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WATER RESOURCE VALUE MONITORING FOR BLUE SPRING AND BLUE SPRING RUN, VOLUSIA COUNTY, FLORIDA

FINAL REPORT

Final Report

Water Resource Value Monitoring for Blue Spring and Blue Spring Run, Volusia County, Florida

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Prepared by:

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For:

St. Johns River Water Management District

In Cooperation With:

Florida Department of Environmental Protection

U.S. Geological Survey, Florida Integrated Science Center

Executive Summary

The St. Johns River Water Management District (District) has adopted by rule a minimum flow regime (MFR) for Blue Spring and Blue Spring Run (Blue Spring MFR) in Volusia County, Florida. The Blue Spring MFR will support the protection of the use of Blue Spring as a winter warm-water refuge for the West Indian manatee population and will support the protection of all relevant water resource values (WRVs) in 62-40.473, Florida Administrative Code (FAC). The relevant water resource values include: recreation in and on the water; fish and wildlife habitats and passage of fish; transfer of detrital material; aesthetic and scenic attributes; filtration and absorption of nutrients and other pollutants; sediment loads; and water quality (WSI 2007a).

The Blue Spring MFR defines the minimum long-term mean flow in increments until 2024. The minimum long-term mean flow will increase over time. The first increment sets the minimum long-term mean flow at 133 cubic feet per second (cfs) until March 31, 2009. This minimum long-term mean flow then increases during each of four subsequent 5-year intervals to the following:

April 1, 2009 through March 31, 2012 – 137 cfs
April 1, 2014 through March 31, 2019 – 142 cfs
April 1, 2019 through March 31, 2024 – 148 cfs
After March 31, 2024 – 157 cfs

During the rule adoption process, the District received numerous comments from individuals and other agencies regarding implementation of the Blue Spring MFR. A recurring comment was that given the phased structure of the rule, the District may not be able to ensure the required flows will actually be achieved by the dates established in the flow regime. To address this concern, the District's Governing Board authorized District staff to develop a comprehensive Blue Spring Minimum Flow Regime Action Plan (Action Plan) that directs the implementation of a multi-faceted approach by District staff to ensure to the extent possible that the increasing minimum flows required by the flow regime will be met in the future. The Action Plan was designed to adaptively manage implementation of the Blue Spring MFR in combination with environmental monitoring to ensure that the Blue Spring MFR protects the springs WRVs and unique flora and fauna.

In the Action Plan, the District expressed its intent to accomplish the Action Plan through strategic implementation of objectives and action strategies associated with the following four major plan components: (1) monitoring and periodic evaluation; (2) water supply planning and alternative water supply development; (3) permitting and enforcement; and (4) reporting. This report provides a summary of the first year of intensive Blue Spring WRV Monitoring (October 2007 through September 2008) from multiple governmental agencies and consultants and addresses the first major plan component of the Action Plan (monitoring and periodic evaluation). Data analysis and reporting are ongoing and this report represents a preliminary examination of the results. Key accomplishments include:

- A detailed survey of Blue Spring and Blue Spring Run has been completed by the District. Results of this survey can be coupled with water level and velocity data to estimate surface area, volume, and residence time of the waters contained in the spring ecosystem;
- Monthly water chemistry sampling from three stations within the spring run has been completed allowing the characterization of the water quality and an estimation of the uptake of pollutants along the length of the spring run;
- Water quality field parameters were measured for up to 284 days at three stations located along the length of Blue Spring Run;
- Light attenuation has been measured at three stations to characterize the amount of solar energy available to primary producers;
- The general biological structure of the algae, aquatic plants, and macroinvertebrates has been characterized;
- Macrofauna utilizing Blue Spring have been characterized, including annual manatee usage, fish species and densities, and aquatic turtle population estimates;
- Ecosystem function has been characterized through estimation of ecosystem metabolism, oxygen diffusion, and particulate export;
- Human use of Blue Spring has been characterized including annual attendance, water contact usage, and a survey of visitor opinions.

Key findings from this first year of monitoring indicate that Blue Spring is a popular state park, with over 400,000 visitors during the 2008 calendar year.

Water quality appears to vary in Blue Spring in response to aquifer discharge rates. Higher concentrations of conservative salts and carbonates are observed during periods of lower flow, possibly indicating a greater proportion of older source water as flow rates decline. Nitrate concentrations are also lower at low flows, adding a certain amount of confirmation to this hypothesis related to water flows and age.

Algal thickness was greatest at the Upper and Middle stations, where filamentous algae measuring > 20 mm dominated the periphyton community. Algae were less abundant at the Lower station, where a roughly equal apportionment of filamentous algae and diatoms was found.

The Stream Condition Index (SCI) was assessed at three locations during four quarterly sampling events. SCI scores ranged from 4 -15 (on a 100 point scale) at all three stations on all dates, placing them in the "Impaired" category, indicating that Blue Spring is not supporting a healthy macroinvertebrate community. Over the limited time frame of this study the SCI was found to decline even more at lower spring flows.

While genera of the two endemic snails reported to occur in Blue Spring, the Blue Spring Hydrobe (*Aphaostracon asthenes*) and the Pygmy Siltsnail (*Floridobia parva*) were represented in samples; their identification at the species-level could not be confirmed.

A diversity of fish and turtles utilize Blue Spring as well, with 25 fish species and 6 aquatic turtle species observed. Highest fish diversity was observed during periods of lower flow. It is hypothesized that this may be due to the attraction of the system to more salt tolerant or dependent fish species during lower flows.

Manatee use of Blue Spring continues to increase. Total observed manatees have increased from 11 individuals in 1970 to 301 in 2008 and the maximum daily count of manatees per season has increased from 11 animals in 1970 to 231 animals during the 2008 manatee season.

The increasing trend in manatee use of Blue Spring as a winter, warm water refuge necessitated that the District adopt a phased minimum flow regime for Blue Spring to accommodate the anticipated increase in the West Indian Manatee population. Because the observed maximum daily manatee count has exceeded projected counts by approximately 23%, on average, during the last three manatee seasons, the District recommends that the Blue Spring MFR computational process be verified in 2011, based on the most current data. The District will use this information to evaluate whether an amendment to the applicable provision of Chapter 40C-8, FAC, is warranted.

Blue Spring shows similar patterns to other Florida spring ecosystems, ecosystem productivity is correlated to solar inputs and peaks in the late spring/early summer. However, overall ecosystem productivity of Blue Spring appears to be lower than some other Florida spring ecosystems. This appears to be a function of physical factors, such as a naturally occurring low concentration of dissolved oxygen in the groundwater discharged by the spring; and of biological factors, such as the dominance of benthic algae found within the spring run. Other measures of ecosystem function, particulate export and nutrient assimilation rates, produced variable results suggesting that in-water recreation may influence these parameters.

This report represents the first year of intensive monitoring for Blue Spring during a 25 year Action Plan period with emphasis on intensive studies during each fifth year. This monitoring plan design appears to be successful with a few recommended additions. Ecological parameters found to be most sensitive to flows are recommended to be added to the routine sampling to be conducted every year. These include: SCI, fish, water clarity (as measured by horizontal Secchi disk), and monthly ecosystem metabolism.

In addition, the assessment of manatee populations can be enhanced by adopting and refining two existing protocols: First, the assessment of manatee body condition and health could better utilize evaluation scales to assess the degree of cold stress skin lesions and general body condition. The methods used to assess cold stress impacts should be described and a cold stress database should be developed. Second, the assessment and quantification of manatee distribution and packing densities could be improved through the use of hand-held digital cameras. This could be accomplished by implementing a systematic manatee season monitoring protocol utilizing the surveyed zones within the Blue Spring Run and hand-held digital cameras. If possible, these surveys should coincide with the annual statewide manatee Synoptic Surveys and the sampling protocol should be established through cooperative efforts between the District, DEP, FWC, and USFWS. The resulting data should be used to verify and refine the manatee carrying capacity model developed by the District.

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Acknowledgements

Wetland Solutions, Inc. (WSI) gratefully acknowledges the following individuals for their assistance provided over the course of this project: G. B. "Sonny" Hall, Ph.D., Technical Program Manager with the St. Johns River Water Management District (SJRWMD) provided overall project guidance and reviewed all deliverables. Blue Spring State Park (BSSP), Park Manager Robert (Bob) Rundle, Assistant Park Manager, David Foster, Park Biologist, Megan Keserauskis, and Park Ranger, Wayne Hartley provided park data and shared a wealth of observations. Representing the US Geological Survey (USGS) was Supervisory Hydrologist James (Leroy) Pearman who directed physical and chemical parameter monitoring of the spring. Researchers from the Florida Department of Environmental Protection, Bureau of Assessment and Restoration Support included Joy Jackson, Russ Frydenborg, and Thomas Frick, who oversaw detailed sampling of the physical, chemical, and biological components of the spring system. Dana Bryan of the Florida Department of Environmental Protection, Division of Recreation and Parks provided human use surveys which were conducted by Dr. Mark Bonn (Bonn Marketing Research Group, Inc.). Drs. Kirsten Work, Melissa Gibbs, and Terry Ferrell of Stetson University conducted fish and turtle sampling of the spring run. We thank Eric Munscher for his aquatic turtle data for this and other spring ecosystems. This project was completed under contract agreement SJ24790 between the SJRWMD and WSI.

1.0 Introduction

1.1 Background

The St. Johns River Water Management District (District) adopted by rule a minimum flow regime (MFR) for Blue Spring and Blue Spring Run (Blue Spring MFR) in Volusia County, Florida (40C-8.031(1)(f), Florida Administrative Code [FAC]). The Blue Spring MFR was adopted pursuant to the Minimum Flows and Levels (MFLs) program mandated by Florida law (Section 373.042, Florida Statutes [FS]). The MFLs Program establishes MFLs for surface water and ground water systems. Under this statute, the minimum flow for a surface water course shall be the limit at which further withdrawals would be significantly harmful to the water resources or the ecology of the area. Once an MFL is established, an applicant for a consumptive use permit (CUP) or environmental resource permit (ERP), pursuant to Chapters 40C-2, 40C-20, 40C-4, or 40C-40, FAC, would be required to provide reasonable assurance that the minimum flow would not be violated by a proposed water withdrawal or the construction or operation of a proposed surface water management system.

Blue Spring and Blue Spring Run in Volusia County, Florida are internationally famous as a winter warm-water refuge for the endangered West Indian manatee, a large aquatic mammal that requires warm-water winter refuges to survive near the northern extreme of its range. Blue Spring is the only naturally occurring large manatee winter warm-water refuge on Florida's east coast and specifically for the St. Johns River manatee population. Manatee use of Blue Spring Run as a winter warm-water refuge has increased since 1978, when routine manatee counts were begun in the spring run (Rouhani *et al.* 2007). During the 2008 / 2009 winter season (Oct. to Apr.), 301 individual manatees were observed to utilize Blue Spring and Blue Spring Run (BSSP data).

Due to the unique relationship between Blue Spring and Blue Spring Run and the survival and expansion of the manatee population in Florida, a minimum flow regime that would be sufficient to protect manatees' use of Blue Spring as a winter warm-water refuge under catastrophic conditions was developed, hereafter referred to as the "Blue Spring MFR" (40C-8.031(1) (f), FAC; see Rouhani *et al.* 2007 for background). In addition to their importance to manatee populations, Blue Spring and Blue Spring Run provide numerous other environmental and societal functions including habitat for numerous other plant and animal species, water quality maintenance, and human recreation in Blue Spring State Park. Section 62-40.473, FAC, requires the consideration of these 10 human use and ecological Water Resource Values (WRVs) when establishing MFLs including:

- Recreation in and on the water (62-40.473 (1) (a), FAC)
- Fish and wildlife habitats and the passage of fish (62-40.473 (1) (b), FAC)
- Estuarine resources (62-40.473 (1) (c), FAC)
- Transfer of detrital material (62-40.473 (1) (d), FAC)
- Maintenance of freshwater storage and supply (62-40.473 (1) (e), FAC)

- Aesthetic and scenic attributes (62-40.473 (1) (f), FAC)
- Filtration and absorption of nutrients and other pollutants (62-40.473 (1) (g), FAC)
- Sediment loads (62-40.473 (1) (h), FAC)
- Water quality (62-40.473 (1) (i), FAC)
- Navigation (62-40.473 (1) (j), FAC)

These WRVs were previously described and summarized as part of the process of Blue Spring MFR adoption (WSI 2006).

The Blue Spring MFR will support the protection of the use of Blue Spring as a winter warm-water refuge for the West Indian manatee population and will support the protection of all relevant WRVs in 62-40.473, FAC. The seven relevant water resource values include: recreation in and on the water; fish and wildlife habitats and passage of fish; transfer of detrital material; filtration and absorption of nutrients and other pollutants; aesthetic and scenic attributes; sediment loads; and water quality.

To develop the Blue Spring MFR, the District formed the Blue Spring Minimum Flow Interagency Working Group (Blue Spring MFIWG), consisting of experts from the District and from various organizations including the Florida Department of Environmental Protection (FDEP), the Florida Fish and Wildlife Conservation Commission (FWC), and the Blue Spring State Park (BSSP). The U.S. Fish and Wildlife Service (USFWS) and Save the Manatee Club, Inc. (SMC), also participated in the Blue Spring MFIWG, primarily in reviewing and commenting on draft recommendations.

The Blue Spring MFR defines the minimum long-term mean flow in increments until 2024. The minimum long-term mean flow will increase over time. The first increment sets the minimum long-term mean flow at 133 cubic feet per second (cfs) until March 31, 2009. This minimum long-term mean flow then increases during each of four subsequent 5-year intervals to the following:

April 1, 2009 through March 31, 2012 – 137 cfs
April 1, 2014 through March 31, 2019 – 142 cfs
April 1, 2019 through March 31, 2024 – 148 cfs
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As explained in the Action Plan, the District used the best information available and computer simulation models of Blue Spring hydrodynamics to calculate the Blue Spring MFR. While the Blue Spring MFR is based on protection of the increasing numbers of manatees that use Blue Spring as a winter warm water refuge, the MFR is also expected to protect all applicable ecological and human use WRVs listed in Section 62-40.473, FAC. However, it was recommended to the District that additional data would be useful to verify these conclusions and to better understand the relationship between spring flows and related WRVs in Blue Spring and Blue Spring Run. This data collection effort was found to be particularly important in the event that the actual growth rate of manatee usage of Blue Spring differs from the growth projections used to calculate the Blue Spring MFR. The additional information from the monitoring and data collection efforts described in this report, will be used by the District to verify that flows from Blue Spring will not fall below the established minimum flows due to ground water withdrawals and to determine whether rule amendments are warranted in the future.

The Action Plan directed that a detailed Monitoring Plan be developed that encompasses all phases of the physical, chemical, and ecological data monitoring and analysis required for the periodic evaluation of the Blue Spring MFR. The Monitoring Plan was developed by the District and their consultant Wetland Solutions, Inc. (WSI) in partnership with FDEP and FWC to cooperatively develop, fund, and implement the Monitoring Plan work elements. Continuing oversight will be provided by representatives of the Blue Spring MFIWG, the U.S. Geological Survey (USGS), and the USFWS. The approved Monitoring Plan (WSI 2007b) includes a detailed program of environmental and ecological data collection at Blue Spring over the next 25 years with intensive sampling period occurring once each five years with reduced monitoring activities during intervening years. This report provides a summary of the first year of intensive Blue Spring WRV Monitoring.

1.2 Project Objectives and Monitoring Plan

A detailed Blue Spring WRV Monitoring Plan was prepared to accomplish this objective (WSI 2007b). The following MFIWG members cooperatively developed the Monitoring Plan components (**Table 1-1**). **Table 1-2** provides more detail on the individual team member responsibilities to complete the proposed monitoring efforts.

TABLE 1-1.
Blue Spring monitoring plan components and team members.

Monitoring Category	Team Members
Physical and chemical conditions monitoring • Hydrological and meteorological • Water quality • Bottom contour mapping	DEP; USGS; ; Dr. Robert Knight, Wetland Solutions, Inc.; Dr. Kirsten Work, Stetson University; District
Manatee population and behavior monitoring	FWC, DEP, USGS, District
Water resource value monitoring • General biological structure • Ecological functions • Human uses	DEP; FWC; USGS; Dr. Robert Knight, Wetland Solutions, Inc.; Dr. Kirsten Work, Stetson University; District

TABLE 1-2.
Summary of Blue Spring monitoring plan responsibilities.

Parameter Group	Subcategory	Responsibilities
Physical & Chemical Conditions Monitoring		
Hydrological & meteorological	Spring discharge	USGS (Florida Integrated Science Center)
	Bottom temperature profile	USGS (Florida Integrated Science Center)
	Weather data	USGS (Florida Integrated Science Center) and District (Division of Hydrologic Data Services)
Water Quality	Field Meters	USGS (Florida Integrated Science Center) and WSI
	Recording Data Sondes	WSI
	Analytical Parameters	USGS (Florida Integrated Science Center)
Bottom contour mapping	Bathymetric mapping	District (Division of Surveying Services)
Manatee Population and Behavior Monitoring		
Manatee population	Manatee biology	District, DEP (Blue Spring State Park), USGS
Remote sensing	Manatee biology	District, DEP, FWC
Water Resource Values Monitoring		
General Biological Structure	Periphyton / Algae	DEP (Department of Water Resource Management)
	Plants	DEP (Department of Water Resource Management)
	Macroinvertebrates	DEP (Department of Water Resource Management)
	Mollusks	DEP (Department of Water Resource Management)
	Fish	Stetson University, WSI
	Turtles	Stetson University, WSI
Ecosystem Function	Ecosystem metabolism	WSI
	Particulate export	WSI
	Oxygen Diffusion	WSI
	Pollutant assimilation	WSI
Human Use	Total human use	DEP (Blue Spring State Park, DRP, DPS)
	Water contact use	DEP (Blue Spring State Park)
	Aesthetics	DEP (Blue Spring State Park)

2.0 Description of the Study Site

2.1 Site Location

Blue Spring State Park is located in Volusia County, Florida, two miles west of Orange City, six miles southwest of DeLand, and adjacent to the St. Johns River (**Figure 2-1**). The latitude and longitude of Blue Spring is 28°56′ 51″ North and 81°20′ 23″ West, respectively.

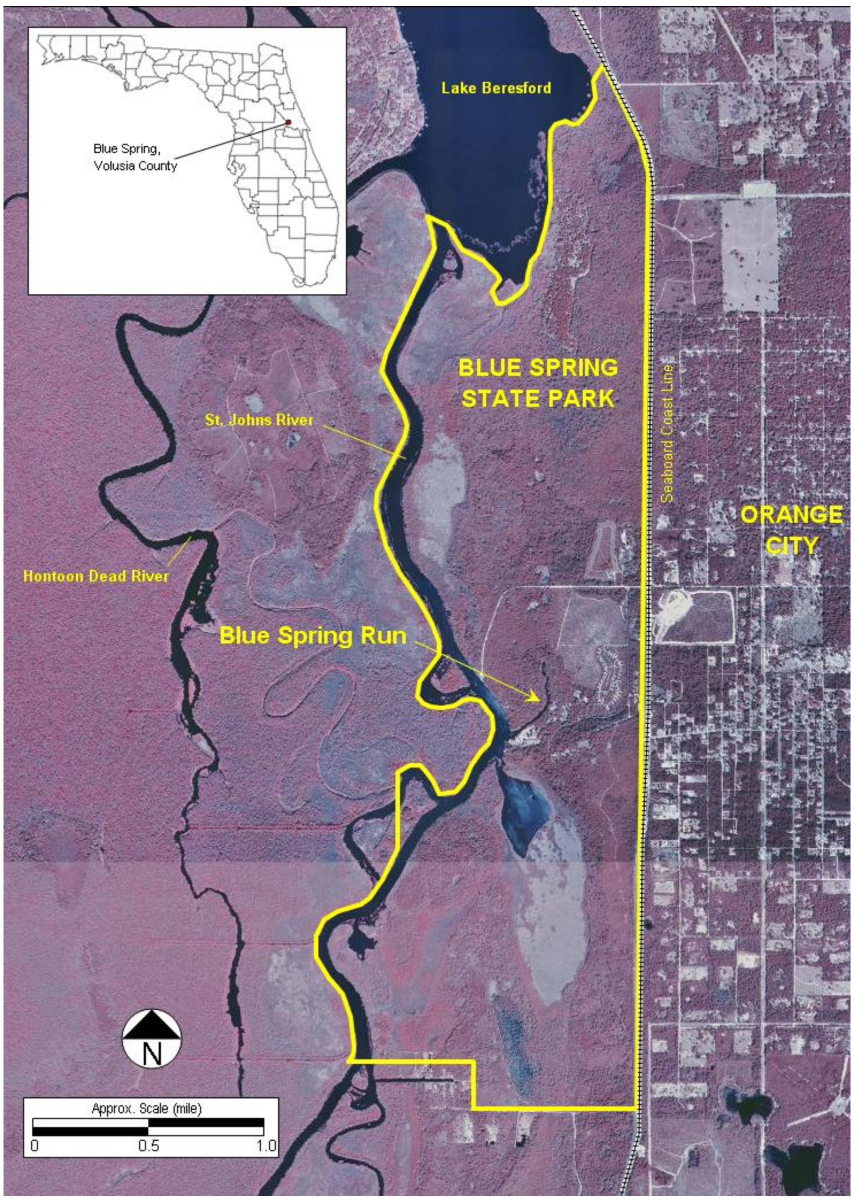


FIGURE 2-1. Location map of Blue Spring State Park and Blue Spring Run, Volusia County, Florida (USGS aerial photo).

2.2 Physical Description

Blue Spring has a semi-circular spring pool in a conical depression with a notable boil in the center. The spring pool measures 135 ft (41.1 m) north to south and 105 ft (32 m) east to west. Water depth over the vent is approximately 18 ft (5.5 m) during average water levels. The bottom of the spring pool and upper portions of the spring run is composed of limestone. The spring vent is an elongated fissure in the limestone which approaches 120 ft (37 m) in depth (**Figure 2-2**). The water is clear and blue with a greenish tinge. The banks surrounding the spring pool are steep and sandy and rise to about 15 to 20 ft (4.6 to 6.1 m) above the water level (above data from Scott *et al.* 2002). **Figure 2-3** shows the spring run with major features.

The bottom profile of the spring and spring run were surveyed in 2007 by the District. The calculated wetted surface-area of the spring and spring run is 4.1 acres (1.7 hectares). The calculated length of the spring pool and spring run starting at the upper edge of the spring basin to the point of confluence with the St. Johns River is 2,198 feet (670 m). As illustrated in **Figure 2-4** the spring run is divided into three designated reaches with previously estimated lengths as follows:

- The Public Use Area (1,280 ft [390 m]) extending from the Spring Boil downstream to the Swimming Area and including the Diver Entry dock;
- A Manatee Refuge with limited public access or viewing opportunities (508 ft [155 m]) extending from the Swimming Area down to the Upper Observation Deck; and
- Manatee Refuge with Public Viewing (410 ft [125 m]) extending downstream from the Upper Observation Deck down to the mouth of Blue Spring Run.

All public access to and viewing of the spring run is from the east/south side of Blue Spring Run. The park also includes a concession outfit, meeting facilities, a historic residential house, camp sites, cabins, pavilions, a playground, and restroom facilities (**Figures 2-3 and 2-4**).

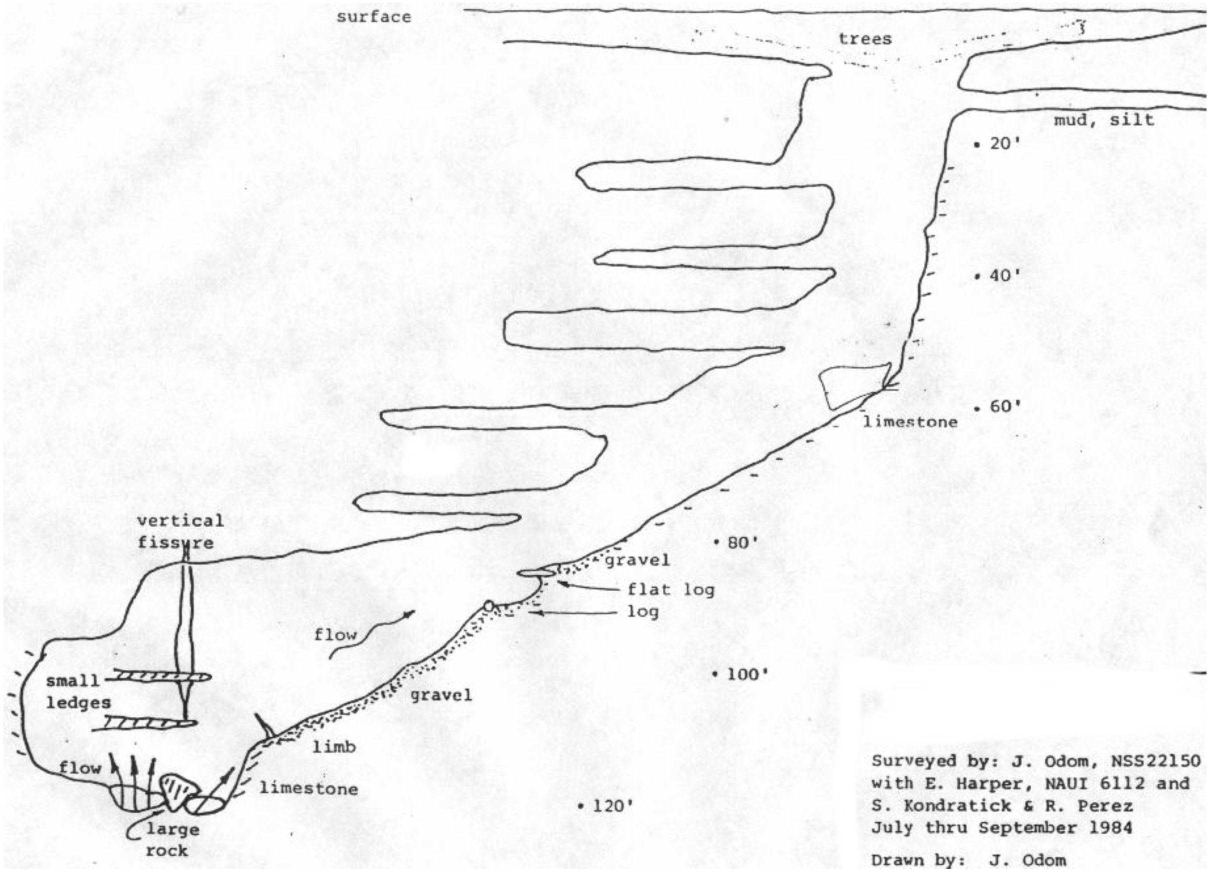


FIGURE 2-2. Profile of the Blue Spring cave system as surveyed and drawn by J. Odom in 1984.

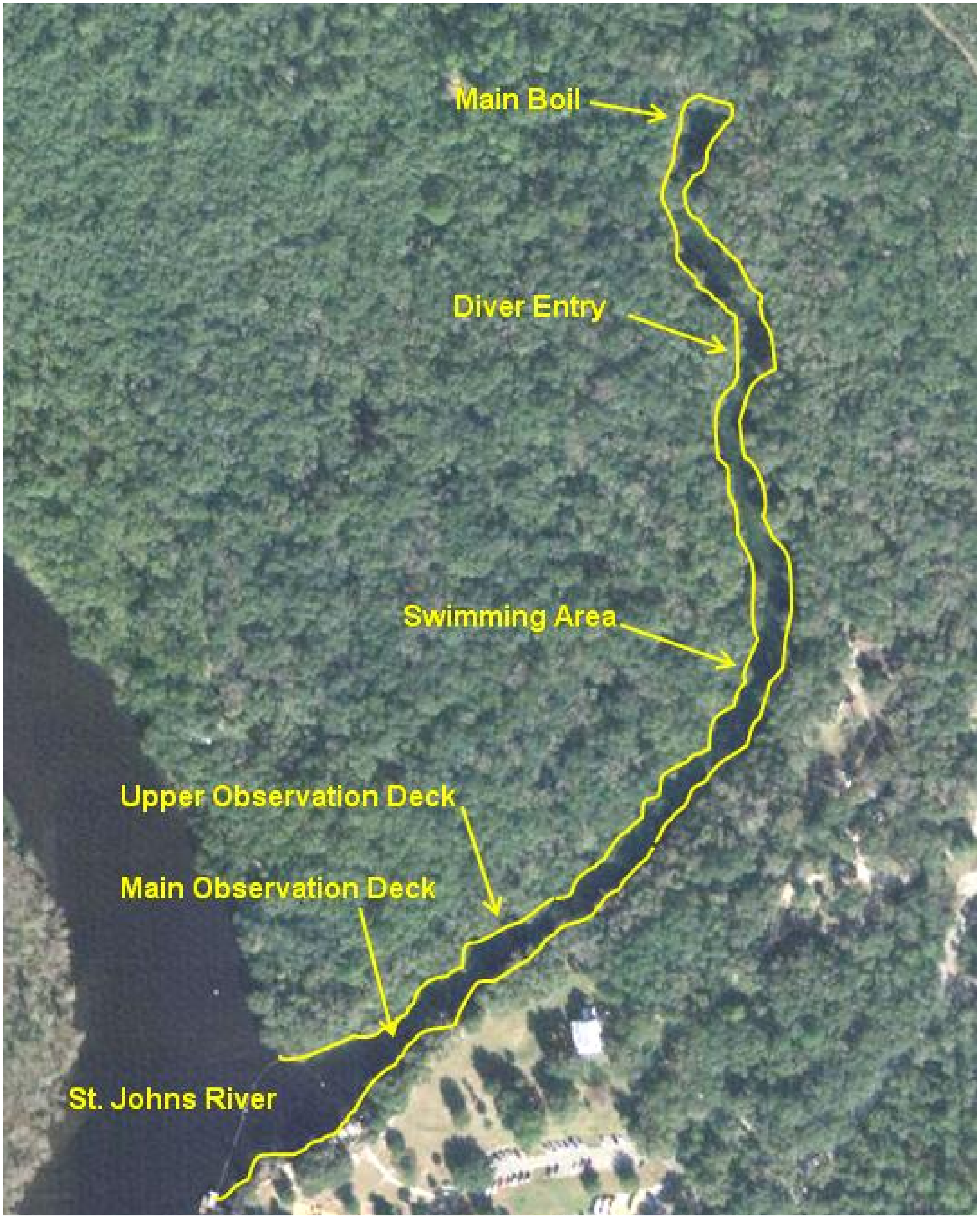


FIGURE 2-3. Aerial view of Blue Spring and Blue Spring Run showing principal geographical features.

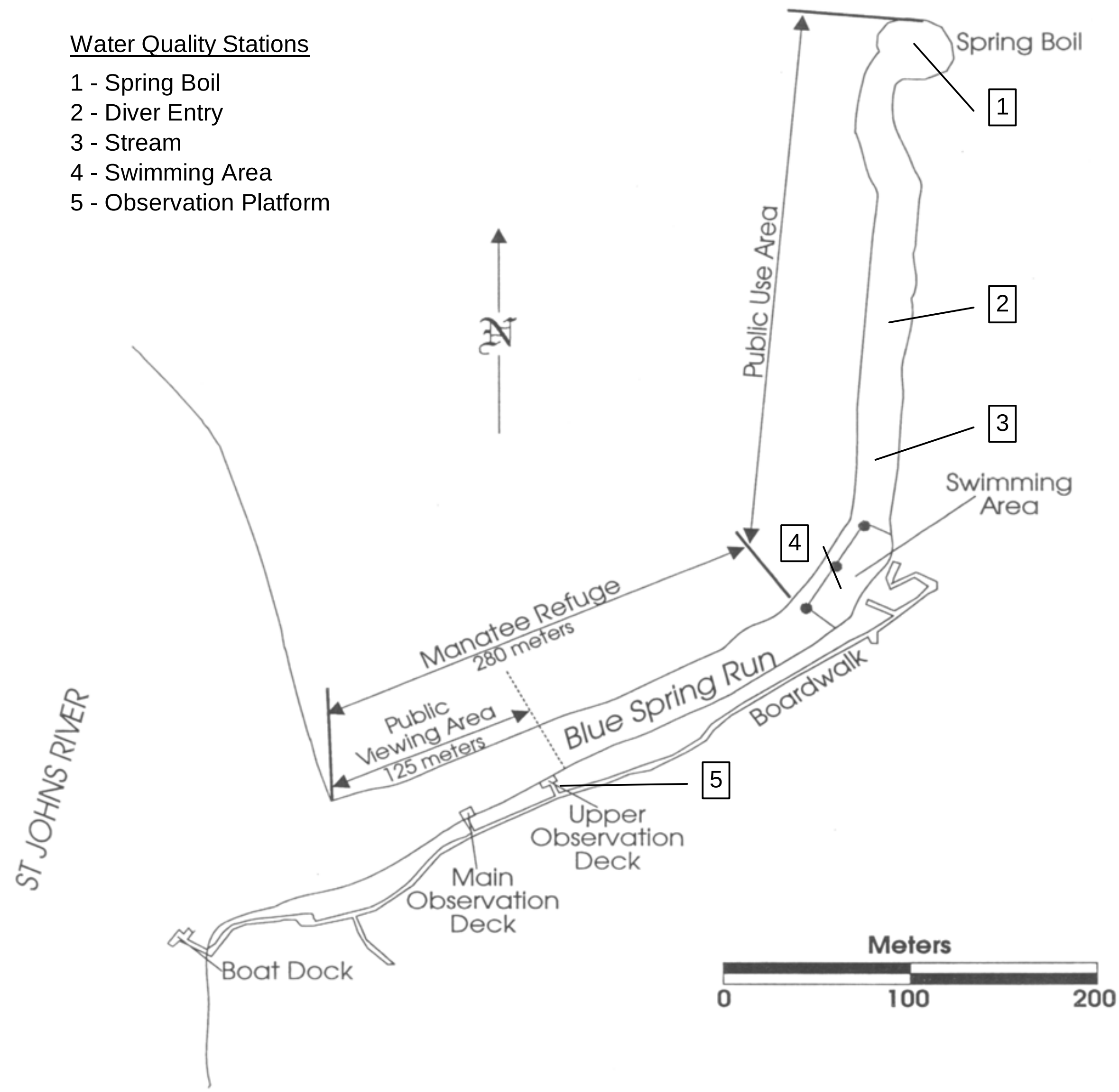
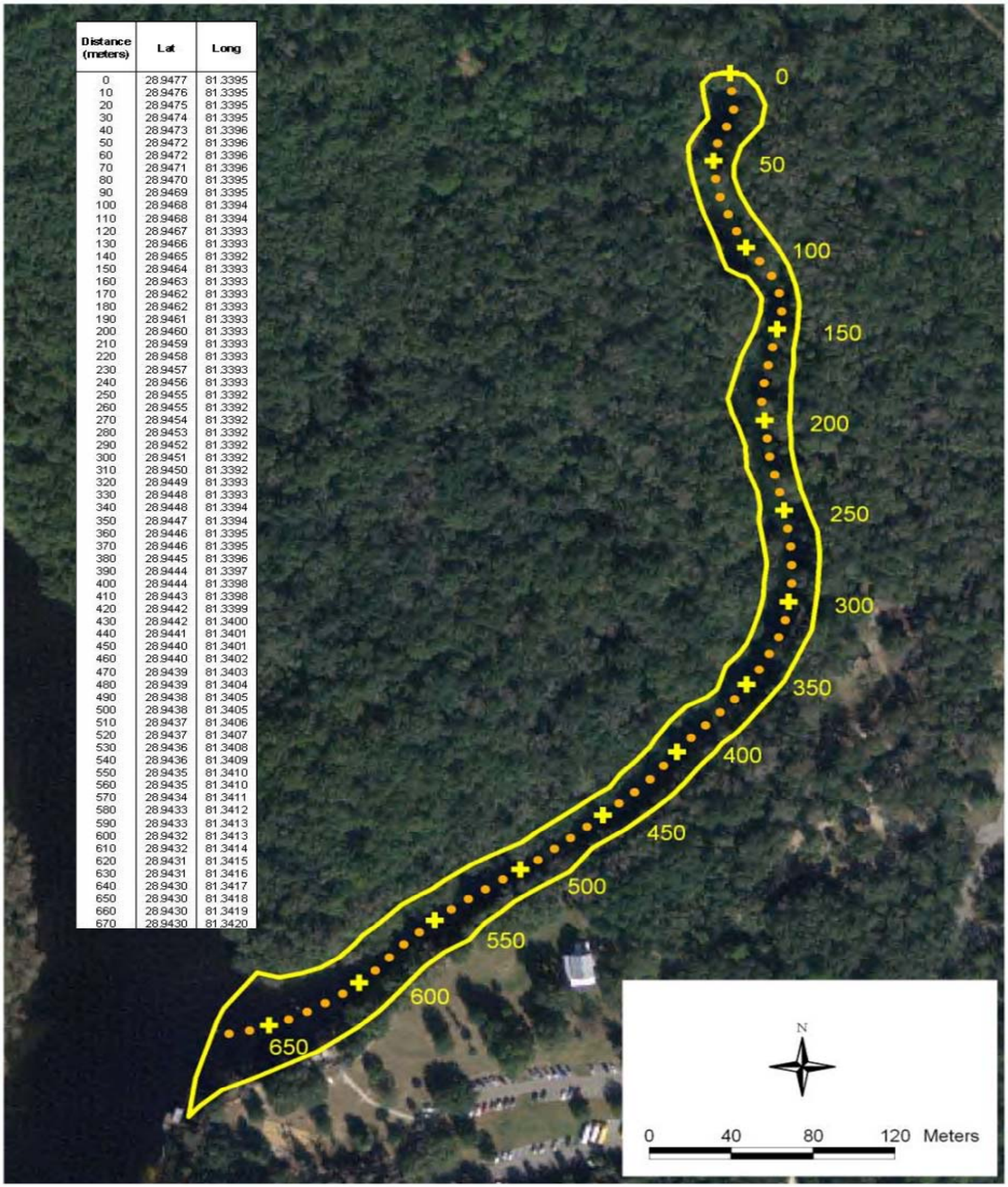


FIGURE 2-4. Map of Blue Spring Run showing the location of areas designated for manatee protection, swimming and diving, and passive nature study (from Sucsy 2002).

2.3 Sampling Locations

A standardized sampling location system was established in the Blue Spring WRV Monitoring Plan to facilitate the organization and collation of data from historical and future sampling efforts. This sampling system consists of longitudinal distances in meters from the upstream (northern) edge of the spring pool and extends downstream to the confluence of the spring run with the St. Johns River (**Figure 2-5**). Sampling locations are designated by a three letter prefix followed by the longitudinal distance, *i.e.* VBS 355 designates a station located in Volusia Blue Spring (VBS) 355 m (1,164 ft) downstream from the upstream edge of the spring pool.



Distance (meters)	Lat	Long
0	28.9477	81.3395
10	28.9476	81.3395
20	28.9475	81.3395
30	28.9474	81.3395
40	28.9473	81.3396
50	28.9472	81.3396
60	28.9472	81.3396
70	28.9471	81.3396
80	28.9470	81.3395
90	28.9469	81.3395
100	28.9468	81.3394
110	28.9468	81.3394
120	28.9467	81.3393
130	28.9466	81.3393
140	28.9465	81.3392
150	28.9464	81.3393
160	28.9463	81.3393
170	28.9462	81.3393
180	28.9462	81.3393
190	28.9461	81.3393
200	28.9460	81.3393
210	28.9459	81.3393
220	28.9458	81.3393
230	28.9457	81.3393
240	28.9456	81.3393
250	28.9455	81.3392
260	28.9455	81.3392
270	28.9454	81.3392
280	28.9453	81.3392
290	28.9452	81.3392
300	28.9451	81.3392
310	28.9450	81.3392
320	28.9449	81.3393
330	28.9448	81.3393
340	28.9448	81.3394
350	28.9447	81.3394
360	28.9446	81.3395
370	28.9446	81.3395
380	28.9445	81.3396
390	28.9444	81.3397
400	28.9444	81.3398
410	28.9443	81.3398
420	28.9442	81.3399
430	28.9442	81.3400
440	28.9441	81.3401
450	28.9440	81.3401
460	28.9440	81.3402
470	28.9439	81.3403
480	28.9439	81.3404
490	28.9438	81.3405
500	28.9438	81.3405
510	28.9437	81.3406
520	28.9437	81.3407
530	28.9436	81.3408
540	28.9436	81.3409
550	28.9435	81.3410
560	28.9435	81.3410
570	28.9434	81.3411
580	28.9433	81.3412
590	28.9433	81.3413
600	28.9432	81.3413
610	28.9432	81.3414
620	28.9431	81.3415
630	28.9431	81.3416
640	28.9430	81.3417
650	28.9430	81.3418
660	28.9430	81.3419
670	28.9430	81.3420

FIGURE 2-5. Aerial view of Blue Spring Run showing standardized sampling station locations and corresponding latitude and longitude coordinates marked at 10-m intervals. Sampling stations are designated by the following example: VBS 220 is Volusia Blue Spring, 220 m station.

