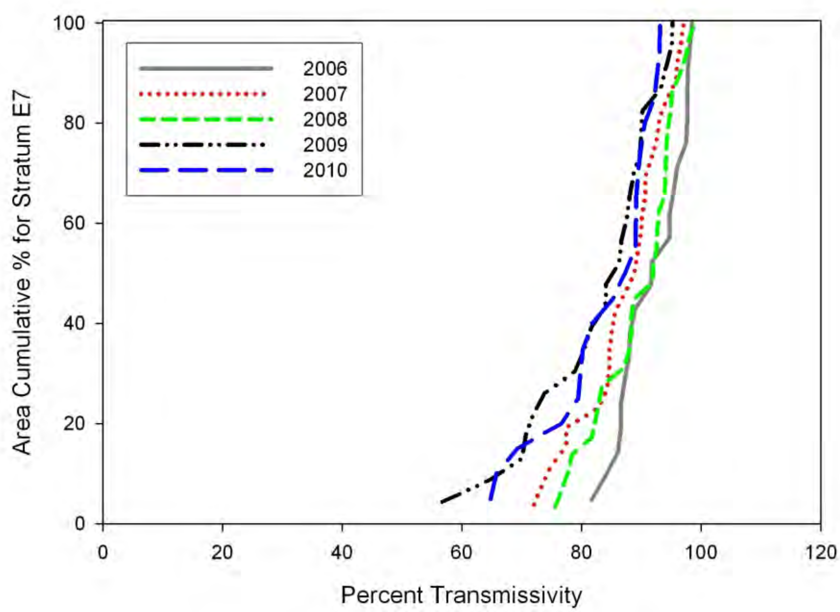

Figure B-66. Estimates of areal extent of transmissivity in stratum E7 (2006-2010)

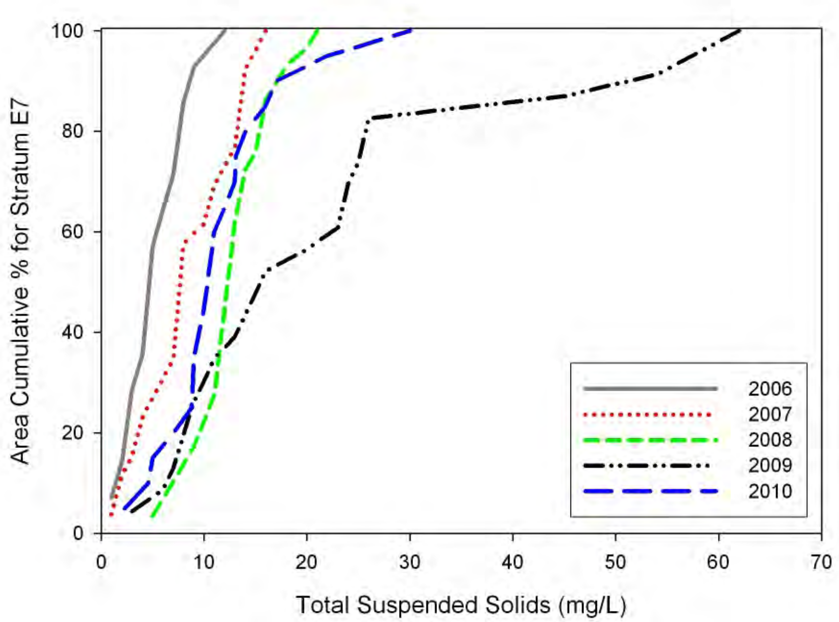

Figure B-67. Estimates of areal extent of total suspended solids in stratum E7 (2006-2010)

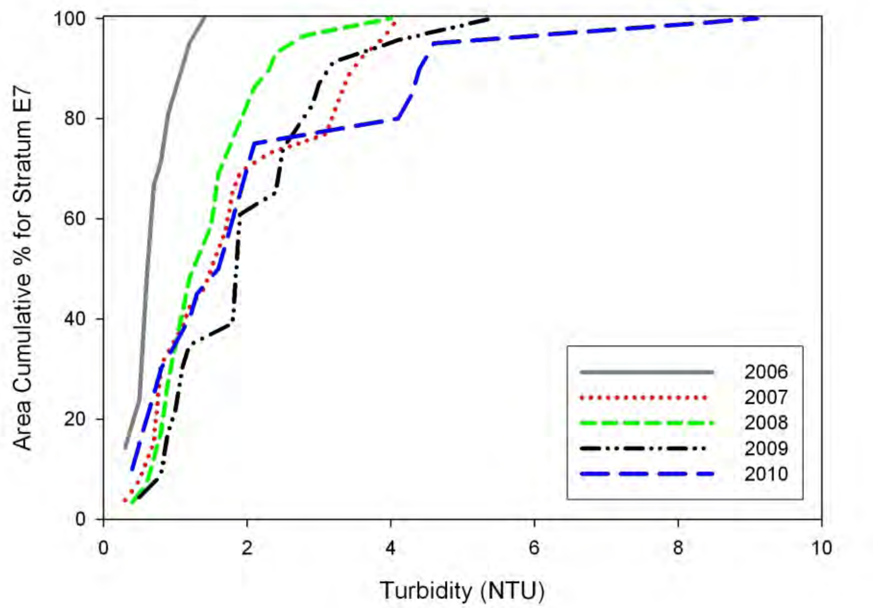

Figure B-68. Estimates of areal extent of turbidity in stratum E7 (2006-2010)

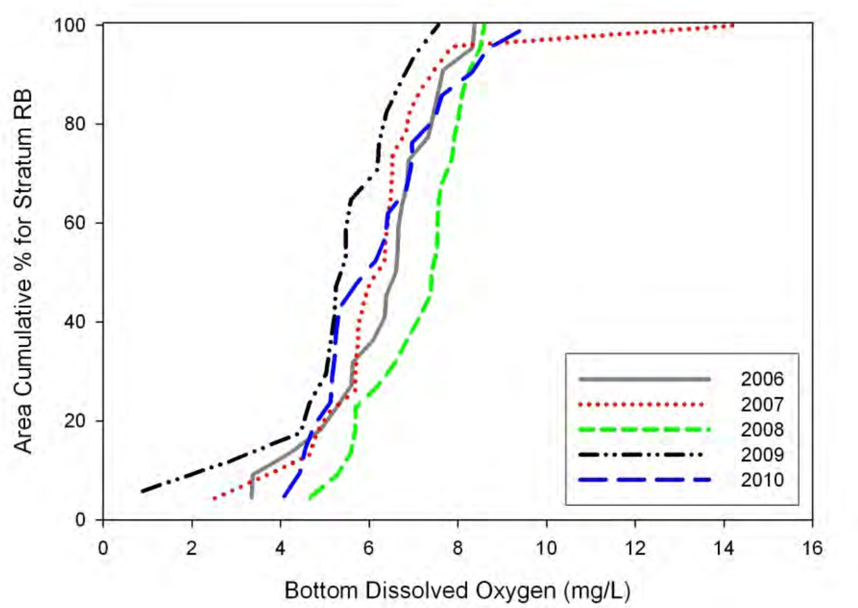

Figure B-69. Estimates of areal extent of bottom dissolved oxygen in stratum RB (2006-2010)

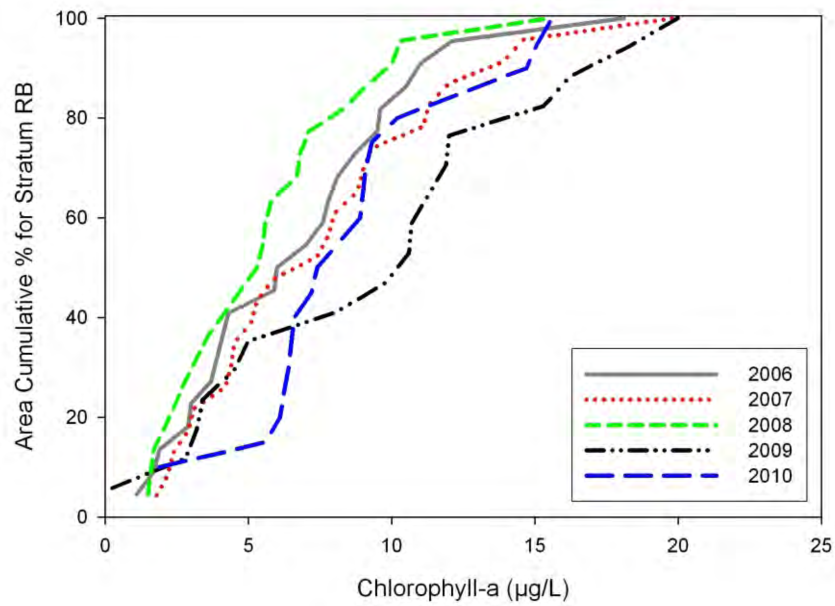

Figure B-70. Estimates of areal extent of chlorophyll-a in stratum RB (2006-2010)

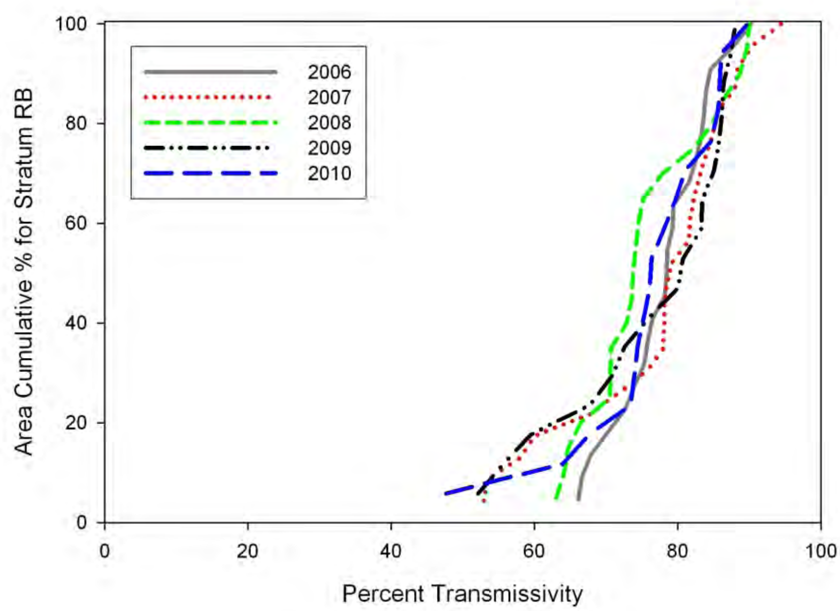

Figure B-71. Estimates of areal extent of transmissivity in stratum RB (2006-2010)

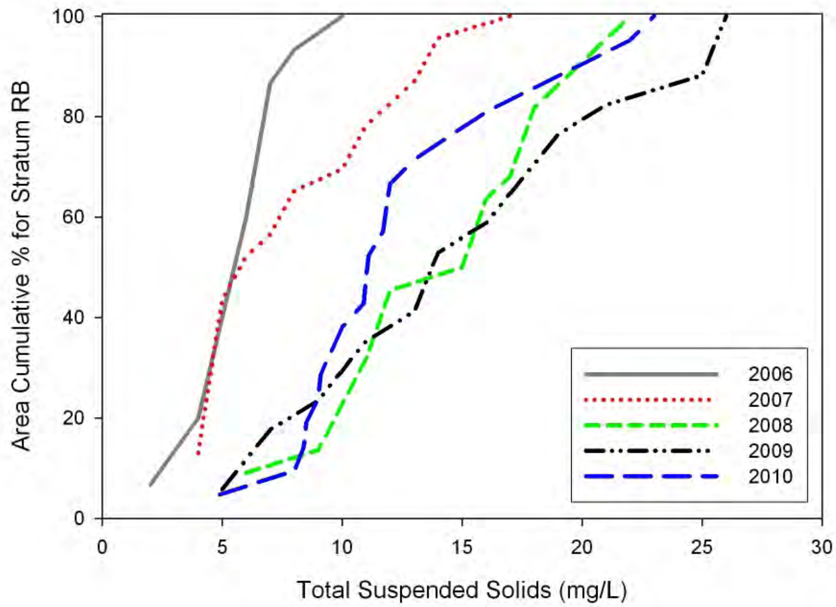

Figure B-72. Estimates of areal extent of total suspended solids in stratum RB (2006-2010)

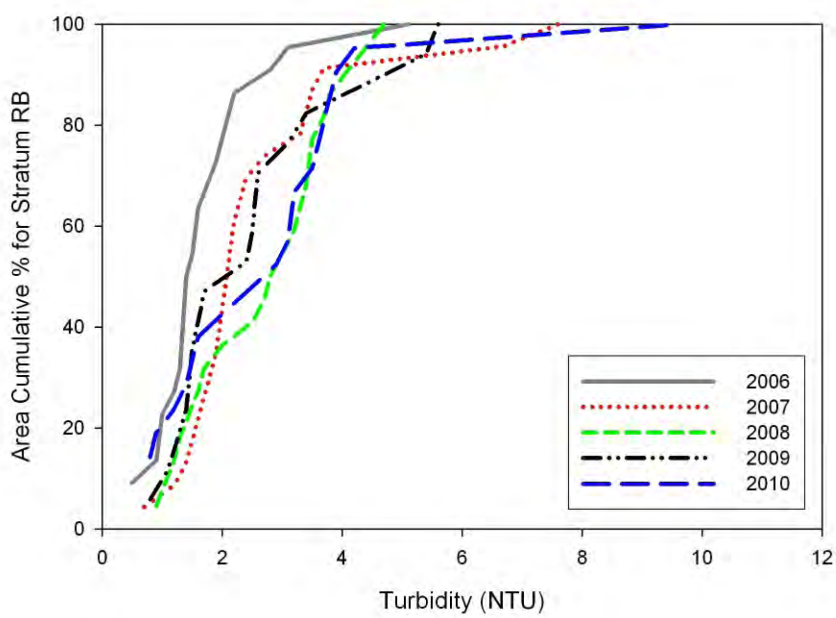

Figure B-73. Estimates of areal extent of turbidity in stratum RB (2006-2010)

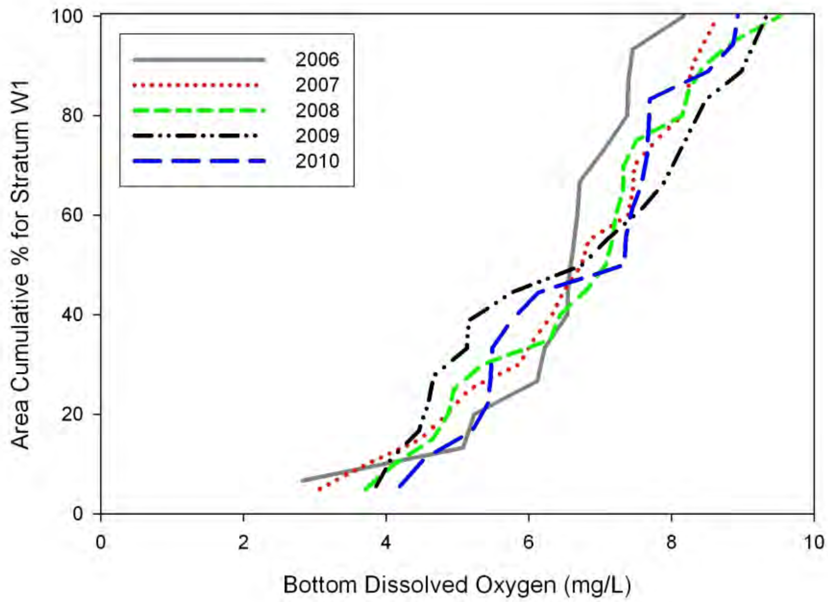

Figure B-74. Estimates of areal extent of bottom dissolved oxygen in stratum W1 (2006-2010)

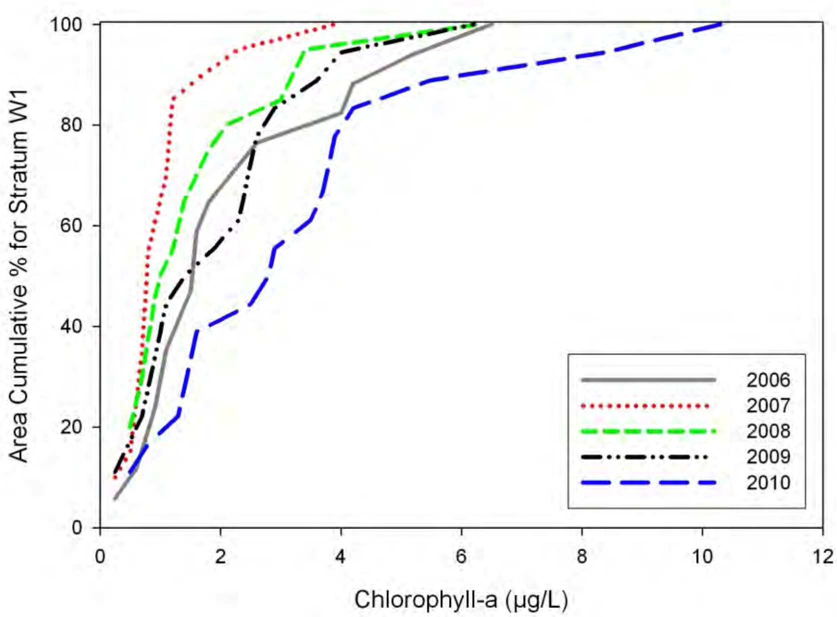

Figure B-75. Estimates of areal extent of chlorophyll-a in stratum W1 (2006-2010)

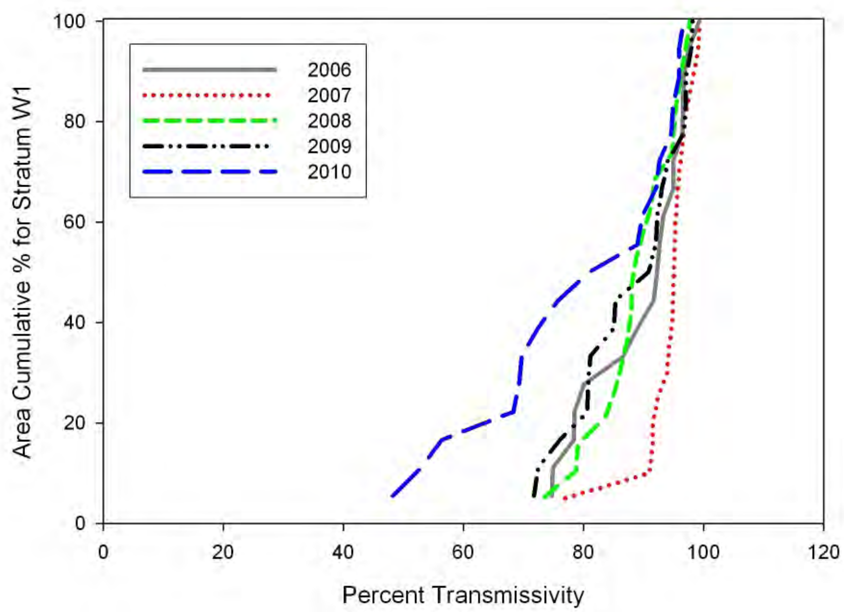

Figure B-76. Estimates of areal extent of transmissivity in stratum W1 (2006-2010)

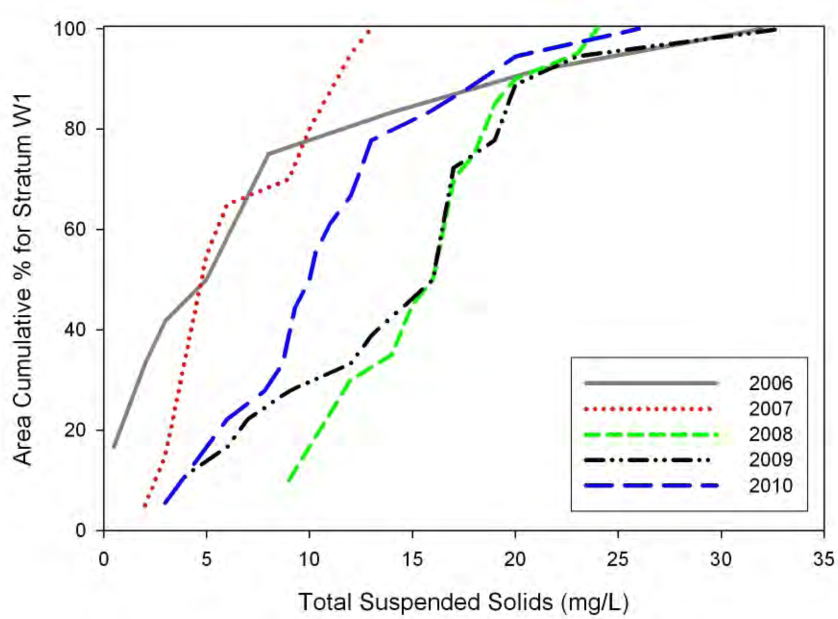

Figure B-77. Estimates of areal extent of total suspended solids in stratum W1 (2006-2010)

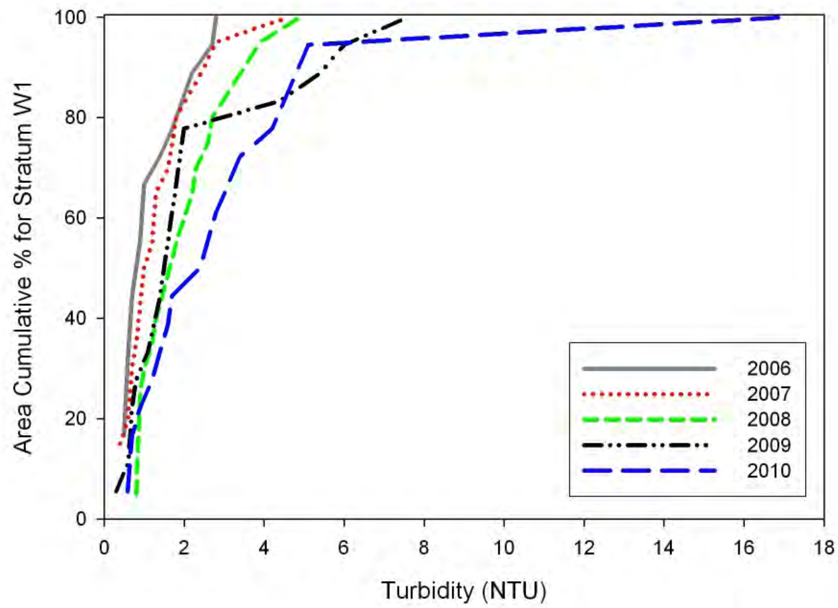

Figure B-78. Estimates of areal extent of turbidity in stratum W1 (2006-2010)

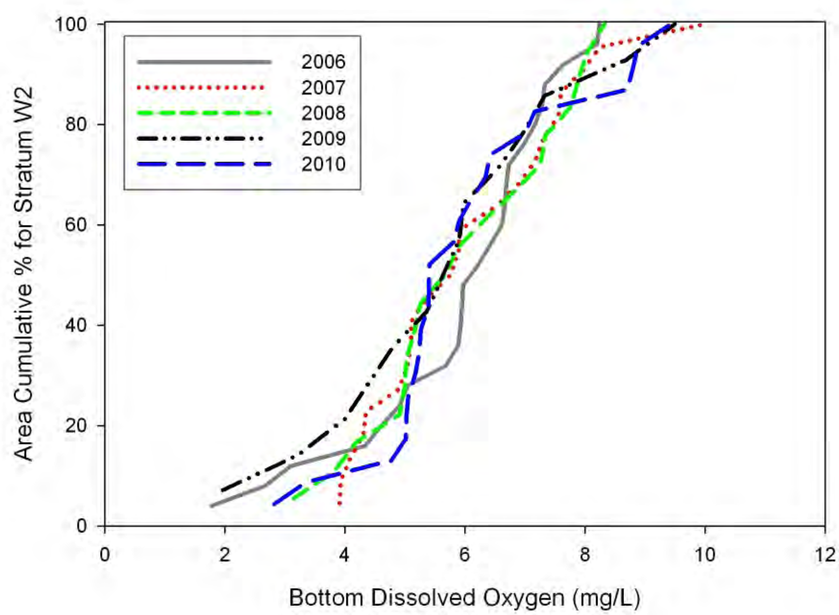

Figure B-79. Estimates of areal extent of bottom dissolved oxygen in stratum W2 (2006-2010)

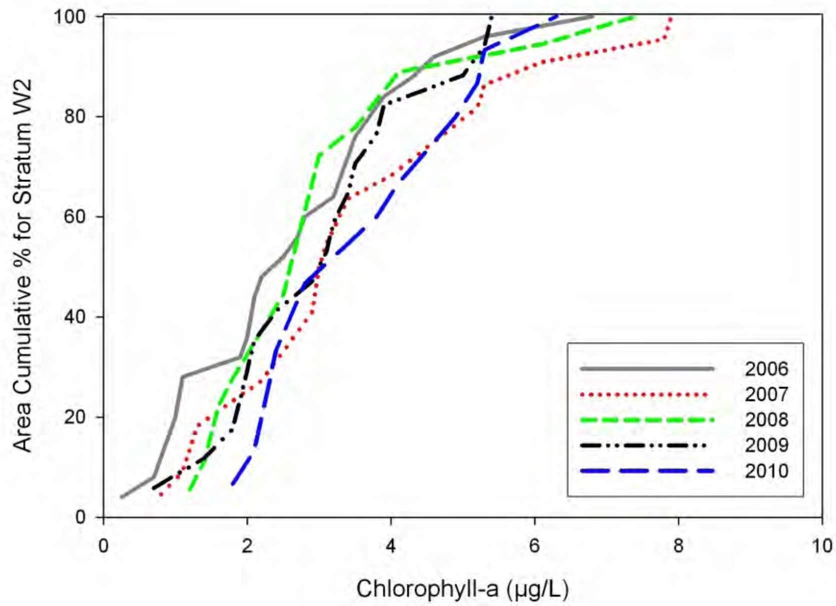

Figure B-80. Estimates of areal extent of chlorophyll-a in stratum W2 (2006-2010)

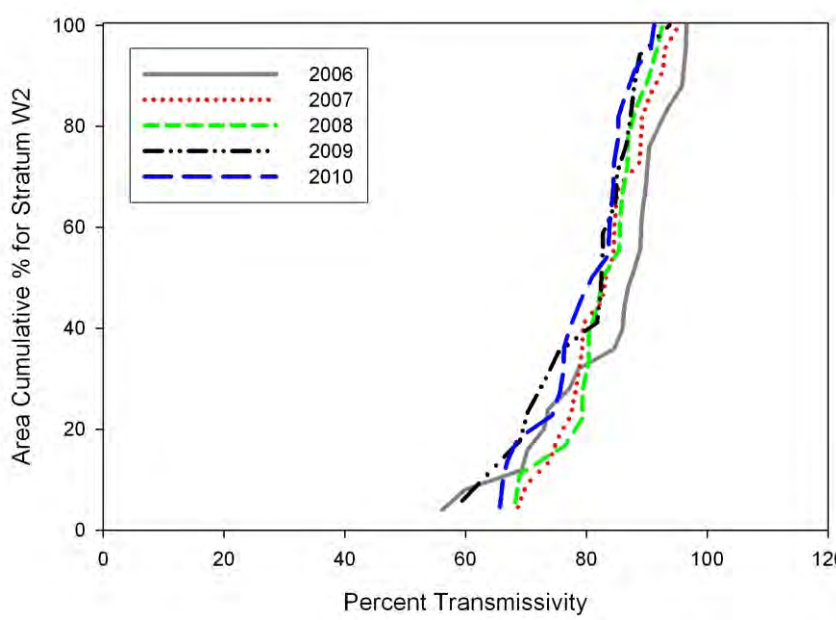

Figure B-81. Estimates of areal extent of transmissivity in stratum W2 (2006-2010)

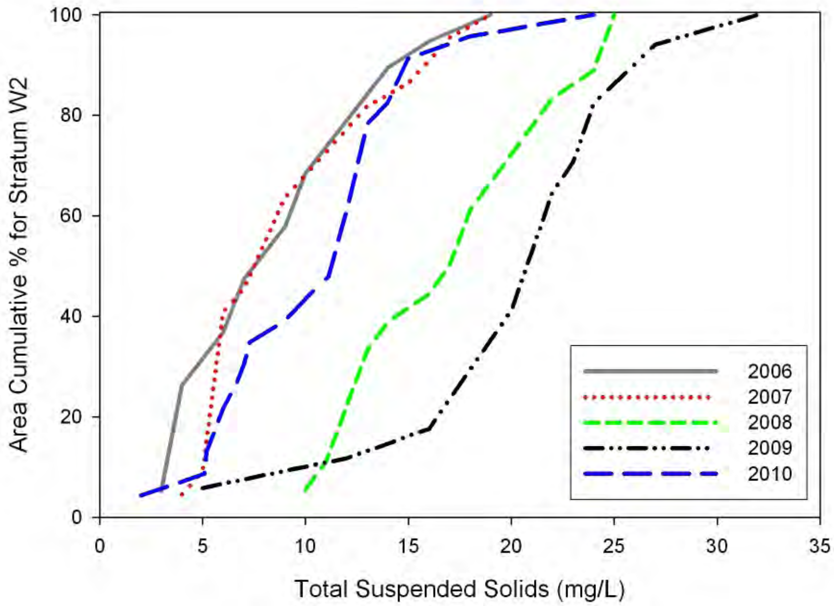

Figure B-82. Estimates of areal extent of total suspended solids in stratum W2 (2006-2010)

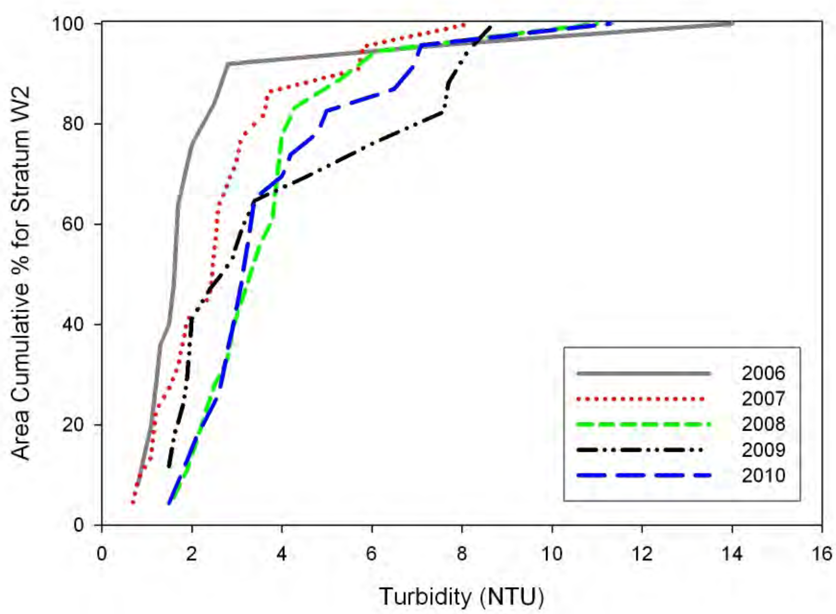

Figure B-83. Estimates of areal extent of turbidity in stratum W2 (2006-2010)

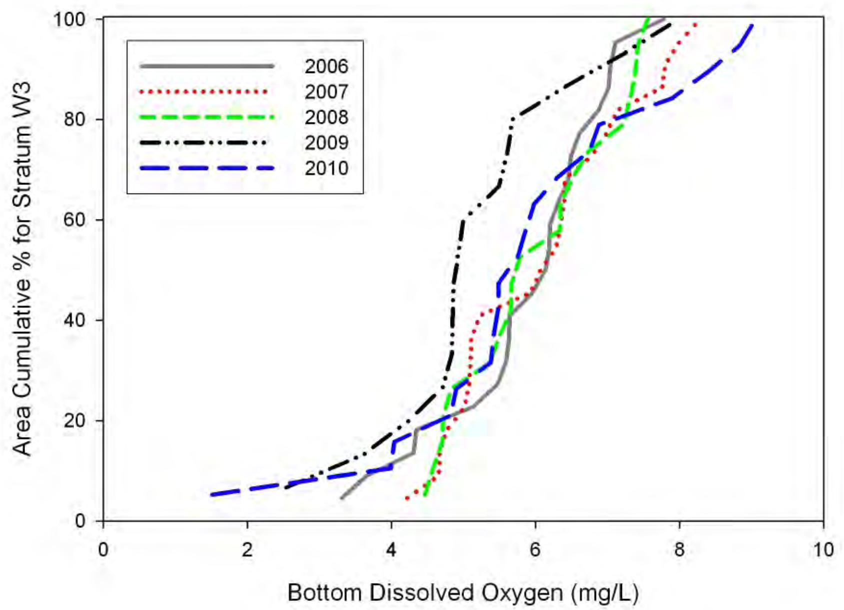

Figure B-84. Estimates of areal extent of bottom dissolved oxygen in stratum W3 (2006-2010)

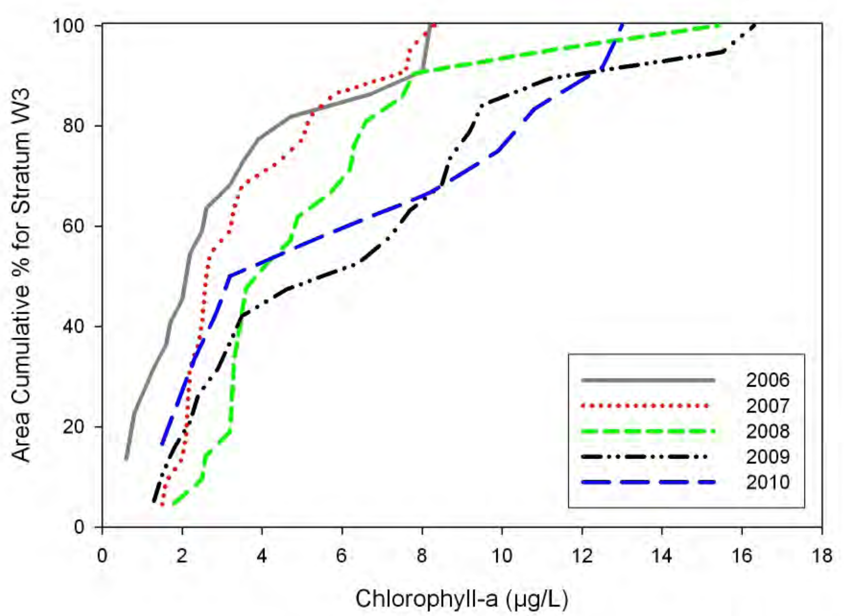

Figure B-85. Estimates of areal extent of chlorophyll-a in stratum W3 (2006-2010)

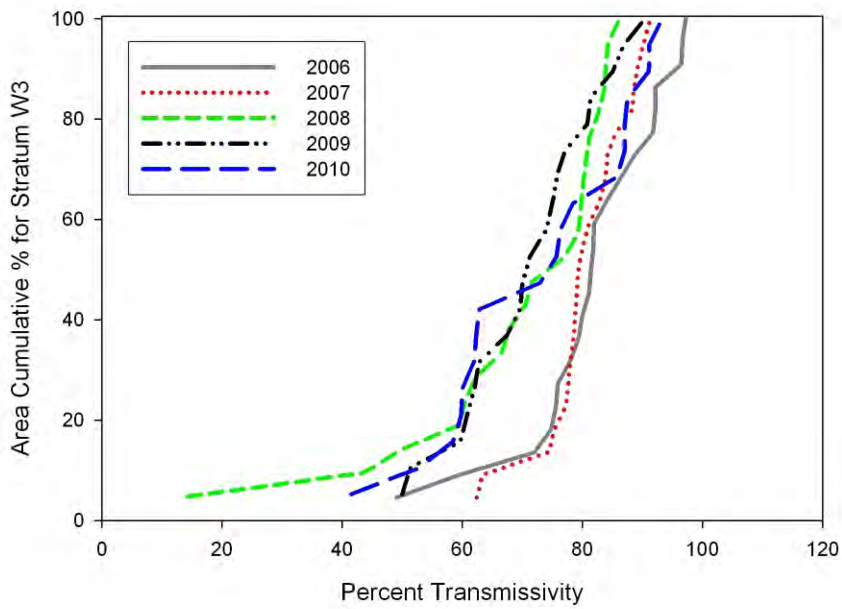

Figure B-86. Estimates of areal extent of transmissivity in stratum W3 (2006-2010)

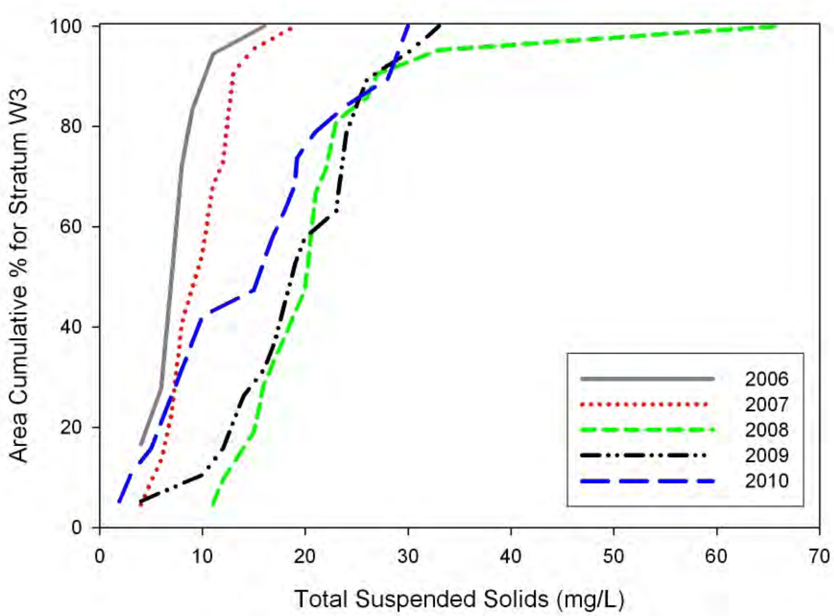

Figure B-87. Estimates of areal extent of total suspended solids in stratum W3 (2006-2010)