3.0 Methods

3.1 Introduction

Preliminary descriptions of the monitoring components, including sampling methods, standard operating procedures, sampling stations, sampling frequency, responsible parties, and data base management, were previously described in the Blue Spring MFR Monitoring Plan (August 2006). Detailed monitoring methods and changes to the original preliminary plan are described below. Responsibilities for each of the monitoring components were previously listed above in **Table 1-2**. In addition to the specified duties noted in **Table 1-2**, WSI provided technical support to the District's project manager and consolidated report editing.

The period covered by this report is District Fiscal or Water Year 2007/2008 (WY2007/08 October 2007 through September 2008). This fiscal year is designated as Year 1 of the Blue Spring WRV monitoring. As indicated in the monitoring plan summarized in **Table 3-1**, this initial year was the first of the intensive sampling years that will re-occur at five-year intervals. While chemical and biological sampling will continue in Blue Spring over the next four years (Water Years 2 through 5), the next intensive sampling year will be Water Year 6 (WY2012/13). This five-year pattern is expected to continue through October 2024.

As shown in **Table 3-1**, the sampling locations of the various monitoring plan components span most of the length of Blue Spring Run, from the Spring Boil to approximately 630-m downstream (within 40-m of the confluence of Blue Spring Run and the St. Johns River).

Water Year 2007/2008 experienced a major tropical storm from August 19-21, 2008 (Tropical Storm Fay). This storm deposited large amounts of precipitation (> 6 ") in the upper and middle St. Johns River basin, resulting in elevated water levels in the river and in Blue Spring Run. This event interrupted several of the sampling efforts during the end of the water year from mid-August through September 2008.

TABLE 3-1.
Summary of Blue Spring WRV monitoring plan components.

Parameter Group	Subcategory	SOP	Sampling Locations	Frequency	Description
Physical & Chemical Conditions Monitoring					
Hydrological & meteorological	Spring discharge	USGS (Shelton 2005)	VBS 520-330	Daily and Monthly	Monthly and daily spring discharges and daily spring stages
	Bottom temperature profile	Provisional	VBS 630-460	Hourly	Hourly spring run bottom temperatures recorded at 10 meter (m) intervals
	Weather data		Near spring run	Hourly	Continuous measurements of air temperature, barometric pressure, St. Johns River temperature upstream of confluence with Blue Spring, precipitation, relative humidity, insolation, and photosynthetically active radiation (PAR)
Water Quality	Field Meters	DEP FT 1000, 1100, 1200, 1400, 1500, 1700 USGS (Kroening 2003*)	VBS 10, 330, 520	Monthly, during intensive sampling (one year in five), and quarterly at VBS 330 during intervening years	Water temperature, pH, specific conductance, conductivity, dissolved oxygen, light penetration - one sample per event
	Recording Data Sondes	DEP FT 1900	VBS 35, 355, 570	Six times, one year in five	Water temperature, pH, specific conductance, conductivity, dissolved oxygen - continuous hourly values for about 2 weeks per event
	Analytical Parameters	DEP FS 2000, 2100 (Kroening 2003*)	VBS 10, 330, 520	Monthly, during intensive sampling (one year in five), and quarterly at VBS 330 during intervening years	Calcium, silica, sulphate, magnesium, chlorides, sodium, alkalinity, ammonia N, nitrate+nitrite N, total kjeldahl N, ortho P, total dissolved P, total P - grab samples
Bottom contour mapping	Bathymetric mapping	Provisional	Spring run	NA	Spring run bottom contour elevation mapping
Manatee Population and Behavior Monitoring					
Manatee population	Manatee biology	Provisional	Spring run	Daily, November - March	Monitor individual manatee attendance and provide maximum one-day count
Remote sensing	Manatee biology	NA	Spring run	Daily, November - March	Experiment with remote sensing to track manatee distribution and packing densities
Water Resource Values Monitoring					
General Biological Structure	Periphyton / Algae	DEP FS 7000, LT 7000	VBS 10-110, 210-310, 420-520	Quarterly, one year in five	Percent cover and macroscopic analysis of dominant phyla
	Plants	Provisional	VBS 10-110, 210-310, 420-520	Quarterly, one year in five	Percent cover of aquatic macrophytes and canopy
	Macroinvertebrates	DEP FT 3000	VBS 10-110, 210-310, 420-520	Quarterly, one year in five	Species diversity and dominance estimates
	Mollusks	Provisional	VBS 10-110, 210-310, 420-520	Quarterly, one year in five	Species diversity and dominance estimates
	Fish	Provisional	VBS 10-110, 110-210, 210-310, 310-410, 410-520	Quarterly, one year in five	Species diversity and dominance estimates
	Turtles	Provisional	VBS 10-110, 110-210, 210-310, 310-410, 410-520	Quarterly, one year in five	Species diversity and dominance estimates
Ecosystem Function	Ecosystem metabolism	Provisional	VBS 35-355, 355-5720	Six times, one year in five	Gross and net primary productivity, community respiration, P/R ratio, ecological efficiency
	Particulate export	Provisional	VBS 10-330, 330-520	Six times, one year in five	Net export of particulate matter (inorganic and organic)
	Oxygen Diffusion	Provisional	VBS 10-330, 330-520	Six times, one year in five	Needed to correct upstream-downstream dissolved oxygen rate-of-change estimates for atmospheric oxygen exchanges
	Pollutant assimilation	Provisional	VBS 10-330, 330-520	Monthly, one year in five	Net changes of mass loads of nitrate N, total N, ortho P, and total P
Human Use	Total human use	Provisional	Spring boil and run	One year in five	Human-use days associated with the park and the spring run
	Water contact use	Provisional	Spring boil and run	One year in five	Human-use days for water contact activities (wading, swimming, snorkeling, scuba diving, etc.)
	Aesthetics	Provisional	Spring boil and run	One year in five	Qualitative exit surveys

* http://water.usgs.gov/owq/FieldManual/

3.2 Physical and Chemical Conditions Monitoring

3.2.1 Hydrological and Meteorological

3.2.1.1 Flow and Level Data

Staff from the USGS, Florida Integrated Science Center (Orlando), maintains an array of sampling equipment to provide real-time water quality data within the manatee refuge zone (approximately VBS 360 to VBS 640). At approximately VBS 370, a data-collection platform (water-stage recorder, acoustic velocity meter, and water-quality instrument) is located adjacent to the spring run to measure water stage height, discharge, temperature, and specific conductance. Real time data from this location are available online from the USGS (station name: USGS 02235500 BLUE SPRINGS NEAR ORANGE CITY, FL, http://waterdata.usgs.gov/nwis/uv?site_no=02235500)

The Blue Spring streamflow gaging station at VBS 370 consists of a water-stage recorder and an acoustic velocity meter (AVM) collecting data at a 15-minute interval and transmitted to the Geostationary Operational Environmental Satellite (GOES) at hourly intervals and from there into the USGS database for display at the USGS NWISWeb website. Continuous streamflow for Blue Spring has been obtained since November 1998 except for periods when water levels inundated the gaging station.

Typically a relationship exists between the stage (water level) and discharge of a stream. The data from the water-stage recorder demonstrates the backwater effect from the St. Johns River as the water level reflects the fluctuation of the river and not that of the flow of the spring. Therefore a "conventional" stage versus discharge rating was not possible for this site, and the index-velocity method is utilized in the computation of streamflow at this site due to the variable backwater conditions caused by the St. Johns River. This method utilizes the water level to determine a stage or gage height that defines a cross sectional area rating for the spring run. The AVM collects velocity data by measuring the time-of-travel of a sound wave between two transducers located at an approximate 45 degree angle to each other on opposite sides of the channel. The measured velocity is indexed to the mean velocity of the entire cross-section determined by monthly discharge measurements. The cross sectional area is multiplied by the mean velocity to compute the 15-minute interval discharges from which the daily discharges are obtained in the USGS data processing system.

The station has been successfully operated since November 1998 except for periods when the gage structure was inundated during floods on the St. Johns River (*e.g.*, August 26 to November 7, 2008 due to Tropical Storm Fay). The flows determined are considered good to fair and adequately define the flow variability of the spring. An extension will be done on the gaging structure during early summer of 2009 to make it possible to collect data throughout normal and higher flow conditions.

3.2.1.2 Bottom Temperature Profile

Because of the importance of the spring run as warm water manatee refuge during the winter, water temperatures in the lower spring run are continuously measured and recorded. Beginning at approximately VBS 500, and going downstream 150 meters, the bottom temperatures of the spring run are monitored at 10-m intervals. The equipment utilized for monitoring bottom temperatures is subject to disruption by manatees. The sensors have been re-installed on three different occasions due to the curiosity of manatees (personal communication with L. Pearman). Initially they were installed from a location about 10 meters into the St. Johns River (from the junction of the spring run with the river) to a location about 150 meters up the spring run at 10-meter intervals. This sensor string would delineate the movement upstream of the colder St. Johns River water from that of the warmer spring water during the winter months. Summer months were deemed to be unimportant so when the instrumentation was made inoperable due to manatee disturbances in the winter no effort was made to reinstall until the beginning of the next cold season. The sensors were initially installed in November 2000, reinstalled in August 2007, and installed at third time in November, 2008. Success has been intermittent in obtaining a complete record throughout the temperature array. However, the data have been complete enough to define the extent of the movement of cold water during the past several winters. Newer technology utilizing one continuous cable (old technology was a separate cable for each sensor) should make it easier to maintain continuous operation.

Continuous water temperature data have also been collected since December 1998 to date at the location of the streamflow gaging station at VBS 370. The station is located upstream of the influence of the colder St. Johns River water so the variation in water temperature data is generally caused by radiant heating during the summer months between the spring outlet and the station. Specific conductance is also measured continuously at this station. These data are highly variable and generally inversely related to the flows in the spring (*i.e.,* higher flows correlate with lower specific conductance). These additional water temperature and specific conductance data are available from the USGS NWISWeb website.

3.2.1.3 Weather Data

In conjunction with District and USGS staff, a weather station was originally planned for installation on the State Park property. This planned weather station was not installed during WY2007/2008; however WSI installed and maintained a temporary weather station located in an unshaded area approximately 30 m to the west of the BSSP administrative offices. This temporary weather station collected hourly rainfall and solar data for the period between November 13, 2007 and August 29, 2008.

Continuous rainfall data were collected by use of a USA Infinities brand tipping bucket rain gauge. This recorder was checked for obstructions and logged data were downloaded on at least a monthly basis for the duration of the field sampling effort.

Two LI-COR brand light sensors (models LI-190SA, quantum sensor and LI-200SA, pyranometer) were installed in an open area free of shading at Blue Spring State Park. These sensors measure photosynthetically active radiation (PAR) and total insolation, respectively. Data were recorded using a LI-COR brand data logger (LI-1000) every minute and averaged to output integrated hourly data. On an approximate monthly basis, light sensors were checked, cleaned as necessary, and data downloaded. However, an instrumentation failure that prevented solar data acquisition occurred during the period of May 22, 2008 to August 6, 2008. Solar data for this time period and for other dates not covered by the WSI temporary weather station were estimated based on an average of data from the two nearest Florida Automated Weather Network (FAWN) stations, located in Apopka and Pierson (FAWN link: http://fawn.ifas.ufl.edu/).

3.2.2 Water Quality

3.2.2.1 Field Parameters

Field water quality meters (YSI model 556 MPS) were utilized to collect field parameters (water temperature, dissolved oxygen concentration and percent saturation, pH, and specific conductance) and to verify data sonde readings. Field meters were calibrated prior to and following sampling following manufacturers' protocols.

3.2.2.2 Light Attenuation

Underwater light transmission and attenuation were estimated based on photosynthetically active radiation measurements using LiCor brand quantum sensors and data loggers. Vertical light attenuation data were collected in Blue Spring Run during each bi-monthly sampling event at three locations (VBS 35, 355, 570) at 30 cm (1 ft) depth intervals through the water column. The resulting data were used in conjunction with community metabolism estimates to calculate the photosynthetic efficiency of the spring system. Light extinction (attenuation) coefficients were calculated using PAR data and the Lambert-Beer equation (**Equation 1**, Wetzel 2001):

$$I_z = I_o(e^{-kz}) \quad \textbf{[Equation 1]}$$

Where:

I_z = PAR at depth z, umol/m^2/s

I_o = PAR at the water surface, umol/m^2/s

k = diffuse attenuation coefficient, m-1

z = water depth, m

As an additional measure of water clarity, horizontal Secchi measurements were collected on multiple dates in Blue Spring Run. To accomplish this, a white and black, 20-cm diameter Secchi disk was attached to a fiberglass survey tape, and the average horizontal distance that the Secchi disk was visible to an underwater observer wearing a face mask was recorded.

3.2.2.3 Recording Data Sondes

Continuous recording multi-parameter data sondes were deployed at the upstream, middle, and downstream reach of the Blue Spring Run at VBS 35, 355, and 570 as depicted in **Figure 2-4**. Yellow Springs, Inc. model 6920 and/or In-Situ, Inc. model 9500 data-logging sondes with optical dissolved oxygen sensors were utilized. These data sondes were typically deployed for at least a two-week sampling interval in each of the six bi-monthly sampling events. In between sampling events, a single data sonde was typically deployed at the VBS 570 location to provide a continuous data record at that downstream location. The data sondes were programmed to record and store readings of dissolved oxygen concentration, oxygen percent saturation, pH, water temperature, and specific conductance every half hour during each deployment period.

The sondes were calibrated prior to deployment using manufacturer-recommended methods and were post-calibrated after each deployment period. The prescribed FDEP SOPs (FT 1000, FT 1100, FT 1200, FT 1400, and FT 1500) were adhered to during this study.

The data sondes were deployed in the spring run flow path below the water surface in fabricated PVC tube housings. FDEP SOP FT19000 (Continuous Monitoring with Multi-parameter Meters) states that the stability and reliability of the equipment must be confirmed on a daily basis using grab samples from the same location. Due to the proposed length of this study, daily visits for this purpose were not feasible. Field parameter comparisons were made during the bi-weekly and bi-monthly deployment and collection of sondes using a calibrated YSI 556 meter.

3.2.2.4 Analytical Parameters

During the 2008 water year (October 2007 to September 2008) monthly water quality samples were collected by USGS personnel at three stations. These three stations were approximately located at VBS 35, VBS 355, and VBS 570. Following collection, samples were shipped to the USGS national laboratory for water chemistry analyses. Samples were collected using standard USGS protocols to conform to parts per billion (ppb) sample collection procedures. This protocol necessitates the use of two-person "clean hands/dirty hands" techniques ensuring that the raw water sample is not allowed contact with possible atmospheric or human contamination.

The 2007/2008 water year is the only year that USGS has collected water quality samples at the three locations along the spring run. Samples historically have been collected at or near the location of the streamflow gaging station at VBS 370. These historic samples were collected in 1960, 1964-94, and 1998 to date at frequencies varying from monthly to quarterly and possibly less frequent in some years.

3.2.3 Bottom Contour Mapping

3.2.3.1 Bathymetric Mapping

Blue Spring and Blue Spring Run were surveyed by District, Division of Surveying Services staff. A total of 24 transects were surveyed between June 7, 2007 and August 27, 2008. At each transect a corresponding survey benchmark was installed along the southern shoreline (adjacent to the boardwalk).

Volume and area estimates of the Blue Spring pool and run (for ecosystem metabolism analysis) were calculated by WSI using the District survey points and Bentley PowerCivil software.

3.3 Manatee Population and Behavior Modeling

3.3.1 Manatee Populations

Manatees entering the spring run and pool of Blue Spring State Park (BSSP) are routinely documented by park staff. As a state park, staff members are present throughout the year and any manatee visitation is likely to be observed. Particular attention to manatee presence is made during the period when manatees are most likely to be present, typically the six months between October and March. This is accomplished by at least one daily visual survey of the entire spring run, typically conducted from a canoe. Data recorded include the number of individuals, their unique identity if known from morphological characteristics (including scars and injuries), and a variety of other supplemental information such as water and air temperature. By following this protocol, the maximum daily number of manatees, the number of manatees which stayed, and the total number of manatees can be determined with reasonable accuracy.

Since 1978, manatee use at BSSP has primarily been conducted by Park Ranger, Wayne C. Hartley. Daily surveys are performed during manatee seasons (October- March) and typically conducted in the morning, when the manatee numbers are greatest. For detailed daily counts, park staff utilizes a data sheet (**Appendix E**), which divides the entire length of the spring run into 20 zones, to assist with the documentation of the total number of manatees, manatee counts per zone, and the presence of known individual manatees. During each survey, additional collected data include: starting and ending times; temperature readings of the air, spring run, and the St. Johns River; and the intrusion distance of tannin-colored river water (if any) into the spring run.

This visual survey method by an experienced observer has several advantages: 1) it allows known individuals to be documented and cataloged; 2) distressed or injured animals can be identified earlier, supporting their subsequent aid; 3) equipment is simple (canoe, camera, data sheets); 4) data collected is readily available and does not require complicated analyses reducing overall cost; and 5) the ability of a trained observer to adjust their survey techniques to incorporate variations in the environment or manatee behavior.

BSSP staff members initiated qualitative observations regarding manatee cold related health/body condition during the 2006 manatee season to document and evaluate sub-lethal cold stress. Observation include notation of body condition and overt cold stress ischemic skin lesions to document the level of cold stress experienced by the manatee population accessing Blue Spring Run.

3.3.2 Remote Sensing

The use of remote sensing technology was identified as a potentially desirable methodology by the Blue Spring MFIWG. Options discussed included the use of remote operated vehicles (ROVs), terrestrially mounted video cameras, or in-water sonar technologies to document manatee presence in the spring run.

3.4 Water Resource Values Monitoring

3.4.1 Overview

Monitoring of Water Resource Values (WRVs) at Blue Spring State Park (BSSP) was collaborative in nature and designed to document the existing biological conditions of Blue Spring and to provide information relevant to future management decisions. To address the general biological structure, the Florida Department of Environmental Protection's (FDEP) Bureau of Assessment and Restoration Support and Bureau of Laboratories sampled several biological communities (including algae, aquatic macrophytes, and snails) as well as chemical and physical characteristics at sampling stations within three monitoring zones (Upper, Middle, and Lower) located along Blue Spring Run (**Figures 2.3 and 2.4**). The three monitoring zones are defined as the upper zone (approximately VBS 50 to VBS 150), the middle zone (approximately VBS 250 to VBS 350), and the lower zone (approximately VBS 450 to VBS 550).

Faculty from Stetson University sampled fish and turtle populations in the spring run. USGS sampled water chemistry and collected real-time stage, discharge, and temperature data. WSI quantified ecosystem metabolism, oxygen diffusion, and particulate export. To address human use BSSP staff documented park attendance, FDEP/FPS staff in conjunction with Dr. Mark Bonn conducted a survey of visitor profiles and perceptions, and WSI conducted surveys of water contact usage by visitors as well as horizontal Secchi readings. Detailed methods utilized for this monitoring are described below.

3.4.2 General Biological Structure

All field and laboratory biological methods followed FDEP Standard Operating Procedures (SOPs, see http://www.floridadep.org/labs/qa/sops.htm for details) and met FDEP quality assurance standards (http://www.floridadep.org/labs/qa/index.htm). Water parameters (temperature, pH, dissolved oxygen, and specific conductance) were measured using Yellow Springs Instruments (YSI) brand meters. Calibrations and verifications were performed according to FDEP Standard Operating Procedures (SOP) FT1000. Water chemistry samples were not collected by FDEP as part of this monitoring as they were being collected by other monitoring teams; *e.g.*, USGS and the on-going semi-annual FDEP Stream Condition Index (SCI) monitoring in Blue Spring Run, following established FDEP protocols (Barbour *et al.* 1996).

Spring run sediments were characterized at each of the three sampling locations. Three replicate Petite Ponar dredge samples were combined and analyzed for Kjeldahl nitrogen and total phosphorus. Sediment particle size was analyzed on material from a single Petite Ponar dredge for each sampling location.

Habitat quality was assessed within the “upper”, “middle”, and “lower” 100 meter study segments of the spring run to quantify coverage of productive habitats (roots, rock, aquatic vegetation, woody debris, and leaf material). Habitat Assessment evaluates eight attributes known to have potentially important effects on benthic macroinvertebrates:

- substrate diversity,
- substrate availability,
- water velocity,
- habitat smothering,
- artificial channelization,
- bank stability,
- riparian buffer zone width, and
- riparian vegetation quality.

Twenty points are possible for each parameter. The total score is placed into one of four categories: Optimal (≥ 120), Suboptimal (81-119), Marginal (41-80), and Poor (≤ 40).

3.4.2.1 Periphyton and Algae

The FDEP Bureau of Assessment and Restoration Support sampled periphyton and algae from three zones in the spring run on a quarterly basis. The purpose of sampling was to characterize the algal community in Blue Spring Run and to determine whether macroinvertebrate communities in this spring run are impaired as previously reported (FDEP 2008).

Periphyton community sampling was conducted at each of three zones using the Qualitative Periphyton Sampling method (FS 7220) which consists of collecting algae found on natural substrates. Ten aliquots were apportioned among the major habitats, as identified during the Habitat Assessment, and then combined together into one composite sample.

Additionally, the Rapid Periphyton Survey (RPS) (FS 7230) was conducted. The RPS is a modified version of the Rapid Habitat and Periphyton Assessment method developed by Stevenson *et al.* (2004) for the U.S. Environmental Protection Agency. In this method, the same eleven transects used for collecting snails were used to observe algal presence, thickness, and type (filamentous or diatoms). Each of the nine points along each transect were assessed for a total of 99 sampling points per site.

3.4.2.2 Aquatic Plants

Linear Vegetation Surveys were conducted by FDEP staff following Stream and River Habitat Assessment methods (FT 3000) at all of the sites. In this method, plants were identified in the 10 m intervals between transects established for snail and the rapid periphyton assessments. All plants in the water and up to an approximation of the mean high water mark were identified to genus or species level (when possible) for each section. If a particular species had extensive coverage, it was assigned dominance or co-dominance. This method is a rapid screening tool for ecological condition and estimates how closely a site's flora resembles that of an undisturbed condition.

3.4.2.3 Macroinvertebrates

Macroinvertebrate sampling was performed at all sites using the Stream Condition Index (SCI) methodology. The SCI procedure involves sampling productive habitats using 20 sweeps of a US 30 mesh D-framed dip net. The sweeps are apportioned across productive habitats which had been identified during the Habitat Assessment (see above) leaving some sweeps to be taken in "minor" habitats (*e.g.*, sand, silt). Aquatic macroinvertebrates were sorted to the lowest possible taxonomic order and placed in an alcohol-filled jar for further identification.

3.4.2.4 Snails

A quantitative Snail Population Survey was performed to target the snail populations in Blue Spring by FDEP. Within each site's 100 m stretch, eleven transects were arranged across the stream at ten meter intervals. Each transect was separated into nine, equally-distant points. Point 1 was located approximately 0.1 m from the right bank, point 5 was in the middle, and point 9 located 0.1 m from the left bank. The remaining points were sequentially distributed between these points, in an approximately equidistant fashion. A single point was randomly selected from each transect for a total of eleven sub-samples.

Snails were collected at each point and the eleven sub-samples were combined into a single sample for the Upper, Middle, and Lower sampling stations.

During the first two sampling events, a Petite Ponar was used to collect the snails, but the rocky substrate prevented the Ponar from closing automatically so it was necessary to close it manually each time. In the latter two sampling events, a metal quadrat with a surface area equal to that of a Petite Ponar (231 cm^2) was used in combination with a dip net to collect the snails.

3.4.2.5 Fish

Quantitative visual (mask and snorkel) and seine monitoring of fish populations in Blue Spring was conducted four times during the first year of intensive monitoring by faculty and students from Stetson University (led by Dr. Kirsten Work and Dr. Melissa Gibbs [Work and Gibbs 2008]). Fish sampling at Blue Spring was conducted on December 6, 2007, March 12, 2008, May 29, 2008; and September 25, 2008. Fish density, diversity, and biomass were estimated quarterly at five stations within Blue Spring located at approximately VBS 0-110, 110-210, 210-310, 310-410, 460-560 (see **Figures 2-4** and **3-1**). The area of each station was approximately 500 m^2, with the exception of station 1, which was much larger (2,500 m^2) as it encompassed the entire headspring area. Each sampling trip began at the headspring (station 1) and continued downstream to station 5. This sampling scheme was developed for previous fish surveys (2000-2004), allowing comparisons to be made between stations and time periods. Station 5 was not sampled on two of the sampling dates during Water Year 2007/2008 due to the presence of a large number of manatees on December 6, 2007 and the intrusion of tannin-stained river water which impaired visibility on September 25, 2008.

One new method was employed during the Water Year 2007/2008 sampling period. At the start of each sampling trip, the entire length of the run from the headspring to station 5 was visually surveyed (via snorkeling) to identify and enumerate larger fish species (> 7.6 cm, with the exception of sunfish for which all individuals were enumerated) that easily evade capture by seine in the clear spring water. Upon completion of the snorkel survey, three sub-sampling sites were seined using a 6 m x 2.4 m seine (3 mm mesh) at each of the five stations. Captured fish were identified in the field, enumerated, and released. The seine sites were located along the bank on both sides of the spring run, and each sub-sampling site was approximately 6 m long x 3 m wide and 30 cm to 1 m deep. Criteria for initial selection of sub-sampling sites were: presence of fish, nearby cover (bushes, submerged limbs, algal beds), and relative freedom from obstacles to the seine within the site. Most sites had sandy substrate covered with varying densities of algae, with the exception of two sub-sampling sites at station 1, which were rockier and had the least available fish cover. Dissolved oxygen was measured with a YSI 85 meter at all sites within stations during sampling events.

From counts of fish in each sample, the density of each fish species was calculated on each sampling date by dividing the number of individuals counted by the area sampled. Biomass for each fish species was estimated based on approximate mean length and weights for each species counted using published length-weight relationships (Schneider *et al.* 2000). Fish assemblage diversity was calculated using the Shannon-Wiener diversity index on the calculated densities of individual species (Zar 1984). In addition, the proportion of the assemblage that was exotic and the proportion that can be described by each functional group (herbivores, invertivores, and piscivores) were calculated for each station and sampling date.

Measures of density and diversity between 2008 and 2000-2004 were compared with Wilcoxan signed rank tests. The Wilcoxan signed rank test is a nonparametric test used to compare differences between pairs of data. The differences between the pairs are ranked in order of magnitude and given the sign of the difference associated with each rank. The sum of the negative ranks is T, which is compared to a table of significance to determine the p-value. A p-value smaller or equal to 0.05 indicates a 5% or less chance that the diverging results could have occurred by chance. Data that produce tests with p-values less than or equal to 0.05 are considered significantly different (Zar 1984).

Measures of fish abundance and diversity were correlated with *in-situ* dissolved oxygen concentrations using Spearman rank correlation. Spearman rank correlation is a nonparametric test in which the variation in two variables is compared from their respective ranks. The magnitude of the data points in each variable is ranked. The sum of squared differences in ranks is used to produce the Spearman rank correlation coefficient, which is compared to a table of significance to determine the p-value (Zar 1984). All statistical tests were run using SPSS version 15.0 (SPSS, Inc. 2006).

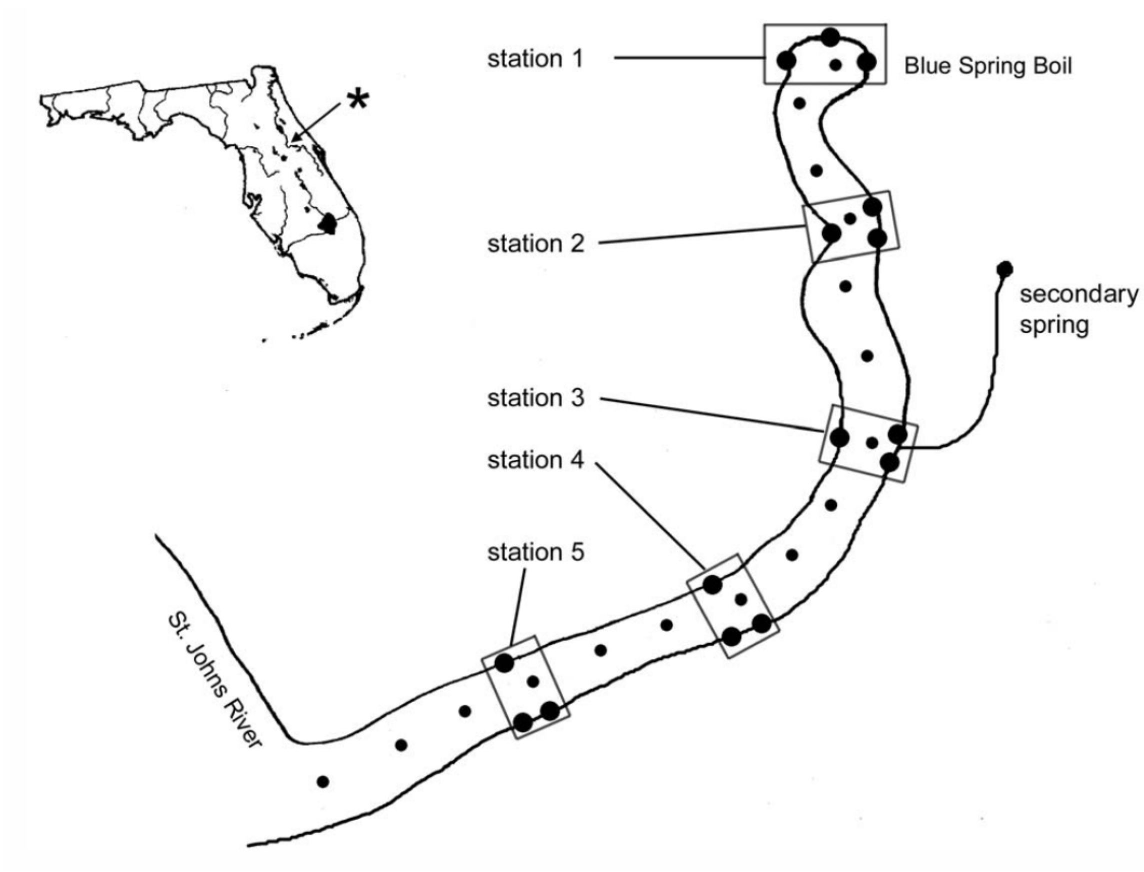


FIGURE 3-1. The fish sampling stations of Blue Spring for the surveys of 2000-2004 and 2007-2008. Larger dots represent seine sites; smaller dots represent additional water quality stations. Snorkel surveys were conducted over the entire run, both within the stations and between the stations (from Work and Gibbs 2008).

3.4.2.6 Turtles

Quantitative monitoring of the aquatic turtle community utilizing Blue Spring was conducted four times during the first year of intensive monitoring by faculty and students from Stetson University (led by Dr. Terrence Farrell, Farrell *et al.* 2009). Turtle monitoring was conducted on October 20-23, 2007; March 18-20, 2008; April 11-13, 2008; and October 3-6, 2008. During each sampling event, turtle censuses were conducted by snorkeling the entire spring run (from station VBS 0 to VBS 670, or to the downstream point where tannin-colored river water prevented the visual location of turtles) and capturing all observed turtles by hand or net.

After hand capture, data were collected on species, turtle weight, carapace length, carapace width, plastron length, shell height, and sex (using sexual differences in tail length and forefoot claw length). At the time of initial capture, turtles were permanently and uniquely marked for later identification. Turtles were marked either by drilling or filing unique patterns in their marginal scutes, a technique which does not harm the turtles and has been used for decades in turtle population studies. Softshell turtles, which lack hard scutes, cannot be marked with this method and data were collected on individuals without marking. However, tattooing with liquid nitrogen has begun to be used for this species and could be incorporated at Blue Spring (personal communication with Eric Munscher).

Estimates of the population densities for the turtle species in the spring run were calculated using mark-recapture techniques and measured weights by species. In each season (spring, summer, fall, winter), censuses were performed over multiple days (2-4). The resulting sample period was divided into an initial period and a second sampling period. These two censuses taken close together in time allowed calculation of the Lincoln-Peterson abundance estimates (**Equation 2**, Bolen and Robinson 1999) which provided estimates of population size for each turtle species. In this technique, the species' population size is estimated from the number of turtles observed in each census and the proportion of the turtles recaptured in the second census. For species that had few captures and recaptures in a sample period (3 species), population estimates were not calculated due the low sample size.

Lincoln-Peterson formula:

$$N = (M \times C) / R \qquad \textbf{[Equation 2]}$$

Where:

N = estimated population size

M = number of turtles marked in the initial sample

C = number of turtles marked in the second sample

R = number of recaptured turtles in the second sample

A 95% confidence interval of population estimates used these formulas:

$$\text{Upper 95\% CI} = N + 1.96 [\sqrt{(((M^2 \times C \times (C - R)) / R^3)}] \qquad \textbf{[Equation 3]}$$

$$\text{Lower 95\% CI} = N - 1.96 [\sqrt{(((M^2 \times C \times (C - R)) / R^3)}] \qquad \textbf{[Equation 4]}$$

For the lower 95% confidence interval, a value of zero turtles was presented for the lower limit if the calculation using these equations returned a negative population size.

To get estimates of aquatic turtle population density (as individuals/hectare), the population size estimate by species was divided by 1.03 hectares, the average surface area of the spring run during survey events. Aquatic turtle biomass estimates (in kg/hectare) were calculated by multiplying population density for a species by the average body mass (in kg) measured from surveys for that species.

3.4.3 Ecosystem Function

3.4.3.1 Ecosystem Metabolism

Upstream-downstream measurements of dissolved oxygen and percent saturation were used to quantify total system metabolism using the methods pioneered by H.T. Odum and used in previous ecological studies of Florida springs (Odum 1956, 1957a, 1957b; WSI 2005, 2006). Two segments in the spring run (VBS 35 to VBS 355 and VBS 355 to VBS 570) were monitored at their upstream and downstream ends with recording data sondes to provide a record of hourly dissolved oxygen concentration, percent oxygen saturation, specific conductance, pH, and temperature. The upper segment of the spring run corresponds to the public use area (illustrated in **Figure 2-2** above) which includes the spring boil, the upstream entry point, and the lower swim area and dock. The lower segment of the spring run corresponds to the manatee refuge area (shown in **Figure 2-2** above), the lower observation platforms, and the canoe launch area.

Utilizing these hourly field data for dissolved oxygen concentration and estimated oxygen diffusion rates as a function of percent saturation of dissolved oxygen and current velocity, the following components of community metabolism were estimated:

- Gross Primary Productivity (GPP) - the total primary productivity of the entire submerged plant community, including all algae and macrophytes in g $O_2/m^2/d$. GPP is the sum of net primary productivity (NPP) and community respiration (CR). The measured GPP does not account for the primary productivity of emergent and floating plants (which are largely absent in the Blue Spring system).

- Net Primary Productivity (NPP) - the net difference between GPP and community respiration, which is equal to the carbon fixation rate available at the base of the aquatic food web. The integrated area under the daytime oxygen rate-of-change curve, corrected for diffusion, provides an estimate of daily NPP in g $O_2/m^2/d$.

- Community Respiration (CR) - the dark respiration or oxygen consumption of the entire aquatic community, including microbial populations, algae, macrophytes, and fauna. The average value of the nighttime oxygen rate-of-change curve, corrected for diffusion, provides an estimate of CR (oxygen consumption in g $O_2/m^3/hr$). This CR estimate can be multiplied by 24 hours and by the average water depth to estimate the 24-hour community respiration in g $O_2/m^2/d$. This calculation is based on the generally accepted assumption that daytime respiration is approximately the same as nighttime respiration.

- P/R ratio - the unit less ratio between GPP and CR, indicating autotrophic (> 1) vs. heterotrophic (<1) status of the aquatic ecosystem.
- Photosynthetic Efficiency - the efficiency of conversion of useable photosynthetically-active radiation to GPP (g O_2/mol light).

3.4.3.2 Oxygen Diffusion

Diffusion of dissolved oxygen has been previously measured *in situ* in a number of Florida spring runs following the methods of Copeland and Duffer (1964) and McKellar (1975). The rate of oxygen diffusion was measured using the floating dome technique in conjunction with water depth and flow velocity measurements during multiple sampling events, allowing development of a regression between oxygen diffusion rate and current velocity. Attempts to use this method in Blue Spring were generally unsuccessful due to the extremely low ambient dissolved oxygen concentrations in the spring flow. For this reason a regression between dissolved oxygen diffusion and current velocity developed from the Silver River, Wekiva River, Rock Springs Run, Alexander Springs Run, and Juniper Run was used instead. The best-fit regression equation from these other spring run ecosystems provided the ability to estimate diffusion rates in Blue Spring Run in response to estimated hourly current velocities in each of the study segments.

3.4.3.3 Ecosystem Metabolism Analysis

Ecosystem metabolism was estimated using a spreadsheet adaptation (Microsoft Excel) of the upstream/downstream dissolved oxygen (DO) method developed by H.T. Odum (1956; 1960) and Odum and Hoskin (1957). This method estimates and subtracts upstream from downstream DO mass fluxes corrected for atmospheric diffusion to determine the metabolic oxygen rate-of-change of the aquatic ecosystem. Dissolved oxygen mass inputs typically include spring discharges, atmospheric diffusion into the water column, accretion from other undocumented stream or spring seep inflows and the release of DO as a by-product of aquatic plant photosynthesis. Oxygen losses include diffusion from the water column to the atmosphere (under super-saturated conditions), the metabolic respiration of the aquatic microbial, plant, and animal communities, and sediment biological oxygen demand.

The downstream DO concentration measured at any time is the net effect of these gains and losses as shown in the following conceptual equation:

delta DO = GPP – CR + Din + A **[Equation 5]**

Where:

delta DO = DO rate-of-change, g $O_2/m^2/d$

GPP = gross primary productivity, g $O_2/m^2/d$

CR = community respiration, g $O_2/m^2/d$

Din = diffusion into the water under unsaturated conditions, g $O_2/m^2/d$

A = accrual of DO from other spring boils, g $O_2/m^2/d$

Community respiration (CR) is equal to all aquatic respiratory activities of microbes, plants and animals living in the spring boils and spring run. Primary productivity is assumed to only occur in response to sunlight and stops during the dark hours of each diurnal period. Community respiration occurs throughout day and night periods. For the purposes of this analysis it was assumed that nighttime CR equals daytime CR. Net primary productivity (NPP) is defined as the difference between GPP and CR and represents the net increase or decrease in community-produced DO during each daily interval.

Areas, volumes, current velocities and diffusion measurements were used to estimate ecosystem metabolism. Water surface area was estimated for each of the study segments using the survey conducted by the District and corrected hourly using an estimated stage: area relationship. Average velocities were estimated from the stage: volume relationship and USGS spring discharge measurements. Nominal travel times for the water mass were estimated based on the length of the spring run and the estimated hourly current velocities.

3.4.3.4 Particulate Export

Particulate matter (inorganic and organic) export was sampled using a plankton net (mesh size 153 µm) suspended in the current at mid-depth during each bi-monthly sampling event at the three data sonde locations (VBS-35, VBS-355, VBS-570). Samples were collected for a known time period and water velocity, allowing an export rate to be calculated. The collected particulate material was rinsed into a sample bottle and returned to the laboratory for dry weight (DW) and ash-free dry weight (AFDW) analyses. Particulate samples were combusted at an oven temperature of 450^{o} C. Particulate export results are reported as dry weight (DW) and ash-free dry weight (AFDW) per upstream area per time (g DW/m^2/d and g AFDW/m^2/d, respectively).