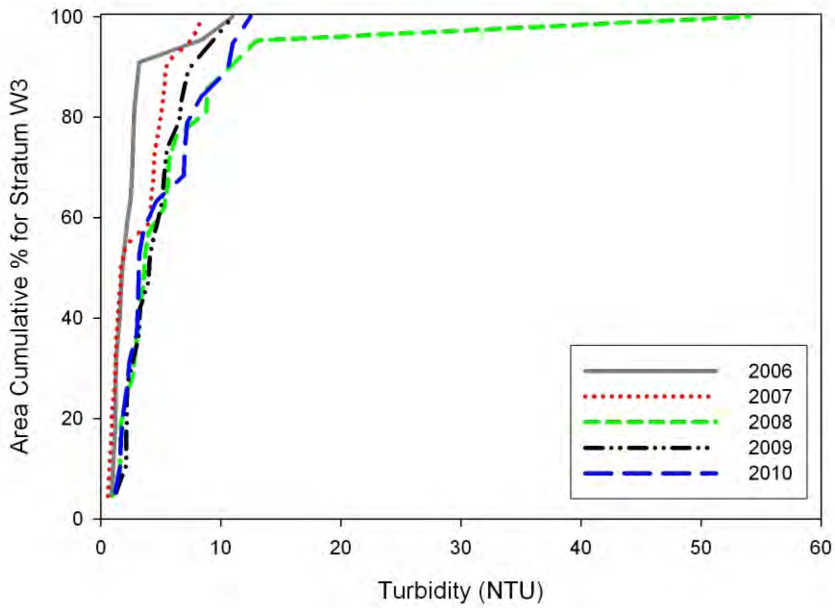

Figure B-88. Estimates of areal extent of turbidity in stratum W3 (2006-2010)

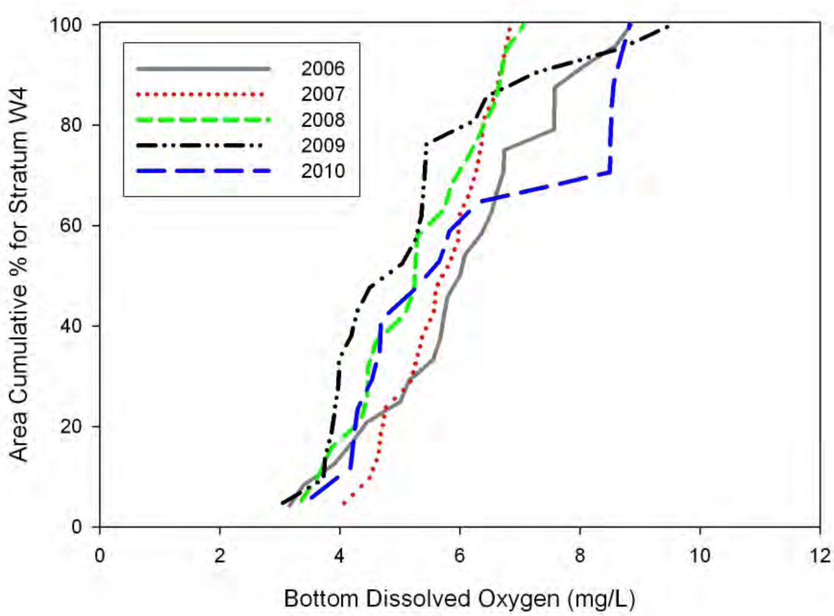

Figure B-89. Estimates of areal extent of bottom dissolved oxygen in stratum W4 (2006-2010)

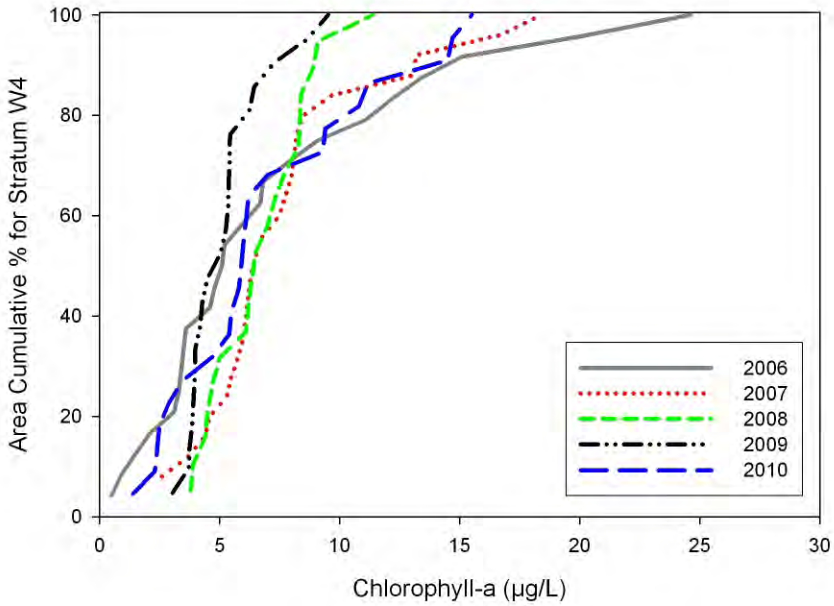

Figure B-90. Estimates of areal extent of chlorophyll-a in stratum W4 (2006-2010)

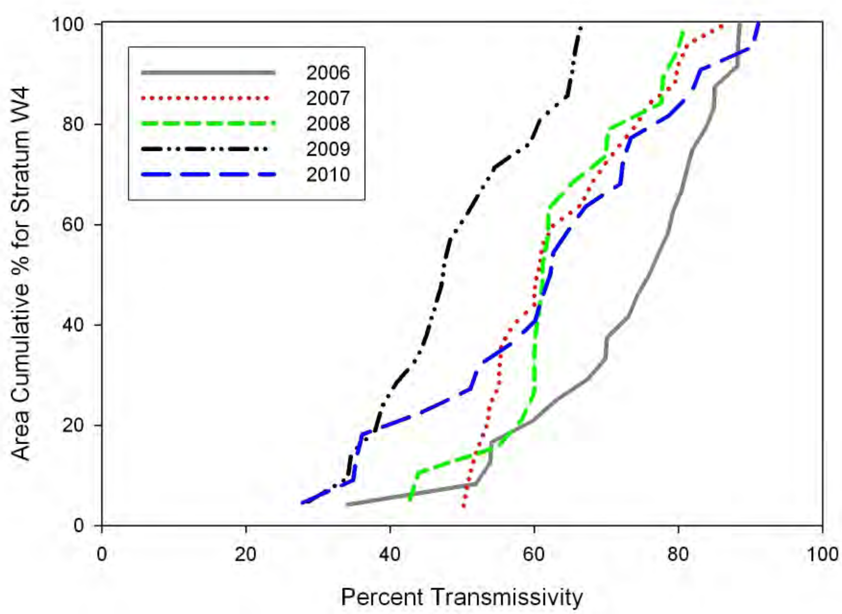

Figure B-91. Estimates of areal extent of transmissivity in stratum W4 (2006-2010)

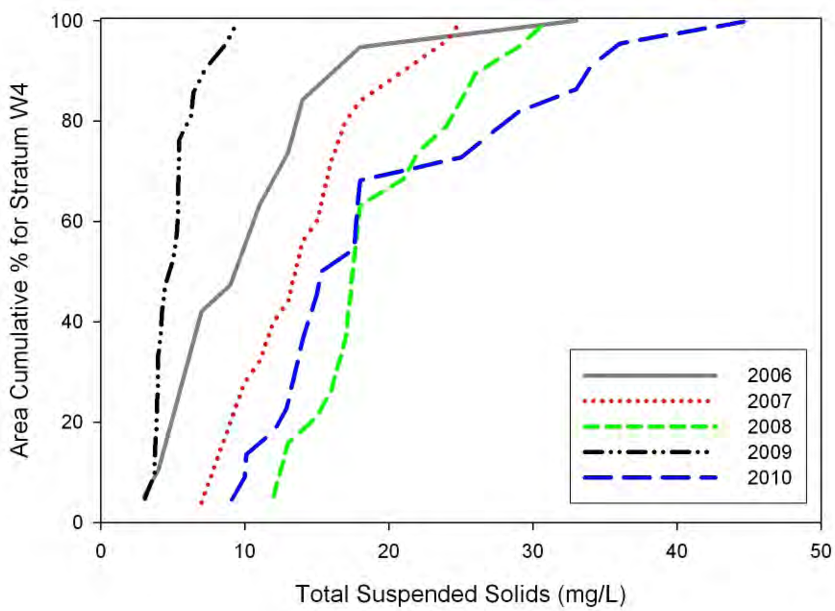

Figure B-92. Estimates of areal extent of total suspended solids in stratum W4 (2006-2010)

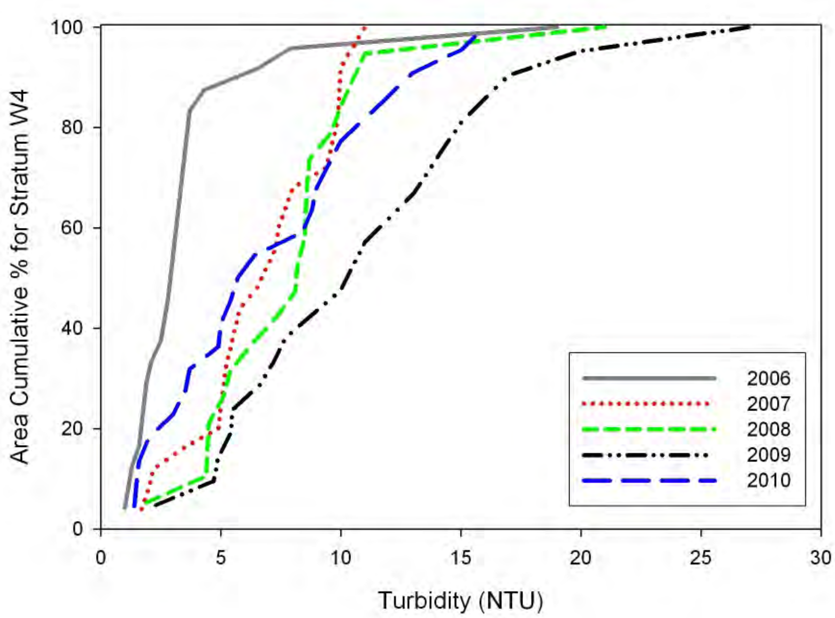

Figure B-93. Estimates of areal extent of turbidity in stratum W4 (2006-2010)

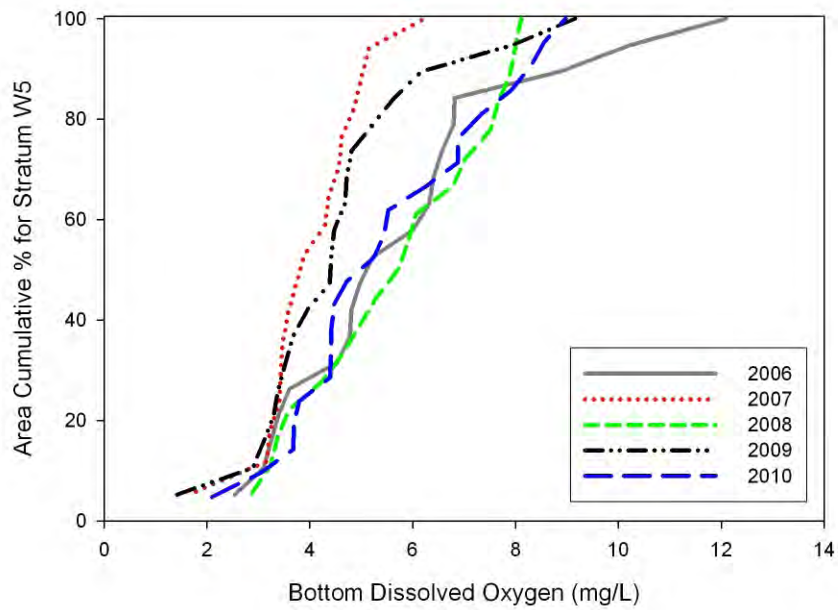

Figure B-94. Estimates of areal extent of bottom dissolved oxygen in stratum W5 (2006-2010)

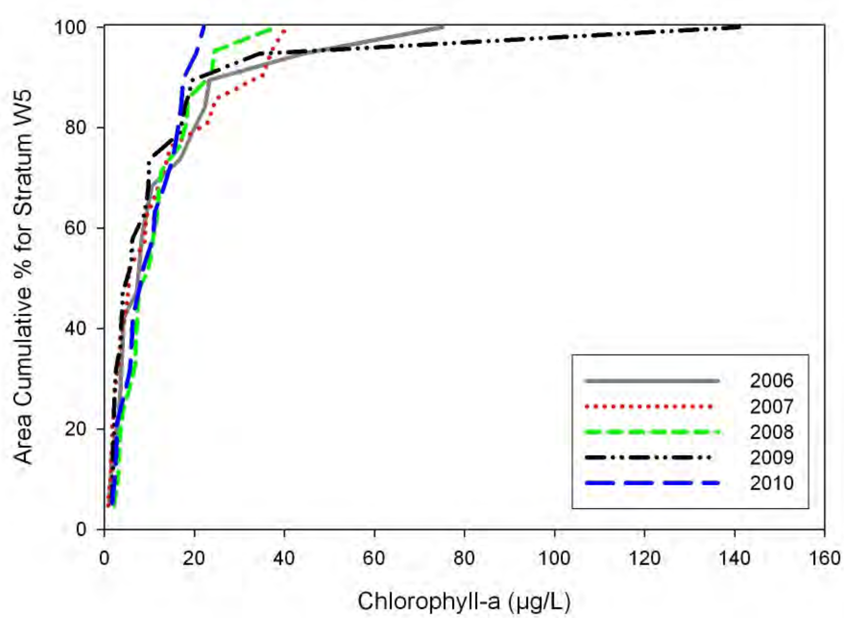

Figure B-95. Estimates of areal extent of chlorophyll-a in stratum W5 (2006-2010)

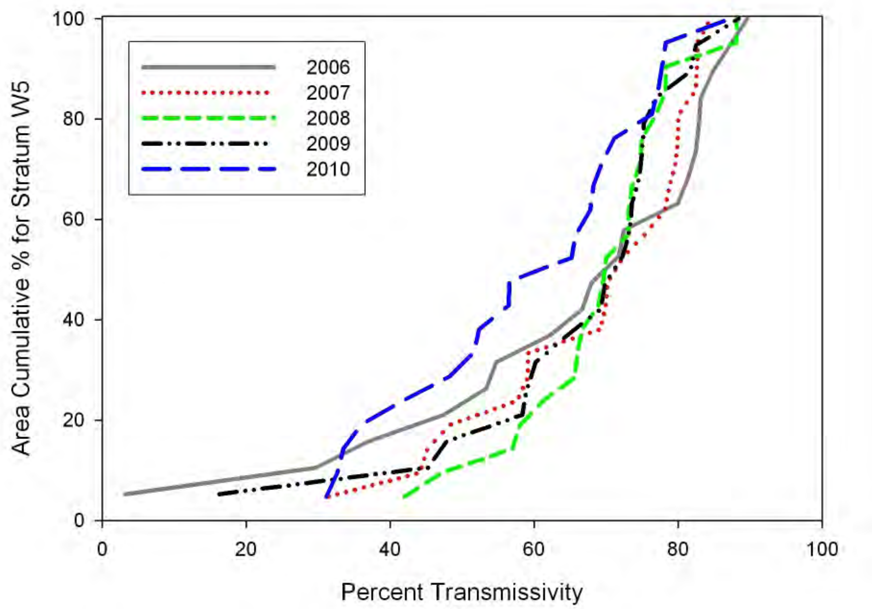

Figure B-96. Estimates of areal extent of transmissivity in stratum W5 (2006-2010)

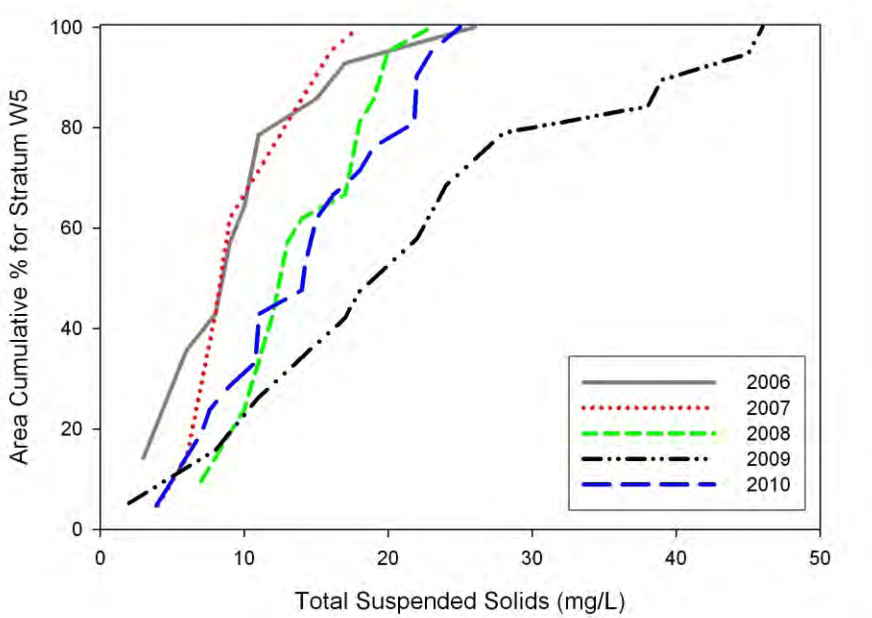

Figure B-97. Estimates of areal extent of total suspended solids in stratum W5 (2006-2010)

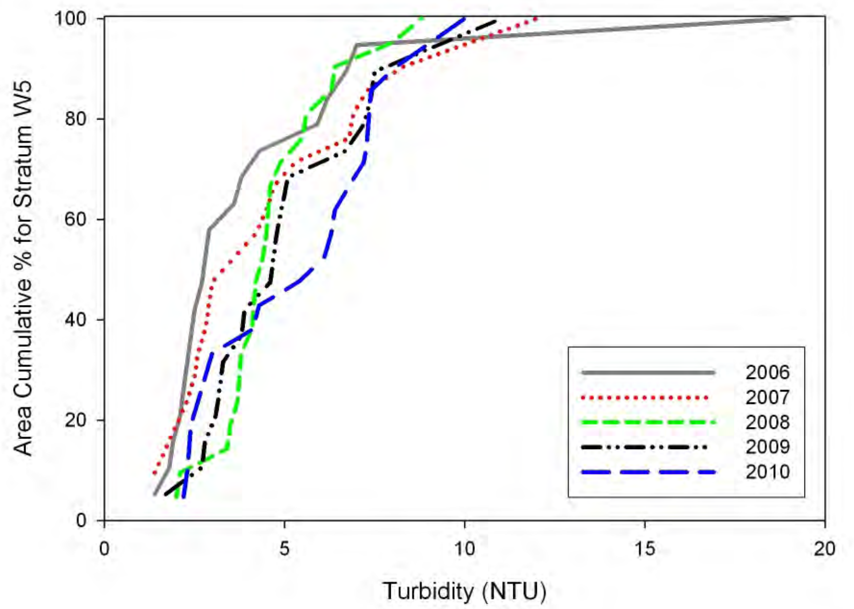

Figure B-98. Estimates of areal extent of turbidity in stratum W5 (2006-2010)

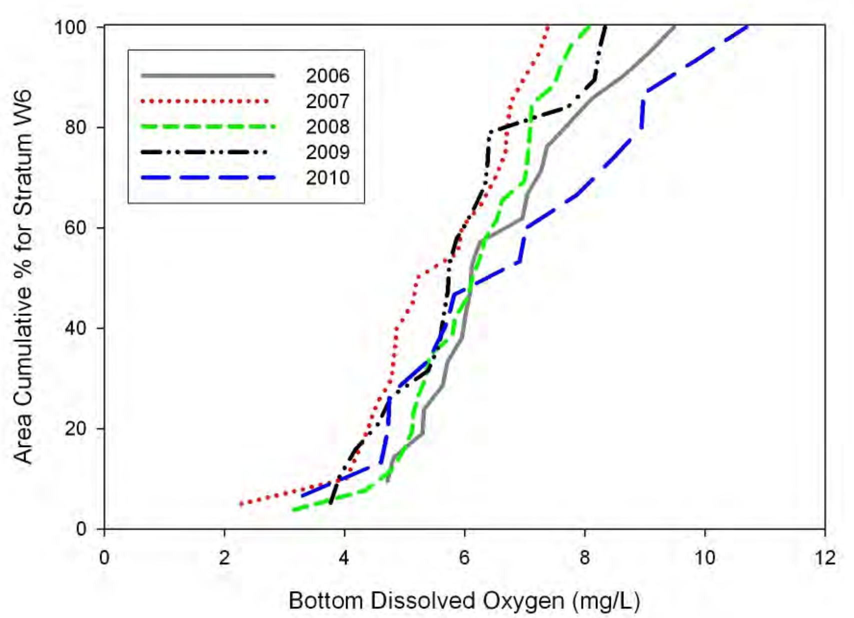

Figure B-99. Estimates of areal extent of bottom dissolved oxygen in stratum W6 (2006-2010)

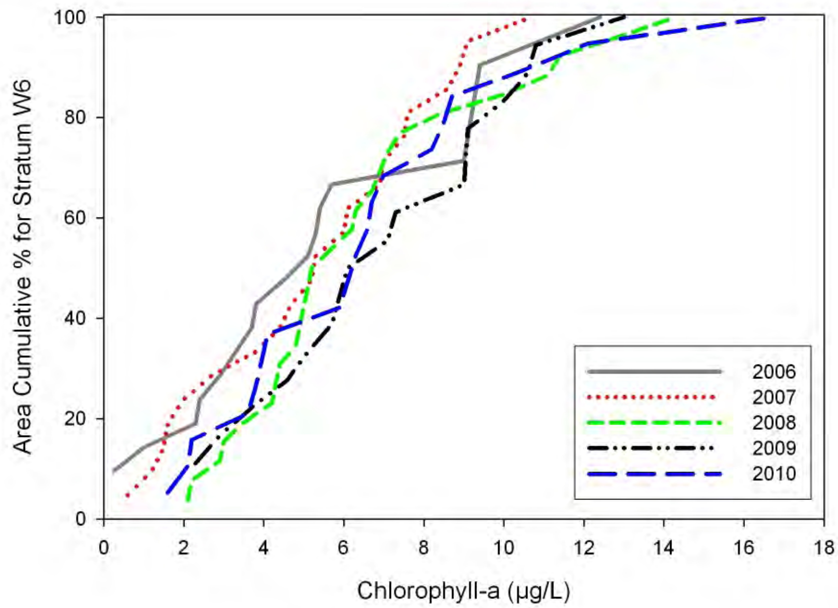

Figure B-100. Estimates of areal extent of chlorophyll-a in stratum W6 (2006-2010)

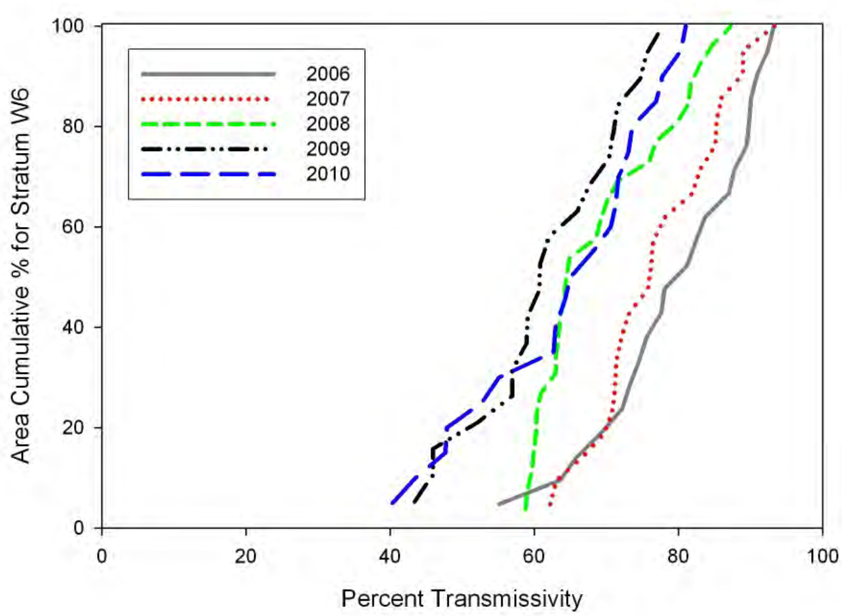

Figure B-101. Estimates of areal extent of transmissivity in stratum W6 (2006-2010)

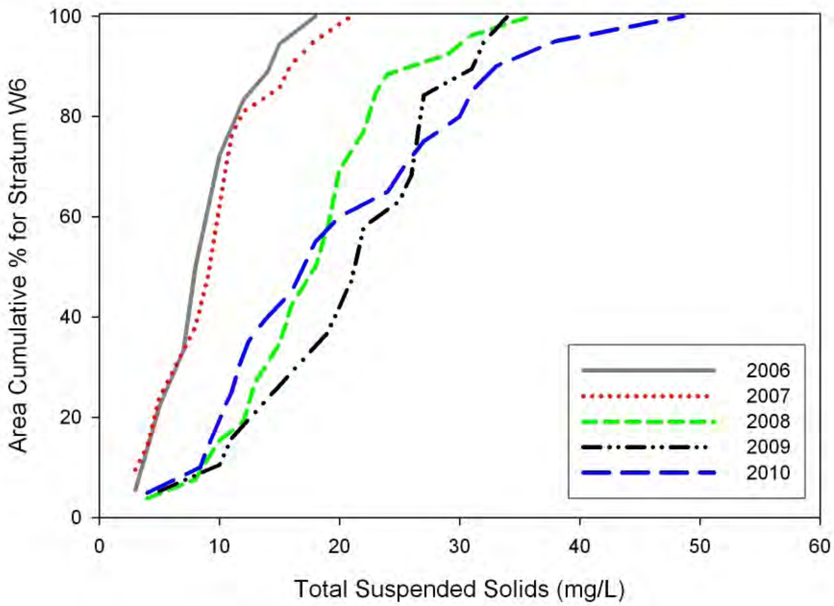

Figure B-102. Estimates of areal extent of total suspended solids in stratum W6 (2006-2010)

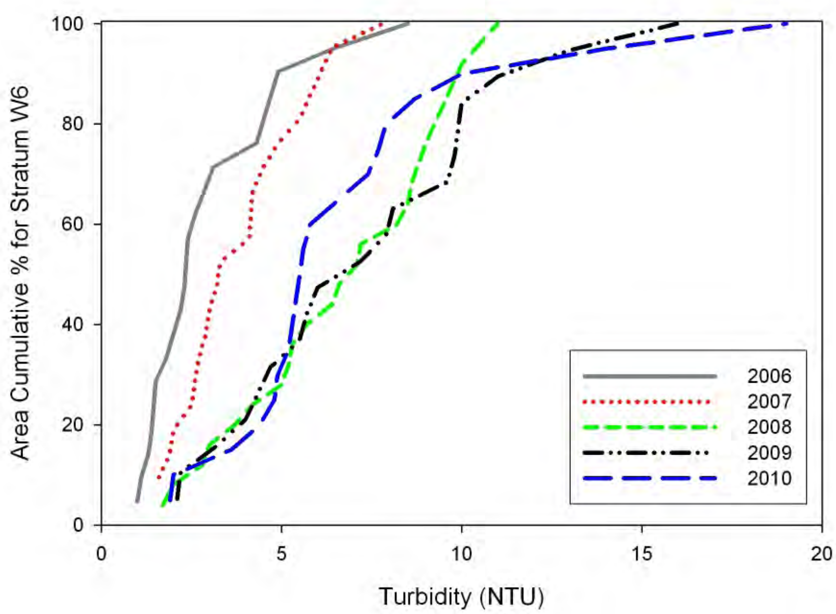

Figure B-103. Estimates of areal extent of turbidity in stratum W6 (2006-2010)

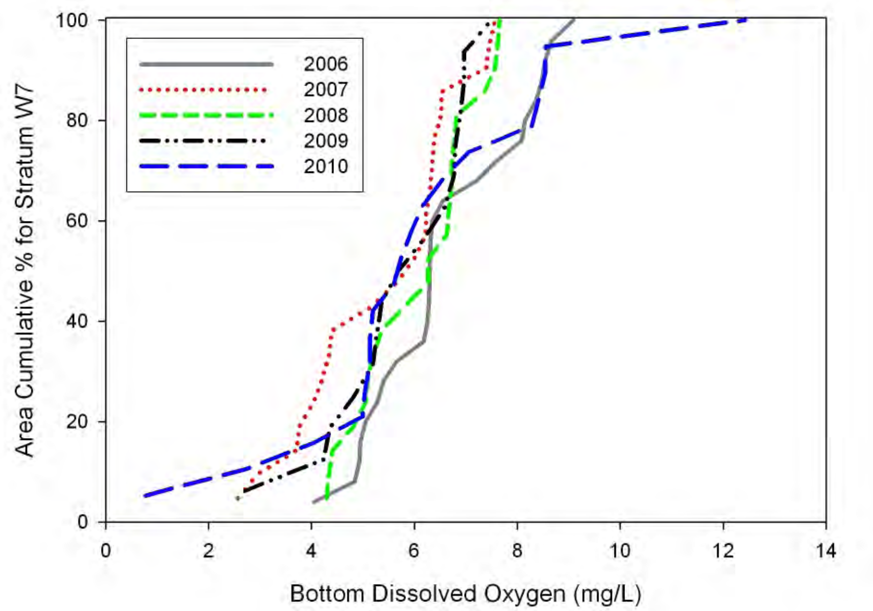

Figure B-104. Estimates of areal extent of bottom dissolved oxygen in stratum W7 (2006-2010)

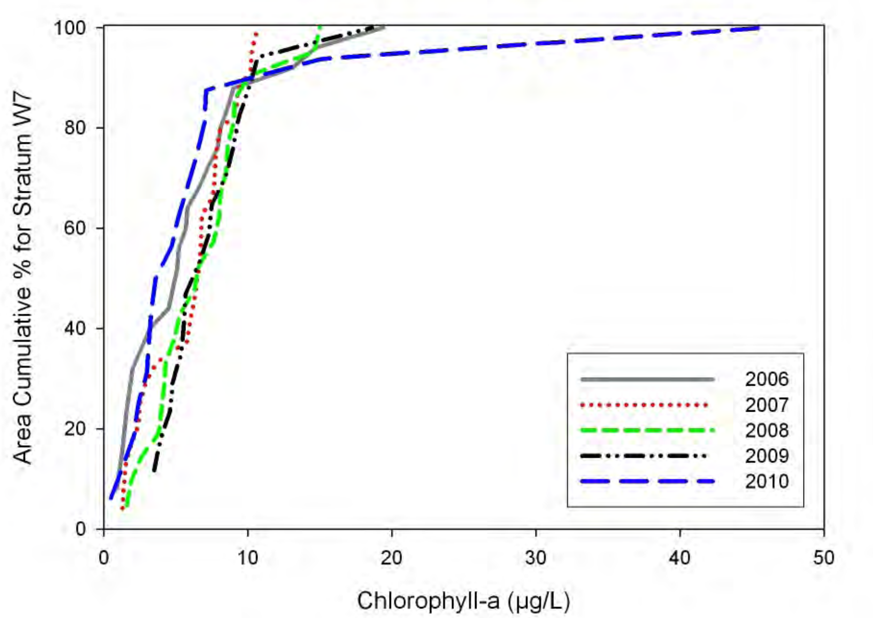

Figure B-105. Estimates of areal extent of chlorophyll-a in stratum W7 (2006-2010)

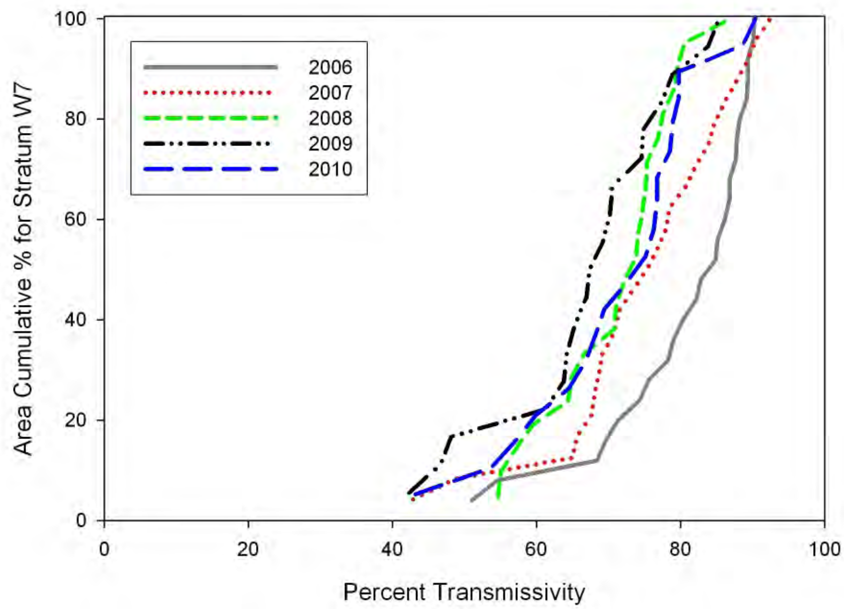

Figure B-106. Estimates of areal extent of transmissivity in stratum W7 (2006-2010)

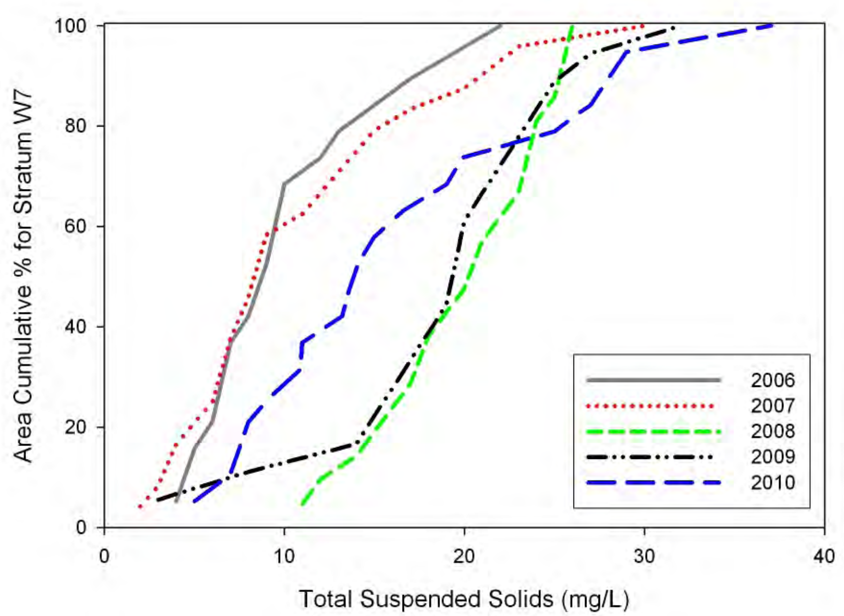

Figure B-107. Estimates of areal extent of total suspended solids in stratum W7 (2006-2010)

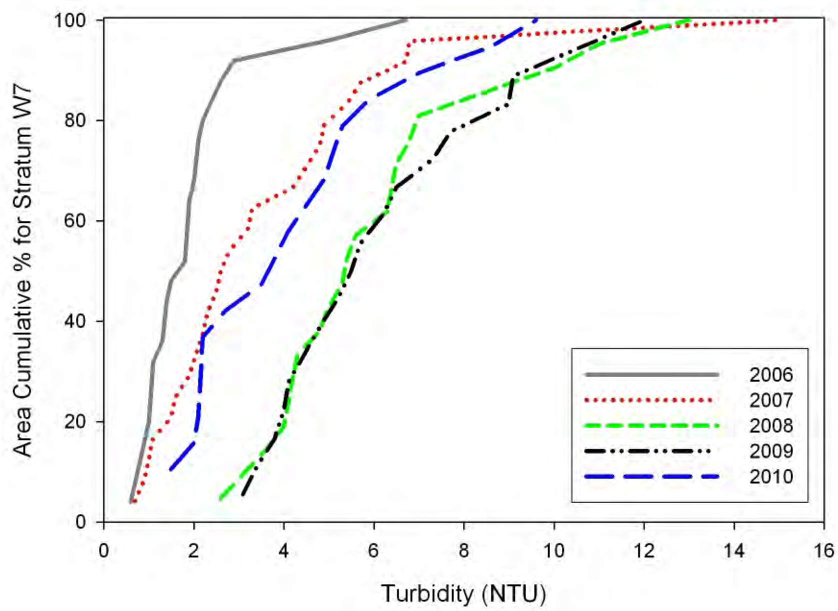

Figure B-108. Estimates of areal extent of turbidity in stratum W7 (2006-2010)