3.4.3.5 Nutrient Assimilation

Nutrient assimilation rates for total nitrogen, nitrate, ammonia, total phosphorus, and soluble reactive phosphorus, were made for the Blue Spring Run segments (VBS-35 – 355, VBS-355 – 570, and VBS-35 – 570) by calculating upstream-downstream concentration changes during from each monthly sampling period. Average nutrient mass inputs and outputs were estimated based on average water concentrations and flows over the study period. Water quality and stream velocity data were provided by USGS (Florida Integrated Science Center) as noted in **Table 3-1**.

3.4.4 Human Use

3.4.4.1 Total Human Use

Estimates of human use and visitor perceptions were made by Bonn Marketing Research, Inc. (Bonn 2008). Data collection was accomplished by conducting 100 surveys (**Figure 3-2** provides an example) during the months of January, February, June, and July 2008 for a total of 400 completed surveys. These time periods were chosen to document visitor responses during periods of peak park usage, the winter manatee viewing season and the summer swimming season. The purpose of the 2008 human use monitoring was to replicate a previous survey conducted in 2003 by Bonn in which park visitor characteristics and behaviors were documented. Information obtained in 2003 and 2008 included spending, duration of visit, group size, visitor origin, willingness to return, education, gender, marital status, ethnicity, and income. Supplementary information was also gathered from visitors pertaining to their number of park visits, how they learned about the park, their willingness to pay for entry, their perceptions of springs in relation to water supply demands, and their willingness to pay for alternate water sources. Additionally the 2008 study collected information on the activities in which visitors participated (such as swimming, scuba diving, and walking) as well as visitor perceptions of water clarity and depth. Also investigated during the 2008 survey were visitor perceptions of the percentage of spring flow reduction that would be considered harmful to the aesthetics of the park, harmful to swimming and scuba diving, or harmful to an overall positive experience while visiting the park.

2008 Volusia Blue Spring Visitor Survey

Survey ID #______________
Date: ___________________
Surveyor's Initials_________

Q01 City: ______________________

Q02 County: ___________________ State: _____________

Q03 Country: _________________ Zip Code: __________

Q04 What is the main purpose for your visit today?
____

Q05 # in your travel party: _______________

Q06 Is this your first visit to Blue Spring? Y N

Q07 If Y, how did you hear about Blue Spring?
____

Q08 Will you come back to Blue Spring in the near future?
Y N

Q09 If Yes, Within the next 6 months? Y N Undecided
Within the next year? Y N Undecided
Within the next two years? Y N Undecided

Q10 Check all of the following activities you participated in during this trip?

1= Looking for/watching manatees
2= Swimming, bathing, floating, snorkeling, tubing, wading
3= Canoeing/ kayaking in the spring run
4= Scuba diving
6= Sight-seeing, sunbathing, picnicking, strolling, birding, nature study, photography, etc.

Q11 We are interested in determining your opinions about water- related issues at this park.

Did you visit the park in 2003 or before?

Y N (If **No**, Skip to Q14)

Q12 Rate the water **quality (clarity)** now compared to then:

	Better	About the Same	Worse	Not Sure
Swimmers	1	2	3	4
Divers	1	2	3	4
Walkers	1	2	3	4

Specific comments: ____________________________

Q13 Rate the **water depth/ flow** now compared to then:

	Better	About the Same	Worse	Not Sure
Swimmers	1	2	3	4
Divers	1	2	3	4
Walkers	1	2	3	4

Specific comments: ____________________________

Q14 Do you believe it is in the public interest to reduce spring flow in state parks to meet public water supply need?
Y N

Q15 Blue Spring flow may decline in the future because of increased well pumping. What percentage of flow could be lost before you considered it to constitute significant harm to:

	% Flow Loss
1= Aesthetics of the park	____________
2= Swimming or diving experience	____________
3= Positive experience visiting the park	____________

Q16 Please rate the importance of Florida State Park springs, lakes, and rivers to your quality of life:

Very Unimportant						Very Important
1	2	3	4	5	6	7

Q17 If you knew the alternative water supply source (other than groundwater) could be developed so as to not reduce spring flows in state parks, would you be willing to pay more for them on your monthly water bill?
Y N

Q18 If **Yes**, would the amount you are willing to increase your water bill be considered to be:
1 = none 2=minimal 3=moderate 4=substantial

Q19 If you knew that alternative water supplies (other than groundwater) could be developed so as to not lower the flow of a park spring, would you support your local government in the development of alternative water sources? Y N

Q20 How much more would you be willing to spend on the entrance fee for ach visit if you knew the money would go to the maintenance and protection of Blue Spring?
$_________________

Q21 Gender: 1=M 2=F

Q22 Ethnicity: CAU HIS AFAM ASA OTH

Q23 Highest Level of Education: ______________________

Q24 Total Household Annual Income: __________________

Q25 Marital Status: M S W/D

Q26 Please rate your overall visit to Blue Spring:

Poor 1 2 3 4 5 Excellent

FIGURE 3-2. Blue Spring State Park 2008 visitor survey form (from Bonn Marketing Research Group, Inc.).

3.4.4.2 Human Uses

FDEP/FPS human usage statistics are primarily categorized into day use and overnight use by park visitors. Detailed data for water contact use are not routinely collected by FDEP but can be estimated from park entry statistics and detailed human use surveys that were made on two dates by WSI staff.

Detailed assessments of water-dependent human uses were conducted by WSI at Blue Spring State Park on Friday, May 23 and Tuesday, June 24, 2008. An observation station was selected to allow a survey of the designated swim area, including the grassy area to the south of the spring and adjacent to the concessions building. Observational counts were made of all visible human uses in the swimming area and the immediate surrounding areas (**Table 3-2**). The swimming area is delimited by a labeled and roped-off area in the water. The surrounding area under observation consisted of the swimming dock, the picnic shelter, the open area next to the shelter and the board walk coming into and out of the area. The spring area available for in-water recreation within this observation area was approximately 0.53 ha (1.31 ac). Five primary water contact activities (wading [less than waist deep], bathing [greater than waist deep and less than neck deep], snorkeling, swimming, and floating) were identified for the in-water human use category. Five primary water-view activities (standing on dock, walking on boardwalk, sunbathing, under picnic shelter, and sitting in boardwalk area) were identified for the out-of-water human use category.

Counts of all persons within the observation area were rapidly conducted at about 15 minute intervals from 10:30 until 14:30 on each date. Five of the observed uses were considered to represent direct water contact. The five water-view activities did not depend on direct contact with the water but were water dependent as they were all directed at the water resource either as an aesthetic point of focus or as the ultimate attraction before or after returning to the shore.

TABLE 3-2
Human use categories documented at Blue Spring State Park on May 23, and June 24, 2008.

Category	Activity Name	Description
In the Water	Wading- Waist Deep	Contact with the water no more than knee depth. Includes people wading in shallow water, standing on stairs, and people sitting with feet in water.
	Bathing- Chest Deep	Contact with the water greater than knee depth. Indicates significant body immersion in the water.
	Snorkeling	Indicated by having a mask or goggles on and actively placing face under water.
	Swimming	Swimming for exercise or recreation.
	Floating	Use of tubes, rafts, floats, etc. to keep a significant portion of the body above the water.
Out of the Water	Standing on Dock	Generally not attired in a bathing suit, may include nature study.
	Walking on Boardwalk	Typically traveling between destinations.
	Sunbathing	Lying prone in the sun.
	Under Picnic Shelter	Engaged in eating and drinking.
	Sitting in Boardwalk Area	Relaxing on seats along boardwalk area.

4.0 Results

4.1 Physical and Chemical Conditions Monitoring

4.1.1 Hydrological and Meteorological

4.1.1.1 Morphometry of Blue Spring Pool and Spring Run

A survey of the Blue Spring Pool and Spring Run was conducted by the SRJWMD from June 7, 2007 through August 27, 2008. The survey consisted of twenty-four (24) cross-sections with Transect 1 at the Blue Spring Run confluence with the St. Johns River and Transect 24 at the Blue Spring Pool. Detailed bathymetries of the Blue Spring Pool and Spring Run, as well as Transect cross-sections are illustrated in **Appendix A**.

The estimated wet area and water volume in Blue Spring Run at the time of the survey was 1.74 ha (4.29 acres) and 26,620 m^3 (940,080 cubic feet [cu ft]), respectively. **Figure 4-1** presents the estimated stage/area and stage/volume relationship for the upstream, middle, and downstream reach of the Blue Spring Run at VBS 35, 355, and 570.

4.1.1.2 Flow and Level Data

Flow in Blue Spring and Blue Spring Run is largely controlled by the difference in stage between the Floridan aquifer and the level of water in the St. Johns River (Rouhani *et al.* 2007). Perhaps counter intuitively, water levels in Blue Spring Run are primarily controlled by the level of water in the St. Johns River and not by the spring discharge rate (Sucsy 2005).

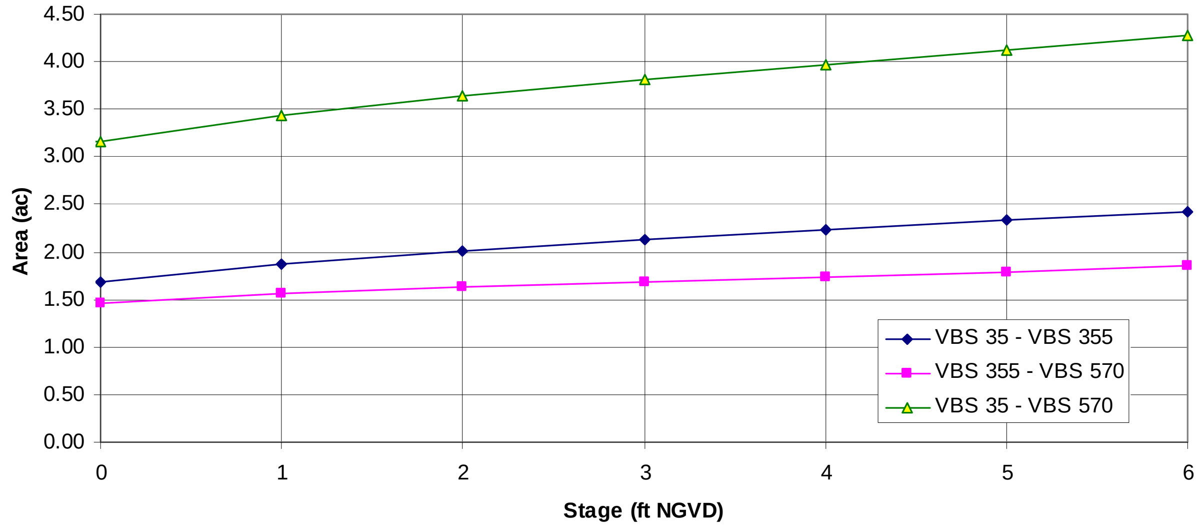
Detailed flow data for Blue Spring Run are summarized for the period 1932 to 2008; with a LOESS or LOWESS (locally weighted scatter plot smoothing) data curve overlain (**Figure 4-2**). These data are based on discrete water level records and a stage/discharge relationship for the spring run. The long term mean flow over the period-of-record (POR) evaluated for this report was 384,100 m^3/d (157 cfs). Minimum and maximum recorded flows were 242,213 and 518,679 m^3/d (99 and 212 cfs), respectively. Examining only manually collected (non AVM) flow and level data (which span the time period of 1932 through September 1998) results in a mean flow of 386,560 m^3/d (158 cfs) and a median flow of 389,000 m^3/d (159 cfs). Flow and water level percentile frequency estimates for these manually collected data (1932 through September 1998) are illustrated in **Figure 4-3**. The estimated average and median discharge rates for Blue Spring during the water year described in this report (October 2007 through September 2008) were 322,948 and 325,395 m^3/d (132 and 133 cfs). For comparison purposes the approved Blue Spring MFR through March 31, 2009 is 133 cfs.

Average stage over the full period-of-record was 0.44 m above National Geodetic Vertical Datum 1929 (1.44 ft NGVD29). Minimum and maximum recorded stages during the full period-of-record were -0.14 and 1.98 m (-0.46 and 6.49 ft NGVD29), respectively. Examining only manually collected level data (which span the time period of 1932 through September 1998) resulted in an average stage of 0.48 m above National

Geodetic Vertical Datum 1929 (1.58 ft NGVD29). The estimated average and median stages for Blue Spring during the water year described in this report (October 2007 through September 2008) were 0.13 and 0.08 m NGVD (0.42 and 0.26 ft NGVD).

Figure 4-4 provides a time series of annual average discharge and stage readings for the period from 1932 through 2008 (1.44 ft NGVD29 and 157.1 cfs, respectively). These data show a long term decline in discharge and stage over the period-of-record (POR). The average and median discharge over the past decade (a period long enough to influence the portions of the ecological community monitored in this study) were about 5 percent lower than the period-of-record data for this spring and spring run, while the average and median stages over the past decade were about 41 and 58 percent lower than the POR. The ecological data presented for this water year are interpreted in the light of this observed flow and stage reduction.

As with other spring systems, rainfall patterns influence the discharge of Blue Spring. **Figure 4-5** illustrates the discharge of Blue Spring and Alexander Spring (Lake Co.) from 1932 to 2002. The discharge data have been smoothed using a LOESS regression and shows that discharge from these two springs appear to fluctuate in concert (particularly after 1982) suggesting that rainfall patterns influence discharge values. **Figure 4-6** shows a double mass curve of the Blue Spring and Alexander Spring cumulative annual discharge values. The strong linear correlation between cumulative discharge of these two springs further supports that rainfall patterns are responsible for the observed variations in discharge at Blue Spring (and Alexander Spring). This line of reasoning is supported by recent published findings concerning Florida rivers, which observed that variations in flow are attributable to variations in rainfall which are occurring over multi-decadal periods (Kelly and Gore 2008).



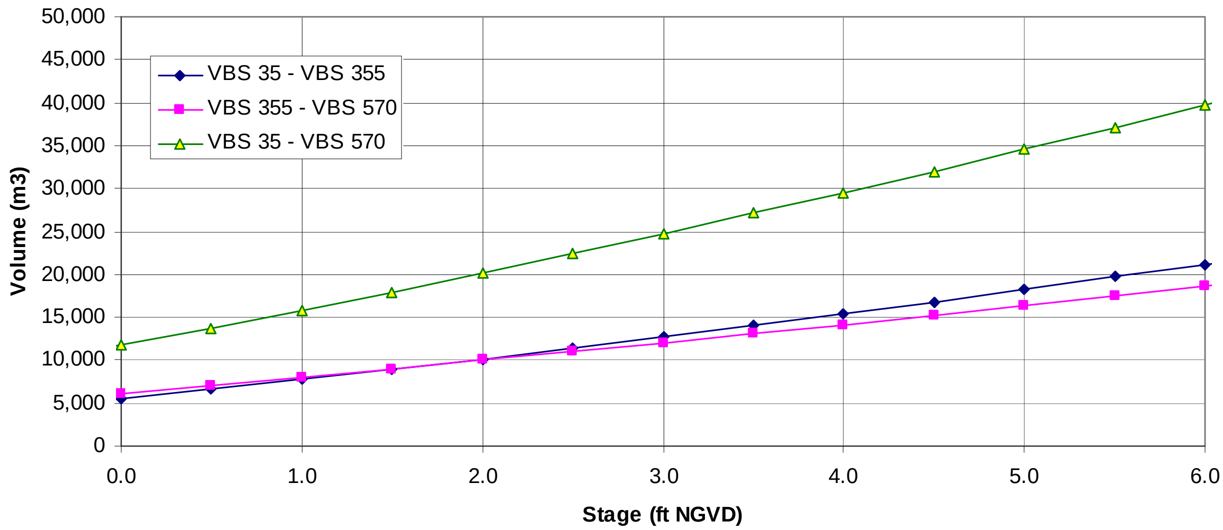
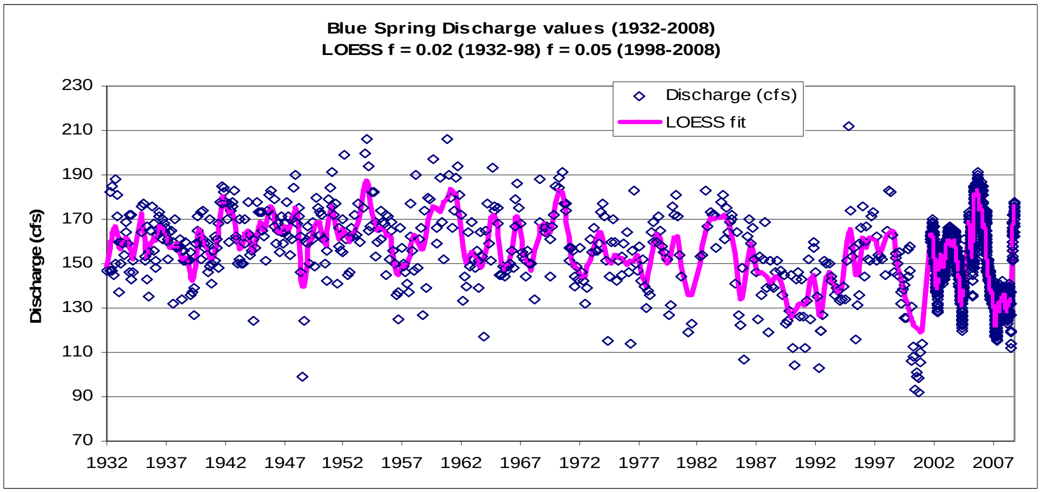
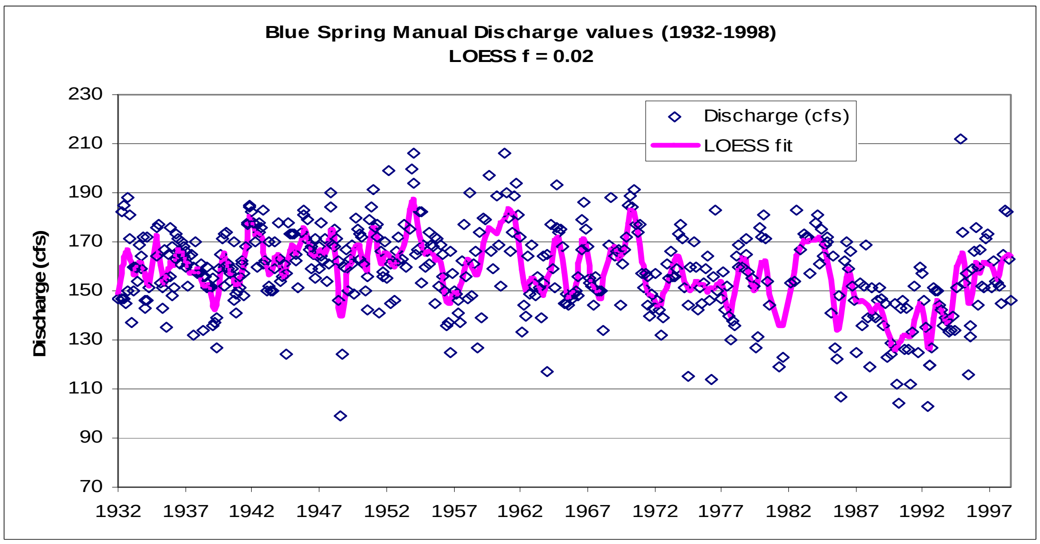


FIGURE 4-1. Stage /area and stage / volume relationship for the upstream, middle, and downstream reach of the Blue Spring Run.





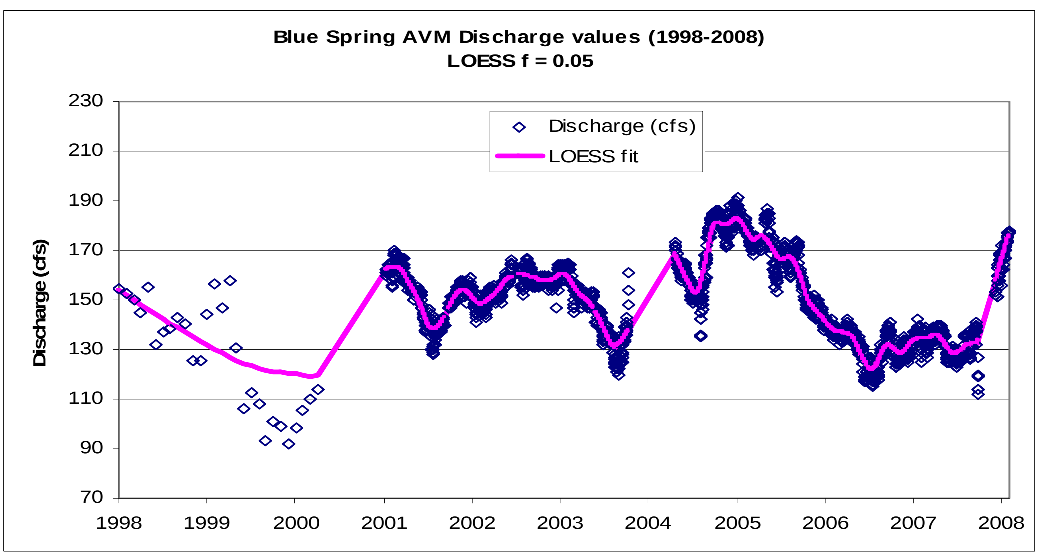


FIGURE 4-2. Blue Spring discharge values with LOESS fit overlain; top- the period from 1932 through 2008; middle- manual measured data only (1932 to 1998); bottom- AVM data only (1998 to 2008).

Figure 4-7 illustrates the percentile frequency estimates for hydraulic residence time (HRT) and velocity for three segments in Blue Spring Run. HRT and mean flow velocity for Blue Spring Run were estimated based on the updated District bathymetric data. In the upstream segment extending from the spring boil downstream to the swim area (VBS-35 to VBS-355) the estimated average HRT over the entire period-of-record was 0.57 hrs with a range of 0.26 to 1.77 hrs. The estimated average HRT during the current water year (WY2007-08 October 2007 through September 2008) was 0.49 hrs. Estimated average velocity in this portion of the spring run over the entire period-of-record was 0.19 m/s (0.63 ft/s) with a range from 0.05 to 0.38 m/s (0.18 to 1.23 ft/s). The average estimated current velocity during the 2007-08 water year was 0.22 m/s (0.71 ft/s).

In the downstream segment extending from the swim area to the lower manatee observation deck (VBS-355 to VBS-570) the estimated average HRT was 0.57 hrs with a range of 0.30 to 1.59 hrs. Estimated average velocity in this portion of the spring run was 0.11 m/s (0.37 ft/s) with a range from 0.04 to 0.20 m/s (0.12 to 0.65 ft/s). The average HRT and current velocity for this reach during WY2007-08 were 0.52 hrs and 0.12 m/s (0.40 ft/s).

For the overall spring run extending from the spring pool downstream to the lower manatee observation deck (VBS-35 to VBS-570) the estimated average HRT was 1.14 hrs with a range of 0.57 to 3.36 hrs. Estimated average velocity in the entire spring run was 0.15 m/s (0.50 ft/s) with a range from 0.05 to 0.28 m/s (0.15 to 0.92 ft/s). The average HRT and current velocity for this reach during WY2007-08 were 1.01 hrs and 0.17 m/s (0.55 ft/s).

Linear regression analysis showed no apparent relationship between water stage and spring discharge during the entire period of record ($R^2 = 0.0004$ in **Figure 4-8**). Over the long-term this analysis supports the conclusion by Sucsy (2005) and Rouhani *et al.* (2007) that water stage in Blue Spring Run is not controlled by Blue Spring flow but rather by water levels in the contiguous reach of the St. Johns River.

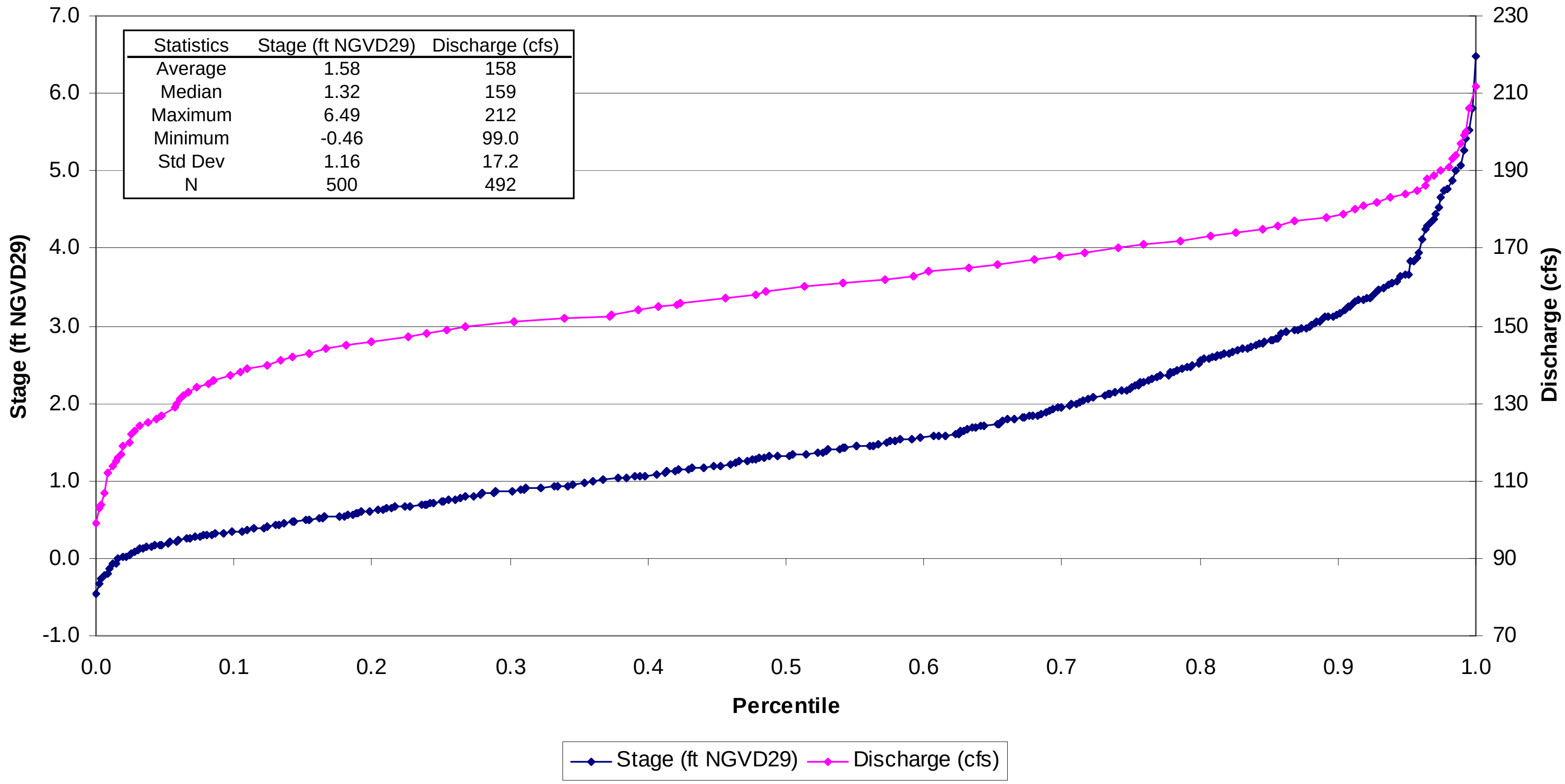


FIGURE 4-3. Blue Spring percentile frequency curves for discharge and stage for manual readings only (the period from 1932 through September 1998).

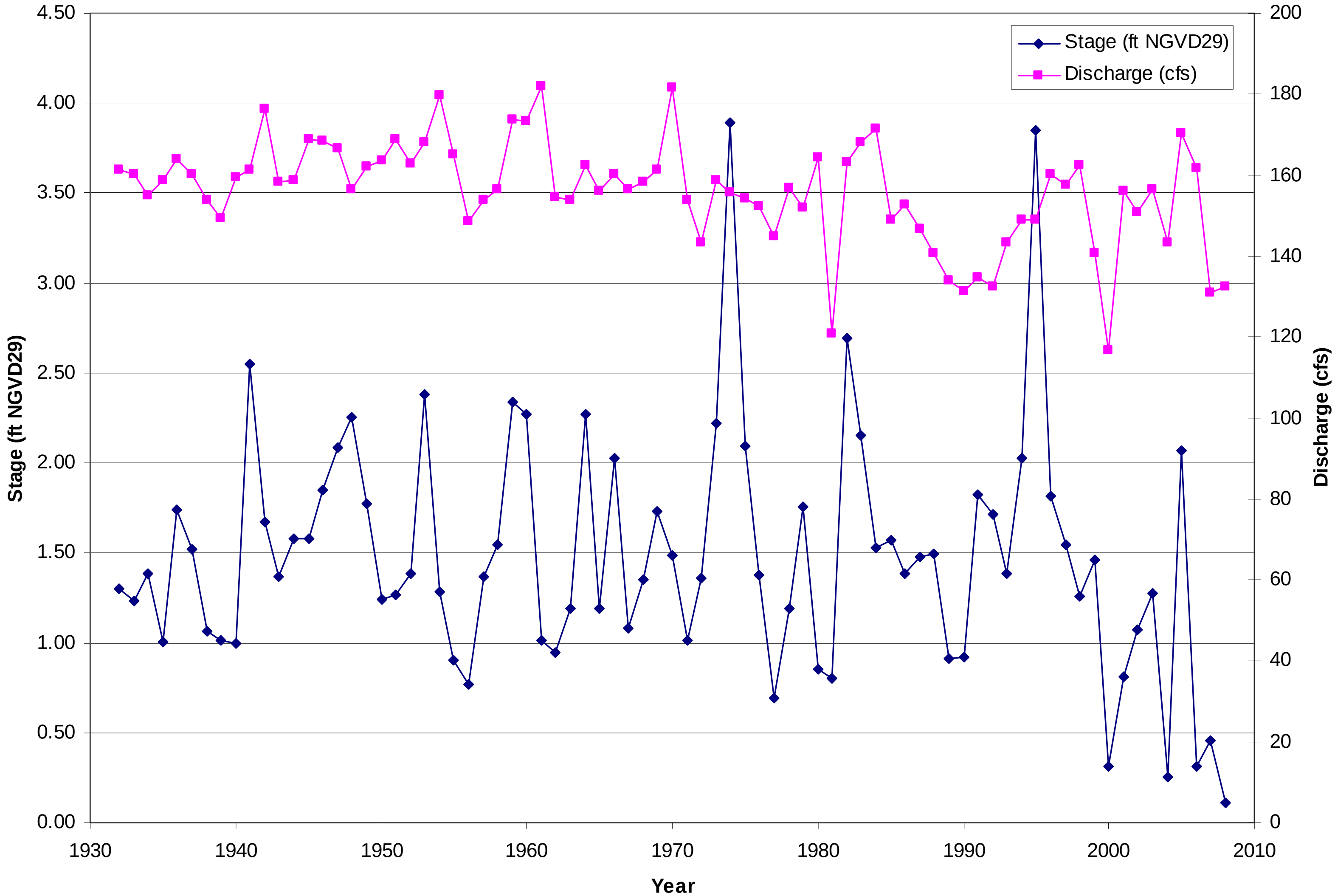


FIGURE 4-4. Blue Spring annual average discharge and stage readings for the period from 1932 through 2008.

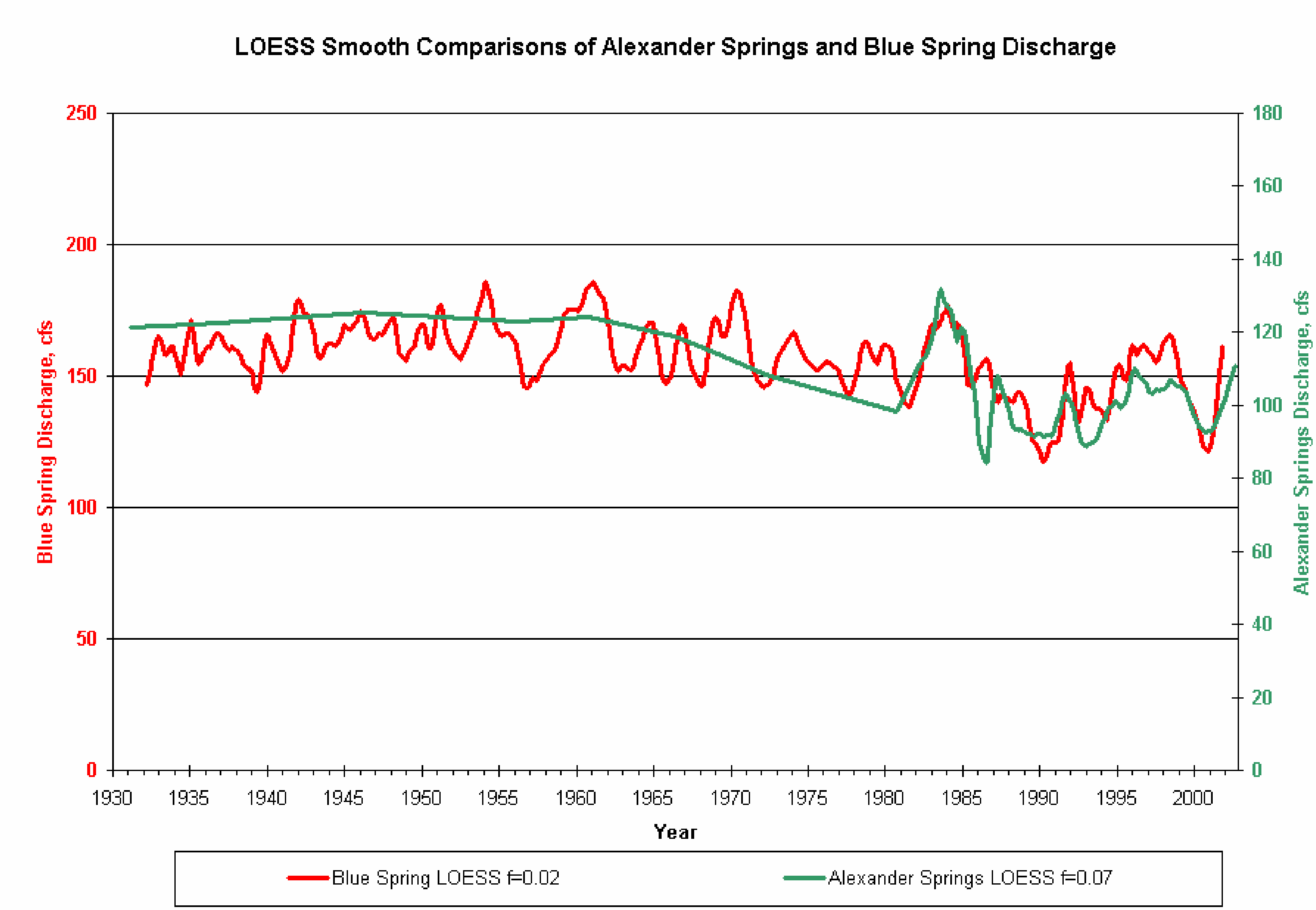


FIGURE 4-5. Discharge time series for Blue and Alexander Springs with data smoothed by LOESS regression (used with permission from District).

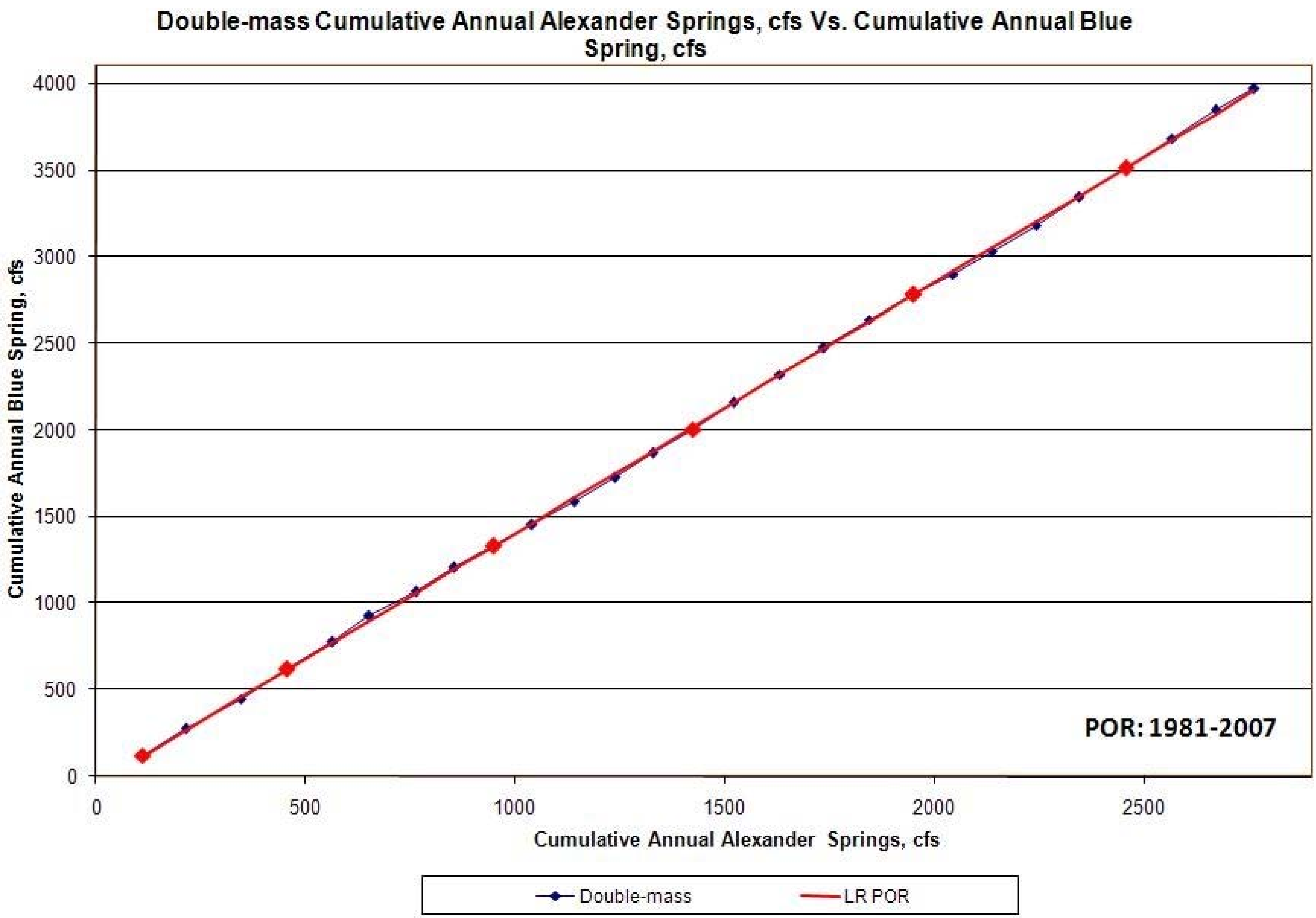
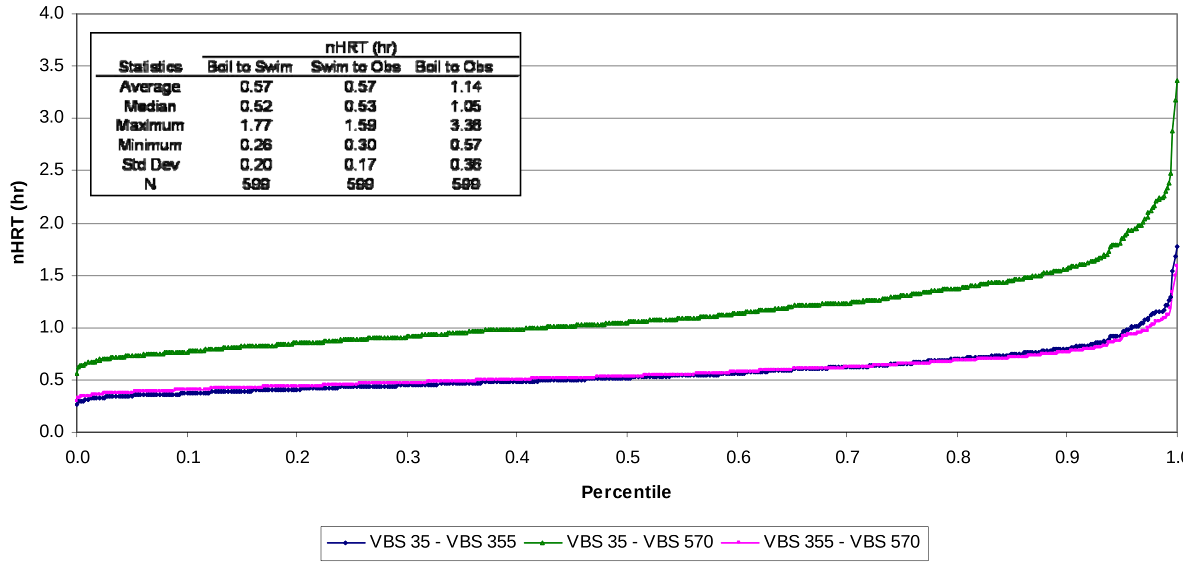


FIGURE 4-6. Double mass curve for Blue Spring annual cumulative discharge and Alexander Spring annual cumulative discharge (used with permission from District).