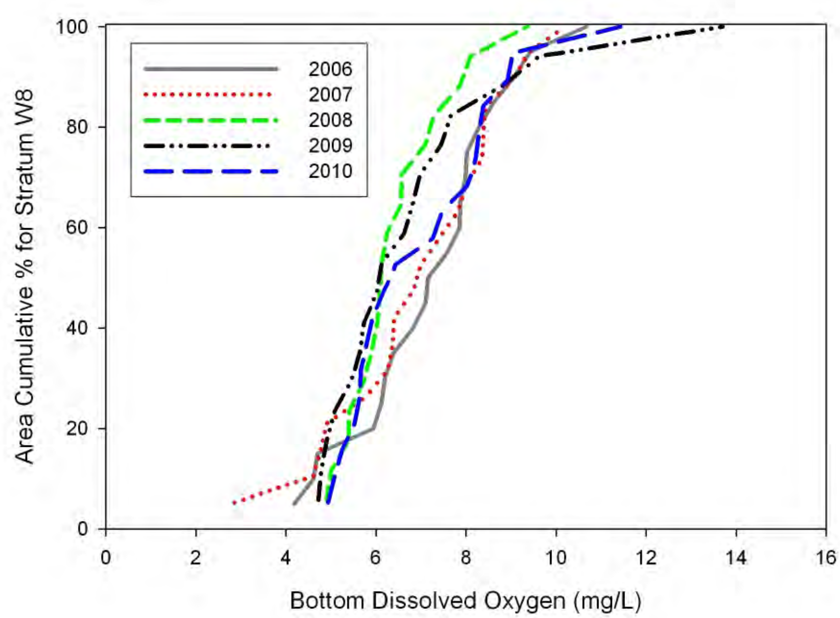

Figure B-109. Estimates of areal extent of bottom dissolved oxygen in stratum W8 (2006-2010)

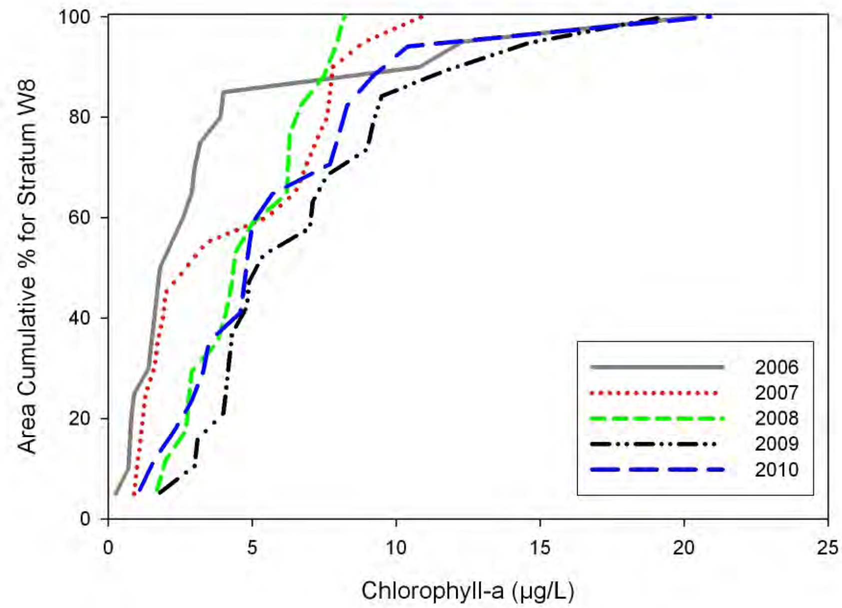

Figure B-110. Estimates of areal extent of chlorophyll-a in stratum W8 (2006-2010)

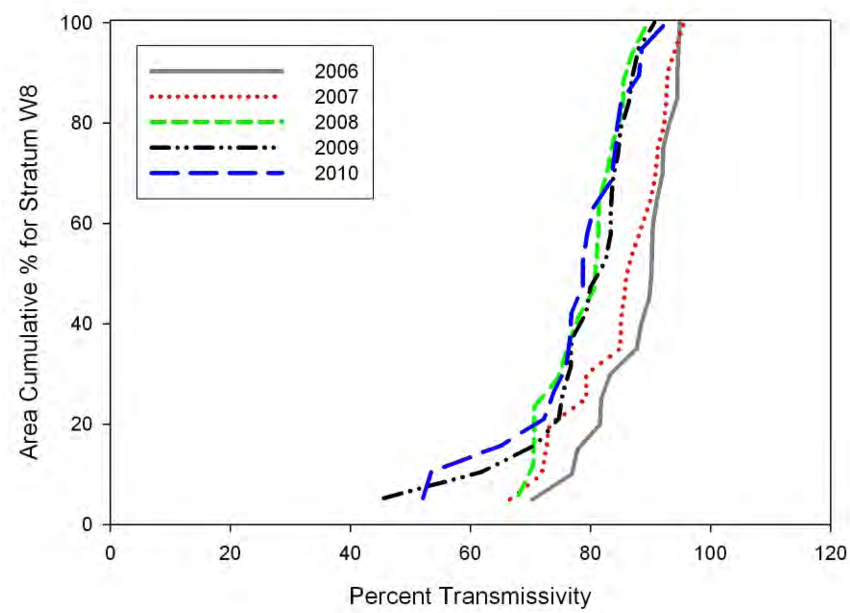

Figure B-111. Estimates of areal extent of transmissivity in stratum W8 (2006-2010)

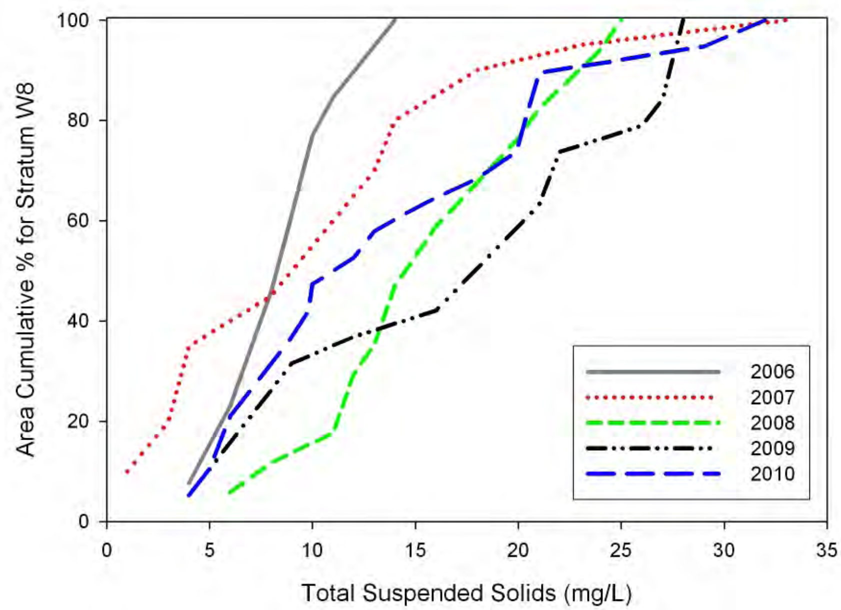

Figure B-112. Estimates of areal extent of total suspended solids in stratum W8 (2006-2010)

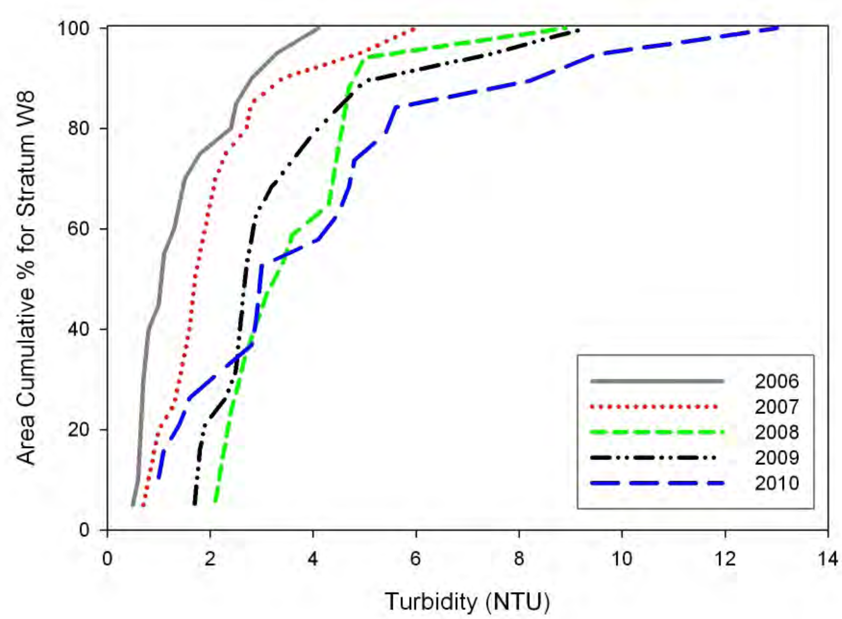

Figure B-113. Estimates of areal extent of turbidity in stratum W8 (2006-2010)

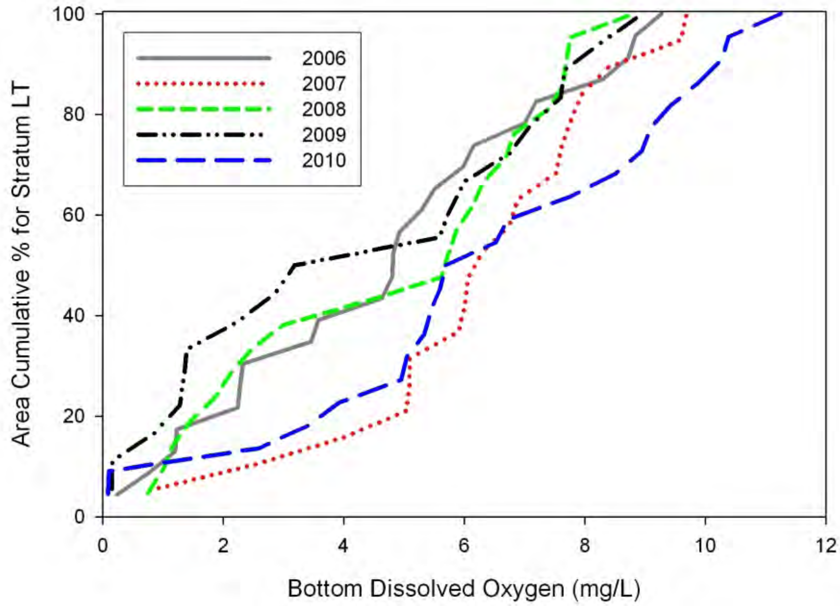

Figure B-114. Estimates of areal extent of bottom dissolved oxygen in LT (2006-2010)

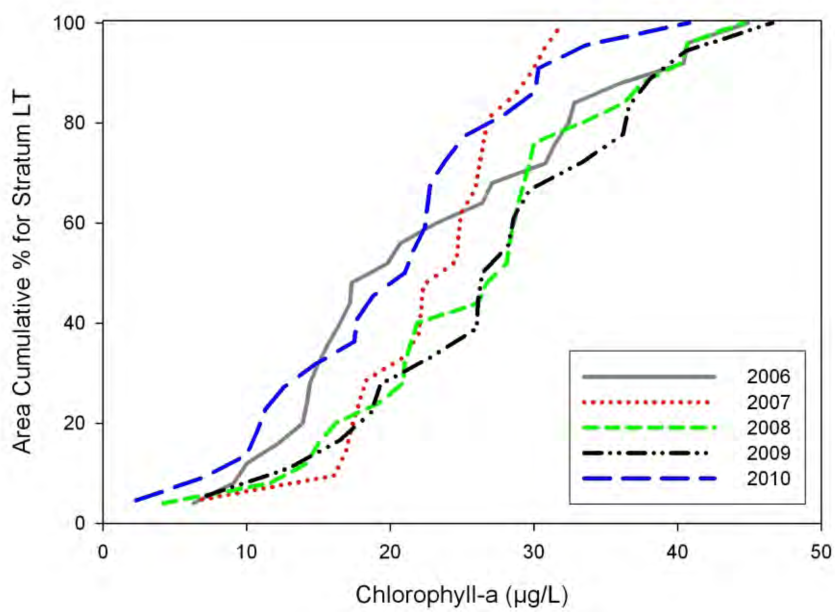

Figure B-115. Estimates of areal extent of chlorophyll-a in LT (2006-2010)

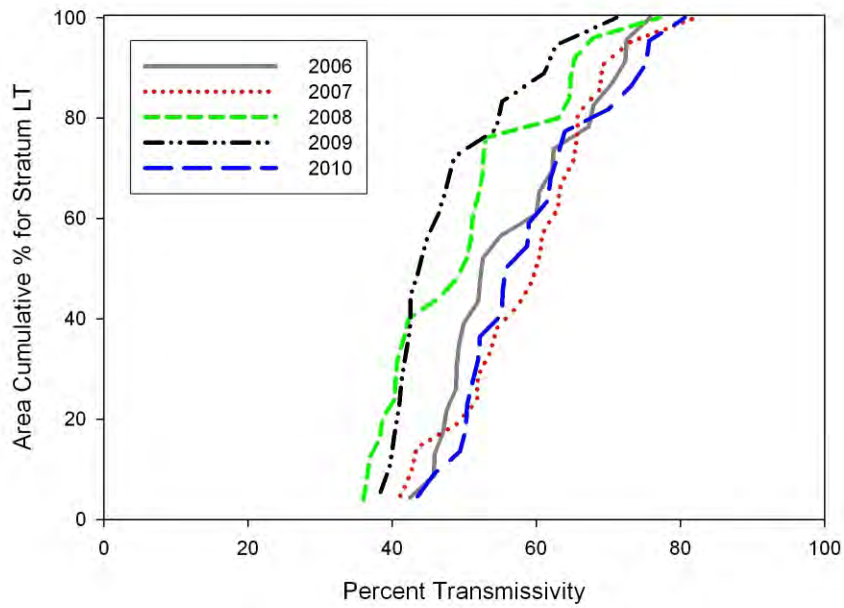

Figure B-116. Estimates of areal extent of transmissivity in LT (2006-2010)

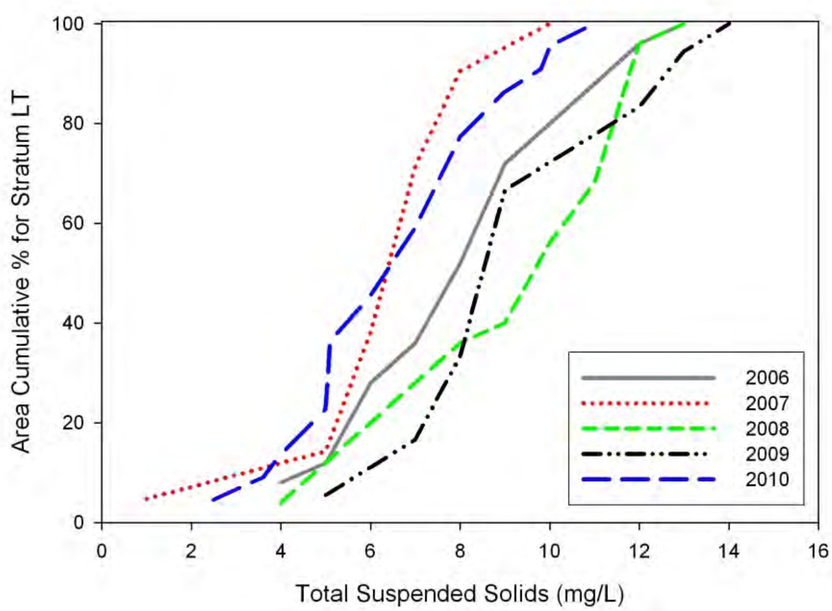

Figure B-117. Estimates of areal extent of total suspended solids in LT (2006-2010)

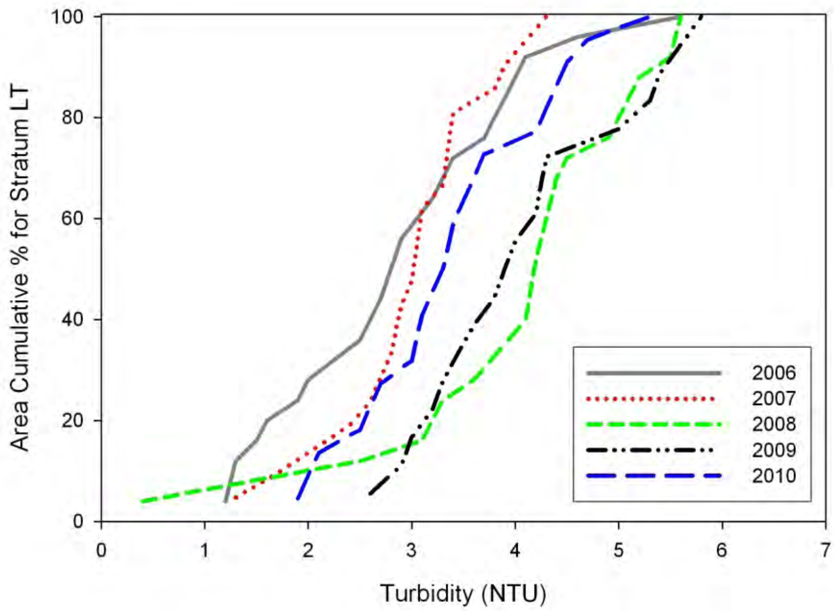

Figure B-118. Estimates of areal extent of turbidity in LT (2006-2010)

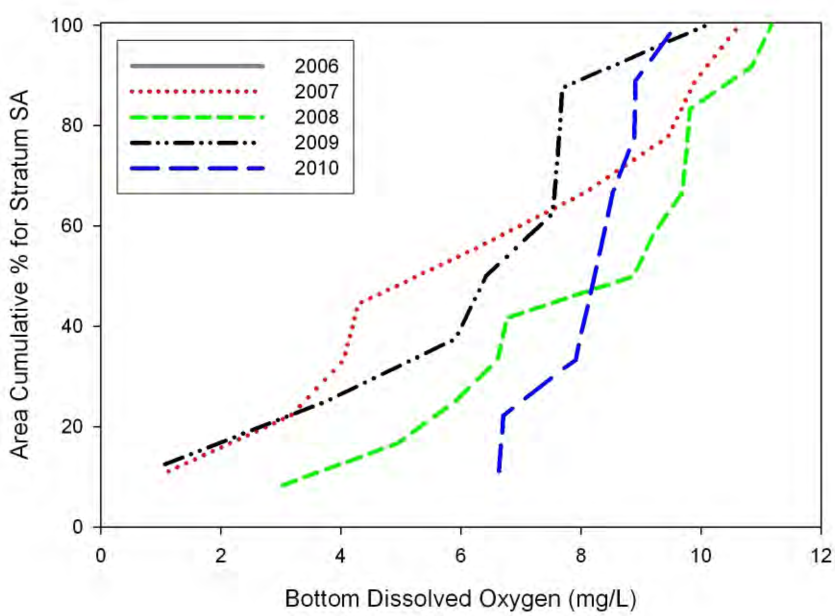

Figure B-119. Estimates of areal extent of bottom dissolved oxygen in SA, the northern half of Lake Seminole (2006-2010)