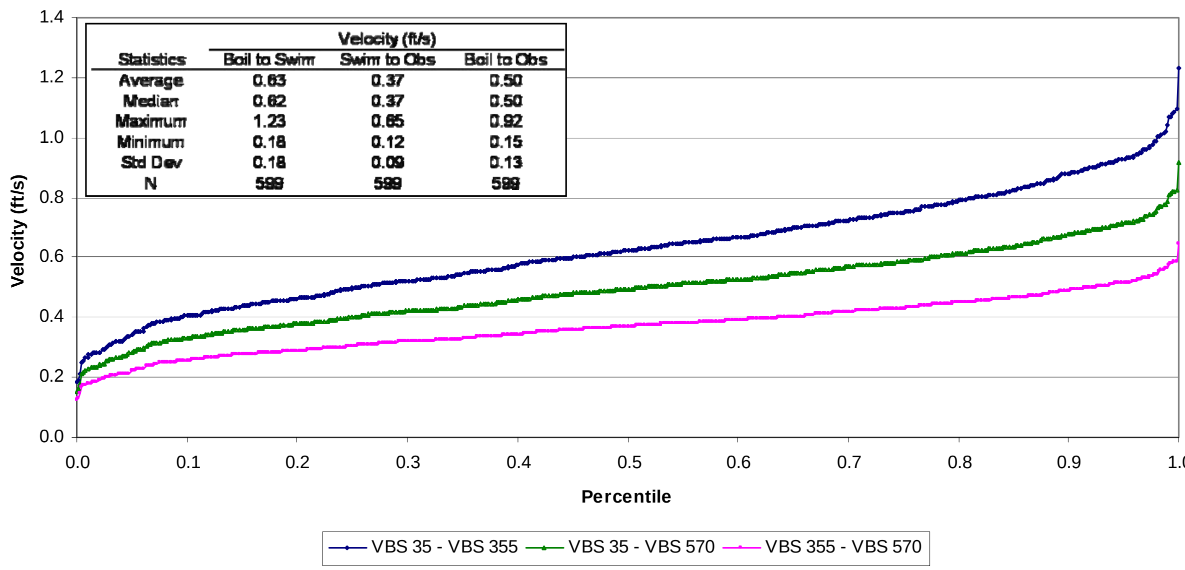


FIGURE 4-7. Blue Spring percentile frequency graphs for estimated nominal hydraulic residence time (nHRT) and current velocity by spring run segment, both calculated from spring volume and discharge estimates.

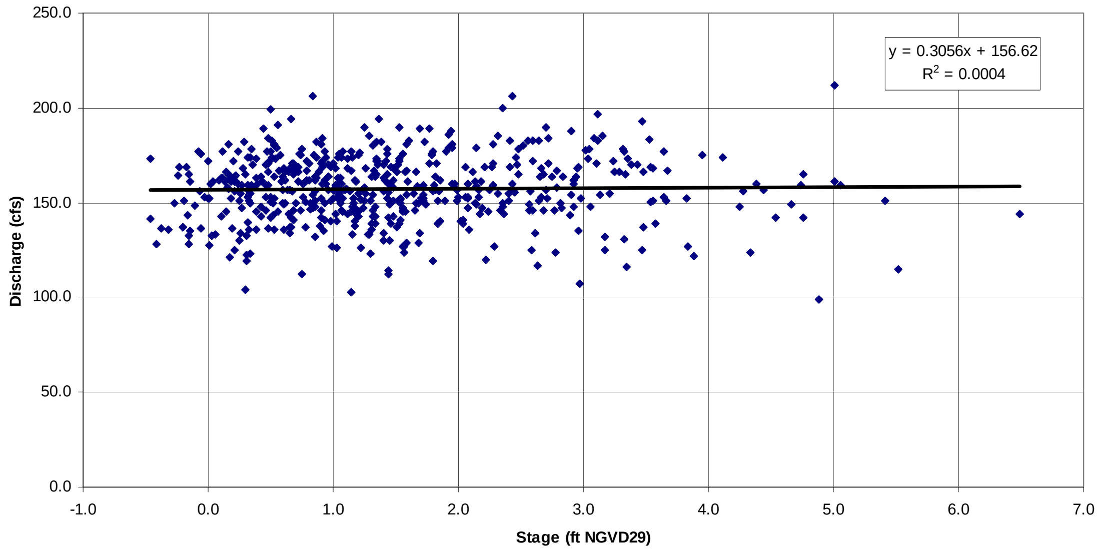
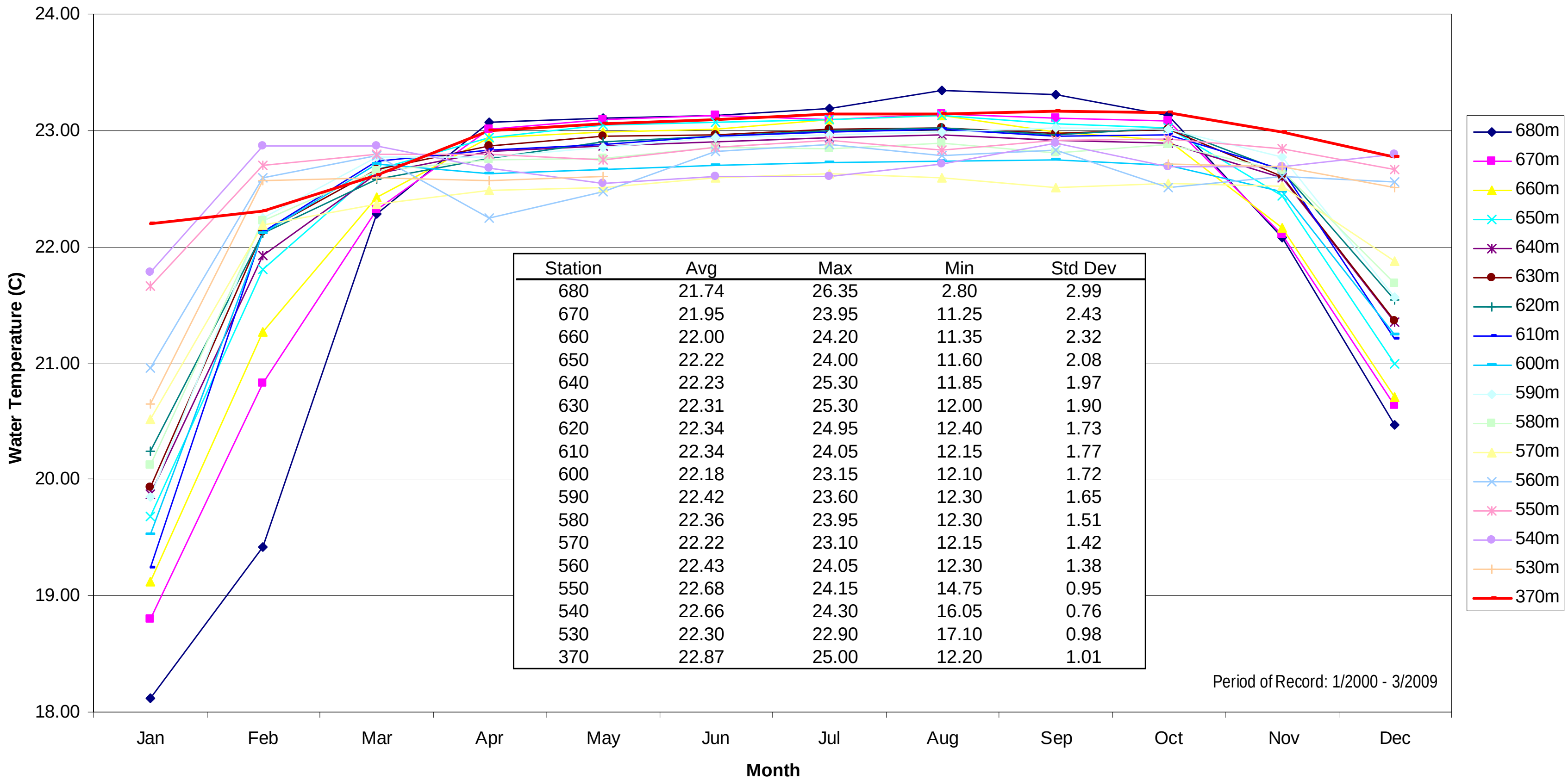


FIGURE 4-8. Blue Spring water stage versus discharge for the period from 1932 to 2008.

4.1.1.3 Bottom Temperature Profile

Beginning at approximately VBS 530, and going downstream 150 meters, the bottom temperature of the spring run was monitored at 10-m intervals. Over the period of record (January 2000 through March 2009) the average bottom water temperatures ranged from 21.7 to 22.9 °C from VBS-680 (St. Johns River) to VBS-370 (streamflow gaging station), respectively (**Figure 4-9**). **Figure 4-9** illustrates the observed upstream extent of the colder St. Johns River water into Blue Spring Run during the winter months. The lowest bottom temperatures near the confluence between Blue Spring Run and the St. Johns River typically occurred in the months of January and February.



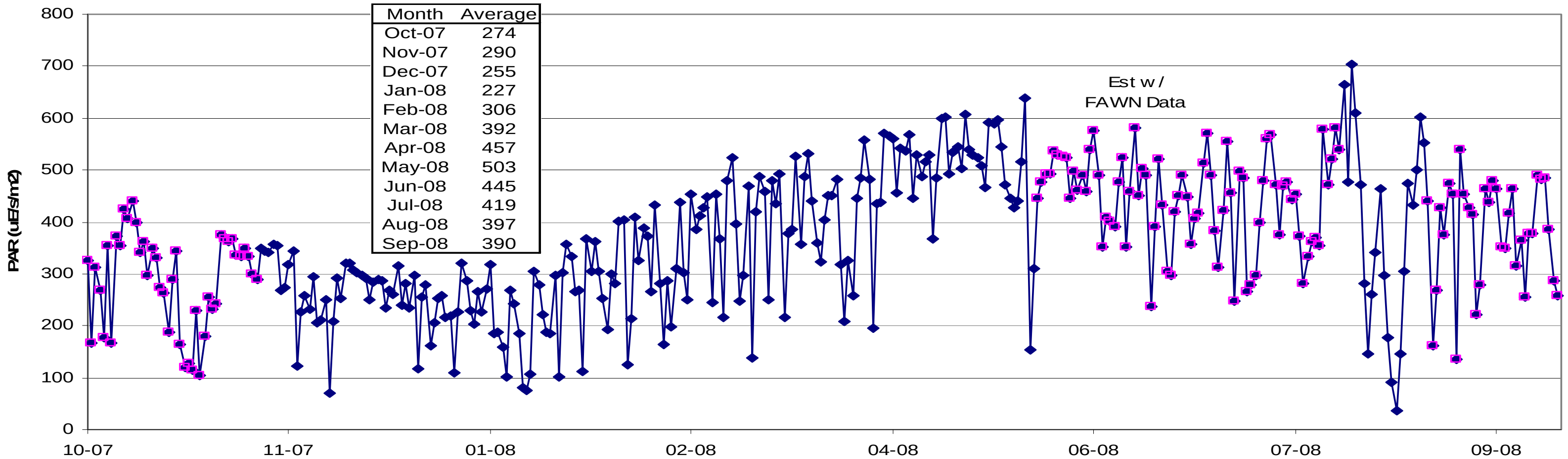
Station	Avg	Max	Min	Std Dev
680	21.74	26.35	2.80	2.99
670	21.95	23.95	11.25	2.43
660	22.00	24.20	11.35	2.32
650	22.22	24.00	11.60	2.08
640	22.23	25.30	11.85	1.97
630	22.31	25.30	12.00	1.90
620	22.34	24.95	12.40	1.73
610	22.34	24.05	12.15	1.77
600	22.18	23.15	12.10	1.72
590	22.42	23.60	12.30	1.65
580	22.36	23.95	12.30	1.51
570	22.22	23.10	12.15	1.42
560	22.43	24.05	12.30	1.38
550	22.68	24.15	14.75	0.95
540	22.66	24.30	16.05	0.76
530	22.30	22.90	17.10	0.98
370	22.87	25.00	12.20	1.01

FIGURE 4-9. Monthly average bottom water temperature measurements at Blue Spring (USGS data).

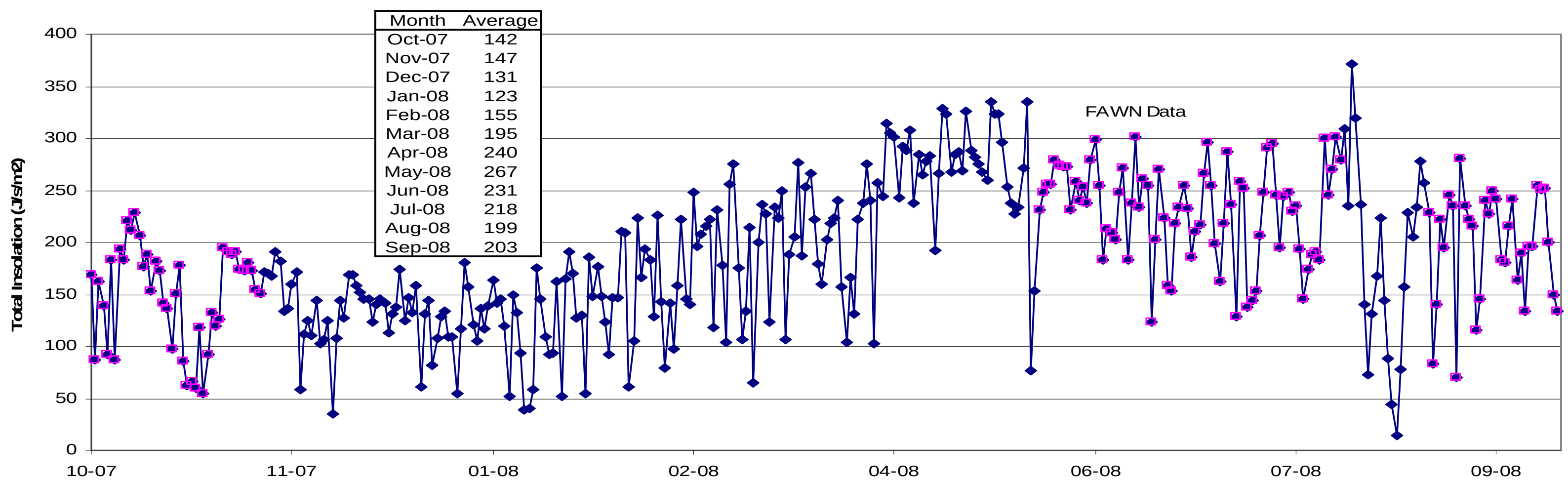
4.1.1.4 Weather Data

Inputs of solar energy were measured at Blue Spring State Park through Water Year 2007/2008 to allow normalization of rates of primary productivity measured in the spring and spring run (**Figure 4-10**). Both total insolation and PAR were recorded during this period. Over the period of record (October, 2007 through September, 2008), the average insolation recorded or estimated was 363.0 $J/s/m^2$ and the average PAR was 187.5 $\mu E/s/m^2$. The range of daily measured values for insolation was from 15 to 372 $J/s/m^2$ and for PAR was 36 to 705 $\mu E/s/m^2$. There was a general seasonal pattern of lower light availability during the winter and higher availability during the late spring and early summer months. This pattern was interrupted with especially low light inputs during the later part of the summer of 2008 when Tropical Storm Fay traveled through the area. Florida Automated Weather Network (FAWN) data from the Apopka and Pierson stations were utilized to estimate light values during periods of local equipment failure.

Figure 4-11 provides a record of the precipitation measured in Blue Spring State Park during this same period of record. The total recorded rainfall during Water Year 2007/2008 was 160 cm (63.0 inches), for an average daily precipitation rate of 0.43 cm/d (0.17 in/d). The maximum month for rainfall was August 2008 with 54 cm (21 in) and the lowest month was May 2008 with 0.81 cm (0.32 in) recorded, with maximum rainfall corresponding to Hurricane Fay's passage over the study site. Florida Automated Weather Network (FAWN) data from the Apopka and Pierson stations were utilized to estimate rainfall amounts during periods of local equipment failure

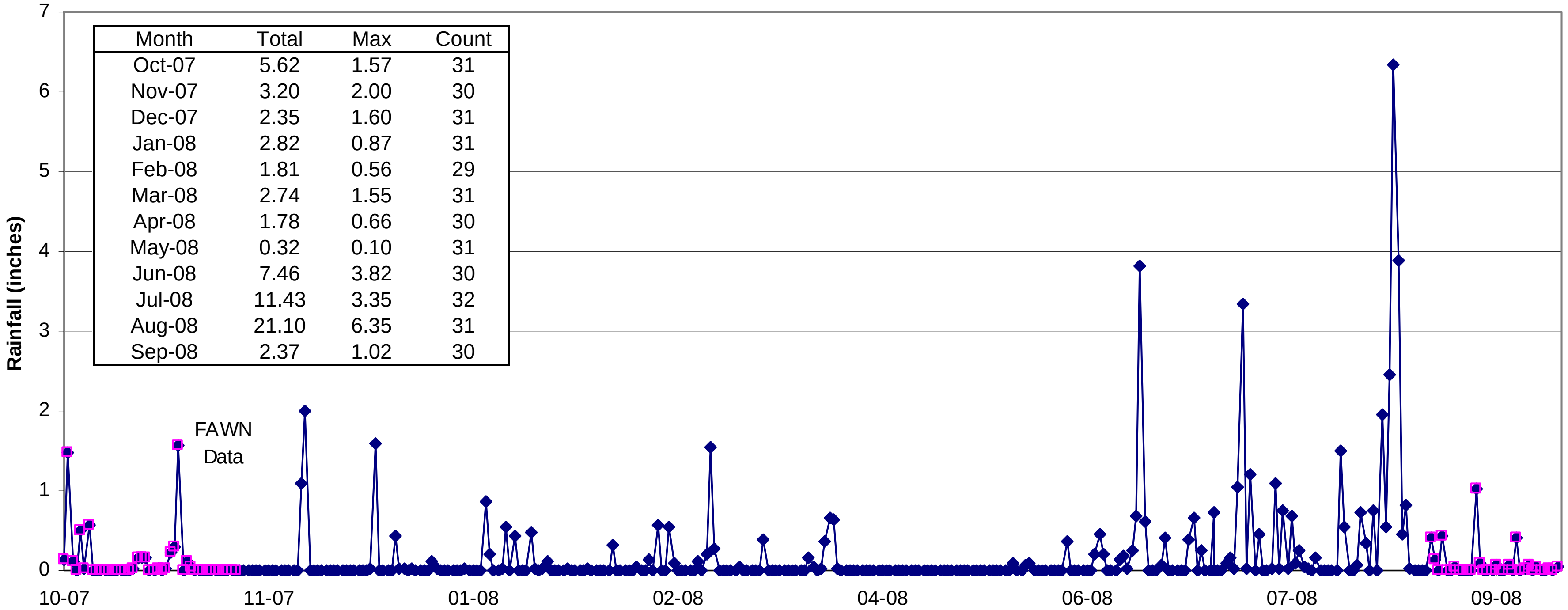


Month	Average
Oct-07	274
Nov-07	290
Dec-07	255
Jan-08	227
Feb-08	306
Mar-08	392
Apr-08	457
May-08	503
Jun-08	445
Jul-08	419
Aug-08	397
Sep-08	390



Month	Average
Oct-07	142
Nov-07	147
Dec-07	131
Jan-08	123
Feb-08	155
Mar-08	195
Apr-08	240
May-08	267
Jun-08	231
Jul-08	218
Aug-08	199
Sep-08	203

FIGURE 4-10. Incident total insolation and photosynthetically active radiation measurements at Blue Spring State Park during Water Year 2007/2008. FAWN data are from the Apopka and Pierson stations.



Month	Total	Max	Count
Oct-07	5.62	1.57	31
Nov-07	3.20	2.00	30
Dec-07	2.35	1.60	31
Jan-08	2.82	0.87	31
Feb-08	1.81	0.56	29
Mar-08	2.74	1.55	31
Apr-08	1.78	0.66	30
May-08	0.32	0.10	31
Jun-08	7.46	3.82	30
Jul-08	11.43	3.35	32
Aug-08	21.10	6.35	31
Sep-08	2.37	1.02	30

FIGURE 4-11. Precipitation measured at Blue Spring State Park during Water Year 2007/2008. FAWN data are from the Apopka and Pierson stations.

4.1.2 Water Quality

4.1.2.1 USGS Grab Samples

Table 4-1 provides a summary of the monthly water quality data collected by the USGS in Blue Spring and Blue Spring Run during Water Year 2007/2008 (see **Appendix B**). Instantaneous flows measured during the sampling events averaged about 323,000 m^3/d (132 cfs). Average water depth at the sampling points ranged from 1.24 m (4.0 ft) at the upstream station (VBS-35) to 3.05 m (9.9 ft) at the downstream station (VBS-620). The vertical Secchi depth was measured one time at two downstream stations influenced by dark waters from the St. Johns River (0.52 m at VBS-570 and 1.8 m at VBS-620.

Water temperature was about 23.1 °C throughout the first half of the spring run. Average temperatures increased below that point to 23.4 °C at VBS-500, 23.6 °C at VBS-570, and 26.8 °C at VBS-620, the confluence with the St. Johns River. Average color in the spring run ranged from 8.7 CPU at the upstream station to 25.6 CPU at the downstream station.

The concentration and percent saturation of dissolved oxygen increased markedly downstream from the spring boil to the end of the spring run. The dissolved oxygen concentration at the spring boil was very close to zero (average 0.02 mg/L) and average concentrations were less than 4.4 mg/L at all stations. Oxidation-Reduction Potential (ORP) averaged about -58 to -94 mV along the length of the spring run.

Average total chloride concentrations ranged from 475 to 517 mg/L. Average dissolved carbon dioxide ranged from 13.8 to 15.6 mg/L. Average dissolved fluoride ranged from 0.095 to 0.1097 mg/L. Average hardness ranged from 303 to 322 mg/l as $CaCO_3$. Alkalinity averaged about 23 mg/L as $CaCO_3$. Dissolved silica averaged 7.7 to 8.3 mg/L. Sulfate averaged between 77 and 83 mg/L.

Average calcium concentrations ranged from about 69 to 74 mg/L. Potassium averages ranged from 9.2 to 9.9 mg/L. Magnesium averaged between 30 and 33 mg/L. Dissolved sodium ranged from 249 to 269 mg/L.

Total nitrogen (TN) average concentrations ranged from 0.58 to 0.67 mg/L. On average, approximately 62% of this nitrogen was in the nitrate form with average concentrations between 0.35 and 0.40 mg/L. Ammonia nitrogen averages ranged from 0.10 to 0.11 mg/L (about 17% of TN) and organic nitrogen ranged from 0.08 to 0.23 mg/L (22% of TN).

Total phosphorus (TP) average concentrations in Blue Spring Run ranged from 0.079 to 0.092 mg/L. On average, approximately 85% of this phosphorus was in the form of dissolved ortho-phosphate.

TABLE 4-1. Water quality statistics for Blue Spring from monthly surface grab samples (USGS and WSI data).

Parameter Group	Parameter	Units	Station	Statistics: Average	Maximum	Minimum	StdDev	N	Period of Record	
DISSOLVED OXYGEN	DO	%	VBS-10	0.300	0.300	0.300	---	1	11/27/07	11/27/07
			VBS-35	2.31	13.0	0.00	2.56	27	11/13/07	8/29/08
			VBS-355	9.19	13.0	3.50	2.66	27	11/13/07	8/29/08
			VBS-500	15.3	15.6	15.0	0.424	2	8/5/08	8/5/08
			VBS-570	13.8	25.7	3.20	5.63	26	11/13/07	8/29/08
			VBS-620	56.5	86.9	26.0	43.1	2	7/8/08	7/8/08
	DO	mg/L	VBS-10	0.020	0.020	0.020	---	1	11/27/07	11/27/07
			VBS-35	0.194	1.10	0.00	0.196	35	10/29/07	9/30/08
			VBS-355	0.787	1.20	0.300	0.233	34	10/29/07	9/30/08
			VBS-500	1.29	1.31	1.27	0.028	2	8/5/08	8/5/08
			VBS-570	1.16	2.18	0.260	0.477	34	10/29/07	9/30/08
			VBS-620	4.36	6.51	2.20	3.05	2	7/8/08	7/8/08
FLOW	Flow-Inst	cfs	VBS-35	131	141	117	7.30	12	10/29/07	9/30/08
			VBS-355	129	139	117	7.11	7	2/25/08	9/30/08
			VBS-570	133	140	127	4.23	13	10/29/07	9/30/08
GENERAL INORGANIC	Cl-T	mg/L	VBS-35	517	590	221	97.1	12	10/29/07	9/30/08
			VBS-355	475	591	0.060	169	13	10/29/07	9/30/08
			VBS-570	486	594	165	129	12	10/29/07	9/30/08
	CO2	mg/L	VBS-35	14.8	21.0	7.50	3.55	12	10/29/07	9/30/08
			VBS-355	13.8	17.0	6.90	2.66	11	10/29/07	9/30/08
			VBS-570	15.6	38.0	6.60	7.88	11	10/29/07	9/30/08
	F-D	mg/L	VBS-35	0.095	0.140	0.060	0.024	12	10/29/07	9/30/08
			VBS-355	0.095	0.150	0.060	0.025	13	10/29/07	9/30/08
			VBS-570	0.097	0.150	0.070	0.028	12	10/29/07	9/30/08
	Hardness	mg/L as CaCO3	VBS-35	322	340	230	29.8	12	10/29/07	9/30/08
			VBS-355	322	350	230	31.6	12	10/29/07	9/30/08
			VBS-570	303	350	170	60.8	12	10/29/07	9/30/08
	Si-D	mg/L	VBS-35	8.31	8.77	7.35	0.460	12	10/29/07	9/30/08
			VBS-355	7.72	8.76	0.010	2.35	13	10/29/07	9/30/08
			VBS-570	8.14	8.73	6.59	0.695	12	10/29/07	9/30/08
	SO4	mg/L	VBS-35	83.2	94.5	37.7	15.4	12	10/29/07	9/30/08
			VBS-355	76.6	94.7	0.090	27.3	13	10/29/07	9/30/08
			VBS-570	80.0	97.9	27.5	20.0	12	10/29/07	9/30/08
METAL	Ca-D	mg/L	VBS-35	73.8	76.6	64.2	3.40	12	10/29/07	9/30/08
			VBS-355	68.5	77.7	0.020	20.9	13	10/29/07	9/30/08
			VBS-570	69.7	77.1	42.2	11.8	12	10/29/07	9/30/08
	K-D	mg/L	VBS-35	9.94	11.2	4.93	1.63	12	10/29/07	9/30/08
			VBS-355	9.15	11.1	0.010	3.13	13	10/29/07	9/30/08
			VBS-570	9.51	11.0	4.87	1.85	12	10/29/07	9/30/08
	Mg-D	mg/L	VBS-35	33.1	36.8	16.6	5.36	12	10/29/07	9/30/08
			VBS-355	30.4	37.2	0.010	10.5	13	10/29/07	9/30/08
			VBS-570	31.2	37.1	12.7	7.46	12	10/29/07	9/30/08
	NA-D	mg/L	VBS-35	269	307	122	48.1	12	10/29/07	9/30/08
			VBS-355	249	304	0.060	87.8	13	10/29/07	9/30/08
			VBS-570	253	299	92.1	63.3	12	10/29/07	9/30/08
	NA-T	%	VBS-35	63.2	66.0	53.0	3.33	12	10/29/07	9/30/08
			VBS-355	63.3	66.0	53.0	3.33	12	10/29/07	9/30/08
			VBS-570	63.0	65.0	53.0	3.22	12	10/29/07	9/30/08
	SAR	ratio	VBS-35	6.50	7.30	3.50	0.980	12	10/29/07	9/30/08
			VBS-355	6.51	7.10	3.50	0.974	12	10/29/07	9/30/08
			VBS-570	6.25	7.00	3.10	1.13	12	10/29/07	9/30/08
	SR-D	µg/L	VBS-35	1,147	1,260	654	160	12	10/29/07	9/30/08
			VBS-355	1,063	1,280	0.200	354	13	10/29/07	9/30/08
			VBS-570	1,126	1,290	611	202	12	10/29/07	9/30/08

TABLE 4-1 CONTINUED. Water quality statistics for Blue Spring from monthly surface grab samples (USGS and WSI data).

Parameter Group	Parameter	Units	Station	Statistics					Period of Record	
				Average	Maximum	Minimum	StdDev	N		
NITROGEN	NH4-N	mg/L	VBS-35	0.107	0.140	0.040	0.025	12	10/29/07	9/30/08
			VBS-355	0.109	0.250	0.040	0.051	11	10/29/07	9/30/08
			VBS-570	0.097	0.120	0.050	0.018	12	10/29/07	9/30/08
	NOx-N-D	mg/L	VBS-35	0.400	1.13	0.210	0.235	12	10/29/07	9/30/08
			VBS-355	0.402	1.10	0.200	0.238	11	10/29/07	9/30/08
			VBS-570	0.352	0.750	0.160	0.142	12	10/29/07	9/30/08
	OrgN	mg/L	VBS-35	0.077	0.100	0.050	0.016	11	10/29/07	8/27/08
			VBS-355	0.094	0.230	0.050	0.051	11	10/29/07	9/30/08
			VBS-570	0.228	0.820	0.060	0.288	12	10/29/07	9/30/08
	TKN	mg/L	VBS-35	0.175	0.240	0.060	0.044	12	10/29/07	9/30/08
			VBS-355	0.198	0.350	0.130	0.077	11	10/29/07	9/30/08
			VBS-570	0.324	0.910	0.140	0.282	12	10/29/07	9/30/08
	TN	mg/L	VBS-35	0.578	1.20	0.450	0.200	12	10/29/07	9/30/08
			VBS-355	0.600	1.20	0.470	0.210	11	10/29/07	9/30/08
			VBS-570	0.673	1.40	0.470	0.307	12	10/29/07	9/30/08
PHOSPHORUS	OrthoP	mg/L	VBS-35	0.071	0.081	0.060	0.006	12	10/29/07	9/30/08
			VBS-355	0.071	0.079	0.065	0.005	11	10/29/07	9/30/08
			VBS-570	0.073	0.118	0.063	0.015	12	10/29/07	9/30/08
	PO4-T	mg/L as PO4	VBS-35	0.217	0.249	0.183	0.018	12	10/29/07	9/30/08
			VBS-355	0.218	0.241	0.200	0.015	11	10/29/07	9/30/08
			VBS-570	0.223	0.361	0.192	0.046	12	10/29/07	9/30/08
	TDP	mg/L	VBS-35	0.071	0.090	0.060	0.010	12	10/29/07	9/30/08
			VBS-355	0.069	0.080	0.060	0.007	11	10/29/07	9/30/08
			VBS-570	0.075	0.120	0.060	0.016	12	10/29/07	9/30/08
	TP	mg/L	VBS-35	0.082	0.130	0.060	0.017	12	10/29/07	9/30/08
			VBS-355	0.079	0.090	0.070	0.005	11	10/29/07	9/30/08
			VBS-570	0.092	0.150	0.070	0.027	12	10/29/07	9/30/08
PHYSICAL	Alk-D	mg/L as CaCO3	VBS-35	23.0	23.0	23.0	---	1	4/28/08	4/28/08
			VBS-570	23.0	23.0	23.0	---	1	4/28/08	4/28/08
	Color	CPU	VBS-35	8.67	50.0	2.00	13.3	12	10/29/07	9/30/08
			VBS-355	7.00	25.0	2.00	6.04	13	10/29/07	9/30/08
			VBS-570	25.6	125	1.00	41.4	12	10/29/07	9/30/08
	Depth	m	VBS-35	1.24	2.53	0.640	0.508	20	11/13/07	8/29/08
			VBS-355	1.29	2.80	0.610	0.596	18	11/13/07	8/29/08
			VBS-500	1.60	1.60	1.60	0.00	2	8/5/08	8/5/08
			VBS-570	2.02	2.71	0.610	0.637	17	11/13/07	8/29/08
			VBS-620	3.05	3.05	3.05	0.00	2	7/8/08	7/8/08
	ORP	mV	VBS-35	-57.50	-31.00	-85.00	27.93	4	6/24/08	7/8/08
			VBS-355	-54.73	-38.50	-87.00	27.94	3	6/24/08	7/8/08
			VBS-570	-68.58	-31.20	-94.00	27.43	4	6/24/08	7/8/08
			VBS-620	-94.00	-92.00	-96.00	2.83	2	7/8/08	7/8/08
	pH	SU	VBS-10	7.45	7.45	7.45	---	1	11/27/07	11/27/07
			VBS-35	7.39	7.80	7.01	0.196	47	10/29/07	9/30/08
			VBS-355	7.43	8.10	7.09	0.219	46	10/29/07	9/30/08
			VBS-500	7.12	7.12	7.12	0.00	2	8/5/08	8/5/08
			VBS-570	7.42	8.03	6.60	0.266	45	10/29/07	9/30/08
			VBS-620	7.79	7.89	7.69	0.141	2	7/8/08	7/8/08
	Secchi	m	VBS-570	0.52	0.52	0.52	0.00	2	8/29/08	8/29/08
			VBS-620	1.80	1.80	1.80	0.00	2	7/8/08	7/8/08

TABLE 4-1 CONTINUED. Water quality statistics for Blue Spring from monthly surface grab samples (USGS and WSI data).

				Statistics					Period of Record	
Parameter Group	Parameter	Units	Station	Average	Maximum	Minimum	StdDev	N		
PHYSICAL	SpCond	umhos/cm	VBS-10	2,114	2,114	2,114	---	1	11/27/07	11/27/07
			VBS-35	2,081	2,290	1,070	230	47	10/29/07	9/30/08
			VBS-355	2,059	2,290	1,060	247	46	10/29/07	9/30/08
			VBS-500	2,013	2,013	2,013	0.00	2	8/5/08	8/5/08
			VBS-570	1,970	2,290	491	440	45	10/29/07	9/30/08
			VBS-620	1,913	2,118	1,708	290	2	7/8/08	7/8/08
	Turb	NTU	VBS-35	0.00	0.00	0.00	0.00	8	10/29/07	7/22/08
			VBS-355	0.013	0.100	0.00	0.035	8	10/29/07	7/22/08
			VBS-570	0.238	1.90	0.00	0.672	8	10/29/07	8/27/08
SOLID	TDS	mg/L	VBS-35	1,107	1,280	564	174	24	10/29/07	9/30/08
			VBS-355	1,061	1,280	5.00	278	25	10/29/07	9/30/08
			VBS-570	1,045	1,310	424	241	24	10/29/07	9/30/08
TEMPERATURE	Wtr Temp	C	VBS-10	23.1	23.1	23.1	---	1	11/27/07	11/27/07
			VBS-35	23.0	23.1	22.8	0.089	35	10/29/07	9/30/08
			VBS-355	23.1	24.3	22.8	0.230	34	10/29/07	9/30/08
			VBS-500	23.4	23.4	23.4	0.028	2	8/5/08	8/5/08
			VBS-570	23.6	28.9	22.9	1.42	34	10/29/07	9/30/08
			VBS-620	26.8	30.0	23.5	4.60	2	7/8/08	7/8/08

4.1.2.2 Field Parameters from Recording Data Sondes

WSI recorded water quality field parameters for up to 284 days at three stations located along the length of Blue Spring Run (**Table 4-2** and **Figures 4-12 to 4-13**). These data indicate that water exiting the Blue Spring vent was highly consistent with regards to temperature, pH, dissolved oxygen, and specific conductance over this water year.

Water temperature at the upstream Blue Spring Run station (VBS-35) averaged 23.1°C (73.6 °F) and varied by only 0.1 °C over this entire period. The recorded pH at this station averaged 7.34 SU and varied by only 0.25 SU during this period. Dissolved oxygen averaged 0.04 mg/L at this station and was also very stable with a recorded range between 0.00 to 0.14 mg/L. The average specific conductance at this upstream station was 2,178 µS/cm with an observed range from 2,055 to 2,329 µS/cm.

At the middle station in Blue Spring Run, conditions were similar but slightly more variable than observed upstream. Water temperature at the VBS-355 station averaged 23.1 °C (73.6 °F) and varied by only 0.1 °C over this entire period. The recorded pH at this station averaged 7.37 SU and varied by only 0.26 SU during this period. Dissolved oxygen averaged 0.44 mg/L at this station and was also very stable with a recorded range between 0.04 to 0.80 mg/L. The average specific conductance at the middle station was slightly lower than upstream at 2,154 µS/cm with an observed range from 2,034 to 2,364 µS/cm.

Conditions at the downstream station (VBS-570) were also stable throughout the year with the exception of the final few weeks in August 2008 when Tropical Storm Fay slowly traveled over this area of Florida. Water temperature at this downstream station averaged 23.4 °C (74.2 °F) and varied by 7.1 °C over this entire period. The recorded pH at this station averaged 7.41 SU and varied by 0.60 SU during this period. Dissolved oxygen averaged 0.83 mg/L at this station and had a recorded range between 0.11 to

3.75 mg/L. The average specific conductance at the downstream station was lower than upstream at 2,099 µS/cm with an observed range from 1,034 to 2,300 µS/cm. The data collected during late summer 2008 clearly show the influence of the observed rise in water levels and entry of tannic-stained, low conductance water from the adjacent St. Johns River.

A slight diurnal pattern was visible in all of the pH data, presumably due to exchange of CO_2 with the water column during photosynthesis and respiration. Dissolved oxygen concentration and percent saturation varied diurnally in response to the low incoming dissolved oxygen concentration in the spring flow combined with the competing influences of primary productivity, atmospheric diffusion into the under-saturated water, and community respiration. On most days, diurnal dissolved oxygen concentrations clearly demonstrated autotrophic activity in this spring run as described in detail under the topic of ecosystem metabolism. Diurnal dissolved oxygen and pH fluctuations are influenced by the amount of sunlight measured at Blue Spring State Park during those periods.

TABLE 4-2. Blue Spring field parameter statistics for Water Year 2007/2008 based on recording data sondes deployed at three locations in the spring run.

Parameter	Station	Average	Median	Maximum	Minimum	Std Dev	N
Temp (C)	VBS-35	23.1	23.1	23.2	23.1	0.03	143
	VBS-355	23.1	23.1	23.2	22.9	0.06	190
	VBS-570	23.4	23.2	29.8	22.7	1.03	284
pH (SU)	VBS-35	7.34	7.33	7.51	7.26	0.06	127
	VBS-355	7.37	7.35	7.54	7.28	0.07	174
	VBS-570	7.41	7.42	7.52	6.92	0.08	268
DO (mg/L)	VBS-35	0.04	0.03	0.14	0.00	0.03	127
	VBS-355	0.44	0.46	0.80	0.04	0.15	190
	VBS-570	0.83	0.78	3.75	0.11	0.40	284
DO (%)	VBS-35	0.22	0.23	1.69	-0.09	0.30	127
	VBS-355	4.35	4.85	9.39	0.43	1.80	190
	VBS-570	9.34	8.48	49.4	1.31	5.17	284
SpCond (uS/cm)	VBS-35	2,178	2,177	2,329	2,055	77.2	143
	VBS-355	2,154	2,133	2,364	2,034	88.4	190
	VBS-570	2,099	2,124	2,300	1,034	196	284

Period of Record: 11/07 - 08/08

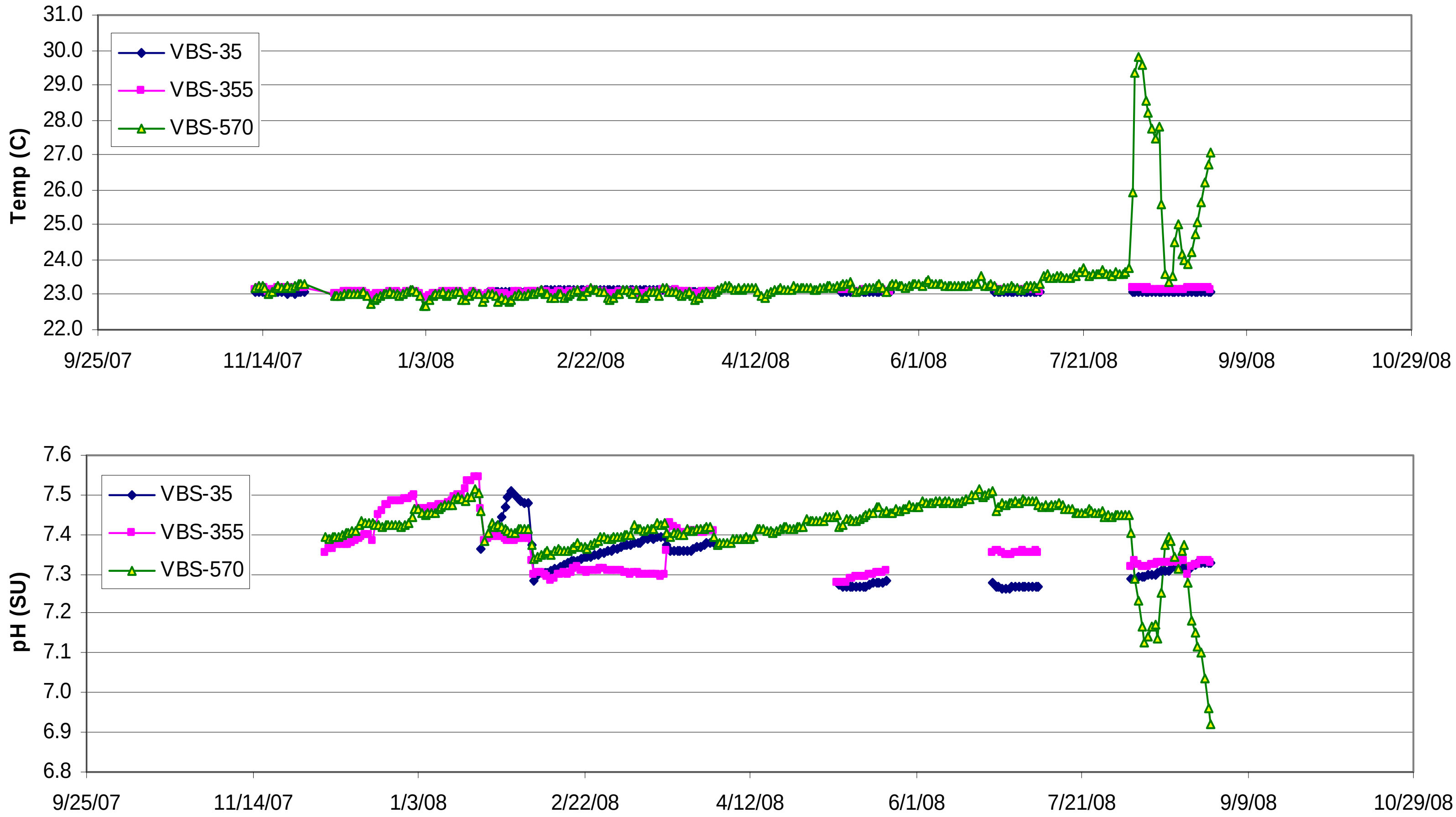


FIGURE 4-12. Blue Spring water temperature and pH summary for Water Year 2007/2008 based on recording data sondes deployed in the spring run.

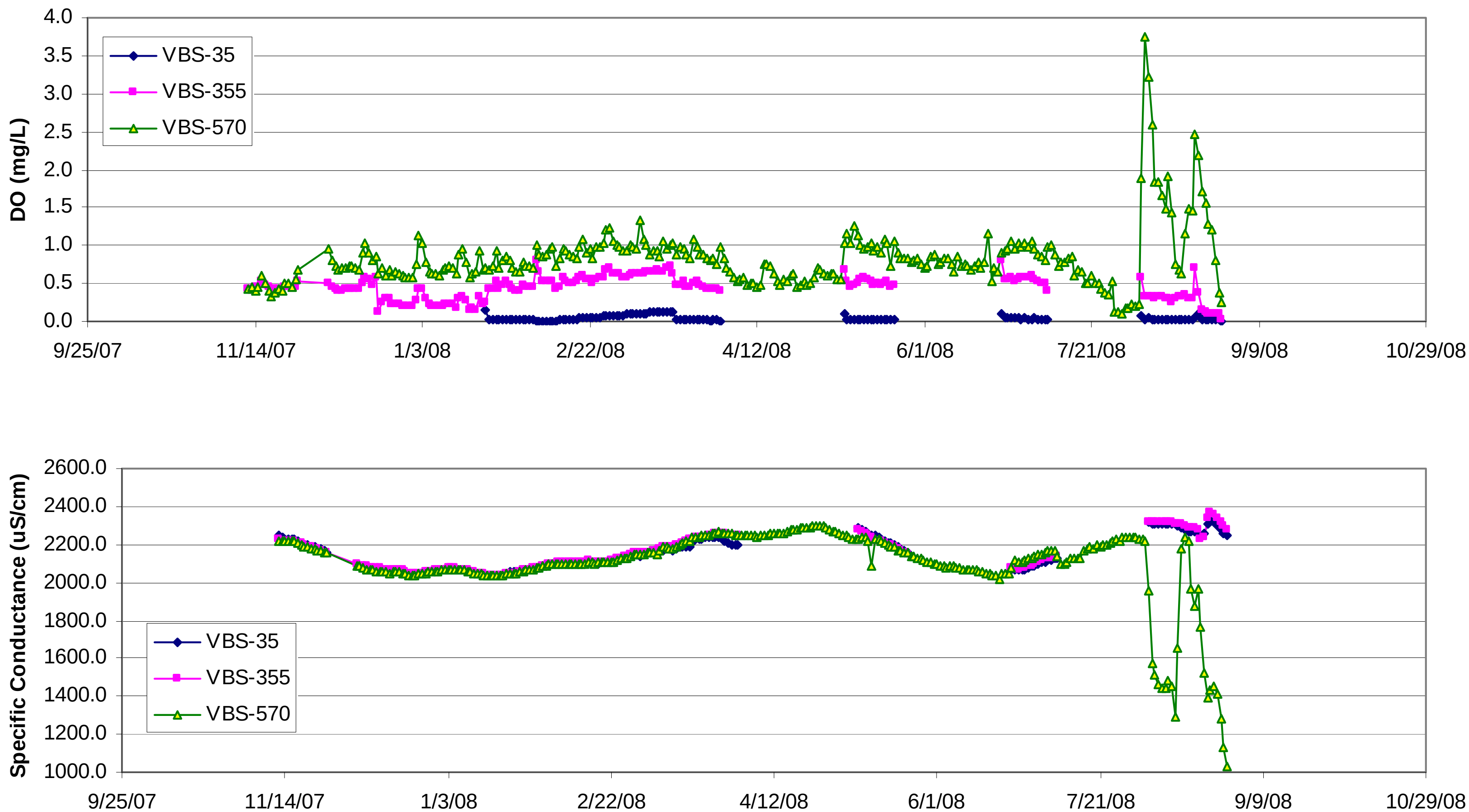


FIGURE 4-13. Blue Spring dissolved oxygen and specific conductance summary for Water Year 2007/2008 based on recording data sondes deployed in the spring run.

4.1.2.3 Light Attenuation

Measured attenuation of PAR was generally similar along the spring run (**Table 4-3**), with average extinction estimates between 0.49 to 0.55 m^{-1}. Estimated percent transmission of PAR in the spring run water was on the order of 60% (at 1 m water depth) at all three stations. Undisturbed conditions at all three stations resulted in lower measured light extinction values between 0.25 and 0.32 m^{-1}. Recreational swimming in the upper portion of the spring run, manatee activity, and intrusion of dark water from the St. Johns River were all observed to contribute to seasonal lowering of light transmission (greater turbidity or color) in Blue Spring and Blue Spring Run (**Figure 4-14** and **Appendix C**).

Horizontal Secchi disk readings are summarized in **Figure 4-15**. At the upstream station the readings averaged about 15 m (49 ft) with a range of observed values between 8.5 and 23.2 m (28 to 76 ft). Average Secchi disk readings declined with distance down the spring run with averages of about 7.9 m (26 ft) at the mid-point (VBS-355) and 5.8 m (19 ft) at VBS-570. Horizontal Secchi disk visibility was dramatically reduced in the lower spring run during period of St. Johns River inundation.

TABLE 4-3. Blue Spring light attenuation measurements during Water Year 2007 / 2008.

Station	Date	k (diffuse attenuation coefficient = slope, m-1)	Percent Transmittance (1m)	Birgean Percentile Absorption (1m)
VBS 35	11/27/07	0.371	69.0	31.0
	1/22/08	0.454	63.5	36.5
	2/6/08	0.637	53.3	46.7
	3/18/08	0.377	68.7	31.3
	4/1/08	1.37	26.0	74.0
	5/8/08	0.278	75.7	24.3
	6/24/08	0.747	47.5	52.5
	7/8/08	0.430	65.4	34.6
	8/5/08	0.425	65.4	34.6
	8/29/08	0.389	67.8	32.2
VBS 355	11/27/07	0.413	66.2	33.8
	1/22/08	0.454	63.6	36.4
	2/6/08	0.383	68.2	31.8
	3/18/08	0.564	57.2	42.8
	4/1/08	0.757	46.9	53.1
	5/8/08	0.521	59.4	40.6
	6/24/08	0.589	55.5	44.5
	7/8/08	0.477	62.4	37.6
	8/5/08	0.319	72.7	27.3
	8/29/08	0.447	64.0	36.0
VBS 570	11/27/07	0.406	66.7	33.3
	1/22/08	0.387	67.9	32.1
	2/6/08	0.461	63.1	36.9
	3/18/08	0.491	61.2	38.8
	4/1/08	0.399	67.2	32.8
	5/8/08	0.246	78.3	21.7
	6/24/08	0.445	64.1	35.9
	7/8/08	0.325	72.3	27.7
	8/5/08	0.407	66.6	33.4
	8/29/08	1.81	16.3	83.7

Station	Average		
VBS 35	0.548	60.2	39.8
VBS 355	0.493	61.6	38.4
VBS 570	0.538	62.4	37.6

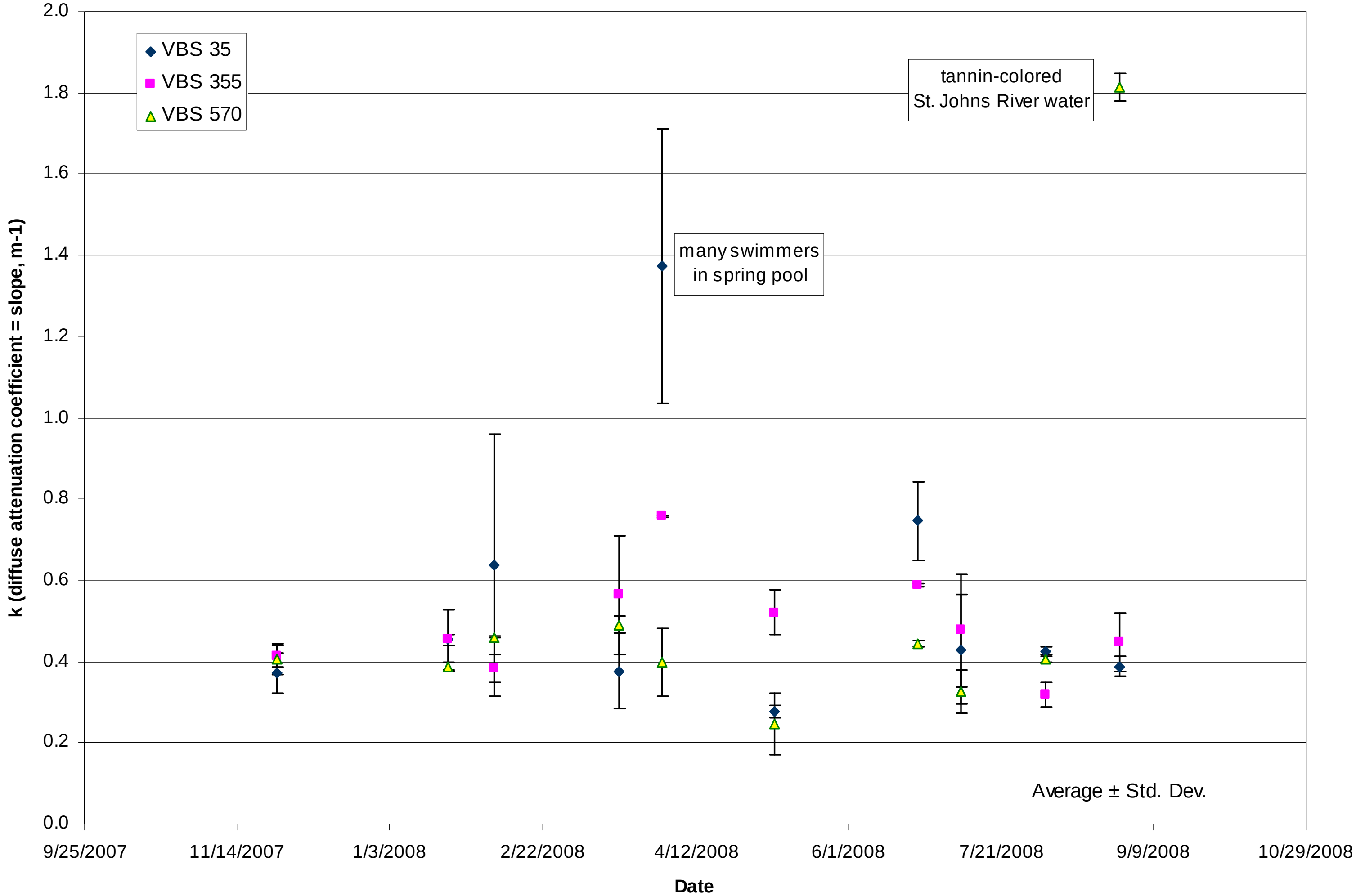
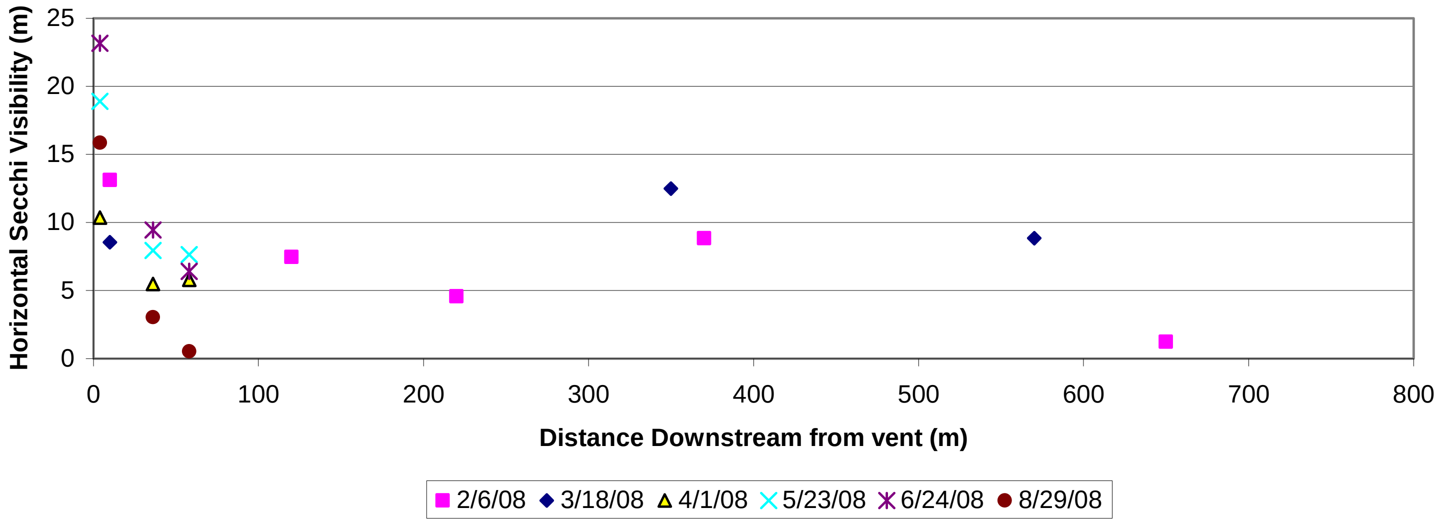


FIGURE 4-14. Blue Spring light attenuation estimates during Water Year 2007 / 2008.



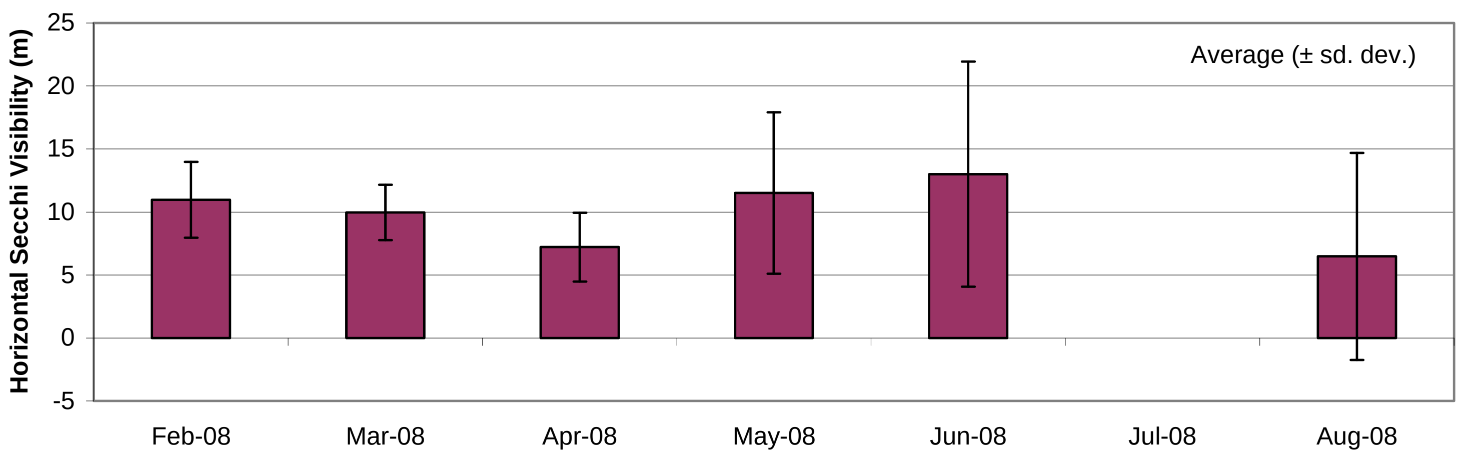


FIGURE 4-15. Blue Spring horizontal Secchi disk measurements during Water Year 2007 / 2008.

4.1.2.4 FDEP Field Parameter and Sediment Monitoring

FDEP has summarized 7 years of monitoring data (nutrients, microbiology, field and physical parameters) from Blue Spring in a 2008 report (FDEP 2008). The report found that levels of ammonia, total Kjeldahl nitrogen, and total phosphorus tended to be at or below the 40th percentile of levels typical of streams in Florida, while levels of nitrate-nitrite typically exceeded the value found in the 90th percentile of Florida streams. Results of the nutrient sampling suggest that ammonia, total Kjeldahl nitrogen, and total phosphorus concentrations have been relatively stable over the sampling period, while nitrate concentrations have exhibited more temporal variation (**Table 4-4).**

TABLE 4-4. Summary of Blue Spring FDEP Springs Initiative nutrient parameters by sampling date (from FDEP 2008, "A"= value reported is the arithmetic mean (average) of two or more determinations; "I" = below practical quantification limit; "J" = estimated value; "U" = below detection limit; "Q" = outside of holding time).

Nutrient Data

Date	Ammonia (mg/L)	Qualifier	TKN (mg/L)	Qualifier	Total Phosphorus (mg/L)	Qualifier	Nitrate-Nitrite (mg/L)	Qualifier
October 17, 2000	0.093	AJ	0.3		0.093		0.11	
November 8, 2001	0.01	U	0.14	I	0.069	JQ	0.64	
April 17, 2002	0.018	I	0.25		0.072		0.58	J
October 21, 2002	0.022		0.21		0.067	J	0.9	
May 19, 2003	0.01	U	0.13	I	0.069	A	0.78	
October 14, 2003	0.01	U	0.24		0.076		0.5	
April 20, 2004	0.041		0.2		0.098		0.39	
November 8, 2004	0.015	I	0.2	I	0.059	I	1.1	
April 26, 2005	0.011	I	0.19	I	0.076		0.57	
May 24, 2006	0.01	UQ	0.24	I	0.069		0.65	
November 1, 2006	0.058		0.32		0.078		0.42	
May 8, 2007	0.075		0.35		0.08		0.34	
Average	**0.03**		**0.23**		**0.08**		**0.58**	
Standard Deviation	**0.03**		**0.07**		**0.01**		**0.26**	
Median	**0.02**		**0.23**		**0.07**		**0.58**	

As part of the FDEP (2008) report, public health microbiology (bacteriological) indicators were sampled from the water column. *Escherichia coli, Enterococci*, fecal coliform bacteria, and total coliform bacteria concentrations (CFU/100ml) are presented in **Table 4-5**. Throughout this sampling period, *E. coli* data remained below the "single sample" criterion considered safe for "designated swim/beach areas" (235 CFU/100 ml), with a median value of 4 CFU/100 ml. *Enterococci* data from the sample period ranged from 6 to 40 CFU/100 ml over the sampling period, with a median of 23 CFU/100 ml, all below the specified safe criterion of 61 CFU/100 ml. Fecal coliform data have continuously complied with the Class III water quality standard, ranging from 1 to 16 CFU/100 ml, with a median of 2 CFU/100 ml. Total coliform data have ranged from 10 to 90 CFU/100 ml, with a median of 40 CFU/100 ml. Summary results and statistics for the microbiology parameters are shown in **Table 4-5**.

TABLE 4-5. Summary of Blue Spring FDEP Springs Initiative bacterial parameters by sampling date (from FDEP 2008, “A”= value reported is the arithmetic mean (average) of two or more determinations; “I” = below practical quantification limit; “J” = estimated value; “U” = below detection limit; “Q” = outside of holding time).

Microbiology Data

Date	*Enterococci* (CFU/100 mL)	Qualifier	*Escherichia coli* (CFU/100 mL)	Qualifier	Fecal Coliforms (CFU/100 mL)	Qualifier	Total Coliforms (CFU/100 mL)	Qualifier
October 17, 2000	26	Q	2	Q	10	Q	40	Q
March 21, 2001	20	Q	4	Q	1	KQ	10	Q
November 8, 2001	40	Q	8	Q	2	Q	20	Q
April 17, 2002	32	Q	12	Q	2	Q	90	Q
October 21, 2002	6	Q	1	KQ	1	KQ	40	Q
May 19, 2003	6	BQ	4	BQ	1	KQ	20	BQ
October 14, 2003	10	BQ	2	BQ	2	BQ	50	BQ
April 20, 2004	40	Q	23	BQ	8	BQ	54	Q
November 8, 2004	6	BQ	2	KQ	4	BQ	16	BQ
April 26, 2005	No Result	Q	No Result	Q	No Result	Q	No Result	Q
May 24, 2006	30	BQ	10	BQ	16	BQ	64	Q
November 1, 2006	30	BQ	18	BQ	2	KQ	50	Q
May 8, 2007	10	BQ	2	BQ	2	BQ	16	BQ
Average	**21**		**7**		**4**		**39**	
Standard Deviation	**13**		**7**		**5**		**24**	
Median	**23**		**4**		**2**		**40**	

As part of the FDEP (2008) report, field parameters were tested *in situ* for dissolved oxygen (DO), temperature, specific conductivity, and pH. Summary statistics of these data (as well as data for turbidity and color) with qualifier codes are shown in **Table 4-6**. Results from the sampling period show that DO was consistently lower than the Class III water quality standard of 5 mg/L, averaging 2.4 mg/L and ranging from 1.4 to 4.6 mg/L. This low DO regime is likely a natural condition for headwater spring systems discharging ground water, and may result in the exclusion of DO sensitive taxa from the system. Water temperature values were stable, as is typical of spring systems, averaging 23.1 °C. Specific conductivity was elevated compared to most freshwater spring systems, averaging 1,243 µS/cm, and ranging from 198 to 2,019 µS /cm. Lower specific conductance values are likely associated with flooding events from the St. Johns River. The high conductivity of the groundwater discharged at Blue Spring (as well as De Leon, Alexander, and Silver Glen Springs) appears to be a natural characteristic, perhaps associated with relict seawater in the Floridan aquifer system from past higher sea level stands which inundated major river corridors, notably the St. Johns River valley (FDEP 2008). However, this high conductivity can exert a negative influence on many sensitive freshwater invertebrates. The mean pH was 7.3 SU, ranging from 6.4 to 8.0 SU. Turbidity was very low, averaging 0.3 NTU and color was below the detection limit the entire sampling period, both indicative of good water clarity. Summary results and statistics for the field and physical parameters are shown in **Table 4-6**.

TABLE 4-6. Summary of Blue Spring FDEP Springs Initiative field and physical parameters by sampling date (from FDEP 2008, "A"= value reported is the arithmetic mean (average) of two or more determinations; "Q" = outside of holding time; "U"= below detection limit).

Field Testing and Physical Parameters

Date	Dissolved Oxygen (mg/L)	pH (SU)	Specific Conductance (umhos/cm)	Temperature (C°)	Color (PCU)	Qualifier	Turbidity (NTU)	Qualifier
October 17, 2000	2.3	7.6	198	22.8	5	A	0.15	
March 21, 2001	2.2	7.5	2019	23	No Result		No Result	
November 8, 2001	1.5	6.4	1365	22.9	5	U	0.1	
April 17, 2002	2.6	7.1	1381	23.2	5	U	0.1	
October 21, 2002	1.43	7.07	878	23.2	5	UQ	0.15	Q
May 19, 2003	1.38	7.7	1098	23.02	5	U	0.35	A
October 14, 2003	3.34	7.33	1396	23.13	5	UQ	0.2	Q
April 20, 2004	3.22	7.5	1705	23.36	5	Q	0.7	Q
November 8, 2004	1.9	7.3	861	22.9	5	UQ	0.1	Q
April 26, 2005	2.5	8	1280	23	5	Q	0.15	Q
May 24, 2006	4.61	6.52	1055	23.4	5	Q	0.95	Q
November 1, 2006	No Result	No Result	1597	23	5		0.2	
May 8, 2007	1.56	7.25	1321	23.2	5	U	0.25	
Average	**2.38**	**7.27**	**1242.62**	**23.09**	**5.00**		**0.28**	
Standard Deviation	**0.97**	**0.46**	**450.30**	**0.18**	**0.00**		**0.27**	
Median	**2.25**	**7.32**	**1321.00**	**23.02**	**5.00**		**0.18**	

Recent observations from FDEP field parameter (temperature, pH, dissolved oxygen, and specific conductivity) monitoring during the October 2007 to November 2008 time period are presented in **Table 4-7**. Generally, temperature and pH were stable over the sampling period. Dissolved oxygen concentrations averaged 2.59 mg/L and ranged from 1.77 to 4.81 mg/L, except on February 12, 2008 at the Middle Site (5.5 mg/L). Specific conductance averaged 1,760 µS/cm and ranged from 938 to 2,086 µS/cm.

Sediment quality data are summarized in **Table 4-7** and **Figure 4-16**. Kjeldahl nitrogen values varied between dates for each site. Levels were most variable at the Middle Site, where both the highest (1,400 mg N/Kg) and lowest (190 mg N/Kg) levels of Kjeldahl nitrogen were measured. Total phosphorus ranged from 1,500 to 3,100 mg P/Kg and generally increased in concentration from the Upper Site to the Middle and Lower Sites.

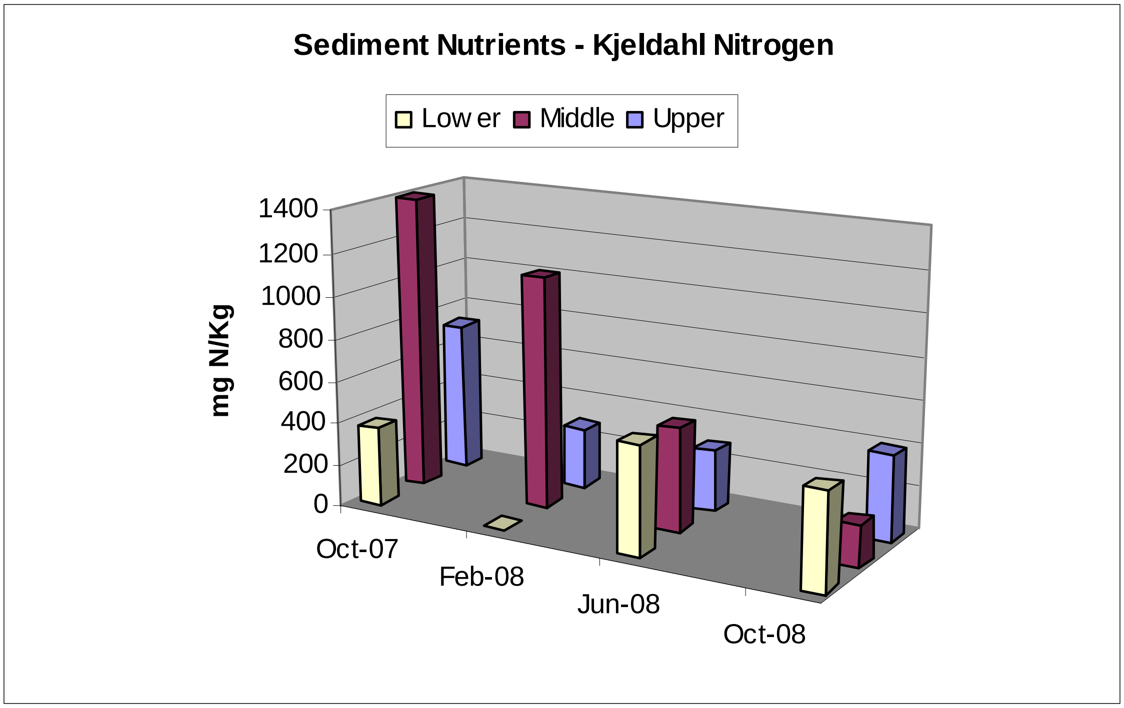
Most of the sediment in Blue Spring Run consisted of larger sand particles (0.125 to 2.0 mm) with minor amounts of silt.

Sediment samples collected on June and November 2008 from each of the study segments were analyzed for the following heavy metals: Arsenic, Cadmium, Chromium, Copper, Lead, and Nickel) by FDEP. Concentrations (mg/kg) of these metals ranged from 3 to 25% of the threshold effect level (TEL) for coastal sediments (FDEP 1994). **Table 4-8** provides the average concentration by location and metal component, while **Table 4-9** presents the average concentration by metal. **Figure 4-17** illustrate these findings visually. Concentrations for each heavy metal were below the threshold effect level (TEL) regardless of sampling date or location (FDEP 1994). See **Appendix D** for additional data.

TABLE 4-7. Summary of Blue Spring field parameters and sediment characteristics by location and sampling date (from FDEP 2009).

Volusia Blue- Upper Site				
Water Quality Measurements	**10/10/2007**	**2/12/2008**	**6/23/2008**	**11/5/2008**
Temperature (°C)	23.12	23.1	23.12	23
pH (SU)	6.38	7.14	7.21	7.24
Dissolved Oxygen (mg/L)	4.81	1.9	1.87	1.77
Specific Conductance (µmhos/cm)	2086	2014	1996	942
Sediment Data				
Kjeldahl Nitrogen (mg N/Kg)	710	290	290	410
Total Phosphorus (mg P/Kg)	1900	1700	1500	2400
Sediment Particle Size, 0.063-0.125mm (% volume < 2mm)	1.39	2.62	1.5	4.18
Sediment Particle Size, 0.125-0.25 mm (% volume < 2mm)	20.2	16.3	25.3	32.3
Sediment Particle Size, 0.25-0.5 mm (% volume < 2mm)	46.5	42.4	54.5	42.3
Sediment Particle Size, 0.5-2.0 mm (% volume < 2mm)	27.9	32.6	14.9	9.33
Sediment Particle Size, <0.063 mm (% volume < 2mm)	4.03	6.14	3.71	11.9
Sediment Particle Size, >2.0 mm (% total dry weight)	7.4	61	69	1.3
Volusia Blue- Middle Site				
Water Quality Measurements	**10/10/2007**	**2/12/2008**	**6/24/2008**	**11/6/2008**
Temperature (°C)	23.36	23.1	23.19	22.9
pH (SU)	6.6	7.2	7.25	7.39
Dissolved Oxygen (mg/L)	3.59	5.5	1.05	1.57 J
Specific Conductance (µmhos/cm)	2082	2018	1992	938
Sediment Data				
Kjeldahl Nitrogen (mg N/Kg)	1400	1100	490	190
Total Phosphorus (mg P/Kg)	2700	2400	3100	2900
Sediment Particle Size, 0.063-0.125mm (% volume < 2mm)	4.28	3.29 A	2.07 A	3.46 A
Sediment Particle Size, 0.125-0.25 mm (% volume < 2mm)	46.1	44 A	22.7 A	40.2 A
Sediment Particle Size, 0.25-0.5 mm (% volume < 2mm)	38.7	42 A	44.5 A	45.8 A
Sediment Particle Size, 0.5-2.0 mm (% volume < 2mm)	4.01	6.24 A	27.1 A	6.78 A
Sediment Particle Size, <0.063 mm (% volume < 2mm)	6.9	4.4 A	3.62 A	3.76 A
Sediment Particle Size, >2.0 mm (% total dry weight)	3.5	2.8	35	4.4
Volusia Blue- Lower Site				
Water Quality Measurements	**10/10/2007**	**2/12/2008**	**6/24/2008**	**11/6/2008**
Temperature (°C)	23.36	ND	23.35	23.06
pH (SU)	6.21	ND	7.34	7.58
Dissolved Oxygen (mg/L)	3.52	ND	1.89	1.79
Specific Conductance (µmhos/cm)	2084	ND	1981	940
Sediment Data				
Kjeldahl Nitrogen (mg N/Kg)	370	ND	510	450
Total Phosphorus (mg P/Kg)	2600	ND	2800	3000
Sediment Particle Size, 0.063-0.125mm (% volume < 2mm)	4.97	ND	8.51	4.74
Sediment Particle Size, 0.125-0.25 mm (% volume < 2mm)	38.4	ND	47.8	39.6
Sediment Particle Size, 0.25-0.5 mm (% volume < 2mm)	41.1	ND	29.3	40.4
Sediment Particle Size, 0.5-2.0 mm (% volume < 2mm)	11	ND	7.58	10.3 J
Sediment Particle Size, <0.063 mm (% volume < 2mm)	4.52	ND	6.83	4.95
Sediment Particle Size, >2.0 mm (% total dry weight)	5	ND	1	1.4

A - Average of two or more determinations
J - Estimated value
ND - No data



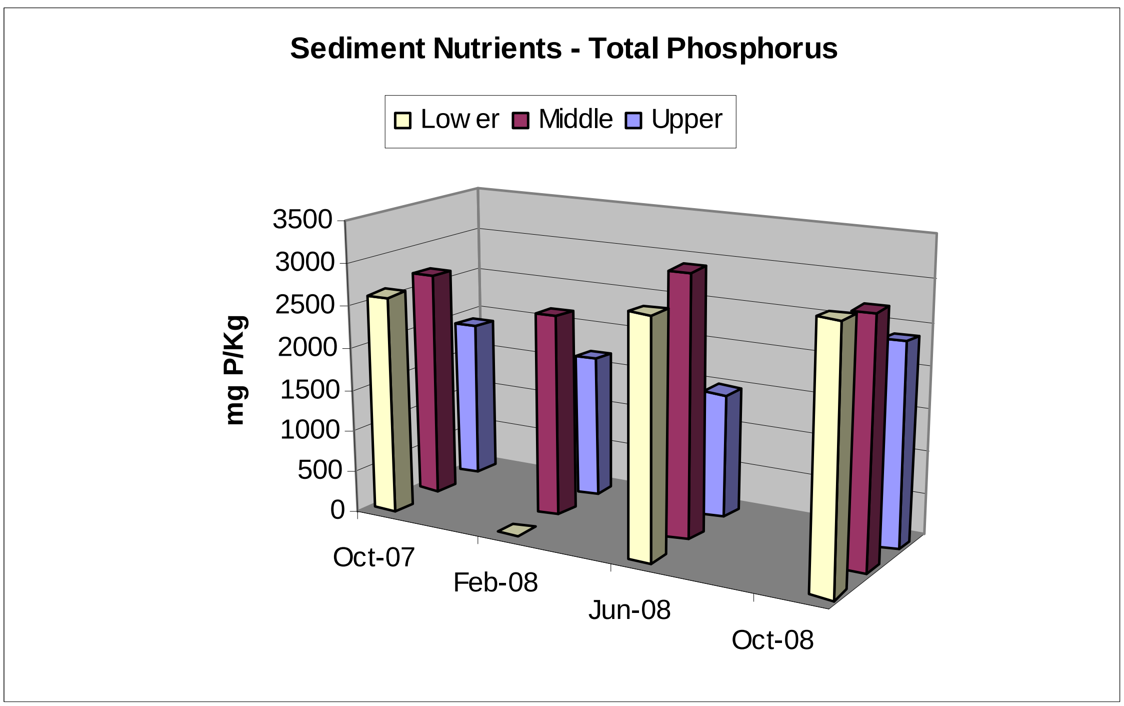


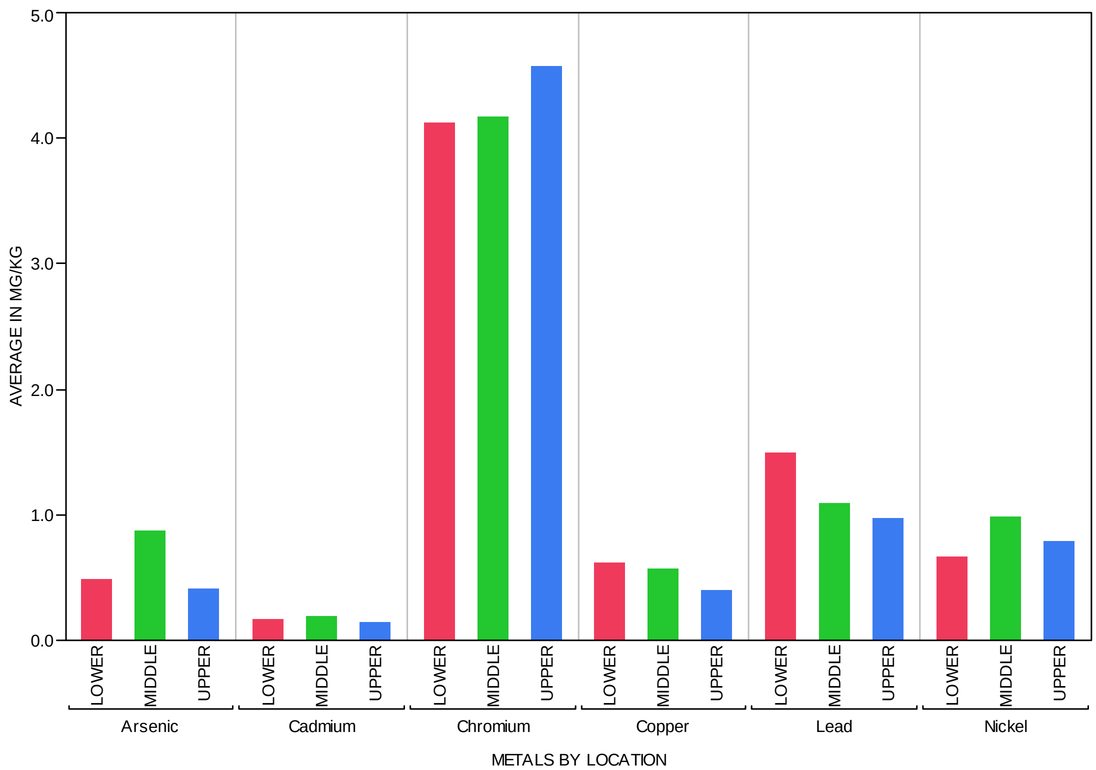
FIGURE 4-16. Kjeldahl nitrogen concentrations (top figure) and total phosphorus concentrations (bottom figure) in sediment samples by station and date. No samples were collected in February 2008 (from FDEP 2009).