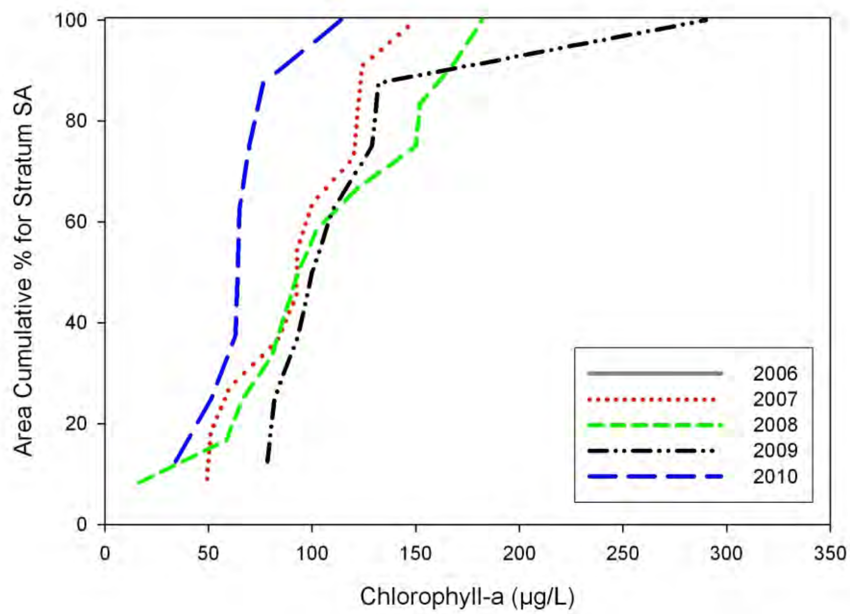

Figure B-120. Estimates of areal extent of chlorophyll-a in SA, the northern half of Lake Seminole (2006-2010)

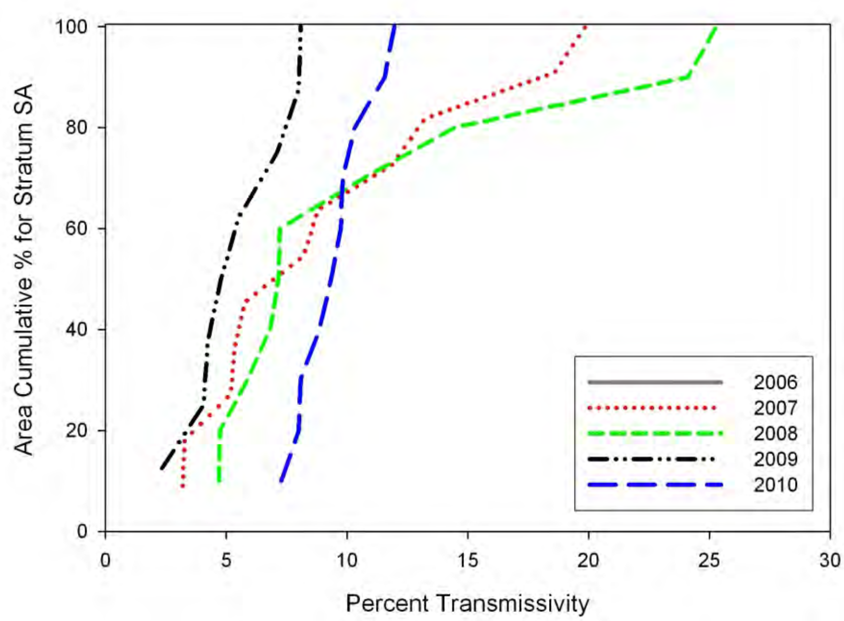

Figure B-121. Estimates of areal extent of transmissivity in SA, the northern half of Lake Seminole (2006-2010)

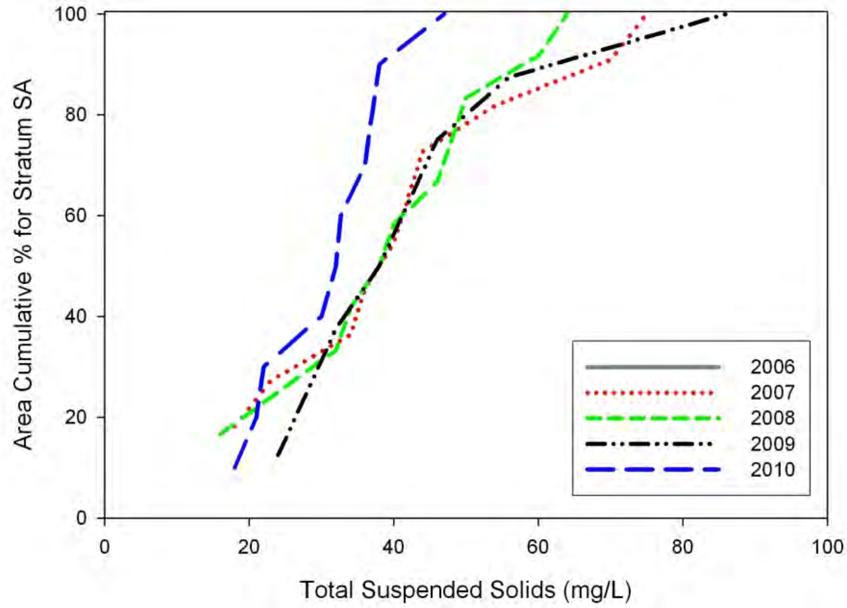

Figure B-122. Estimates of areal extent of total suspended solids in SA, the northern half of Lake Seminole (2006-2010)

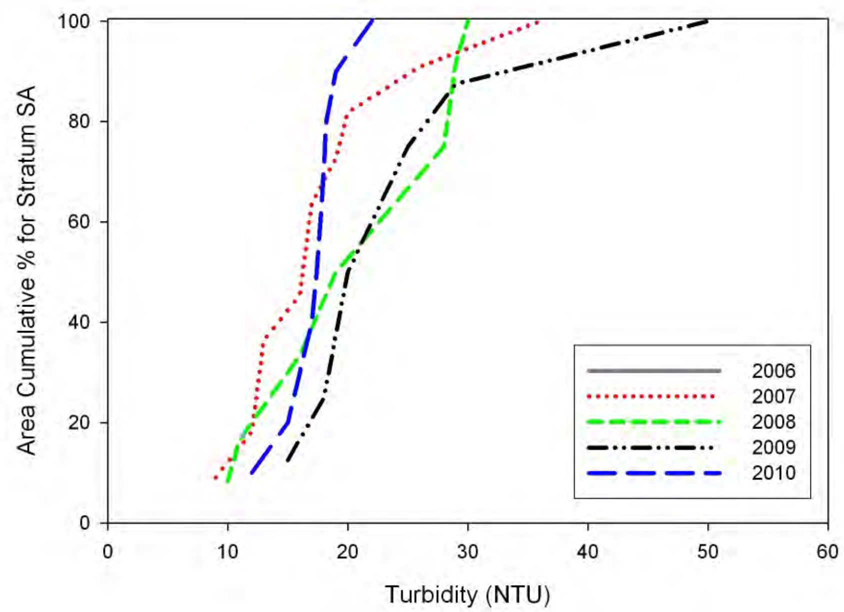

Figure B-123. Estimates of areal extent of turbidity in SA, the northern half of Lake Seminole (2006-2010)

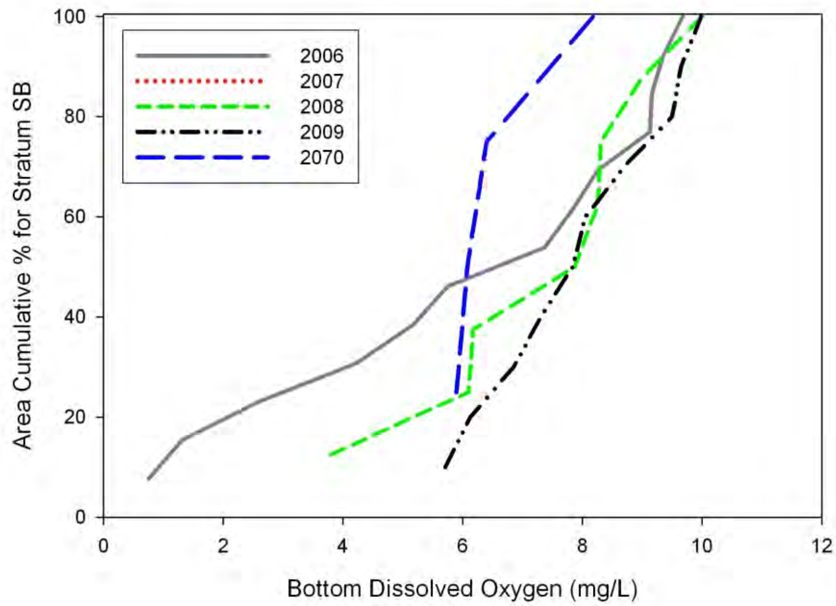

Figure B-124. Estimates of areal extent of bottom dissolved oxygen in SB, the southern half of Lake Seminole (2006-2010)

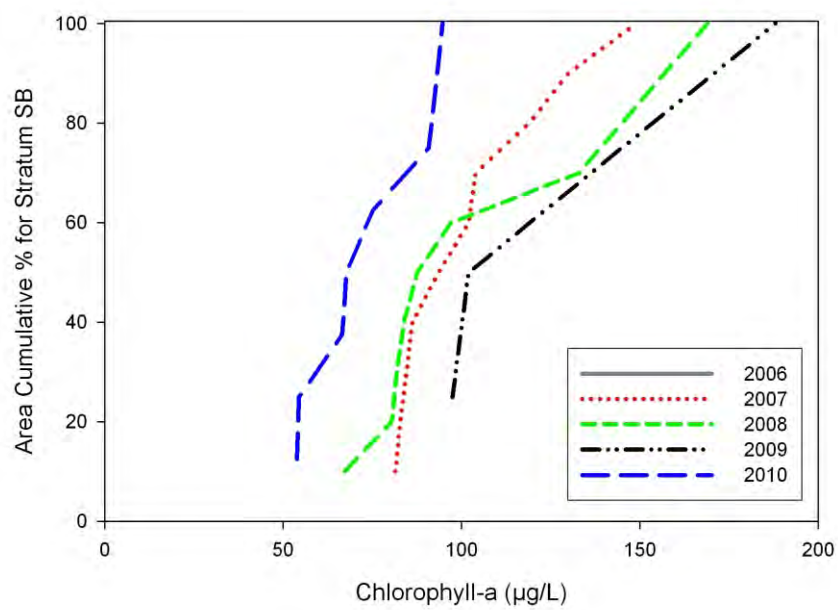

Figure B-125. Estimates of areal extent of chlorophyll-a in SB, the southern half of Lake Seminole (2006-2010)

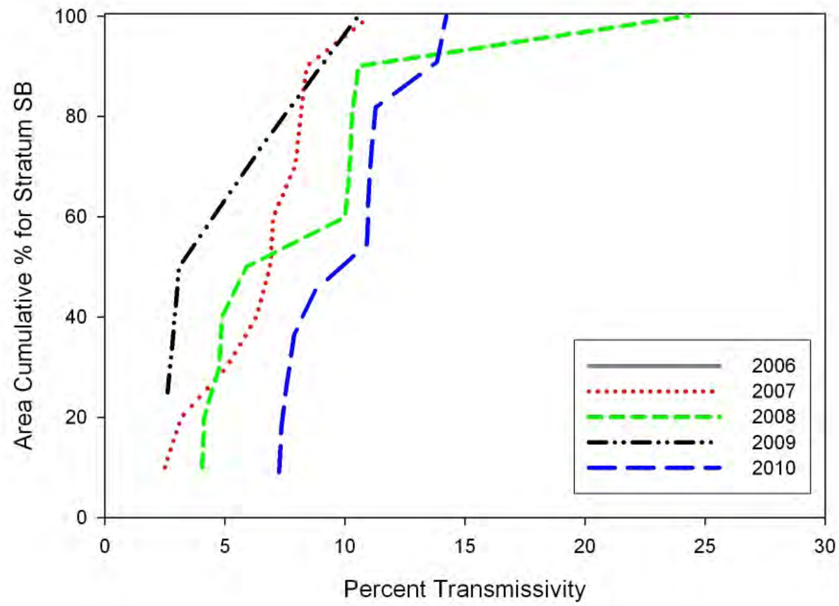

Figure B-126. Estimates of areal extent of transmissivity in SB, the southern half of Lake Seminole (2006-2010)

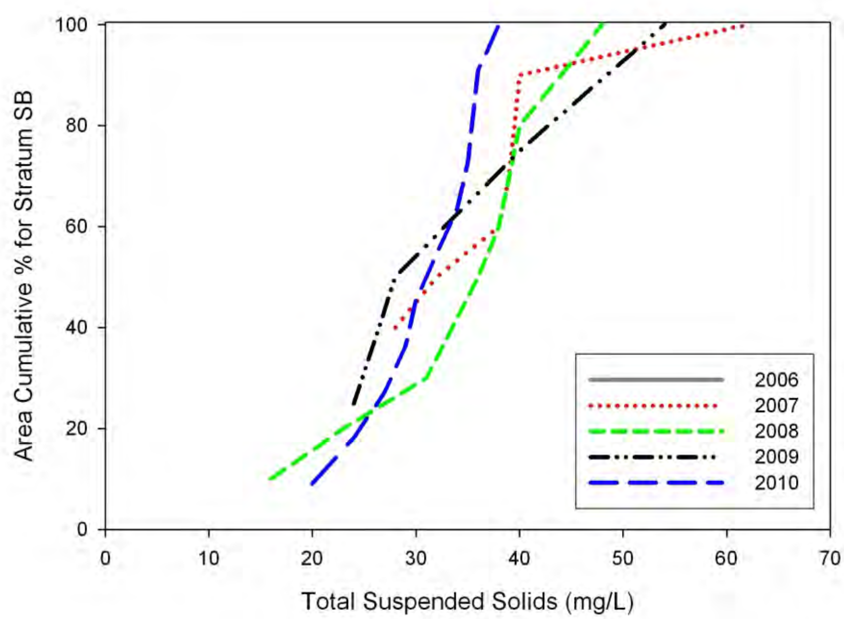

Figure B-127. Estimates of areal extent of total suspended solids in SB, the southern half of Lake Seminole (2006-2010)

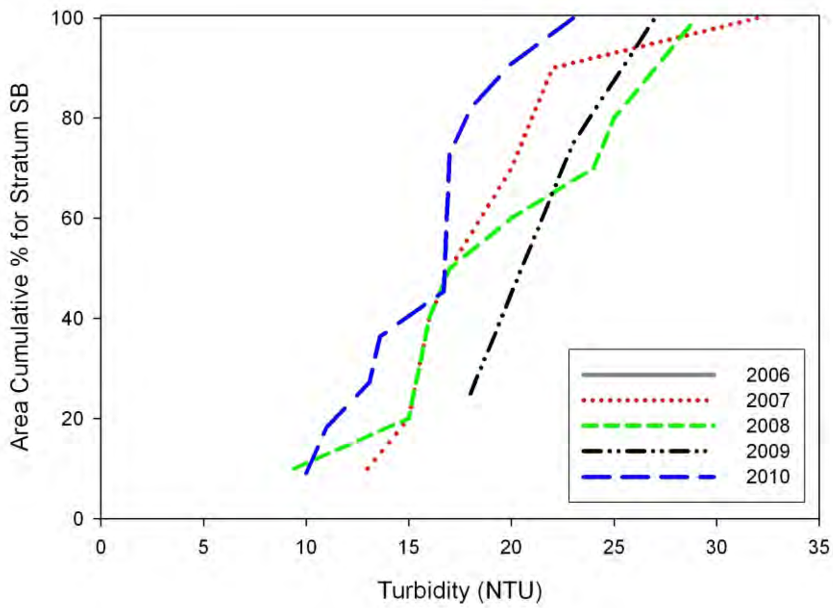

Figure B-128. Estimates of areal extent of turbidity in SB, the southern half of Lake Seminole (2006-2010)

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APPENDIX C: Impaired Waters Rule Criteria Summary Data (2006-2010)

Total observations and violations of State water quality standards for open water strata

[red] - part of stratum or site on the FDEP May 2009 verified list or both FDEP May 2009 verified list and the 303(d) list.

[yellow] part of stratum or site on the 303(d) list.

Strata		DO	pH	Chl-a annual	Turbidity	FC or Shellfish
E1	Violations	15	5	0	1	
	Total Obs	163	167	5	167	NC
E2	Violations	8	4	0	0	
	Total Obs	162	166	5	166	NC
E3	Violations	4	2	0	0	
	Total Obs	155	159	5	167	NC
E4	Violations	3	5	0	0	
	Total Obs	155	159	5	167	NC
E5	Violations	2	6	0	0	
	Total Obs	166	166	5	166	NC
E6	Violations	5	2	0	0	
	Total Obs	160	160	5	168	NC
E7	Violations	1	2	0	0	
	Total Obs	159	159	5	167	NC
RB	Violations	6	4	0	0	
	Total Obs	168	168	5	168	NC
W1	Violations	9	7	0	0	
	Total Obs	160	164	5	168	NC

Total observations and violations of State water quality standards for open water strata-cont

Strata		DO	pH	Chl-a annual	Turbidity	FC or Shellfish
W2	Violations	7	5	0	0	
	Total Obs	159	158	5	166	NC
W3	Violations	3	0	0	1	
	Total Obs	160	160	5	168	NC
W4	Violations	7	0	0	0	
	Total Obs	154	166	5	166	NC
W5	Violations	48	3	4	0	
	Total Obs	158	166	5	166	NC
W6	Violations	0	0	0	0	
	Total Obs	155	167	5	166	NC
W7	Violations	2	2	0	0	
	Total Obs	158	166	5	166	NC
W8	Violations	2	10	0	0	
	Total Obs	160	168	5	168	NC

Open water strata Chl-a comparisons for strata E1 - E7 and W1 - W8 used annual means. Chl-a comparions for strata E1-E7 were compared to TBEP Chl-a targets for Old Tampa Bay (9.3 g/L) and Middle Tampa Bay (8.5 g/L). Strata W1-W8 compared to the State of Florida's Chl-a standard of 11 g/L.

Stratum E1 does not meet FDEP DO standards north of Phillippe Point.

Stratum does not meet TBEP Chl-a targets..

Stratum E2 does not meet fecal coliform bacteria standards along Courtney Campbell Causeway beaches.