TABLE 4--8. Summary of Blue Spring heavy metal sediment characteristics by location and component (from FDEP 2009).

Volusia Blue Spring Study Segment	COMPONENT	N Rows	Average Result (mg/kg)
UPPER	Arsenic	2	0.42
UPPER	Cadmium	2	0.15
UPPER	Chromium	2	4.58
UPPER	Copper	2	0.40
UPPER	Lead	2	0.97
UPPER	Nickel	2	0.79
MIDDLE	Arsenic	2	0.87
MIDDLE	Cadmium	2	0.20
MIDDLE	Chromium	2	4.17
MIDDLE	Copper	2	0.58
MIDDLE	Lead	2	1.10
MIDDLE	Nickel	2	0.99
LOWER	Arsenic	2	0.49
LOWER	Cadmium	2	0.17
LOWER	Chromium	2	4.13
LOWER	Copper	2	0.63
LOWER	Lead	2	1.50
LOWER	Nickel	2	0.67

TABLE 4-9. Summary of Blue Spring heavy metal sediment characteristics by component (from FDEP 2009).

COMPONENT	N Rows	Average Result (mg/kg)	Average Result Percentage of TEL	Threshold Effect Level (TEL, in mg/kg) from FDEP 1994)
Arsenic	6	0.59	8%	7.24
Cadmium	6	0.17	25%	0.676
Chromium	6	4.29	8%	52.3
Copper	6	0.53	3%	18.7
Lead	6	1.19	4%	30.2
Nickel	6	0.82	5%	15.9



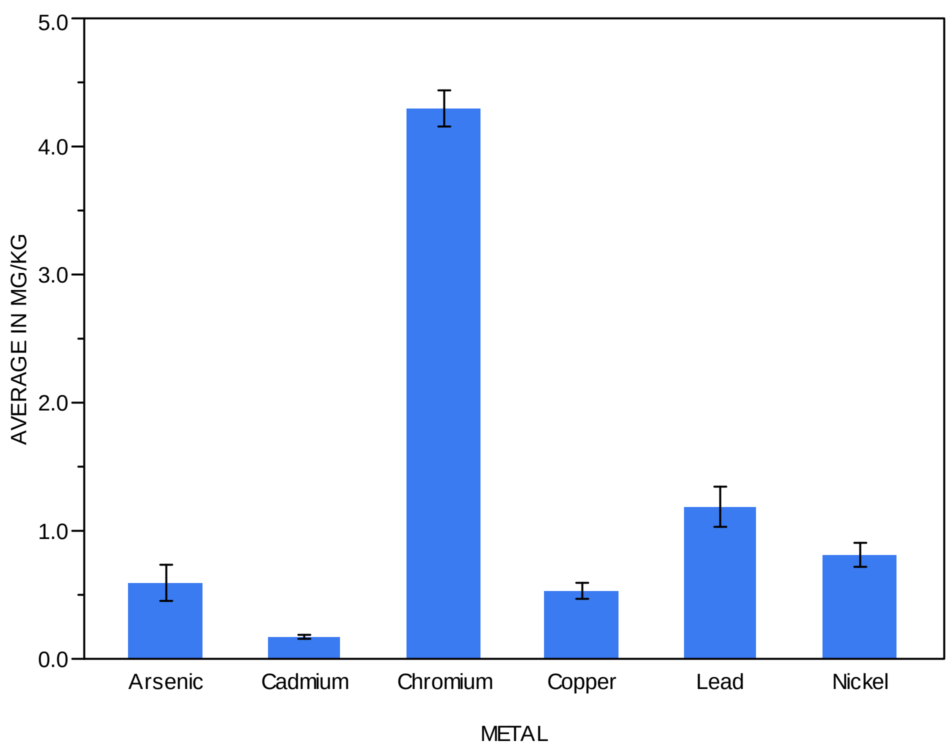


FIGURE 4-17. Summary of Blue Spring heavy metal sediment characteristics by location and component (top) and by average component values (bottom) (FDEP 2009 data).

4.2 Manatee Population and Behavior Modeling

4.2.1 Manatee Population

Manatee use of Blue Spring as a winter, warm-water refuge has increased markedly during the thirty-nine years of observation (**Figure 4-18**). Total observed manatees have increased from about 11 individuals in 1970 to 301 in 2008 and the maximum daily count of manatees per season has increased from 11 animals in 1970 to 231 during the 2008 manatee season. Similarly, the number of manatees that regularly utilize the spring run as a winter refuge (data category labeled "Total Remained" on **Figure 4-18**) increased from 11 in 1970 to over 190 animals in 2008.

Development of the minimum flow regime for Blue Spring relied upon future forecasting of the minimum warm water habitat to accommodate the expanding manatee use at Blue Spring Run (Rouhani *et al.* 2007). The extent of warm water habitat is a function of the maximum daily count of manatees and maximum manatee spread. Time series plots of these two variables display statistically significant exponential trends (Rouhani *et al*. 2007), which continued through the 2006 to 2008 manatee seasons.

A comparison of projected and observed maximum daily manatee counts for the last three manatee seasons (*i.e.*, 2006-2008) indicates that the observed maximum daily count has exceeded projected counts by approximately 23%, on average (**Table 4-10**). Although maximum manatee spread was not calculated, it is likely this parameter also exceeds projections. **Figure 4-19** illustrates the effect such divergences from projected trends have to calculation of the required Blue Spring minimum flow. The blue line in Figure **4-19** represents the projected Blue Spring minimum long term mean flow requirements based on a manatee maximum daily attendance growth rate of 7.02% and a manatee spread growth rate of 5.20% with a spread ceiling of 1.73 manatee/ft (Rouhani *et al.* 2007). Holding the manatee spread and spread ceiling constant, and allowing a one percent ± deviation in manatee growth rate yields significant variations in the timing and magnitude of the recommended Blue Spring MFR (**Figure 4-19**).

During the 2006/2007 manatee season, Blue Spring State Park staff began qualitatively assessing individual manatee physiological/health as a part of the annual daily manatee season *Roll Call Surveys*. The surveys assessed the level of cold stress skin lesions on manatees. Fifteen manatees were documented having cold stress during the 2006 through 2008 manatee seasons (**Table 4-11**), representing approximately 2% of the total number of manatees observed visiting Blue Spring during that time-period. The majority of the cold stress observed was characterized as "minor," and only four animals had cold stress characterized as more intense (*i.e.*, "moderate"). The observers noted that most of the manatees having cold stress arrived at the spring bearing cold stress sores (*i.e.*, the cold stress was not due to the animals being excluded from the warm-water habitat at Blue Spring).

Review of these observations by the MFIWG has led to the recommendation that the protocols and evaluation scales to assess the level of cold stress skin lesions and the general manatee body condition/health should be refined, and a database should be constructed to permanently store field observations. Additionally, the analytical process to assess future cold stress impacts should be thoroughly described.

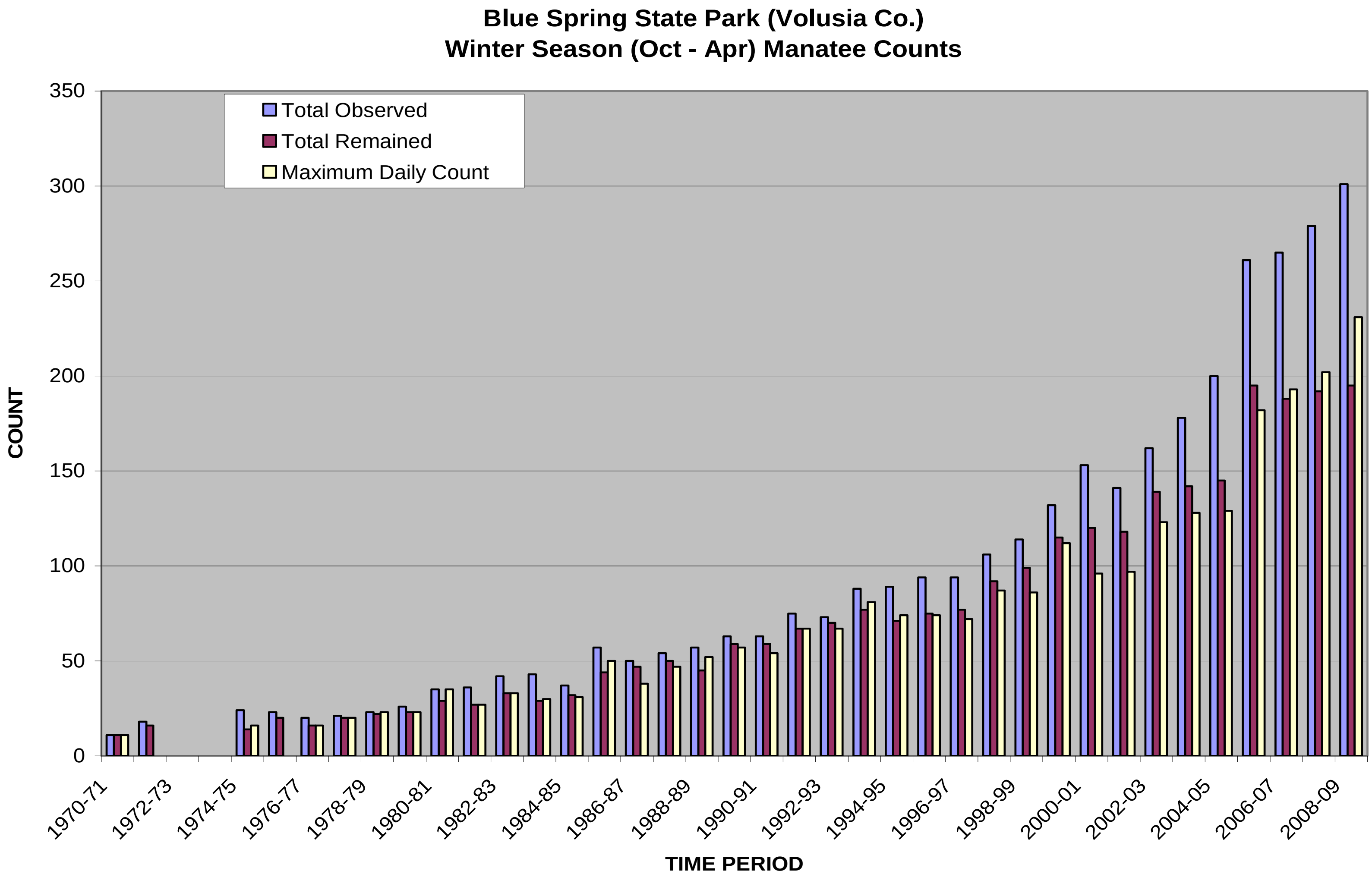


FIGURE 4-18. Blue Spring manatee counts by year (BSSP data).

TABLE 4-10. Projected and observed maximum daily manatee count, ratio of observed to projected maximum daily counts, and adopted mean flow by manatee season (from Rouhani *et al*. 2007).

Season	**Projected Max Daily Manatee Count**	**Observed Max Daily Manatee Count**	**Ratio Observed/ Projected Max Daily Counts**	**Adopted Long Term Mean Flow (cfs)**
2006	158	193	1.22	133
2007	169	202	1.19	133
2008	182	231	1.27	133
2009	195	-	-	**137**
2010	209	-	-	137
2011	224	-	-	137
2012	240	-	-	137
2013	258	-	-	137
2014	277	-	-	**142**
2015	297	-	-	142
2016	318	-	-	142
2017	342	-	-	142
2018	366	-	-	142
2019	393	-	-	**148**
2020	422	-	-	148
2021	452	-	-	148
2022	485	-	-	148
2023	520	-	-	148
2024	558	-	-	**157**
2025	599	-	-	157
2026	642	-	-	157

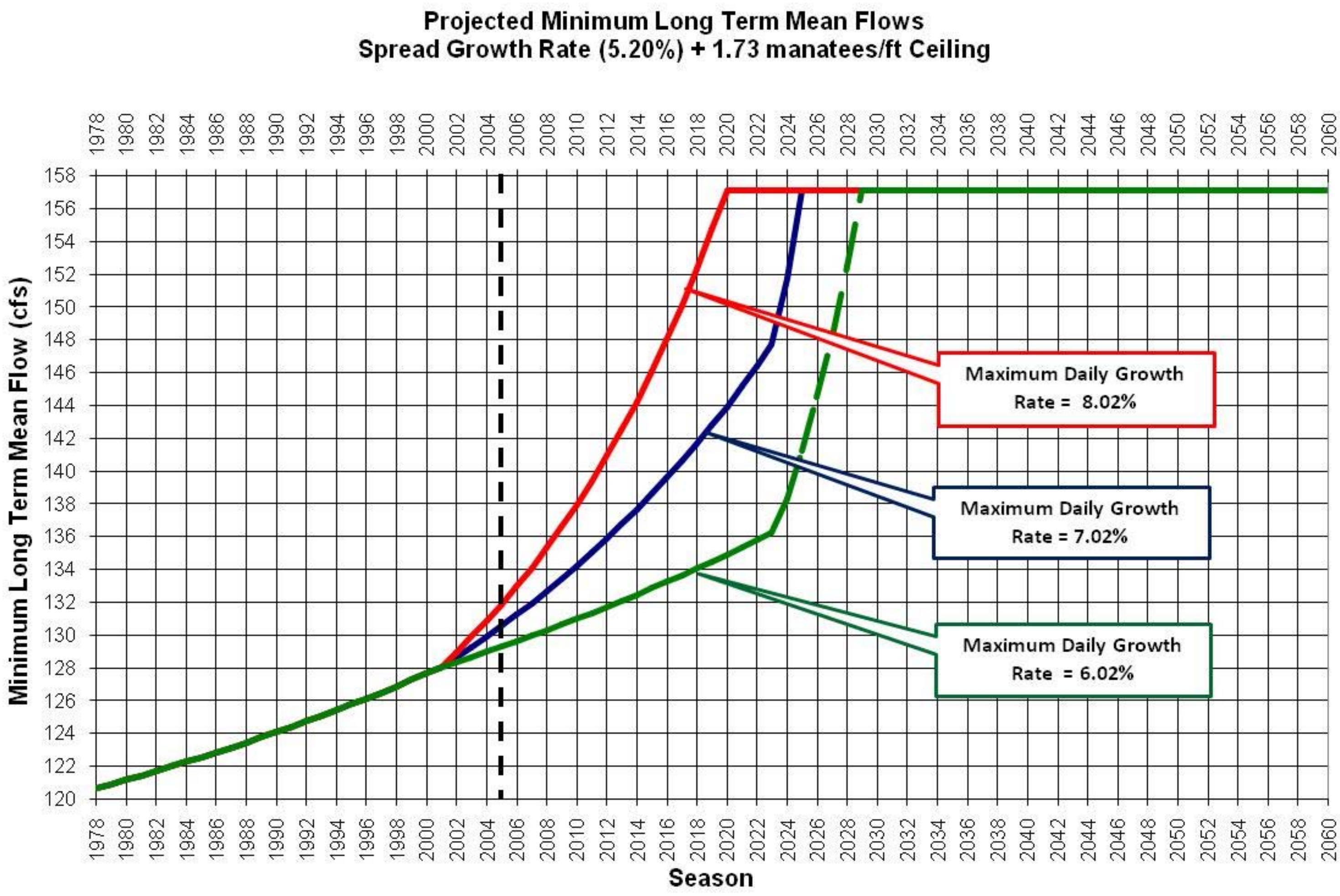


FIGURE 4-19. Sensitivity analysis of projected Blue Spring minimum long-term mean flows: Based on manatee maximum daily attendance rates of 7.02% ± 1% per annum and a manatee spread growth rate of 5.20% per annum with a spread ceiling of 1.73 manatees/ft (from Rouhani *et al.* 2007).

TABLE 4-11. Observations of manatee cold stress at Blue Spring from the 2006 / 2008 manatee seasons (FDEP data).

Season	Date	Manatee Observations				
		Animal Description	Cold Stress Observation	Comments	Total Numbers of Manatees Observed During Season	Number of Manatees Observed with Cold Stress (Percentage)
2006	Jan. 11, 2007	Small yearling	Minor	Cold sores on tail edge	265	4 (2)
	Jan. 19, 2007	U108	Minor	-		
	Feb. 6, 2007	U133	Moderate	Arrived with cold sores on pectorals and tail edge; first time observed in run		
	Mar. 8, 2007	U92	Minor	-		
2007	Nov. 7, 2007	U52	Minor	Arrived with sores	279	4 (1)
	Dec. 6, 2007	U93	Minor	Arrived with sores		
	Dec. 19, 2007	U122	Moderate	Tail edge; arrived with cold sores		
	Mar. 4, 2008	BS510	Moderate	Recent release; stayed in river too long		
2008	Dec. 4, 2008	U97/08	Moderate	Arrived that way	300	7 (2)
	Dec. 23, 2008	BS549 Bungi	Minor	Arrived that way		
	Dec. 24, 2008	BS578 Caylyx	Minor	Arrived that way		
	Dec. 25, 2008	BS579 Pome	Minor	Arrived that way		
	Dec. 25, 2008	U141/08	Moderate	Arrived that way		
	Feb. 22, 2009	BS67 Adam	Minor	2 cold sores		
	Feb. 22, 2009	BS513 Royal	Minor	1 cold sore		

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4.2.2 Remote Sensing

At least one vendor of a tethered submarine-like ROV demonstrated the equipment abilities in the swim area during 2008. This equipment utilized electric motors for maneuvering and a camera inside a waterproof housing to provide underwater imagery. Potential tradeoffs of this equipment include: 1) the equipment is tethered to a control panel/video display, with cable length dictating the range of the equipment and creating an entanglement hazard for the equipment and manatees; 2) the equipment requires a trained operator and is not autonomous; 3) the ROV would be intrusive and perhaps disturb manatees; and 4) the expected high cost of the equipment (purchase or rental, operator training, *etc.*).

Video cameras directed at the spring run were discussed as an option to visually document manatee presence. Potential tradeoffs of this equipment include: 1) images must be interpreted, requiring substantial time for staff review; 2) fixed cameras may over/underestimate manatee presence by failing to capture animals outside the viewing area; 3) image resolution may be inadequate to differentiate between individual animals; 4) the presence of video surveillance cameras and their associated hardware in the state park may reduce aesthetics; 5) the cost of equipment (purchase, installation, maintenance, and operation) may be prohibitive; and 6) the likelihood of considerable negative public opinion in regards to privacy concerns.

Sonar technologies could theoretically identify manatee presence. Potential tradeoffs of this technology include: 1) unknown if commercial equipment/software is available; 2) inability to identify individual manatees or differentiate between the large and numerous fish which co-occur; 3) data would need to be interpreted, requiring substantial time for staff review; and 4) the cost of the equipment (purchase, maintenance, and operation) may be prohibitive.

Perhaps the biggest failing of any remote sensing technology is that it would be unlikely to provide more information than is currently being collected by FDEP/FPS staff and likely be more expensive. The main advantage of a recording technology such as video cameras or sonar counts would be a permanent record of manatee use that could be independently evaluated. A possible compromise would be to collect handheld video data by park staff as a complement to the existing survey technique.

The MFIWG (DEP, FWC, and SJRMWD) and the manatee research community concluded that installation of suspended, remotely operated camera arrays to photo-document manatees in Blue Spring Run was operationally infeasible. Specifically, the MFIWG had concerns regarding the logistics involved to install and operate such a remote system and how the arrays would impact Blue Spring Park aesthetics.

The MFIWG recommends that hand-held digital cameras be used to capture images of manatee packing density and distribution patterns within spring run zones with high numbers of manatee present. These remote sensing surveys should coincide with the annual statewide manatee Synoptic Surveys and observations should be made from fixed photo-points along the pedestrian boardwalk and observation platforms, and from the manatee survey canoe.

4.3 Ecological Monitoring

4.3.1 General Biological Structure

4.3.1.1 Periphyton and Algae

Based on microscopic identification of material captured in plankton nets by WSI, a variety of periphyton and macroalgae exist in Blue Spring. Individual and colonial diatoms were observed (*e.g., Fragilaria, Tabellaria, Nitzschia*, and *Asterionella*). Filamentous macroalgae observed include cyanobacteria (blue-green algae, Cyanophyta) which appeared to be *Lyngbya* sp., as well as green algal species (Chlorophyta *e.g.*, *Spirogyra* and *Cladophora*).

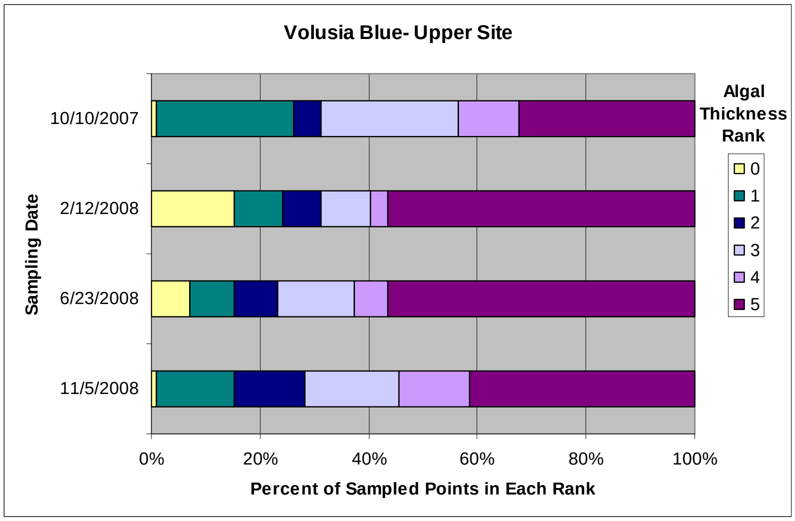
FDEP results of biofilms sampling (epiphytic growths or periphyton) indicate the dominant algal group (63 to 93% of the samples) at each site and for all dates were *Bacillariophyta* (diatoms). The total number of diatom taxa identified from quarterly sampling events ranged from 26 to 52, with either *Fragilaria sp*. or *Staurosira elliptica* being the dominant diatom taxa. To a lesser degree, other algae including filamentous forms (wet taxa), were also observed. Of these wet taxa, the total number of taxa ranging from 8 to 17 with blue-green algae (Cyanophyta) being more abundant than green algae forms (Chlorophyta). Dominant wet taxa algae included *Jaaginema* and *Synechocystis.* See **Table 4-12** for summary statistics of the periphyton sampling conducted by FDEP during the October 2007 to November 2008 time period.

TABLE 4-12. Periphyton summary statistics for Blue Spring by sampling date (from FDEP 2009).

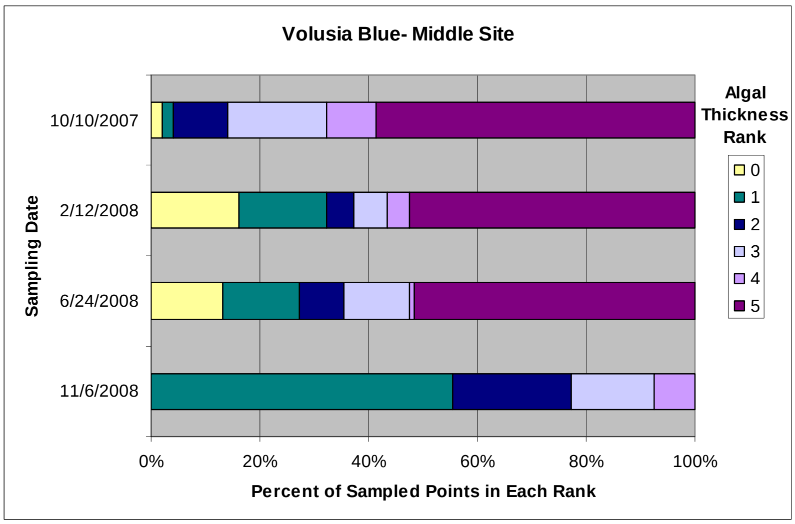
Qualitative Periphyton Sampling Results	Sampling Date	% Bacillariophyta	% Chlorophycota	% Cyanophycota	% Euglenophycota	# Diatom Taxa	Dominant Diatom Taxon	# Wet Taxa	Dominant Wet Algae Taxon	Total # Taxa
Volusia Blue- Upper Site	10/10/2007	70.10	8.97	20.93	0.00	32	Fragilariaceae	13	Microthamnion kuetzingianum	45
	2/12/2008	63.07	1.63	35.29	0.00	26	Staurosira elliptica	14	Jaaginema	40
	6/23/2008	80.40	2.33	17.28	0.00	34	Staurosira elliptica	9	Synechocystis	43
	11/5/2008	86.00	4.00	10.00	0.00	47	Staurosira elliptica	9	Cyanobium parvum	56
Volusia Blue- Middle Site	10/10/2007	83.33	4.00	12.67	0.00	36	Fragilariaceae	17	Synechocystis	53
	2/12/2008	71.10	2.92	25.97	0.00	32	Fragilariaceae	15	Jaaginema	47
	6/24/2008	83.67	3.33	13.00	0.00	38	Staurosira elliptica	12	Jaaginema	50
	11/6/2008	83.00	7.67	8.67	0.33	37	Staurosira elliptica	13	Synechocystis	50
Volusia Blue- Lower Site	10/10/2007	79.73	3.65	16.61	0.00	34	Fragilariaceae	10	Jaaginema	44
	6/24/2008	93.36	2.66	3.99	0.00	35	Staurosira elliptica	8	Chlamydomonas	43
	11/6/2008	85.33	3.67	11.00	0.00	52	Staurosira elliptica	9	Jaaginema	61

FDEP sampling suggest that filamentous algae covered the majority of the Upper and Middle sites for all dates, with the exception of 11/6/2008; on this date the Middle Site was covered mostly by diatoms. In general, the Lower Site had lesser amounts of filamentous algae than the Upper and Middle sites. Filamentous algae were found at a majority of sampled points at the Lower Site on 10/10/2007 and 6/24/2008, and diatoms were found at over 80% of the sampled points on 11/6/2008. Results of benthic algal thickness monitoring are shown in **Figure 4-20.**

Mean benthic algal thickness ranks from each sampling zone and date were correlated against sediment total Kjeldahl nitrogen, total phosphorus concentrations, and riparian canopy cover (**Figure 4-21).** Algal thickness was positively correlated to sediment nitrogen concentrations and negatively correlated to sediment phosphorus concentrations and riparian canopy cover. However, none of the correlations were statistically significant at the 95% level ($p \leq 0.05$).



Algal Thickness Ranks
0 = 0mm, rough
1 = <0.5 mm or slimy
2 = 0.5-1 mm
3 = >1 to <6 mm
4 = 6-20 mm
5 = > 20 mm



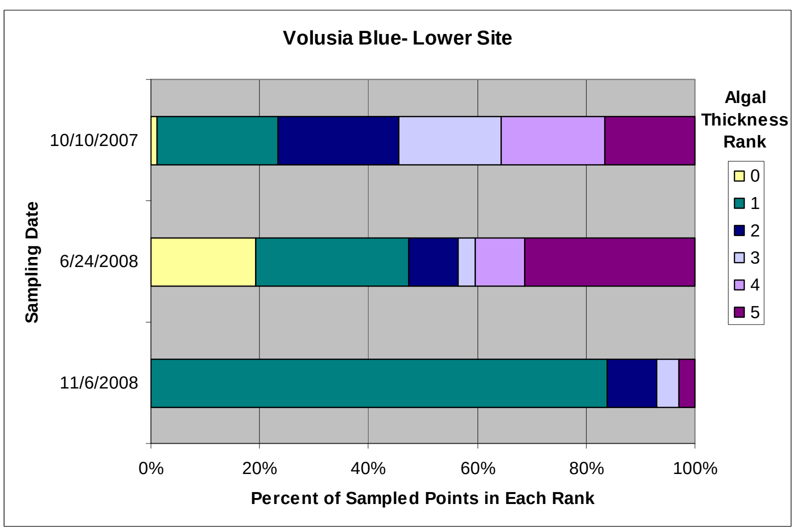
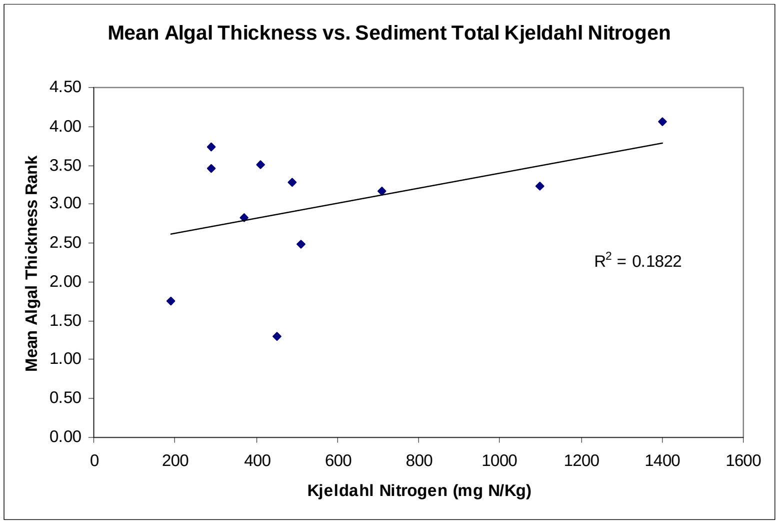
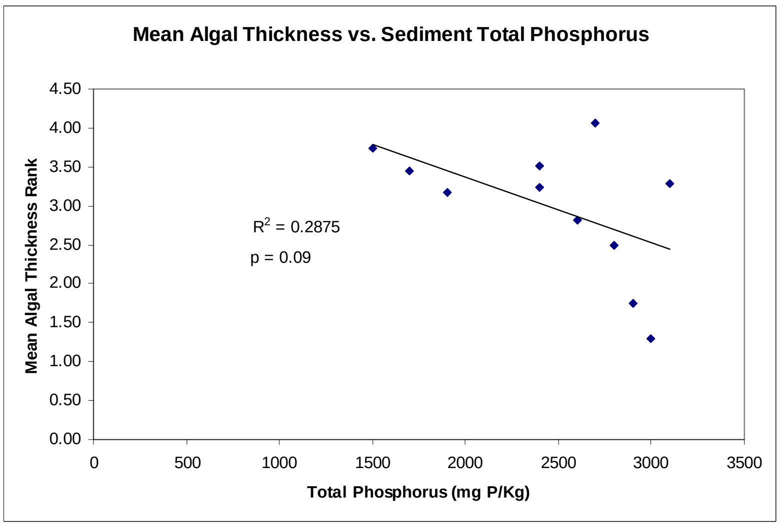


FIGURE 4-20. Blue Spring benthic algal thickness by site and sampling date (from FDEP 2009).





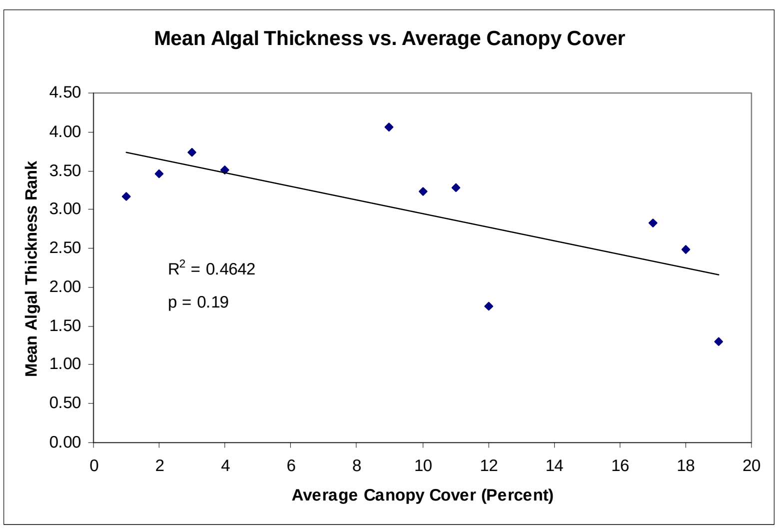


FIGURE 4-21. Correlation between mean algal thickness and sediment total Kjeldahl nitrogen concentrations (top figure), sediment total phosphorus concentrations (middle figure), and riparian canopy cover (from FDEP 2009).

4.3.1.2 Aquatic Plants

The most common native macrophytic plants at Blue Spring were water pennywort (*Hydrocotyle sp.*), common duckweed (*Lemna minor*), southern naiad (*Najas guadalupensis*), buttonbush (*Cephalanthus occidentalis*), and water fern (*Salvinia minima*) at low densities and primarily along the edges of the spring run (**Table 4-13**). Alligator weed (*Alternanthera philoxeroides*) was the most common exotic species, but also at low density. See **Appendix D** for complete list of plants and number of occurrences per visit/event/sampling date.

Based on observations by WSI staff, the only submersed vascular aquatic vegetation was southern naiad. This aquatic plant was observed in single strands and small clumps from approximately VBS 150 to VBS 400. Floating aquatic plants water hyacinth (*Eichhornia crassipes*), water lettuce (*Pistia stratiotes*), and water pennywort were observed in the lower spring run. Although these floating aquatic plants appeared to persist along the shoreline of the spring run, they were most abundant when the St. Johns River entered into the lower spring run.

The diversity and abundance of submersed, floating, and emergent aquatic plants is low and are likely due to the degree of recreational usage (in the upper section) and manatee feeding that the Blue Spring ecosystem is exposed to.

TABLE 4-13. Vascular aquatic vegetation sampling results for blue Spring by sampling event (value is number of transects on which the species was encountered, and "D" means dominant species (from FDEP 2009).

Linear Stream Vegetation Survey Results	Upper Site				Middle Site				Lower Site		
HERBACEOUS SPECIES	**10/10/07**	**2/12/08**	**6/23/08**	**11/5/08**	**10/10/07**	**2/12/08**	**6/24/08**	**11/6/08**	**10/10/07**	**6/24/08**	**11/6/08**
Alternanthera philoxeroides	4	5	4	3	8	4	6	7	6	6	9
Aster carolinianus								1	1		
Azolla caroliniana								5			4
Bacopa monnieri	2		1				1				
Bidens pilosa					4						
Cephalanthus occidentalis		5									
Commelina diffusa		2				2			2	6	
Diodia virginiana				1							
Echinochloa crusgalli	8		9		5	7	2		5		
Eichhornia crassipes											5
Eupatorium capillifolium					2				1		
Hydrocotyle sp.	8	8	6	6	10	10	7	10	8	6	9
Lemna minor	10	6	7	2	10	4		7	9	10	7
Ludwigia repens		2		3	1				1	1	
Ludwigia sp.			1		1						
Luziola fluitans					1		2		2	10	
Mikania scandens	1	1	2	1	4	2			4		
Najas guadalupensis	D(10)	9	8	2	7	1	9	2	4	4	3
Nephrolepis sp.									6		
Nuphar luteum					2				3	2	1
Nymphaea odorata								2			
Panicum rigidulum		1			2						
Paspalum floridanum		3			1						
Paspalum repens		2			2				2	1	3
Phyla nodiflora		3			2						
Pistia stratioides								7		1	9
Pluchea sp.						1			1		
Poaceae sp.											6
Pontederia sp.	1					2			1		
Salvinia minima	10	3	4	1	10	5		7	9	8	9
Samolus parviflorus	3	10	2	2							1
Spirodela sp.	1				10				9		
Spirodela polyrhiza			2	1						9	
Typha latifolia	1										
Wolffiella spp.								8			
WOODY SPECIES											
Acer rubrum					1						1
Baccharis sp.					6		2		6		
Cephalanthus occidentalis	9		10	7, D(2)	7	4	4	3	5	2	3
Gleditsia aquatica	1		1	1		5					
Itea virginica		1			2						
Liquidambar styraciflua					1			1			2
Myrica cerifera	1	1		1	3	1		4			
Quercus nigra	1					2					1
Sabal palmetto	6	9	1	10	5	1	4	7	4		5
Salix carolina					1			1	1		2
Ulmus americana					1				1		

4.3.1.3 Macroinvertebrate Community and Habitat Assessment

Habitat assessment scores ranged from 120 at the Middle Site to 135 at the Upper Site. All scores fell within the "Optimal" (≥120) range (**Table 4-14**), but the Upper Site exhibited the highest values on all sampling dates, while the Middle and Lower Sites had relatively similar scores. These assessment scores suggest that the physical habitat available in Blue Spring has the potential to support a diverse macroinvertebrate community.

TABLE 4-14. Habitat assessment scores for Blue Spring (from FDEP 2009).

Habitat Assessment Scores			
Site	**Date**	**Score**	**Category**
Volusia Blue- Upper Site	10/10/2007	129	Optimal
	2/12/2008	127	Optimal
	6/23/2008	135	Optimal
	11/5/2008	131	Optimal
Volusia Blue- Middle Site	10/10/2007	122	Optimal
	2/12/2008	121	Optimal
	6/24/2008	120	Optimal
	11/6/2008	122	Optimal
Volusia Blue- Lower Site	10/10/2007	124	Optimal
	2/12/2008	*N/A*	*N/A*
	6/24/2008	122	Optimal
	11/6/2008	122	Optimal

Stream Condition Index (SCI) scores were in the "Impaired" category (0-34) for all sites and sampling dates (**Table 4-15**). These results are consistent with historical (2000 to 2007) SCI scores which ranged from 9 to 17 (FDEP 2008). The "Impaired" rating of the macroinvertebrate community present at Blue Spring appears to be due to low dissolved oxygen and elevated conductivity (both natural conditions), as well as from algal smothering (related to anthropogenic nitrate-nitrite enrichment in the springshed). See **Appendix F** for detailed benthic macroinvertebrate summary statistics and SCI metrics.

TABLE 4-15. Benthic invertebrate summary statistics by sampling event for Blue Spring (from FDEP 2009).

Volusia Blue Springs	10/10/2007		2/12/2008		6/23/2008		11/5/2008	
Upper Site								
Stream Condition Index 2007 (value)	4 A		8 A		11 A		9 A	
Stream Condition Index 2007 (category)	Impaired		Impaired		Impaired		Impaired	
Middle Site								
Stream Condition Index 2007 (value)	4 A		6 A		9 A		11 A	
Stream Condition Index 2007 (category)	Impaired		Impaired		Impaired		Impaired	
Lower Site								
Stream Condition Index 2007 (value)	6 A		No Data		4 A		15 A	
Stream Condition Index 2007 (category)	Impaired		No Data		Impaired		Impaired	
Volusia Blue- Upper Site	**10/10/2007**		**2/12/2008**		**6/23/2008**		**11/5/2008**	
Stream Condition Index Metrics	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
Number of Total Taxa	15	14	12	15	17	17	14	13
Number of Ephemeroptera Taxa	0	0	0	0	0	0	0	0
Number of Trichoptera Taxa	0	0	0	0	1	1	0	0
Number of Clinger Taxa	0	0	0	0	0	0	0	0
Number of Long-lived Taxa	0	0	0	0	0	0	0	0
Number of Sensitive Taxa	1	1	1	1	1	1	1	1
Percent of Dominant Taxon	67.6	45.3	34.5	22.2	33.1	43.1	30.2	42.6
Percent Suspension Feeders and Filterers	1.0	0.0	0.0	0.3	2.8	1.6	1.7	4.2
Percent of Tanytarsini Individuals	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0
Percent of Very Tolerant Individuals	17.9	40.9	61.4	56.4	20.4	16.3	37.6	37.4
Total Number of Individuals	151	159	145	149	142	153	149	155
Volusia Blue- Middle Site	**10/10/2007**		**2/12/2008**		**6/24/2008**		**11/6/2008**	
Stream Condition Index Metrics	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
Number of Total Taxa	11	11	14	11	14	16	16	18
Number of Ephemeroptera Taxa	0	0	0	0	0	0	0	1
Number of Trichoptera Taxa	0	0	0	0	0	1	0	0
Number of Clinger Taxa	0	0	0	0	0	0	0	0
Number of Long-lived Taxa	0	0	0	0	0	0	0	0
Number of Sensitive Taxa	0	0	0	0	0	0	1	1
Percent of Dominant Taxon	48.3	42.8	24.1	36.0	23.4	40.6	31.3	45.6
Percent Suspension Feeders and Filterers	1.0	0.7	1.6	1.7	1.0	2.1	5.0	4.7
Percent of Tanytarsini Individuals	0.0	0.0	0.0	0.0	0.0	0.0	1.3	1.9
Percent of Very Tolerant Individuals	24.8	27.6	74.7	64.0	19.6	21.0	75.6	75.0
Total Number of Individuals	145	145	158	150	158	143	160	160
Volusia Blue- Lower Sites	**10/10/2007**		**2/12/2008**		**6/24/2008**		**11/6/2008**	
Stream Condition Index Metrics	Rep 1	Rep 2			Rep 1	Rep 2	Rep 1	Rep 2
Number of Total Taxa	9	11			10	10	20	24
Number of Ephemeroptera Taxa	0	0			0	0	0	0
Number of Trichoptera Taxa	0	0			0	0	0	0
Number of Clinger Taxa	0	0			0	0	0	0
Number of Long-lived Taxa	0	0			0	0	0	0
Number of Sensitive Taxa	0	0			0	0	0	1
Percent of Dominant Taxon	32.9	31.8			55.6	46.2	27.2	27.7
Percent Suspension Feeders and Filterers	1.3	0.7			2.2	1.7	3.3	5.0
Percent of Tanytarsini Individuals	0.0	0.0			0.0	0.0	1.3	2.5
Percent of Very Tolerant Individuals	74.1	67.6			31.9	11.7	47.0	42.1
Total Number of Individuals	158	148			160	145	151	159

4.3.1.4 Snails

As part of the FDEP biological assessment, the snail community was assessed using two methods, a Petite Ponar dredge and a standard D-frame dip net. The second method resulted in more snails being collected in each sample as seen in **Table 4-16**.

Quarterly total snail densities ranged from 229 to 8,983 snails/m^2 at the Upper Site, from 958 to 30,000 snails/m^2 at the Middle Site, and from 1,950 to 27,523 snails/m^2 at the lower site. Average snail densities were higher at the Middle and Lower Site (10,123 and 10,505 snails/m^2, respectively) and lowest at the Upper Site (3,031 snails/m^2). Observed snail densities were highest during the June sampling quarter and lowest during the fall and early spring sampling events. The endemic hydrobiid snail species were the dominant taxa at all three sampling sites (**Table 4-16**).

While both genera of the endemic hydrobiid snails, *Aphaostracon* sp. and *Floridobia sp*., were identified in samples from the Upper Site, and *Floridobia* sp. from the Middle and Lower Sites, species level identifications were not confirmed due to the variability and difficulty in identifying reproductive structures in preserved specimens. Although a comprehensive identification manual for the freshwater snails of Florida has been prepared (Thompson 2004) and should be utilized where possible for species level determinations, better techniques for identifying snails in Blue Spring should be explored.

TABLE 4-16. The density (n/m^2) of snails by taxon and sampling event for Blue Spring (from FDEP 2009).

Volusia Blue-Upper Site				
Snails in Ponar Sample	10/10/2007	2/12/2008	6/23/2008	11/5/2008
Taxon	*Number per square meter*			
Ancylidae	0	0	8	0
Aphaostracon	0	0	0	67
Floridobia	0	25	125	617
Hydrobiidae	317	133	8692	1450
Littoridinops	0	0	58	0
Melanoides	50	16	42	167
Pyrgophorys platyrachis	125	55	58	117

Volusia Blue- Middle Site				
Snails in Ponar Sample	10/10/2007	2/12/2008	6/24/2008	11/6/2008
Taxon	*Number per square meter*			
Ancylidae	0	0	8	67
Amnicola	42	0	0	0
Floridobia	0	66	342	1600
Floridobia floridana	25	0	0	0
Hydrobiidae	708	1508	24725	4800
Littoridinops	8	0	0	467
Littoridinops monroensis	0	0	342	0
Melanoides	50	8	167	267
Micromenetus	0	0	8	0
Planorbella	0	0	8	67
Pyrgophorys platyrachis	0	350	342	333
Tryonia aequicostata	125	0	4058	0

Volusia Blue- Lower Site				
Snails in Ponar Sample	10/10/2007	2/12/2008	6/24/2008	11/6/2008
Taxon	*Number per square meter*			
Ancylidae	0	*N/A*	0	67
Floridobia	8	*N/A*	158	308
Hydrobiidae	383	*N/A*	23308	1333
Littoridinops	25	*N/A*	0	0
Littoridinops monroensis	0	*N/A*	158	0
Melanoides	8	*N/A*	308	25
Physa	0	*N/A*	0	17
Pyrgophorys platyrachis	1092	*N/A*	0	200
Tryonia aequicostata	0	*N/A*	3591	0
Spilochlamys	525	*N/A*	0	0

4.3.1.5 Fish

The fish community of Blue Spring was assessed during four events: a winter sampling event on December 6, 2007; a spring sampling event on March 12, 2008; a summer sampling event on May 29, 2008; and a fall sampling event on September 25, 2008. Data from previous fish sampling events in 2000-2004, were also analyzed for comparison (Work and Gibbs 2008).

Over the course of these sampling events, 26 fish species were observed utilizing Blue Spring. An additional four species have been observed during prior annual surveys (2000 to 2004), each only once: flagfish (*Jordanella floridae*), bluespotted sunfish (*Enneacanthus gloriosus*), blackbanded darter (*Percina nigrofasciata*), and the non-indigenous brown hoplo (*Hoplosternum littorale*) and may be considered occasional inhabitants of Blue Spring. Analysis of the diversity (Shannon-Wiener index) of the fish community utilizing Blue Spring reveals higher diversity in 2007-2008 than in 2000-2004 time period; although the pattern between seasons and stations was similar for both time periods (**Tables 4-17**, **4-18**, and **4-19** and **Appendix G**). In both periods, fish diversity was highest in spring/summer and lowest in fall/winter and diversity was much lower at station 1 than any of the other stations, all of which exhibited similar fish diversities (**Appendix G**).

Total fish assemblage density (based on seine samples) was comparable to previous years; as the average annual density for fish in 2007-2008 (25.0 ± 24.8 fish/m^2) was within the range of abundances for the 2000-2004 time period (8.8-37.4 fish/m^2, **Table 4-17**). The average seasonal densities also did not differ from the seasonal densities of previous years (**Table 4-18, Figure 4-22**); indicating that the seasonal pattern of change in abundance in 2007-2008 was similar to the seasonal pattern of change in 2000-2004. In general, fish abundance was higher in fall/winter and lower in spring/summer. Similarly, the spatial distribution of fish abundance in 2007-2008 was comparable to the period of 2000-2004 (**Table 4-19, Figure 4-23**). Fish abundance was highest at station 1 (VBS 0-110) and lowest at stations 4 (VBS 310 to 410) and 5 (VBS 460 to 560). Statistical comparison between the two sampling periods indicates that the spatial patterns of density variation in 2000-2004 were similar to the patterns observed in 2007-2008.

TABLE 4-17. Annual density, biomass, and diversity of the fish assemblage of Blue Spring in 2000-2004 and 2007-2008. Values represent averages with one standard deviation of all samples collected at all stations and dates within each year (from Work and Gibbs 2008).

Year	Density (no. m^{-2})	Biomass (kg)	Diversity (H')
2000	8.8 ± 6.2	---	0.38 ± 0.20
2001	17.4 ± 14.8	---	0.23 ± 0.13
2002	37.4 ± 47.2	---	0.26 ± 0.13
2003	22.7 ± 22.6	---	0.22 ± 0.12
2004	31.1 ± 42.5	---	0.33 ± 0.12
2007-2008	25.0 ± 24.8	125.7 ± 113.0	0.41 ± 0.10

TABLE 4-18. Seasonal variation in density, biomass, and diversity of the fish assemblage of Blue Spring in 2000-2004 and 2007-2008. Values represent averages with one standard deviation of all stations sampled in each season of each year (from Work and Gibbs 2008).

Year	Season	Density (no. m^{-2})	Biomass (kg)	Diversity (H')
2000	Fall	8.8 ± 6.2	---	0.38 ± 0.20
2001	Winter	14.6 ± 9.4	---	0.29 ± 0.16
	Spring	12.9 ± 9.1	---	0.27 ± 0.15
	Summer	15.5 ± 12.4	---	0.23 ± 0.11
	Fall	34.3 ± 21.2	---	0.15 ± 0.07
2002	Winter	69.4 ± 71.9	---	0.23 ± 0.11
	Spring	28.6 ± 27.7	---	0.27 ± 0.16
	Summer	17.4 ± 8.9	---	0.25 ± 0.18
	Fall	27.0 ± 22.9	---	0.27 ± 0.11
2003	Winter	18.0 ± 17.6	---	0.15 ± 0.10
	Spring	30.9 ± 28.9	---	0.23 ± 0.11
	Summer	20.6 ± 19.1	---	0.30 ± 0.13
	Fall	21.3 ± 23.1	---	0.20 ± 0.11
2004	Winter	50.3 ± 60.1	---	0.29 ± 0.12
	Spring	23.1 ± 25.7	---	0.34 ± 0.09
	Summer	12.0 ± 6.4	--	0.38 ± 0.16
2007	Fall	23.5 ± 48.8	283.3 ± 315.8	0.33 ± 0.09
2008	Winter	19.5 ± 28.4	62.5 ± 73.9	0.31 ± 0.15
	Spring	6.1 ± 6.3	128.5 ± 138.3	0.53 ± 0.29
	Summer	11.3 ± 23.2	28.3 ± 26.0	0.46 ± 0.24

TABLE 4-19. Spatial variation in average density, biomass, and diversity of the fish assemblage of Blue Spring in 2000-2004 and 2007-2008. Values represent averages with one standard deviation of all samples collected at each station for each year (from Work and Gibbs 2008).

Year	Site	Density (no. m^{-2})	Biomass (kg)	Diversity (H')
2000	1	9.6 ± 9.5	---	0.10 ± 0.04
	2	11.0 ± 3.1	---	0.36 ± 0.12
	3	13.7 ± 4.9	---	0.48 ± 0.10
	4	6.8 ± 4.9	---	0.40 ± 0.11
	5	3.1 ± 4.8	---	0.59 ± 0.21
2001	1	18.8 ± 17.9	---	0.10 ± 0.09
	2	21.5 ± 21.2	---	0.24 ± 0.06
	3	21.8 ± 8.7	---	0.35 ± 0.14
	4	13.7 ± 15.2	---	0.26 ± 0.10
	5	9.5 ± 12.9	---	0.25 ± 0.11
2002	1	72.2 ± 77.3	---	0.10 ± 0.07
	2	23.5 ± 13.2	---	0.28 ± 0.09
	3	36.7 ± 26.0	---	0.34 ± 0.11
	4	20.6 ± 9.6	---	0.32 ± 0.09
	5	11.5 ± 18.6	---	0.30 ± 0.12
2003	1	30.5 ± 31.5	---	0.09 ± 0.07
	2	25.9 ± 15.7	---	0.26 ± 0.10
	3	23.0 ± 24.5	---	0.24 ± 0.13
	4	21.2 ± 17.5	---	0.25 ± 0.11
	5	5.0 ± 3.3	---	0.24 ± 0.12
2004	1	54.5 ± 76.6	---	0.16 ± 0.11
	2	37.6 ± 25.2	---	0.40 ± 0.06
	3	24.3 ± 27.6	---	0.37 ± 0.05
	4	23.0 ± 14.7	---	0.36 ± 0.08
	5	4.7 ± 3.3	---	0.35 ± 0.12
2007-2008	1	50.8 ± 34.2	192.4 ± 369.5	0.10 ± 0.07
	2	26.7 ± 16.0	24.9 ± 12.3	0.43 ± 0.15
	3	19.0 ± 16.3	69.4 ± 57.7	0.50 ± 0.19
	4	6.6 ± 5.1	167.6 ± 128.8	0.55 ± 0.11
	5	13.3 ± 4.2	192.3 ± 6.2	0.49 ± 0.21

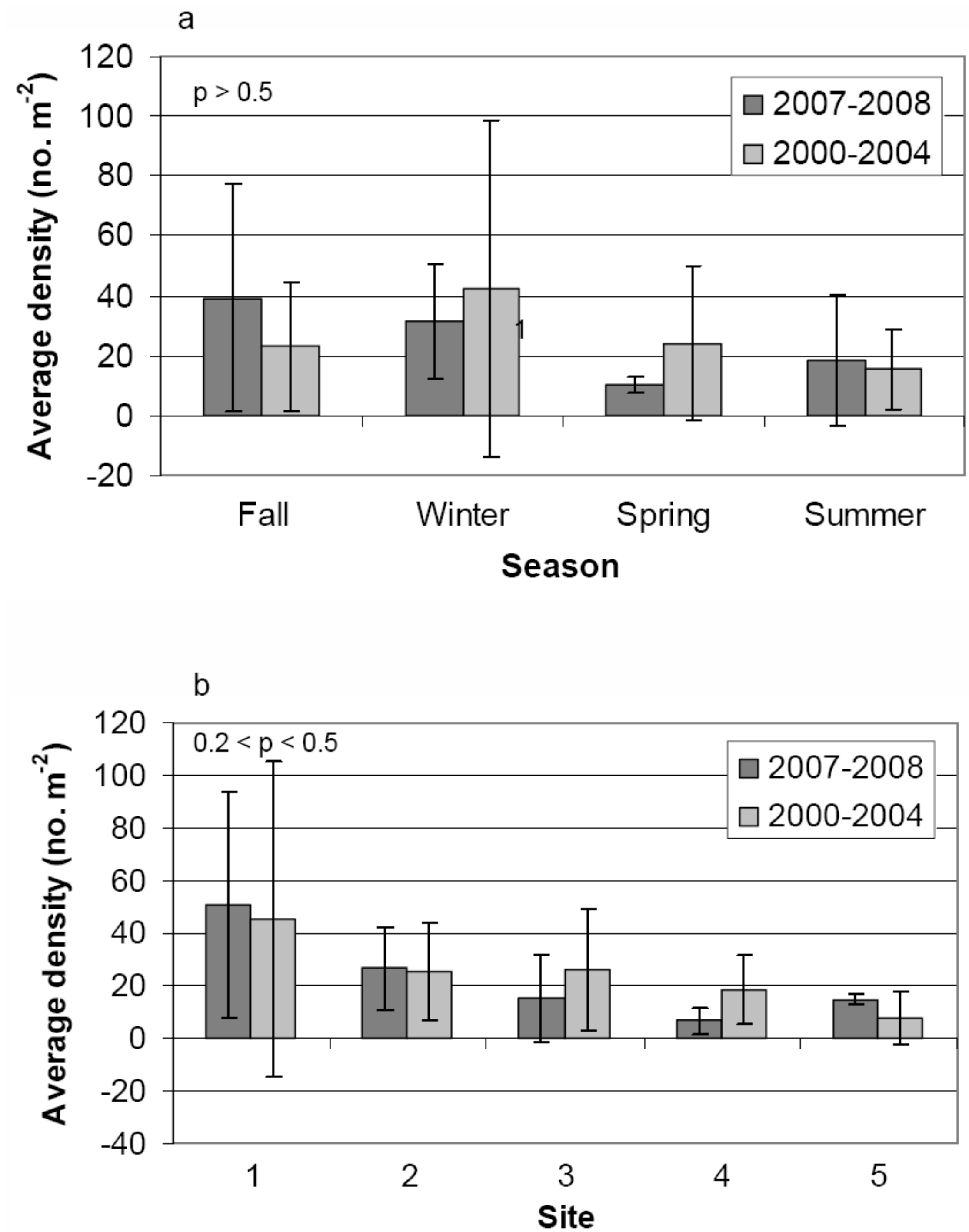


FIGURE 4-22. Seasonal patterns (a) and spatial patterns (b) in the density of all fish in Blue Spring for the 2007-2008 and the 2000-2004 time periods. Values represent averages with one standard deviation of all stations and dates for each season (a) or of all dates for each station (b) over the sampling periods (from Work and Gibbs 2008).

The seasonal pattern of fish biomass was similar to the pattern for density, with maximum total fish biomass during the fall (283.3 ± 315.8 kg) and minimum total biomass during the summer (28.3 ± 26.0 kg; **Figure 4-23, Table 4-18**). This pattern was due to the higher densities of both the most abundant species (mosquitofish) and some of the largest species such as tarpon (*Megalops atlanticus*), longnose gar (*Lepisosteus osseus*), and blue tilapia (*Oreochromis aureus)* in the fall (**Appendix G**).

Total fish biomass was highest at station 5 (192.3 ± 6.2 kg) and was lowest at station 2 (24.9 ± 12.3 kg, **Figure 4-23, Table 4-19**). The station 1 total biomass estimate was large (192.4 ± 369.5 kg), but this station also exhibited the greatest variability. Although mosquitofish density (and hence biomass) could be great in the seine locations, it was probably not accurate to extrapolate these densities over the entire area of station 1 (*e.g.*, numerous small fish are observed along the edge, but not over the center boil portion of station 1).

The presence of non-indigenous (exotic) fish species can be quite dramatic in Blue Spring, as blue tilapia, Vermiculated sailfin catfish (*Pterygoplichthys disjunctivus*), grass carp (*Ctenopharyngodon idella*), and pacu (*Collosoma sp*.) can be routinely observed. However, these species were estimated to comprise a small proportion (1.6 ± 6.0 %) of the total fish assemblage density (**Appendix G**).

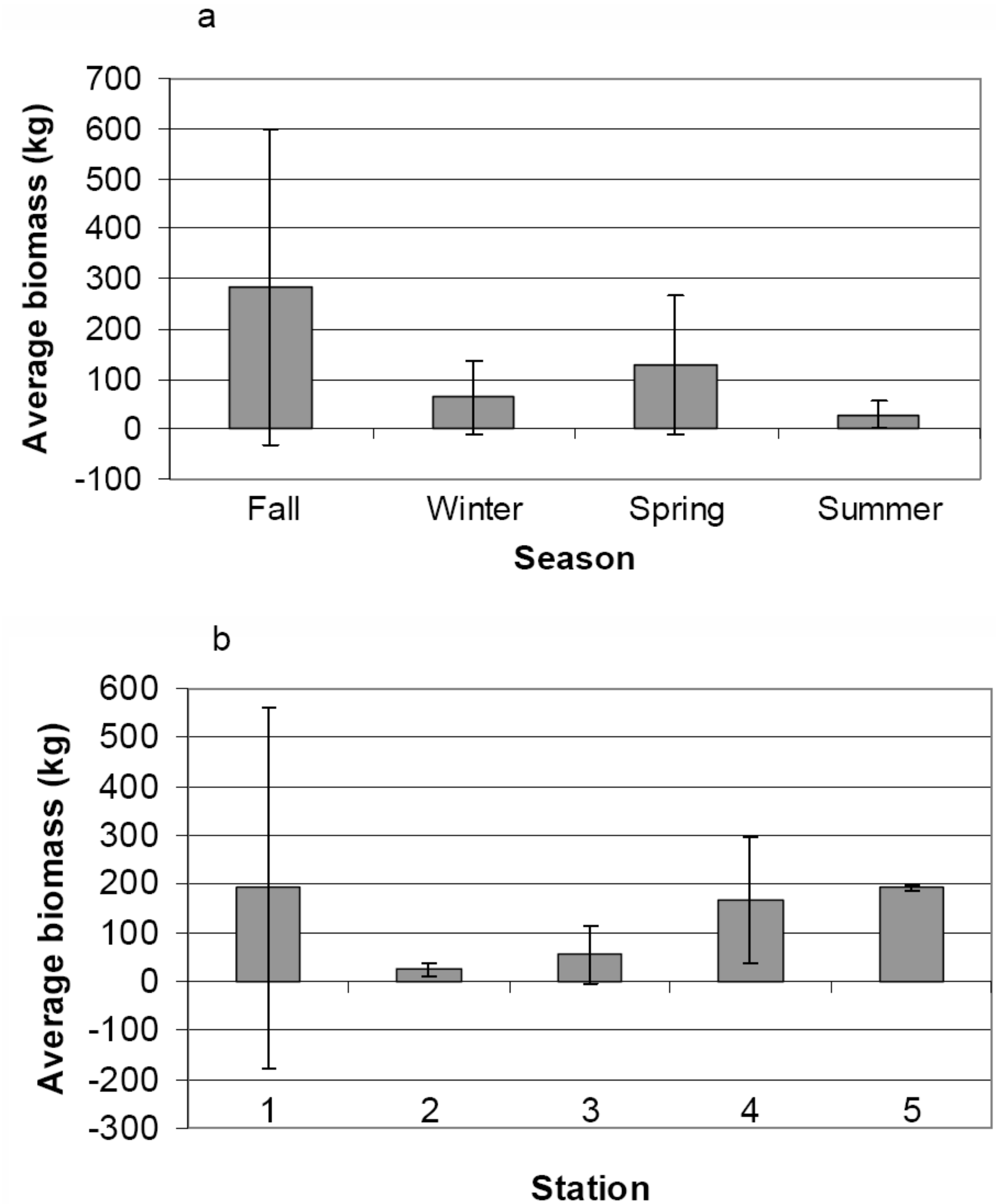


FIGURE 4-23. Seasonal (a) and spatial (b) patterns in the biomass of fish in Blue Spring. Data were collected only in 2007-2008. For larger fish, biomass was calculated from counts of all fish in the run. For smaller fish, biomass was calculated with densities calculated from seine hauls. Values represent averages with one standard deviation of all stations and dates for each season (a) or of all dates for each station (b) over the sampling periods (from Work and Gibbs 2008).

4.3.1.6 Turtles

Population surveys for aquatic turtles were conducted in the Blue Spring Run during four separate sampling periods: October 20-23, 2007; March 18-20, 2008; April 11-13, 2008; and October 3-6, 2008.

A total of seven aquatic turtle species were collected (**Tables 4-20 and 4-21**) including one non-indigenous species to the St. Johns River Basin, the red-eared slider (*Trachemys scripta*). Red-eared sliders, a member of the family Emydidae, are a moderately large North American basking turtle that can be found in a variety of aquatic habitats. While not native to peninsular Florida, red-eared sliders have become naturalized throughout much of the state, possibly as released pet turtles (Thomas 2006). A total of four red-eared sliders were captured and delivered to BSSP staff for disposal.

The other six species captured were native to Florida. These species included two other members of the family Emydidae; most commonly the peninsula cooter (*Pseudemys floridana peninsularis or P. peninsularis*), an herbivorous basking turtle that is abundant throughout Florida. Research has found both male and female biased populations in Florida (Thomas and Jansen 2006). The second native *Pseudemys* species was the Florida red-bellied turtle (*P. nelsoni*); a large basking turtle of which the females are known to place their eggs in alligators' nests (Jackson 2006). All three of the *Pseudemys* species encountered at Blue Spring are omnivorous, although older individuals tend to consume more plant material when compared to younger individuals.

Two member of the family Kinosternidae were observed: one commonly, the loggerhead musk turtle (*Sternotherus minor*) and the other, the common musk turtle (*Sternotherus odoratus*) captured just once. Both species are relatively small, carnivorous, and can be observed actively foraging along the bottom of water bodies. Loggerhead musk turtles are most abundant in spring runs and appear to specialize in clam and snail prey items (Zappalorti and Iverson 2006). The common musk turtle utilizes a range of aquatic habitats, is less common in spring ecosystems, and is a diverse carnivore with less dependence on mollusks than the loggerhead musk turtle (Iverson and Meshaka 2006).

The remaining two species of aquatic turtle were also rarely observed: the common snapping turtle (*Chelydra serpentina*) and the Florida softshell turtle (*Apalone ferox*). The common snapping turtle is a large species with omnivorous feeding habits. It rarely basks but typically lies or walks along the bottom of waterbodies (Aresco *et al*. 2006). The Florida softshell is another large species that is commonly found in many aquatic habitats in Florida. They are predators and their diet often includes insects, snails, and fish (Meylan and Moler, 2006).

The vast major of captured turtles belonged to three species: peninsula cooters, Florida red-bellied turtles, and loggerhead musk turtles (62%, 16%, and 20% respectively). The remaining species were uncommon with red-eared sliders, common musk turtles, Florida snapping turtles and Florida softshell turtles together comprising less than 2% of all turtle captures. Individuals of the six native species were marked with unique set of marginal scute marks, sexed, and a variety of morphological data were collected (**Table 4-20**, **Appendix H**).

TABLE 4-20. The number of turtles marked and the number of different turtles captured in Blue Spring and Blue Spring run during each sampling period (four red-eared sliders, *Trachemys scripta*, were not released and are not included, from Farrell *et al*. 2009).

Common Name	Total Number Marked	Individuals Captured			
		Oct-07	Mar-08	Apr-08	Oct-08
Peninsula Cooter (*Pseudemys floridana*)	120	66	12	35	15
Florida Red-bellied Turtle (*Pseudemys nelsoni*)	31	19	10	21	6
Loggerhead Musk Turtle (*Sternotherus minor*)	38	13	4	7	20
Common Musk Turtle (*Sternotherus odoratus*)	1	1	0	0	0
Florida Snapping Turtle (*Chelydra serpentina*)	3	0	1	2	1
Florida Softshell Turtle (*Apalone ferox*)	0	0	0	1	0
Total	**193**	**99**	**27**	**66**	**42**

TABLE 4-21. Statistics for turtles captured in Blue Spring and Blue Spring run between October 2007-October 2008. Standard deviations are in parentheses and CL indicates carapace length (from Farrell *et al*. 2009).

Species	Unique Individuals Captured	Females Captured	Males Captured	Juveniles Captured	Mean CL (mm)	Mean Mass (g)
Peninsula Cooter *(Pseudemys floridana)*	120	42	76	2	298.9 (± 62.5)	3,548.30 (± 2,039.6)
Florida Red-bellied Turtle *(Pseudemys nelsoni)*	31	11	17	3	271 (± 49.6)	3,046.40 (± 1,394.5)
Loggerhead Musk Turtle *(Sternotherus minor)*	38	9	28	1	93.9 (± 16.6)	137 (± 64.9)
Common Musk Turtle *(Sternotherus odoratus)*	1	0	1	0	75 --	100 --
Florida Snapping Turtle (*Chelydra serpentina)*	3	1	1	1	341 (± 115.8)	10,533.30 (± 9,681.1)
Florida Softshell Turtle (*Apalone ferox*)	1	0	0	1	71 --	50 --

The sex ratios of adults for the three most common species were in each case male-biased (**Figure 4-24**). This was particularly the case for loggerhead musk turtles where only nine of 37 adults (24%) were female, while other studies of the sex ratios for loggerhead musk turtles reported approximately a 1:1 sex ratio (Zappalorti and Iverson 2006). Both of the *Pseudemys* populations were composed of 35% females. These unbalanced sex ratios may reflect the composition of the turtle populations utilizing Blue Spring or possibly be influenced by unequal capture probabilities for individuals of each sex. Juvenile aquatic turtles were uncommon at Blue Spring, comprising only 4% of all captures.

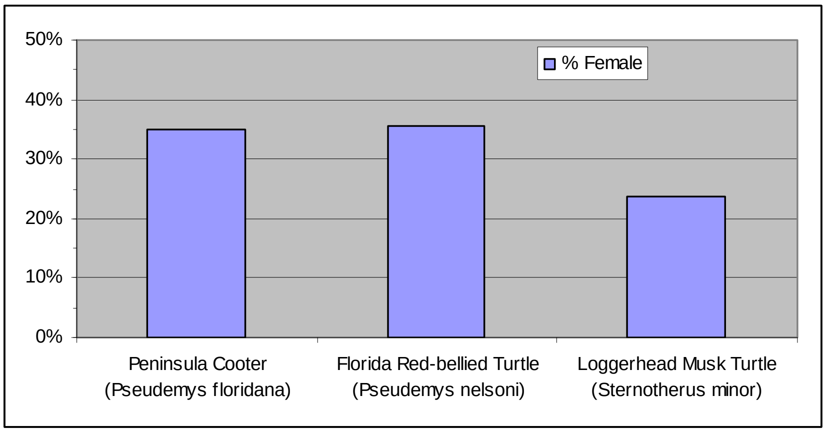


FIGURE 4-24. Percentage of captured adult turtles that were female for the three most common species in Blue Spring (from Farrell *et al*. 2009).

Estimates of turtle population size for the species that had enough recaptures (peninsula cooters, Florida red-bellied turtles, and loggerhead musk turtles) are presented in **Table 4-22** and **Appendix H**. Peninsula cooter population size estimates ranged from 64 (October 2008) to 310 (October 2007) individuals. Florida red-bellied turtle population size estimates ranged from 12 (October 2008) to 64 (October 2007) individuals. Loggerhead musk turtle population size estimates ranged from 18 (October 2007) to 110 (October 2008) individuals. The mobility of aquatic turtles, the short length of the spring run, and the immediate proximity to the St. Johns River makes it likely that the population of turtles at this system is relatively open (*i.e.*, has high levels of immigration and emigration to the St. Johns river).

TABLE 4-22. Population estimates from the four sample periods for peninsula cooters, Florida red-bellied turtles, and loggerhead musk turtles (from Farrell *et al*. 2009).

Species	Survey Date			
	Oct-07	Mar-08	Apr-08	Oct-08
Peninsula Cooter (Pseudemys floridana)	310	--	156	64
Florida Red-bellied Turtle (Pseudemys nelsoni)	64	30	--	12
Loggerhead Musk Turtle (Sternotherus minor)	18	--	--	110
Combined Total	392	30	156	186

Density estimates for peninsula cooter ranged from 62-301 turtles/hectare during the three sample periods with recaptures (**Table 4-23**). These estimates were somewhat higher than estimates for other Florida spring runs and spring-fed rivers including the Homosassa River, with 49 individuals/hectare, and Rainbow Run with 45 individuals/hectare (Thomas and Jansen 2006).

Density estimates for Florida red-bellied turtle ranged from 12-62 turtles/hectare during the three sample periods with recaptures (**Table 4-23**). These values fell within the range of population densities observed by other authors in other Florida spring runs. These previously published values ranged from 4.6 turtles/hectare in Rainbow Run to 78.6 turtles/hectare in Rock Spring Run (Jackson 2006).

Density estimates of loggerhead musk turtle ranged from 17-107 turtles/hectare during the two sample periods with recaptures (**Table 4-23**). These values are lower than those reported in several other springs runs in Florida where densities ranged from 127-2,857 turtles/hectare (Zappalorti and Iverson, 2006).

TABLE 4-23. Density estimates in individuals/hectare from the four sample periods for peninsula cooters, Florida red-bellied turtles, and loggerhead musk turtles (all values are individuals/hectare, from Farrell *et al*. 2009).

Species	Survey Date			
	Oct-07	**Mar-08**	**Apr-08**	**Oct-08**
Peninsula Cooter (*Pseudemys floridana*)	301	--	151	62
Florida Red-bellied Turtle (*Pseudemys nelsoni*)	62	29	--	12
Loggerhead Musk Turtle (*Sternotherus minor*)	17	--	--	107
Combined Total	380	29	151	181

TABLE 4-24. Biomass estimates from the four sample periods for peninsula cooters, Florida red-bellied turtles, and loggerhead musk turtles (all values are kg/hectare, from Farrell *et al*. 2009).

Species	Survey Date			
	Oct-07	**Mar-08**	**Apr-08**	**Oct-08**
Peninsula Cooter (*Pseudemys floridana*)	1068	--	536	220
Florida Red-bellied Turtle (*Pseudemys nelsoni*)	189	89	--	36
Loggerhead Musk Turtle (*Sternotherus minor*)	2.4	--	--	15
Combined Total	1259	89	536	271

4.3.2 Ecosystem Function

4.3.2.1 Ecosystem Metabolism

Ecosystem metabolism was estimated in Blue Spring Run (VBS-35 to VBS-570) for a period of 250 days during this study (November 13, 2007 through August 28, 2008). Detailed metabolism summaries are provided in **Appendix I**. This sampling interval was considerably longer than what was in the Monitoring Plan (six two-week periods or about 84 days) and was accomplished by leaving the downstream sonde in place between the bi-weekly sampling periods and making various assumptions concerning the constancy of the upstream dissolved oxygen conditions and the amount of drift in the calibration of the optical dissolved oxygen sensor.

A total of 171 days of ecosystem metabolism data were analyzed for the upstream spring run segment (VBS-35 to VBS-355) and from 122 to 138 days of ecosystem metabolism data were estimated for the downstream spring run segment (VBS-355 to VBS-570). This actual sampling period was also somewhat longer than originally planned due to the availability of the instruments.

Table 4-25 provides a summary of estimated ecosystem metabolism by stream segment for Water Year 2007/2008. **Figures 4-25** through **4-29** provide time series plots for the various indices of ecosystem metabolism for this monitoring period. Refer to section **3.3.2.1** (Ecosystem Metabolism) for parameter definitions.

TABLE 4-25. Blue Spring estimated ecosystem metabolism parameters from November 2007 to August 2008.

Statistics	GPP (g $O_2/m^2/d$)	NPP (g $O_2/m^2/d$)	CR (g $O_2/m^2/d$)	P/R Ratio	PAR (24hr) (mol/m^2/d)	PAR Efficiency (%)	PAR Efficiency (g O_2/mol)
MAIN BOIL TO VBS 570							
Average	6.77	-6.06	12.8	0.557	15.1	3.87	0.479
Median	6.86	-5.96	13.0	0.514	13.9	3.45	0.427
Maximum	18.0	6.46	22.3	7.48	33.6	13.3	1.65
Minimum	0.16	-19.76	-2.39	-2.40	3.50	0.09	0.01
Std Dev	3.70	4.32	5.08	0.609	5.97	2.22	0.275
N	250	250	250	250	250	250	250
MAIN BOIL TO VBS 355							
Average	4.86	-13.8	18.7	0.268	14.3	2.96	0.367
Median	4.89	-13.7	20.0	0.255	13.5	2.78	0.344
Maximum	10.8	-0.54	31.7	0.818	30.3	8.50	1.05
Minimum	0.79	-30.89	2.96	0.02	3.50	0.55	0.07
Std Dev	2.35	5.50	6.38	0.109	5.63	1.54	0.190
N	171	171	171	171	171	171	171
VBS 355 TO VBS 570							
Average	6.68	-1.18	8.13	0.996	13.9	3.96	0.490
Median	5.30	-1.32	7.95	0.758	13.2	3.54	0.439
Maximum	28.3	21.0	19.8	5.87	28.0	11.2	1.39
Minimum	0.18	-19.50	-0.32	-6.38	3.55	0.09	0.01
Std Dev	5.35	6.25	4.19	1.23	5.38	2.51	0.311
N	138	122	122	122	126	126	126

Gross Primary Productivity (GPP) averaged 6.77 g $O_2/m^2/d$ for the entire spring run segment. Community respiration was higher with an average of 12.8 g $O_2/m^2/d$ for this period-of-record. The resulting average NPP was -6.06 g $O_2/m^2/d$ and the calculated P/R ratio was 0.53. The estimated PAR efficiency for the entire spring run segment was 0.48 g O_2/mol.

GPP was lower in the upstream segment than in the segment as a whole with an estimated average of 4.86 g $O_2/m^2/d$. Community respiration for this shorter segment was higher than the whole spring run with an average of 18.7 g $O_2/m^2/d$ for this period-of-record. The resulting average NPP for this upstream segment was -13.8 g $O_2/m^2/d$ and the calculated P/R ratio was 0.26. The estimated PAR efficiency for the upstream spring run segment was 0.37 g O_2/mol.

GPP was similar in the downstream segment compared to the segment as a whole with an estimated average of 6.68 g $O_2/m^2/d$. Community respiration for this shorter segment was lower than in the upstream and the whole spring run with an average of 8.13 g $O_2/m^2/d$ for this period-of-record. The resulting average NPP for this downstream segment was -1.18 g $O_2/m^2/d$ and the calculated average P/R ratio was 0.82. The estimated PAR efficiency for the upstream spring run segment was 0.37 g O_2/mol.

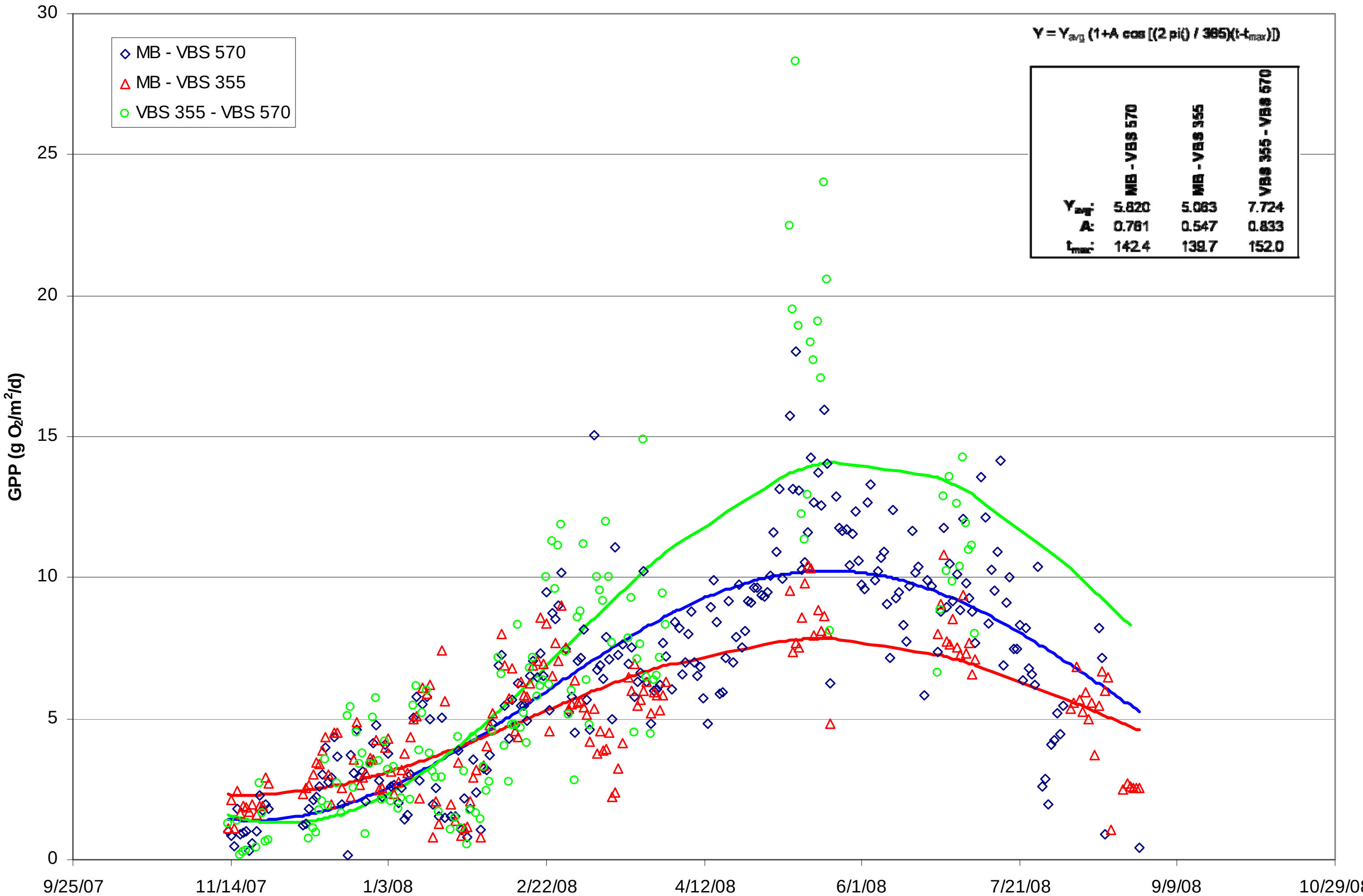


FIGURE 4-25. Blue Spring time series of metabolism gross primary production (GPP, g $O_2/m^2/d$) estimates.