Total observations and violations of State water quality standards for fixed land sites

Land Sites		DO	pH	Cond.	Chl-a	TC	FC
01-01	Violations	5	0	37	0	0	2
	Total Obs	39	39	38	5	5	36
01-03/01-08	Violations	19	0	36	1	0	2
	Total Obs	41	41	40	6	5	37
02-07 (2003-06)	Violations	2	0	3	1	0	1
	Total Obs	4	4	4	1	3	4
02-09 (2007-09)	Violations	14	0	0	4	0	7
	Total Obs	21	21	21	5	0	17
04-02	Violations	8	11	0	0	0	1
	Total Obs	12	11	12	4	1	12
04-03	Violations	15	10	0	0	0	9
	Total Obs	22	24	24	5	3	23
04-04	Violations	4	3	0	0	0	2
	Total Obs	6	6	6	2	0	6
05-05 (2004-06)	Violations	2	0	0	1	2	3
	Total Obs	2	3	3	1	2	3
05-07 (2007-09)	Violations	1	0	4	4	0	5
	Total Obs	12	12	12	4	0	11
06-03	Violations	1	0	0	0	1	14
	Total Obs	33	34	34	5	3	27
06-04	Violations	5	0	0	2	0	1
	Total Obs	12	13	13	5	2	11
08-03	Violations	0	3	3	0	5	36
	Total Obs	42	42	42	5	5	39

Total observations and violations of State water quality standards for fixed land sites-cont

Land Sites		DO	pH	Cond	Chl-a	TC	FC
09-02	Violations	1	0	1	0	0	1
	Total Obs	2	2	2	1	0	2
09-03	Violations	2	0	0	0	3	23
	Total Obs	32	32	32	5	4	30
10-02	Violations	0	0	0	0	5	40
	Total Obs	42	42	42	5	5	41
11-05	Violations	2	0	1	0	3	26
	Total Obs	38	40	39	5	4	37
12-02	Violations	1	0	2	1	2	17
	Total Obs	28	30	30	5	4	29
12-03 (2004-06)	Violations	0	0	0	0	3	8
	Total Obs	8	9	9	1	5	9
12-04 (2006-09)	Violations	0	0	0	0	0	20
	Total Obs	31	32	32	4	0	31
13-02 (2004-06)	Violations	1	0	0	0	3	3
	Total Obs	6	7	7	1	4	7
13-05 (2007-09	Violations	9	0	1	0	0	12
	Total Obs	29	30	30	4	0	28
14-02	Violations	0	0	0	0	0	2
	Total Obs	40	42	42	5	5	41
14-07	Violations	1	1	0	0	0	1
	Total Obs	37	39	39	5	4	38
14-09	Violations	3	1	0	1	0	1
	Total Obs	14	14	14	4	0	12

Total observations and violations of State water quality standards for fixed land sites-cont

Land Sites		DO	pH	Cond	Chl-a	TC	FC
14-10	Violations	6	0	0	0	0	0
	Total Obs	28	29	29	4	0	27
14-11	Violations	9	0	0	0	4	24
	Total Obs	28	30	30	4	5	29
14-12	Violations	2	1	0	0	0	0
	Total Obs	10	10	10	3	0	10
15-04	Violations	24	0	0	0	4	33
	Total Obs	35	35	35	5	5	35
17-01	Violations	0	0	1	0	4	32
	Total Obs	40	42	42	5	5	41
17-03	Violations	7	0	1	0	4	39
	Total Obs	39	41	41	5	5	40
18-03 (2004-06)	Violations	1	0	0	0	1	5
	Total Obs	6	6	6	1	3	6
18-06 (2007-09)	Violations	12	0	0	0	0	17
	Total Obs	34	34	34	5	0	30
19-02	Violations	16	0	40	2	0	3
	Total Obs	38	41	40	5	5	39
19-03	Violations	0	0	1		0	0
	Total Obs	1	1	1	1	0	0
19-07	Violations	0	0	0	0	1	8
	Total Obs	35	39	39	5	4	32
19-08	Violations	1	0	0	0	4	27
	Total Obs	37	41	40	5	4	38

Total observations and violations of State water quality standards for fixed land sites-cont

Land Sites		DO	pH	Cond	Chl-a	TC	FC
19-09	Violations	5	0	4	0	4	30
	Total Obs	38	41	40	5	5	41
19-10	Violations	16	0	1	0	4	30
	Total Obs	38	42	41	5	5	41
22-01	Violations	15	0	10	0	1	21
	Total Obs	20	23	22	5	2	22
22-05	Violations	15	0	0	0	2	11
	Total Obs	20	22	22	3	5	22
22-07	Violations	12	0	0	0	0	7
	Total Obs	14	15	15	3	5	15
22-08	Violations	10	0	6	0	0	6
	Total Obs	19	21	21	3	5	20
22-12	Violations	11	0	0	0	0	9
	Total Obs	15	16	16	3	0	16
22-14	Violations	4	0	0	0	0	9
	Total Obs	13	14	13	3	0	12
22-15	Violations	6	0	0	1	0	6
	Total Obs	8	9	8	3	0	9
23-05	Violations	8	0	0	1	0	1
	Total Obs	14	15	15	5	2	12
23-07	Violations	13	0	2	0	1	3
	Total Obs	26	28	28	5	4	26
23-08	Violations	4	1	13	3	0	2
	Total Obs	31	32	32	5	4	25

Total observations and violations of State water quality standards for fixed land sites-cont

Land Sites		DO	pH	Cond	Chl-a	TC	FC
23-21	Violations						
	Total Obs	6	6	6	1	6	6
23-22	Violations						
	Total Obs	5	5	5	1	5	5
24-01	Violations	15	1	39	2	0	13
	Total Obs	38	39	39	5	4	35
24-02	Violations	21	2	40	0	0	16
	Total Obs	39	41	40	5	5	39
24-03	Violations	9	1	7	1	0	2
	Total Obs	13	13	13	4	2	11
24-07	Violations	4	0	3	0	0	2
	Total Obs	8	8	8	2	0	7
25-02	Violations	5	0	0	4	0	3
	Total Obs	13	13	13	5	4	12
25-07	Violations	5	1	4	3	1	4
	Total Obs	23	23	23	6	3	20
27-03	Violations	14	0	0	0	0	4
	Total Obs	21	22	22	5	2	22
27-08	Violations	0	0	0	0	5	34
	Total Obs	38	41	41	5	5	38
27-09	Violations	4	0	0	0	5	34
	Total Obs	36	39	39	5	5	36
27-10	Violations	1	0	0	0	0	0
	Total Obs	21	21	21	5	1	21

Total observations and violations of State water quality standards for fixed land sites-cont

Land Sites		DO	pH	Cond	Chl-a	TC	FC
32-03	Violations	1	0	24	0	0	1
	Total Obs	23	23	24	3	0	22
35-01	Violations	1	0	0	0	0	5
	Total Obs	8	8	8	4	0	7
35-09	Violations	3	1	0	0	0	22
	Total Obs	37	38	38	5	3	32
35-10	Violations	4	1	0	0	4	17
	Total Obs	40	41	41	5	5	35
35-11	Violations	6	1	0	0	2	14
	Total Obs	40	41	41	5	5	37
35-12	Violations	4	0	0	0	3	27
	Total Obs	41	42	42	5	4	35
35-14	Violations	2	0	3	0	0	5
	Total Obs	11	12	12	2	0	8
39-02	Violations	18	0	0	0	0	15
	Total Obs	22	22	23	3	0	19
40-02	Violations	2	0	0	0	0	12
	Total Obs	23	23	24	3	0	18
44-02	Violations	1	1	24	0	0	3
	Total Obs	23	23	24	3	0	22
45-03	Violations	5	0	0	0	0	17
	Total Obs	21	21	22	3	0	18
46-03	Exceed	7	0	2	1	0	9
	Obs	20	20	21	3	0	17

Total observations and violations of State water quality standards for fixed land sites-cont

Land Sites		DO	pH	Cond	Chl-a	TC	FC
48-03	Exceed	4	0	24	0	0	3
	Obs	23	23	24	3	0	23
51-02	Violations	9	0	0	1	0	14
	Total Obs	15	15	15	3	0	14

Fixed land site Chl-a were compared to the State of Florida's Chl-a standard of 20   g/L.

Number of total observations and violations of State water quality standards for lakes

Lake		DO	pH	Cond	Chl-a *	Turb
Lake Tarpon	Violations	25	38	0	5	0
	Total Obs	156	167	168	5	168
Lake Seminole SA	Violations	6	57	0	5	5
	Total Obs	68	74	74	5	74
Lake Seminole SB	Violations	3	66	0	5	7
	Total Obs	72	78	78	5	78

* - used in TSI calculations

Number of total observations and violations of State water quality standards for bacteria on lakes

Lake		TC 1000	FC 400
Lake Tarpon	Violations	0	0
	Total Obs	15	168
Lake Seminole SA	Violations	0	5
	Total Obs	2	72
Lake Seminole SB	Violations	3	4
	Total Obs	6	77

NC = Not Collected

APPENDIX D: Open Water Strata and Land Site Locations and Descriptions

Open Water Strata:

Marine Waters

W1 St. Joseph Sound

W2 Clearwater Harbor north

W3 Clearwater Harbor south

W4 The Narrows

W5 Long Bayou/Cross Bayou

W6 Boca Ciega Bay north

W7 Boca Ciega Bay central

W8 Boca Ciega Bay south

E1 Safety Harbor/Mobbly Bayou

E2 Largo Inlet

E3 Feather Sound

E4 Gateway

E5 Weedon Island

RB Riviera Bay

E6 Shore Acres

E7 St. Petersburg north

Lakes

SA Lake Seminole north lobe

SB Lake Seminole south lobe

LT Lake Tarpon

Land Sites:

Basin 1– Anclote River

The Anclote River drainage basin is located in the northernmost portion of Pinellas County, in Hillsborough County and in Pasco County, and encompasses approximately 11,040 total acres. Four hundred twenty-eight acres are within unincorporated Pinellas County boundaries. The river has vast areas of undeveloped shoreline containing emergent and shoreline vegetation. These features, in addition to relatively good water quality in the river, make this area an important habitat for birds and fish. The sampling sites listed below are estuarine and therefore no flow data were collected.

> **Site 01-01**: Alt US 19 bridge over the Anclote River, sampled from the east side of the bridge, just north of the main boat channel.
>
> **Site 01-03:** Sampled from the south end of the seawall at 1036 Lodestar Rd. in Pasco County; headwaters of the Anclote River (sampled 2003-May 2005).
>
> **Site 01-08:** Sampled from the south end of the seawall at 5508 Jasperwood Dr. in Pasco County; headwaters of the Anclote River (sampled June 2005-2010).

Basin 2 – Klosterman Bayou

The Klosterman Bayou drainage basin is located in northeast Pinellas County, west of Lake Tarpon, and includes part of the southernmost area of Tarpon Springs. The total basin area encompasses 2,026 acres, with 1,972 acres within unincorporated County boundaries. The main drainage canal begins in wetlands south of the Westin-Innisbrook Golf Course. A roadside ditch conveys stormwater to B Pond. From B Pond stormwater flows through golf course ponds and canals for about 1.2 miles to a weir. From the weir water flows 0.25 miles through golf course ponds to an open flapper valve structure and then in a ditch the remaining 0.5 miles into the Gulf of Mexico just south of Tarpon Springs. The ditch and ponds downstream of the weir are tidally influenced. The golf course uses reclaimed water from the Pinellas County North Sewer Treatment Plant Facility.

> **Site 02-02, Innisbrook Canal:** Sampled from the east side of a culvert under Alternate US 19, approximately 0.5 miles south of Klosterman Road, or 0.6 miles north of the Pinellas Trail Bridge, due west of the Pinellas County North Sewer Treatment Plant Facility (sampled in 2003).
>
> **Site 02-07, Innisbrook Canal:** Sample collected from west side of canal where it passes under the Pinellas Trail (sampled 2004-2006).
>
> **Site 02-09, Innisbrook Canal:** Sample collected at a weir on the golf course; HDI continuous flow station (sampled 2007-2010).

Basin 4 – Brooker Creek

Brooker Creek is located in Hillsborough County and northeastern Pinellas County, east of East Lake Rd. The total basin encompasses approximately 20,970 acres, with approximately 18,948 acres within unincorporated County boundaries. The basin is primarily undeveloped uplands with forested wetlands. The undeveloped forested wetlands combined with good water quality support large bird, fish, and reptile populations. The Brooker Creek Preserve occupies nearly 8500 acres within the western portion of the basin. The Preserve encompasses portions of six hydrologic basins and has been established by the Pinellas Board of County Commissioners to preserve Florida's native flora and fauna. The major discharge is southwest into Lake Tarpon at Chesnut Park, approximately 2 miles north of the Lake Tarpon outfall structure.

Water collected from Brooker Creek stations is often dark brown in color due to tannins from swamp discharge.

Site 04-02: Sample collected off the north side of the bridge over the creek in Hillsborough County (Headwaters of Brooker Creek).

Site 04-03: Sampled off the north side of the Tarpon Woods Blvd. Bridge; USGS continuous flow station.

Site 04-04: Sampled off the south side of Woodlands Blvd.; USGS continuous flow station (sampled 2008-2010).

Basin 5 – Oldsmar

The Oldsmar drainage basin crosses both Pinellas and Hillsborough county boundaries and encompasses the city of Oldsmar. The basin drains 2,381 acres, with approximately 90 acres in unincorporated Pinellas County. The Mobbly Bay Tidal Swamp is an environmentally sensitive area at the southern tip of the drainage basin. This area has been designated as preservation land on the Future Land Use Plan and will remain undeveloped. The major outfalls and tributaries total 2.3 miles in length and discharge into Safety Harbor.

Site 05-05, Moccasin Creek, west branch: Sample collected from the creek as it crosses under the road on the east side of Oakleaf Blvd., just south of Tampa Rd. (sampled 2003-2006)

Site 05-07, Moccasin Creek, west branch: Sample collected at a weir on South Woodlands Dr. in the East Lake Woodlands golf course development; HDI continuous flow station (sampled 2007-2010).

Basin 6 – South Creek

South Creek drainage basin is located in the east central area of Pinellas County, just south of Lake Tarpon. It contains approximately 2,892 acres, with 2,648 acres in unincorporated Pinellas County. Eight hundred acres drain through the basin's major outfall, a 2.3-mile tributary leading to the Lake Tarpon outfall canal approximately 1.25 miles north of the control structure. Cow

Branch Creek discharges to the southwest corner of Lake Tarpon near the mouth of the outfall canal. Lake St. George, approximately 65 acres in area, receives runoff from much of the remaining basin. The Lake St. George outfall discharges to the Lake Tarpon outfall canal about a half-mile south of the basin's major outfall.

Site 06-03, Cow Branch Creek: Sampled from the northwest corner of the Tampa Rd. and Lake St. George Dr. intersection.

Site 06-04, Lake Tarpon Outfall Canal: Sampled off the north side of the outfall canal structure; USGS continuous flow station.

<u>Basin 8 – Smith Bayou</u>

The Smith Bayou drainage basin is located in the northwest Pinellas County. The basin contains about 1,863 acres of land, with approximately 1,683 acres in unincorporated Pinellas County. There is a single tributary in the basin, approximately 2.7 miles in length, that discharges into the Gulf of Mexico.

Site 08-03, Smith Creek: Sample collected from culvert that passes under Alt US 19, just north of Tampa Road and State Road 584 intersection.

<u>Basin 9 – Cedar Creek</u>

The Cedar Creek drainage basin is located in northwest Pinellas County. There are approximately 1,210 acres in the basin, with 29 acres within unincorporated Pinellas County. The major outfall and its one tributary total 2.1 miles in length. They flow west through Hammock Park before discharging into St. Joseph Sound just south of Michigan Blvd.

Site 09-02, Cedar Creek: Sampled from the footbridge at the south end of Harvard Ave., off Michigan Blvd (sampled 2003).

Site 09-03, Cedar Creek: Sampled from the footbridge at the north end of Patricia Ave., off of San Salvador Dr (sampled 2004-2010).

<u>Basin 10 - Curlew Road</u>

Curlew Creek drainage basin is located in north-central Pinellas County and includes parts of the cities of Clearwater and Dunedin. The basin contains approximately 6,800 acres, with 3,834 acres within unincorporated Pinellas County. The three tributaries to the major outfall total 11 miles in length. Curlew Creek discharges into St. Joseph Sound just south of State Rd. 586. Jerry Lake (approximately 60 acres) is located on the main channel in the southwest basin area. There are also many small (1 to 5 acres) natural water storage areas located throughout the basin.

Site 10-02, Curlew Creek: Sampled from the west side of the CR1 Bridge, over the creek; USGS continuous flow station.

Basin 11 – Possum Branch

Possum Branch drainage basin is located in northeastern Pinellas County. The basin contains approximately 1,974 acres of land, approximately 211 of which are within unincorporated Pinellas County. The Lake Tarpon outfall canal drains through the east portion of the basin. The main outfall has one tributary, totaling 1.3 miles in length and draining 635 acres.

> **Site 11-05, Briar Creek:** Sample collected off a small footbridge south of Turtle Creek Ct. in the Briar Creek Mobile Home Park.

Basin 12 – Bishop Creek

Bishop Creek drainage basin is located in east-central Pinellas County and includes portions of the cities of Safety Harbor and Clearwater. It contains approximately 871 acres of land, with 167 acres in unincorporated Pinellas County boundaries. It has two major outfalls which flow west to east and total 3.3 miles. The canals join just west of State Rd. 590 before emptying into Tampa Bay.

> **Site 12-02, Bishop Creek North Branch:** Sample collected from the north branch of Bishop Creek, off the northwest side of Oak Crest Dr., where the creek goes under the road.

> **Site 12-03, Bishop Creek South Branch**: Sample collected from the south branch of Bishop Creek, off the east side of the road where the creek passes under Hargett Ln., approximately 390 ft. north of Enterprise Rd (sampled 2003-2006)

> **Site 12-04, Bishop Creek South Branch**: Sample collected from the south branch of Bishop Creek, where the creek passes under Harbowoods Dr; HDI continuous flow station (sampled 2007-2010).

Basin 13 – Mullet Creek

Mullet Creek drainage basin is located in east-central Pinellas County and includes areas of the cities of Safety Harbor and Clearwater. There are approximately 1,955 acres of land in this basin, with 415 acres in unincorporated Pinellas County. There is one main outfall channel and one tributary, totaling 3 miles in length. The major channel outlets into Old Tampa Bay through the center of the City of Safety Harbor.

> **Site 13-02:** Sample collected from the creek at the north end of 5th Ave. in Safety Harbor, east of Safety Harbor Elementary School, six blocks north of Main St. (sampled 2003-2006).

> **Site 13-05:** Sample collected from a foot bridge over the creek at the end of Meldrum Dr.; HDI continuous flow station (sampled 2007-2010).

Basin 14 – Alligator Creek

Alligator Creek drainage basin is located in central Pinellas County and includes part of the cities of Clearwater and Safety Harbor. The basin contains approximately 5,686 acres of land, with 2,003 acres within unincorporated Pinellas County boundaries. Three tributaries join the major outfall and total 8.2 miles in length. Alligator Creek discharges into Alligator Lake, located within the southern limits of Safety Harbor, and then over a weir into Old Tampa Bay. Lake Chautauqua (58 acres), Beckett Lake (16 acres), and Arbor Lake (39 acres) are located in the upper reaches of the basin. There are also many other natural water storage areas, ranging in size from 1 to 4 acres, located throughout the basin. A major study of the Alligator Creek basin was completed in 1990 and a watershed management plan was completed in 1997.

Site 14-02, Lake Chautauqua: Sample collected from the intersection of the T- shaped swimming dock at the Soule Boy Scout Camp on the southeast end of Lake Chautauqua.

Site 14-07, Alligator Lake above weir: Sample collected from the east end of Alligator Lake, above the weir that flows into Safety Harbor.

Site 14-09, Beckett Lake southern end: Sample collected at box culvert on the south side of the lake along Sunset Point Road. (sampled quarterly in 2007-2010).

Site 14-10, AlligatorCreek above weir: Sample collected from foot bridge at weir located at the end of Glen Oak Ave North. (sample quarterly in 2007-2010).

Site 14-11, Alligator Creek: Sample collected from the creek in Cliff Stevens Park off the west side of Fairwood Ave., at the USGS continuous flow recorder.

Site 14-12, Beckett Lake northern end: Sample collected off boat dock at the Summerville Beckett Lake Lodge. (sampled quarterly 2008-2010).

Basin 15 – Spring Branch

Spring Branch drainage basin is located in west-central Pinellas County and includes part of the city of Dunedin in its upper reaches and Clearwater in its lower reaches. There are approximately 2,144 acres of land in the basin, with 287 acres within unincorporated Pinellas County boundaries. The basin has one major outfall, approximately 4 miles in length. It flows north to south and empties into Stevenson Creek, which in turn discharges to St. Joseph Sound. Several small natural water storage areas, up to 5 acres in size, can be found in the upper basin reaches.

Site 15-04, Spring Branch Creek: Sample collected from the footbridge over the creek on the west side of Betty Ln., just north of Sunset Point Rd; HDI continuous flow recorder in 2007.

Basin 17 – Coastal Zone 1

Coastal Zone 1 Drainage Basin is in the west-central area of Pinellas County. The basin includes portions of the cities of Largo, Clearwater, and Belleair Bluffs, and most of the town of Belleair. The basin contains approximately 2,750 acres of land, with 335 acres in unincorporated Pinellas County. The major outfall has one tributary approximately 1.4 miles in length. The main channel flows to the northwest and empties into Clearwater Harbor just south of Coe Rd. The major outfall drains about 900 acres. A few natural water storage areas are located in the basin and range from 1 to 2 acres.

> **Site 17-01, Rattlesnake Creek:** Sample collected from Rattlesnake Creek approximately 100 feet east of the bridge leading to the entrance of the Belleview Biltmore Resort. Sample is taken on the golf course property, under the cart bridge.
>
> **Site 17-03, Rattlesnake Creek:** Sample collected from the south end of Fairview Rd. at the dead end.

Basin 18 – Stevenson Creek

The Stevenson Creek drainage basin is located in west-central Pinellas County primarily within the city of Clearwater. The total basin area encompasses 3,880 acres, with 690 acres within unincorporated County boundaries. The major outfall and its tributaries total 3.4 linear miles. The creek generally flows to the north over steep sloping terrain finally discharging into Clearwater Harbor just south of Sunset Point Rd. (State Road 588). Many small (1 to 3 acres) natural water storage areas are located throughout the basin. One large storage area, Lake Bellevue (25 acres), is located in the southwest region of the basin. The city of Clearwater operates a tertiary sewage treatment plant that discharges at the mouth of Stevenson Creek. A major study of the Stevenson Creek basin and a watershed management plan were developed and adopted in 2001.

> **Site 18-03, Stevenson Creek:** Sample collected from the south side of the Drew St. Bridge, just east of Betty Ln. (sampled 2003-2006).
>
> **Site 18-06, Stevenson Creek:** Sample collected just south of the railroad tie bridge inside the City of Clearwater Golf Course on Betty Ln.; HDI continuous flow station (sampled 2007-2010).

Basin 19 – Allen's Creek

The Allen's Creek drainage basin is located in the central area of Pinellas County and includes parts of the cities of Clearwater and Largo. There are approximately 4,890 acres of land, with 2,057 acres within unincorporated Pinellas County. The major outfall and tributaries total about 6.5 miles in length. The major outfall flows to the east into Old Tampa Bay. Several medium-size natural water storage areas (3 to 10 acres) are located in the upper reaches of the basin. A major study of the Allen's Creek basin was completed in 1990 and a watershed management plan was developed and adopted in 1997.

Site 19-02, Allen's Creek: Sample collected off the east side of the Belcher Rd. Bridge.

Site 19-07, Allen's Creek: Sample collected off the east side of the Hercules Ave. Bridge near the Maple Swamp Restoration site.

Site 19-08, Allen's Creek: Sample collected from the creek behind the 1st Church of the Nazarene, on the south side of Nursery Rd., just east of Keene Rd.

Site 19-09, Allen's Creek: Sample collected off the south side of the creek as it passes under Belleair Rd., just east of Longbow Ln.; USGS continuous flow station. (sampled from 2003-mid 2006).

Site 19-10, Allen's Creek: Sample collected off the north side of the Kent Place Bridge, west of Alicia Way N.

Site 19-11, Allen's Creek: Sample collected off the west side of Keene Rd. Bridge, right before McMullen/Rosery/Keene intersection. (sampled mid 2004-mid 2005).

Basin 22 – Long Branch

The Long Branch drainage basin is located in the central area of Pinellas County. It contains approximately 1,769 acres of land, with 770 acres within unincorporated Pinellas County boundaries. The major channel flows to the northeast and is approximately 3.5 miles in length, discharging into Old Tampa Bay.

Site 22-01, Long Branch Creek: From US19, head east on Haines Bayshore Rd. Go south on Wolford Dr. until it dead-ends on Whitney. Sample collected off bridge on south side of Whitney Rd.

Site 22-05, Long Branch Creek: To access the site, turn north on 62nd St. N., continue straight through fenced area back to creek. Sample site is at the concrete slab across the stream bed. (sampled 2003-September 2008).

Site 22-07, Long Branch Creek: Sampled from the west branch of the creek, approximately 15 feet west of its merge with the south branch of the creek (south side of Bay Area Outlet Mall). (sampled 2003-September 2008).

Site 22-08, Long Branch Creek: Sampled from the south branch of the creek at the dam, before it merges with the west branch of the creek. To reach the site, drive down 150th Ave. N. to the rear entrance of AutoWay Chevrolet, there is a County easement entrance there. (sampled 2003-September 2008).

Site 22-12, Long Branch Creek: Sample collected from the creek at the USGS station on the south side of East Bay Drive. (sampled October 2008-2010).

Site 22-14, Long Branch Creek: Sample collected alternate sample periods from north and south creeks in the Bay Oaks Apartment Complex on the south side of East Bay Drive. (sampled October 2008-2010).

Site 22-15, Long Branch Creek: Sample collected from the creek at the entrance to the La Playa Motor Home Park on the north side of 150th Ave, west of US 19. (sampled October 2008-2010).

Basin 23 – Roosevelt

The Roosevelt drainage basin is located in east-central Pinellas County and contains parts of the cities of Pinellas Park and St. Petersburg. The basin contains approximately 5,153 acres, with 2,573 acres within unincorporated Pinellas County boundaries. Three major channels totaling 9.5 miles in length drain 5,000 acres of the watershed. Discharge is into Old Tampa Bay.

Site 23-05, Roosevelt Basin: Sampled from the west side of Roosevelt Blvd., south of 28th St. N., near the Home Shopping Network building. Sample is collected as water enters the culvert under Roosevelt Blvd., approximately 0.38 miles northwest of I-275 overpass.

Site 23-07, Roosevelt Basin: Sample collected off the west side of Roosevelt Blvd., approximately 0.38 miles northwest of the Dr. M.L. King Jr. St. N. intersection near entrance to Danka.

Site 23-08, Roosevelt Basin: Sample collected at the salinity barrier of canal that parallels Evergreen Ave.; USGS continuous flow from 2005-2010.

Site 23-21, Roosevelt Basin: Sample collected at two pipes just west of Turnberry Ct., located off Feather Sound Dr. (sampled Oct 2004-January 2006 and 2010).

Site 23-22, **Roosevelt Basin:** Sample collected at three pipes just west of Eagle Point Drive, just past Turnberry Ct. (sampled Oct 2004-January 2006 and 2010).

Basin 24 – Cross Bayou

The Cross Bayou Canal drainage basin is located in the south-central area of Pinellas County and includes parts of the cities of Largo and Pinellas Park. There are approximately 7,916 acres of land, with 6,061 acres within unincorporated Pinellas County boundaries. The canal connects Old Tampa Bay on the east to Boca Ciega Bay in the southwest region of the county. Water can flow in either direction depending on tidal conditions in the two bays. The major channel and its tributaries total approximately 10.5 miles in length and drain about 7,800 acres. The high point in this canal is located at 66th St. North and Bryan Dairy Rd. Drainage northeast and southeast of that point is toward Old Tampa Bay and Boca Ciega Bay, respectively. All sampling locations on the Cross Bayou Canal are estuarine, therefore flow data were not collected.

Site 24-01, Cross Bayou Canal: Sample collected off the north side of the Park Blvd. Bridge over Cross Bayou Canal, east of 83rd St. N., and west of the Wagon Wheel Flea Market.

Site 24-02, Cross Bayou Canal: Sample collected off the west side of Frontage Rd. Bridge over Cross Bayou Canal, just east of the intersection of Roosevelt Blvd. and the Bayside Bridge.

Site 24-03, Cross Bayou Canal: Sample collected off the west side of a small bridge over a culvert where US19 crosses Cross Bayou Canal (sampled 2003-November 2009).

Site 24-07, Cross Bayou Canal: Sample collected off the west side of 66th St North just south of Brian Dairy Road. Site name changed in 2010 from 24-04 to 24-07 (sampled December 2009-2010).

Basin 25 – Starkey Road

The Starkey Road drainage basin is located in west central Pinellas County and contains approximately 7,068 acres of land, with 3,260 acres within unincorporated Pinellas County boundaries. Just over half of the basin is in unincorporated Pinellas, with the remaining portion in the city of Largo. Historically, this basin discharged into Lake Largo and into Four Mile Bayou. Lake Seminole received water from this basin until the bypass canal was constructed in the 1970s. Lake Seminole has become a separate basin since the completion of this canal. The outlet of the Starkey Road basin is located on the north side of Park Blvd. on the eastern edge of Lake Seminole Park. The canal discharges into Long Bayou.

Site 25-02, Seminole Bypass Canal: Sample collected off the south side of the Ulmerton Rd. bridge, where it crosses the Seminole Bypass Canal. The bridge is approximately 0.8 miles east of Seminole Blvd. and 0.8 miles west of Starkey Rd.

Site 25-07, Seminole Bypass Canal: Sample collected from the south side of the 86th Ave Bridge; HDI continuous flow station since 2007.

Basin 27 – McKay Creek

The McKay Creek drainage basin is located in west-central Pinellas County and includes the towns of Belleair and Belleair Bluffs and part of the city of Largo. The basin contains approximately 5,642 acres of land, with 2,614 acres within unincorporated Pinellas County boundaries. The major channel and its one tributary total about 6.2 miles in length and discharge into Clearwater Harbor.

Site 27-03, McKay Creek at Ridgecrest Park: Sample collected inside Ridgecrest Park, located south off Ulmerton Rd. and about 0.3 miles west of 119th St.

Site 27-08, Church Creek: Sample collected from the north side of the Wilcox Rd. Bridge.

Site 27-09, McKay Creek: Sample collected from the east side of the bridge on 20th St., south of West Bay Dr. in Largo.

Site 27-10, McKay Creek: Sample collected from the creek where it enters the Florida Botanical Gardens, from the north side of the structure under Walsingham Rd.

Basins 32/34/42 – Smack's Bayou Site

The three drainage basins that contribute stormwater runoff to the Smack' Bayou sample site are located in southeastern Pinellas County and are within the city of St. Petersburg. Basin 34 contains 1,695 acres and has 1.5 miles of ditches and canals that convey stormwater to the east. Basin 42 is a an area of 1,158 acres with 1.75 miles of ditches that direct stormwater to the east. Basin 32 basin contains 1,366 acres of land and does not have a main stormwater conveyance channel or ditch. The western portions of Basin 32 convey stormwater towards the Smack's Bayou sample site.

Site 32-03, Smack's Creek: Sample is collected at the center of the bridge on 40th Ave NE bridge which is just east of 12th St NE (sampled 2008-2010).

The Joe's Creek drainage basin is located in south-central Pinellas County and includes parts of the cities of Pinellas Park, St. Petersburg, and all of Kenneth City. The basin contains 9,138 acres of land, with 2,131 acres within unincorporated Pinellas County boundaries. The main channel and its tributaries, totaling 11.2 miles in length, generally flow east to west and empty into the Cross Bayou Canal. The south tributary of Joe's Creek is called Miles Creek.

Site 35-01, Joe's Creek: Sample is collected from foot bridge at the north end of shopping center parking lot at the corner of Park Blvd. and 66th St. (sampled quarterly in 2007-2010).

Site 35-09, Joe's Creek: Sample is collected from channel on 58th Ave. E, west of 66th Lane.

Site 35-10, Joe's Creek: Sample collected from west side of the 62nd St. Bridge, just south of 42nd Ave N.

Site 35-11, Joe's Creek: Sample collected off the USGS stream gauge in the creek, northeast of the intersection of 46th St. and 46th Ave N.

Site 35-12, Joe's Creek: Sample collected off the 64th St. Bridge, south of 38th Ave.

Site 35-14, Joe's/Miles Creek: Sample collected at the northwest corner of the Brookside Mobile Manor Mobile Home Park on the south side of the creek; HDI continuous flow station (sampled 2007-2008).

Basin 39 – Bear Creek

The Bear Creek drainage basin is located in south Pinellas County and includes parts of the cities of St. Petersburg, Gulfport, and South Pasadena. The basin contains 2,818 acres of land, with 132 acres within unincorporated Pinellas County boundaries. The main channel and its tributaries total 2.3 miles in length, generally flow east to the southwest, and empty into the Boca Ciega Bay.

> **Site 39-02, Bear Creek:** Sample is collected upstream of a foot bridge at the dead end of 62nd St South between Central Ave and Gulfport Blvd (sampled 2008-2010).

Basin 40 – Booker Creek

Booker Creek drainage basin is located in southeastern Pinellas County and is completely within the city of St. Petersburg. The basin contains 3,133 acres of land. The main channel and its tributaries total 3.37 miles and generally flow to the southeast into Bayboro Harbor.

> **Site 40-02, Booker Creek:** Sample is collected from the west side of the 7th St S bridge and Roser Park Drive (sampled 2008-2010).

Basins 41/43/44 – Coffee Pot Bayou Site

The Coffee Pot Bayou drainage basin is located in southeastern Pinellas County and is entirely within the city of St. Petersburg. Several basins contribute storm water to the bayou including Basin 41- North Coffee Pot, Basin 43 - Coffee Pot Bayou, and the northern portion of Basin 44 - Albert Whitted Basin 41 contains 570 acres of land, Basin 43 consists of 753 acres, and the northern sub-basin of Basin 44 is 190 acres. Basin 41 has a short ditch that conveys storm water to the bayou otherwise the remaining areas only have subsurface pipes.

> **Site 44-02, Coffee Pot Bayou:** Sample is collected from center of the Snell Isle Blvd NE Bridge (sampled 2008-2010).

Basin 45 – 34th Street Basin

The 34th Street Basin drainage area is located in southern Pinellas County and is completely within the city of St. Petersburg. The basin contains 1,513 acres of land. The main channel and its tributaries total 1.4 miles and generally flow to the south into Clam Bayou.

> **Site 45-03, PTEC Drainage Canal Site:** Sample is collected just north of the bridge on 11th Ave S between 34th and 37th St S (sampled 2008-2010).

Basin 46 – Clam Bayou

The Clam Bayou Basin drainage area is located in southern Pinellas County and is completely within the city of St. Petersburg. The basin contains 617 acres of land. The main channel and its tributaries total 1.5 miles and generally flow to the south into Clam Bayou.

Site 46-03, Clam Bayou Site: Sample is collected 50-100 feet north of 22nd Ave S between 40th and 41st St S across from the golf course(sampled 2008-2010) .

Basin 48 – Frenchman's Creek

Frenchmans's Creek Basin drainage area is located in southern Pinellas County and is completely within the city of St. Petersburg. The basin contains 2,571 acres of land. The main channel and its tributaries total about 1 mile and generally flow to the west into Boca Ciega Bay.

Site 48-03, Clam Bayou Site: Sample is collected from the dock at the western most boat ramp in Maximo Park (sampled 2008-2010).

Basin 51 – Little Bayou

The Little Bayou Basin drainage area is located in southeastern Pinellas County and is completely within the city of St. Petersburg. The basin contains 505 acres of land. The main channel and its tributaries total 1.2 miles and generally flow to the east-southeast into Tampa Bay.

Site 51-02, Clam Bayou Site: Sample is collected from the ditch as it runs under 7th St S just south of 56th Ave S (sampled 2008-2010).

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APPENDIX E: Acronyms

APHA – American Public Health Association

AWWA – American Water Works Association

BOD5 – biological oxygen demand 5 day

CCMP – Comprehensive Conservation and Management Plan

Chl-a – chlorophyll-a

CP – Comprehensive Plan

CWA – Federal Clean Water Act

DO – dissolved oxygen

EMAP – Environmental Monitoring Assessment Program

EPA – Environmental Protection Agency

FAC – Florida Administrative Code

FDEP – Florida Department of Environmental Protection

GPS – Global Positioning System

HDI – Hydrographic Data Collection, Inc.

IWR – impaired surface water rules

mg/L – milligrams per liter

NELAC – National Environmental Laboratory Accreditation Conference

NTU – nephelometric turbidity units

PCDEM – Pinellas County Department of Environmental Protection

ppt – parts per thousaned

STORET – STOre and RETrieve

TBEP – Tampa Bay Estuary Program

TBNEP – Tampa Bay National Estuary Program

TMDL – total maximum daily load

TN – total nitrogen

TP – total phosphorus

TSI – trophic state index

TSS – total suspended solids

USGS – United States Geological Survey

WBID – water body identifier

WEF – Water Environment Federation