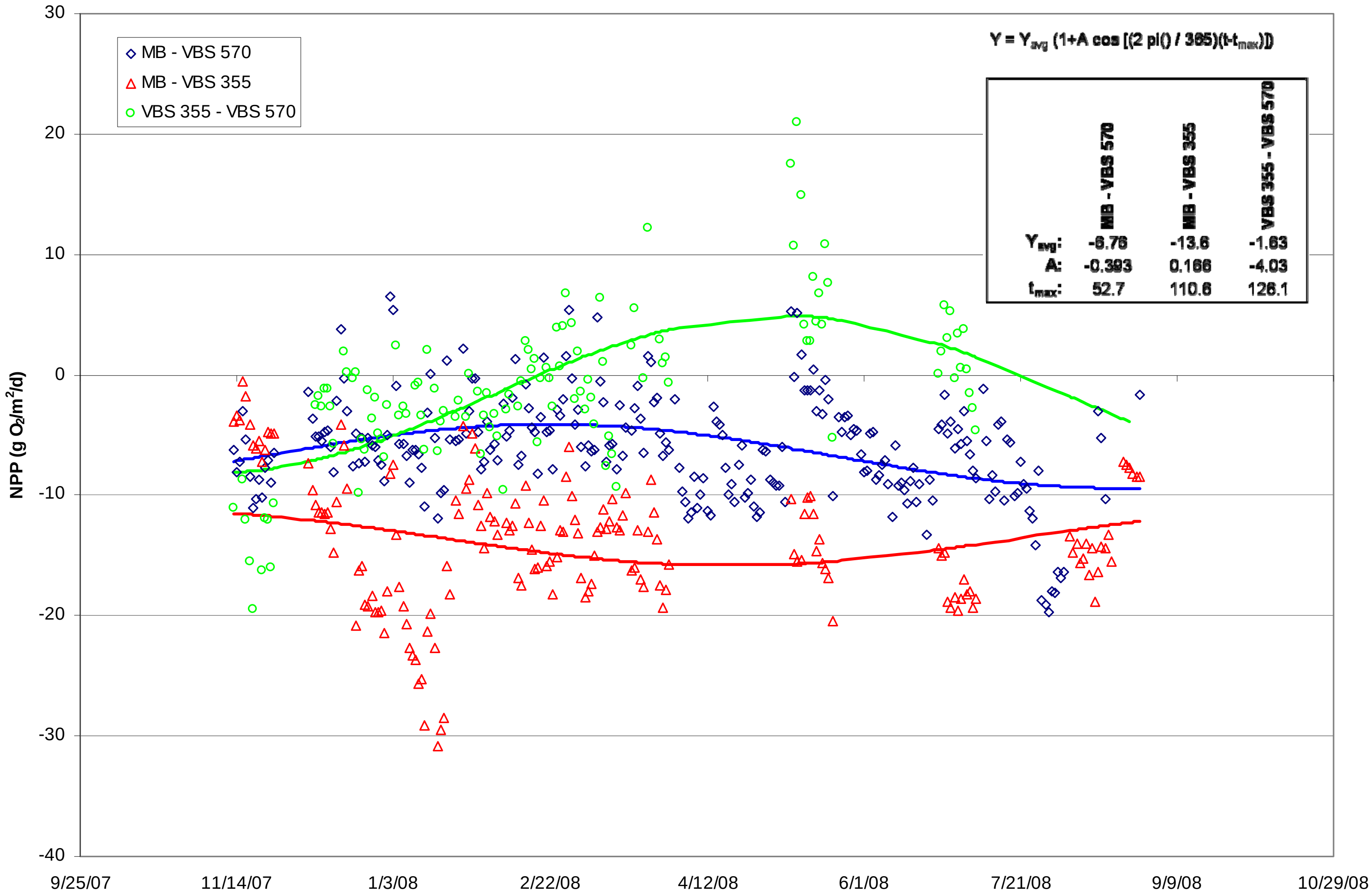


FIGURE 4-26. Blue Spring time series of metabolism net primary production (NPP, g $O_2/m^2/d$) estimates.

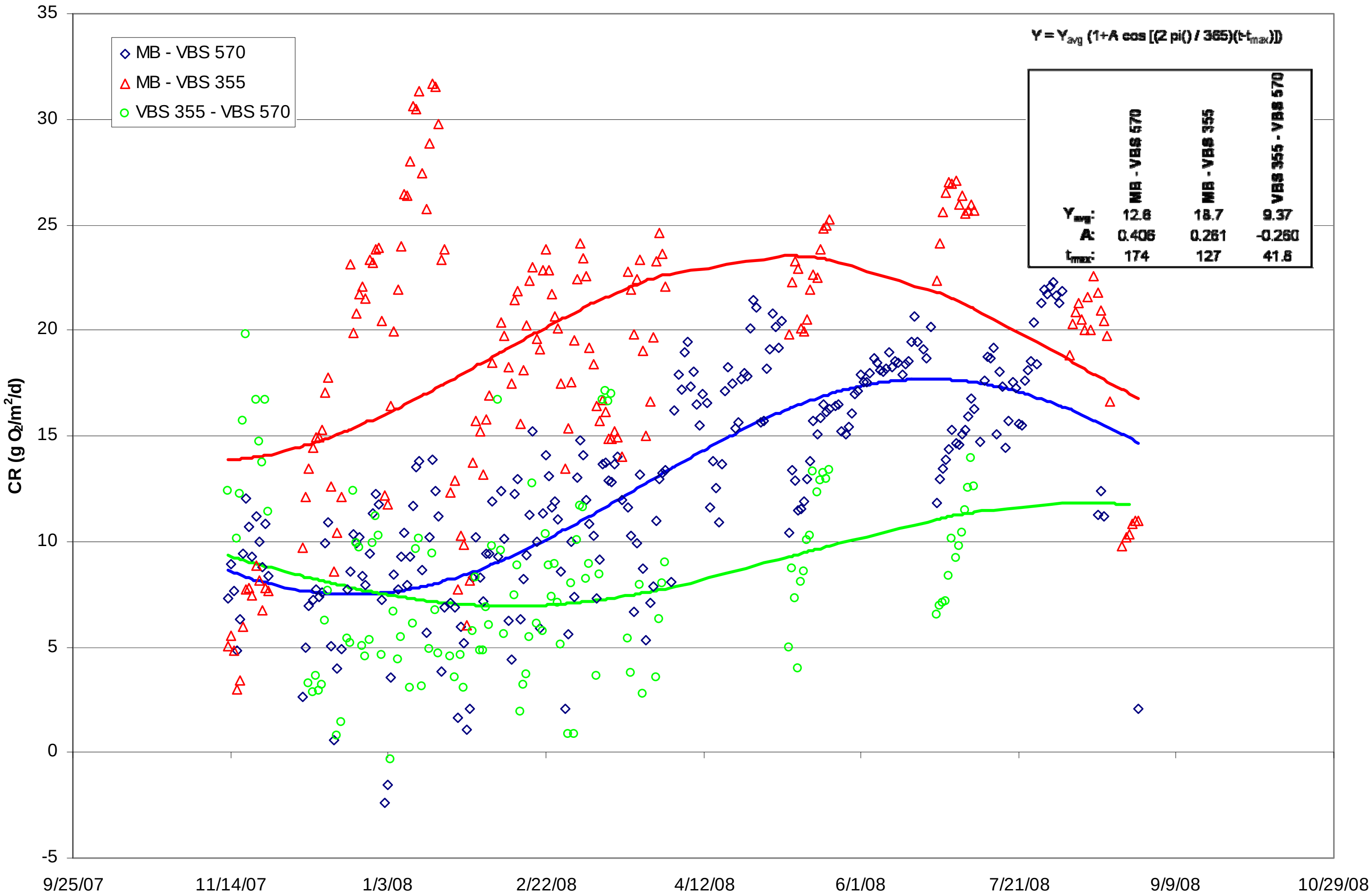


FIGURE 4-27. Blue Spring time series of metabolism community respiration (CR, g $O_2/m^2/d$) estimates.

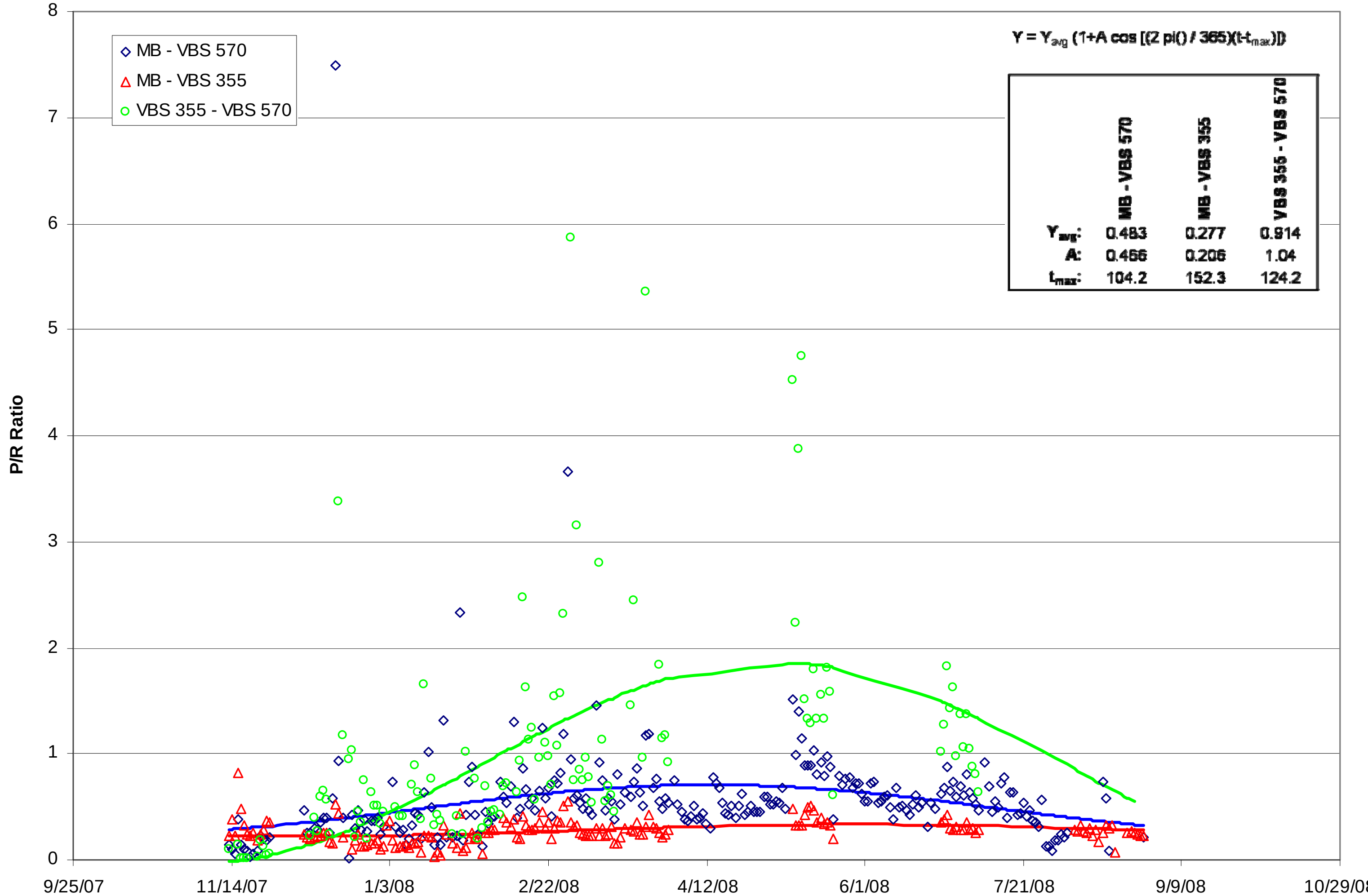


FIGURE 4-28. Blue Spring time series of metabolism productivity/respiration (P/R) ratio estimates.

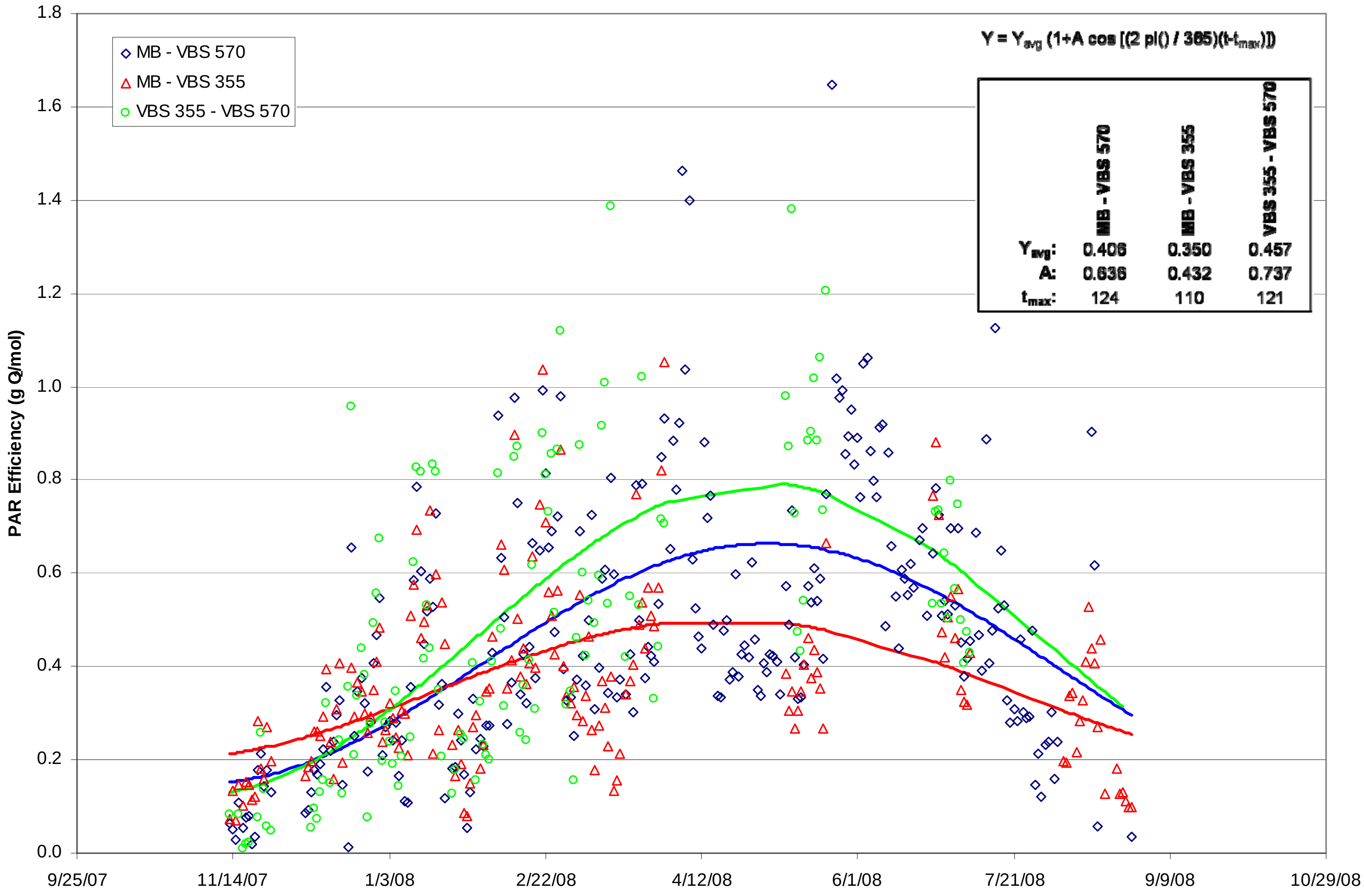


FIGURE 4-29. Blue Spring time series of metabolism photosynthetically active radiation (PAR) efficiency (g O_2/mol) estimates.

Seasonal data fits found that maximum observed GPP in all segments was recorded in late May while peak NPP occurred in May for the lower segment, September for the upstream segment, and February for the spring run as a whole. Community respiration peaks occurred in June for the whole spring run segment, during May for the upstream segment, and during September for the downstream portion of the spring run. The P/R ratio was generally highest in late spring in all three segment analyses as was PAR efficiency.

Blue Spring (Volusia Co.) is one of eleven Florida spring systems that were used to estimate the relationship between ecosystem productivity and incident sunlight in the 1950s (Odum 1957a). In that study, Odum calculated gross primary production on the basis of upstream-downstream changes in dissolved oxygen concentrations using a method similar to the one employed in this study. **Figure 4-30** shows the relatively low GPP and photosynthetic efficiency of Blue Spring compared to other Florida springs. Odum estimated Blue spring's ecosystem productivity as 5.4 g $O_2/m^2/d$ on one date (August 9, 1955) over the upper 450 m of the spring run. This estimate is comparable to the average GPP of 6.77 g $O_2/m^2/d$ measured over a total of 250 full diel periods during Water Year 2007/2008. Odum characterized this spring run as anaerobic and colonized by blue-green algae. As an explanation for the lower photosynthetic efficiency he estimated at Blue Spring, Odum hypothesized that the ecological community has to shift to anaerobic metabolism during dark hours when oxygen is not being produced.

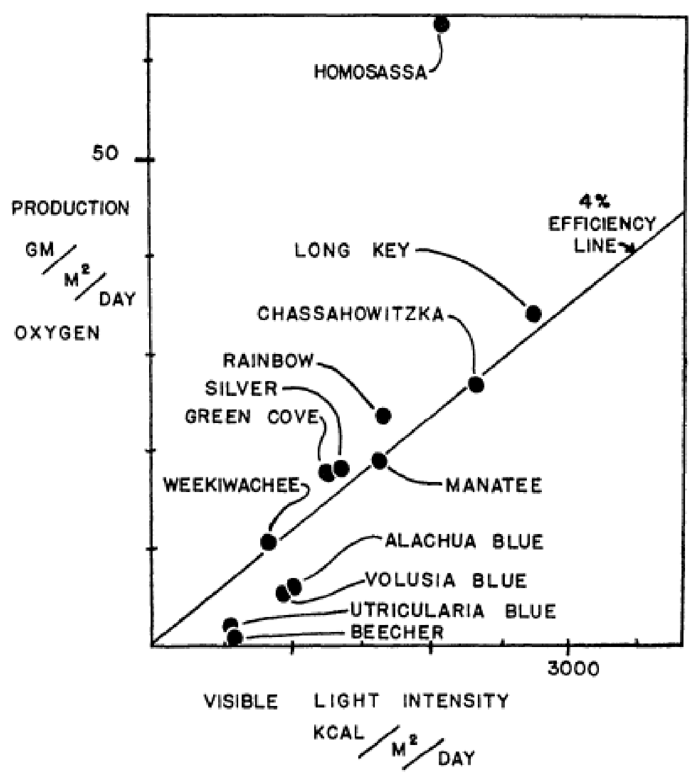


FIGURE 4-30. Gross primary production on an area basis as a function of visible light intensity reaching the level of submersed aquatic vegetation (from Odum 1957a). The ratio between ecosystem productivity and light intensity is a measure of photosynthetic efficiency.

4.3.2.2 Oxygen Diffusion

Oxygen diffusion from air into water (or vice versa) occurs along concentration gradients and the diffusion rate (g $O_2/m^2/hr$) has been shown to be a function of the water velocity and depth of the aquatic environment (O'Conner and Dobbins 1958). This relationship appears to hold true in spring ecosystems and WSI has observed a positive correlation between water velocity and the diffusion rate (**Figure 4-31**) for a number of Florida spring ecosystems. Fitting a linear regression against these data, approximately 72% of the variation in diffusion rate can be explained by water velocity (**Figure 4-31**). A significant relationship between water depth and oxygen diffusion rate has not been observed by WSI in spring runs.

Oxygen diffusion rate was estimated in a variety of different locations along Blue Spring Run seven times during the WY 2007-08 sampling period. Results from these diffusion estimates were inconsistent compared to estimates from other spring runs (see **Figure 4-31**), presumably due to the very low ambient dissolved oxygen concentrations at Blue Spring and the correspondingly minimal concentration gradient between the measurement chamber and the spring water. Diffusion data from the other spring runs were utilized for Blue Spring to correct upstream-downstream oxygen mass balances and community metabolism estimates.

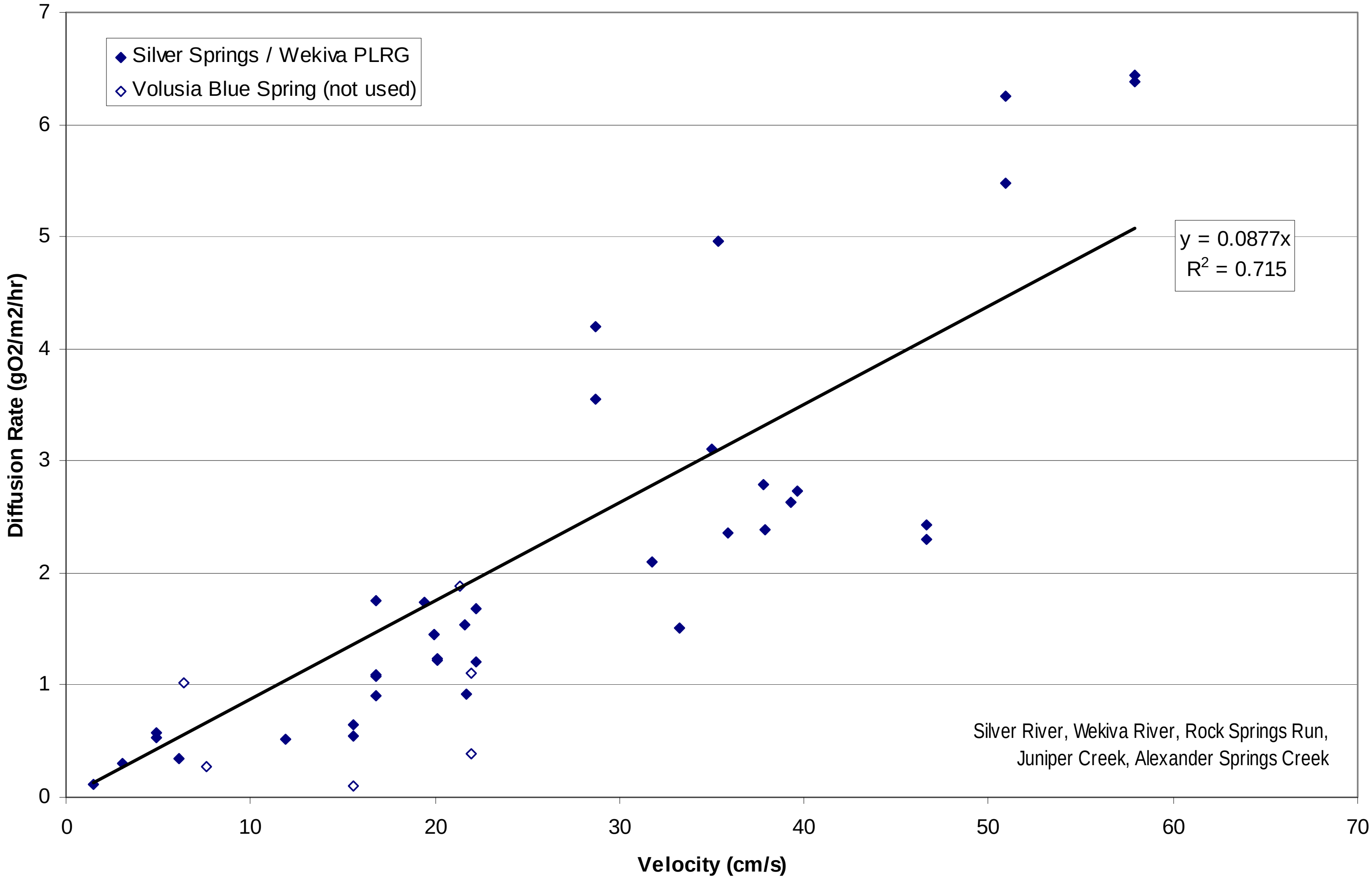


FIGURE 4-31. The relationship between oxygen diffusion and water velocity for multiple Florida springs (Blue Spring data points shown but not used in regression).

4.3.2.3 Particulate Export

Particulate export data for the upper and lower segments of Blue Spring Run are summarized in **Table 4-26**. Detailed data for the particulate export measurements are provided in **Appendix J**. Particulate export was measured at both the upstream and downstream end of each stream segment to allow an alternative method for estimating net ecosystem production within the segment. These net particulate export rates include changes in the amount of organic matter resulting from combined autochthonous (internally produced) and allochthonous (externally produced) sources. Particulate export is also a function of physical action which can suspend particulate matter in the water column. In the case of Blue Spring Run, human in-water recreation was observed to be correlated to downstream export of particulate matter.

Segment particulate organic matter export rates varied widely but were greatest during summer months, presumably as function of increased primary production and in-water recreational activity during this time. The average particulate export rates measured throughout the spring run were 8,121 g/d of dry matter and 2,644 g/d for organic matter. The average particulate export rates at the upstream station (VBS 35) were 16,503 g/d for dry matter and 1,144 g/d for organic matter. The average export rates at the mid-station (VBS 335) were 21,924 g/d (dry matter) and 3,924 g/d (organic matter). The average rates estimated at the downstream station (VBS 570) were 8,121 g/d and 2,644 g/d.

The net particulate export rates for the entire spring run averaged 0.62 $g/m^2/d$ dry matter and 0.20 $g/m^2/d$ of organic matter. For the upstream segment (VBS 35 – VBS 335) the net particulate export rates were estimated as 3.14 $g/m^2/d$ dry matter and 0.55 $g/m^2/d$ of organic matter. For the lower segment these average export rates were estimated as 0.62 $g/m^2/d$ dry matter and 0.20 $g/m^2/d$ of organic matter. Within segments, no consistent pattern of particulate export or uptake was observed; depending on sampling date, a segment could export or capture particulate matter.

The material captured in the plankton net used to estimate particulate export varied between stations. At the uppermost sampling station (VBS 35), the dominant material collected was reddish-brown amorphous organic material and appeared to be bacterial in nature. This material appeared to be growing on the walls of the main spring cavern. Other material collected at VBS 35 included mineral sands (stirred up by in-water recreation) and a limited variety of filamentous algae (*Lyngbya*, *Spirogyra*, and *Cladophora*). At the VBS 355 and VBS 570 stations, algae diversity increased and became the dominant component of the exported material. **Table 4-27** provides a qualitative description of the material collected in plankton net samples and further identifies the algae community present in Blue Spring.

TABLE 4-26. Blue Spring particulate export measurements during Water Year 2007 / 2008.

Station	Dry Matter (g/d)			Organic Matter (g/d)			Dry Matter ($g/m^2/d$)			Organic Matter ($g/m^2/d$)			Area (m^2)
	Up	Down	Net Change	Up	Down	Net Change	Up	Down	Net Change	Up	Down	Net Change	
November 2007													
VBS-SEG1	3,599	3,388	-212	615	868	254	5.02	0.43	-0.03	0.86	0.11	0.03	7,790
VBS-SEG2	3,388	5,687	2,299	868	1,896	1,028	0.43	0.40	0.36	0.11	0.13	0.16	6,394
VSB-SEG1&2	3,599	5,687	2,087	615	1,896	1,282	5.02	0.40	0.15	0.86	0.13	0.09	14,184
January 2008 - February 2008													
VBS-SEG1	4,382	2,527	-1,855	875	745	-130	6.11	0.36	-0.26	1.22	0.11	-0.02	7,001
VBS-SEG2	2,527	4,796	2,269	745	1,740	995	0.36	0.37	0.38	0.11	0.13	0.17	5,989
VSB-SEG1&2	4,382	4,796	414	875	1,740	865	6.11	0.37	0.03	1.22	0.13	0.07	12,990
March 2008 - April 2008													
VBS-SEG1	14,757	39,661	24,903	945	2,467	1,521	20.6	5.80	3.64	1.32	0.36	0.22	6,839
VBS-SEG2	39,661	4,283	-35,378	2,467	735	-1,732	5.80	0.34	-5.99	0.36	0.06	-0.29	5,908
VSB-SEG1&2	14,757	4,283	-10,475	945	735	-211	20.57	0.34	-0.82	1.32	0.06	-0.02	12,747
May 2008													
VBS-SEG1	8,425	7,730	-694	1,016	1,443	427	11.7	1.12	-0.10	1.42	0.21	0.06	6,880
VBS-SEG2	7,730	7,209	-522	1,443	1,762	319	1.12	0.56	-0.09	0.21	0.14	0.05	5,949
VSB-SEG1&2	8,425	7,209	-1,216	1,016	1,762	747	11.74	0.56	-0.09	1.42	0.14	0.06	12,828
June 2008 - July 2008													
VBS-SEG1	48,995	42,977	-6,018	1,934	7,650	5,716	68.3	6.28	-0.88	2.69	1.12	0.84	6,839
VBS-SEG2	42,977	13,019	-29,958	7,650	5,083	-2,566	6.28	1.02	-5.07	1.12	0.40	-0.43	5,908
VSB-SEG1&2	48,995	13,019	-35,976	1,934	5,083	3,150	68.29	1.02	-2.82	2.69	0.40	0.25	12,747
August 2008													
VBS-SEG1	18,862	35,259	16,397	1,479	10,371	8,892	26.3	4.81	2.24	2.06	1.42	1.21	7,325
VBS-SEG2	35,259	13,734	-21,525	10,371	4,649	-5,721	4.81	1.02	-3.50	1.42	0.35	-0.93	6,151
VSB-SEG1&2	18,862	13,734	-5,129	1,479	4,649	3,170	26.29	1.02	-0.38	2.06	0.35	0.24	13,476
AVERAGE (November 2007 - August 2008)													
VBS-SEG1	16,503	21,924	5,420	1,144	3,924	2,780	23.0	3.14	0.76	1.59	0.55	0.39	7,112
VBS-SEG2	21,924	8,121	-13,803	3,924	2,644	-1,279	3.14	0.62	-2.28	0.55	0.20	-0.21	6,050
VSB-SEG1&2	16,503	8,121	-8,382	1,144	2,644	1,501	23.00	0.62	-0.64	1.59	0.20	0.11	13,162

TABLE 4-27. Relative dominance of material collected during particulate export sampling at Blue Spring (2007 / 2008 Water Year).

Location	Date	Primary	Secondary	Tertiary	Other
VBS 35	11/27/07	Quartz sand	Iron bacteria *	*Lyngbya*	
	02/06/08	Iron bacteria *	*Spirogyra*	*Lyngbya*	Pinnate diatoms
	03/18/08	Iron bacteria *	*Cladophora*	*Lyngbya*	*Tabellaria, Spirogyra, Stigeoclonium, Synedra, Arthrospira*
	04/01/08	Quartz sand	Iron bacteria *	*Vaucheria*	Lyngbya, *Spirogyra, Arthrospira, Nitzschia*
	05/08/08	Iron bacteria *	Quartz sand	*Lyngbya*	*Spirogyra, Cladophora (w/ epiphytic diatoms)*
	05/23/08	Iron bacteria *	Quartz sand	Spirogyra	Filamentous cyanobacteria
	06/24/08	Quartz sand	Iron bacteria *	*Spirogyra, Lyngbya, and Cladophora*	*Tabellaria* (w/ smaller epiphytic diatoms)
	07/08/08	Iron bacteria *	Quartz sand	*Spirogyra and Cladophora*	*Tabellaria*
VBS 355	11/27/07	*Lyngbya*	*Spirogyra*	Colonial diatoms (*Tabellaria, Fragilaria*)	*Oscillatory,* detritus, Desmids, Ostracods, Chironomids, Tartigrades
	02/06/08	Iron bacteria *	*Lyngbya*	*Spirogyra* and *Cladophora*	Pinnate diatoms
	03/18/08	Iron bacteria *	*Spirogyra*	*Lyngbya*	Colonial pinnate diatoms, Tartigrades
	04/01/08	Quartz sand	*Vaucheria*	Iron bacteria *	*Lyngbya, Spirogyra, Tabellaria, Nitzschia*
	05/08/08	*Spirogyra*	*Lyngbya and Cladophora*	Iron bacteria *	*Closterium, Biddulphia, epiphytic diatoms (Entophysalis, Fragilaria) on filamentous algae*
	05/23/08	Iron bacteria *	Lyngbya	Quartz sand	pinnate diatoms (Fragilaria), desmids, Biddulphia
	06/24/08	Detritus (terrestrial), Iron bacteria *	Quartz sand	*Spirogyra, Lyngbya, and Cladophora*	Lots of diatoms (*Tabellaria, Melosira, and Fragilaria*)
	07/08/08	Detritus (terrestrial, invertebrate), Iron bacteria *	Filamentous algae (*Spirogyra, Cladophora, and Lyngbya*)	Lots of diatoms (*Tabellaria, Asterionella, and Fragilaria*)	Quartz sand
VBS 570	11/27/07	*Lyngbya*	*Spirogyra*	*Cladophora*	Colonial diatoms (*Tabellaria, Fragilaria*), *Oscillatory,* detritus, Desmids, Ostracods, Chironomids, Tartigrades
	02/06/08	Iron bacteria *	*Lyngbya and Spirogyra*	Colonial diatoms (*Tabellaria, Fragilaria*)	Closterium
	03/18/08	Iron bacteria *	*Lyngbya*	*Spirogyra*	*Tabellaria,* Pinnate diatoms, Desmids (*Closterium*), Ostracods
	04/01/08	*Lyngbya*	Organic detritus (invertebrate, vascular plants)	*Spirogyra*	*Tabellaria,* Annelida
	05/08/08	*Spirogyra*	*Lyngbya*	Quartz sand	*Biddulphia, Closterium, Cladophora*
	05/23/08	*Lyngbya*	*Spirogyra*	Quartz sand	*Biddulphia, Spirogyra,* Filamentous Cyanobacteria, Desmids
	06/24/08	Filamentous algae (*Lyngbya, Spirogyra, Cladophora*)	Detritus (terrestrial, invertebrate), Iron bacteria *	Quartz sand	Closterium, Diatoms (*Biddulphia, Synedra, Fragilaria*)
	07/08/08	Filamentous algae (*Lyngbya* and *Spirogyra*)	Detritus (terrestrial, invertebrate)	Diatoms (Tabellaria, Asterionella)	Lots of Closterium

* Iron bacteria only hypothesized. Visually it appears to be amorphous organic material, reddish/brown colored, and derived from the spring cavern walls.
Filamentous cyanobacteria has multiple size classes, but all appear *Lyngbya-like*.
The amount of sand in samples appears to be positively correlated to the number of swimmers upstream.
Overall, there was more algal variety, more diatoms, and more zooplankton at lower stations; and spring-wide blue-green algae were more abundant than green algae.

4.3.2.4 Nutrient Assimilation

By measuring the concentrations of nutrients at the upstream and downstream end of study segments (*e.g*., upper segment of VBS 35 to VBS 355) and the flow rate in the corresponding segment it is possible to estimate the amount of nutrient assimilation both in terms of concentration (mg/L) and mass (kg/d and kg/ha/d. The estimated nutrient mass balances for the upper, lower, and the entire reach of the Blue Spring Run are presented by nutrient for the period-of-record (POR) in **Table 4-28** and likewise detailed by sampling date in **Appendix K**.

Estimated removals for ammonia nitrogen were negative in the upper segment (-0.93 kg/ha/d), positive in the lower segment and entire spring run (6.45 and 2.45 kg/ha/d, respectively). This suggests that, for the period-of-record, ammonia is assimilated in the upper study segment and released in the lower study segment (and overall spring run). Ammonia can be directly utilized by aquatic plants as a nitrogen source explaining the reduction in the upper study segment. Ammonia can be a natural breakdown product of organic matter and present in the waste products of animals, both of which are more prevalent in the lower study segment and likely explain the net release (3.2 % increase) of ammonia as water travels downstream in the spring run. See **Appendix K** for detailed nutrient assimilation data.

Nitrate+nitrite nitrogen estimated mass removals were positive for the both segments, as well as the spring run (2.64, 22.88 and 11.92 kg/ha/d, respectively). These finding suggest that nitrate is assimilated from water as it moves downstream in the spring run (15.8 % decrease overall for the POR). Nitrate can be directly utilized by aquatic plants as a source of nitrogen and it is likely that the observed reduction is the result of aquatic plant uptake. See **Appendix K** for detailed nutrient assimilation data.

Estimated mass removals for organic nitrogen and total Kjeldahl nitrogen were negative in the upper and lower segments and spring run (Organic N: -9.84, -72.23, and -38.46 kg/ha/d; TKN: -10.77, -67.59, and -36.83 kg/ha/d, respectively). Organic and Kjeldahl nitrogen concentrations are strongly influenced by the amount of organic particulate and dissolved matter in the water. These substances accumulate in the spring run from autochthonous and allochthonous sources and likely from the large number of fish in the spring run. An increase in organic nitrogen is expected in this aquatic system and potentially reflects both a transition of inorganic nitrogen forms (*e.g*., nitrate) to organic forms as well as the accumulation of nitrogen containing detritus. See **Appendix K** for detailed nutrient assimilation data.

Total nitrogen estimated mass removals were negative for both segments, as well as the spring run (-6.96, -43.38 and -23.67 kg/ha/d, respectively). Total nitrogen concentrations are largely influenced by organic and Kjeldahl nitrogen concentrations and thus it is consistent that total nitrogen concentrations increase with distance downstream. Over the POR, there was approximately 31 % increase in total nitrogen concentrations in the water of the spring run as it traveled downstream. See **Appendix K** for detailed nutrient assimilation data.

The estimated mass removal for ortho phosphorus were negative in the upper and lower segments and spring run (-0.07, -0.86, and -0.43 kg/ha/d). Ortho phosphorous (and soluble reactive phosphorus) can be directly utilized by aquatic plants; however concentrations of ortho phosphorous had relatively negligible changes between study segments of the spring run. Over the POR, there was approximately 0.6 % increase in ortho phosphorous concentrations, which was largely due to the lower study segment. In this lower segment detrital accumulation is likely to occur and may result in the release of ortho phosphorous from organic material. See **Appendix K** for detailed nutrient assimilation data.

The estimated mass removal for total phosphorus was positive in the upper segment (1.13 kg/ha/d) and negative in the downstream segments and spring run (-6.72, and -2.47 kg/ha/d, respectively). The overall increase in total phosphorous with distance downstream is likely a consequence of the accumulation of particulate organic matter. See **Appendix K** for detailed nutrient assimilation data.

TABLE 4-28. Summary of estimated nutrient mass removals in Blue Spring by Segment, Parameter, and Period-of-Record (POR, Oct 2007 to Sep 2008).

Segment	Segment Area (ha)	Parameter	Units	Time	Inflow Segment - Up Conc (mg/L)	Inflow Segment - Up Flow (m^3/d)	Inflow Segment - Up Mass (kg/d)	Inflow Segment - Up Mass (kg/ha/d)	Outflow Segment - Down Conc (mg/L)	Outflow Segment - Down Flow (m^3/d)	Outflow Segment - Down Mass (kg/d)	Outflow Segment - Down Mass (kg/ha/d)	Removal Conc (mg/L)	Removal Conc (%)	Removal Mass (kg/d)	Removal Mass (kg/ha/d)	Removal Mass (%)
VBS 35 - 355	0.72	NH4-N	mg/L	POR	0.11	323,560	34.5	48.2	0.11	323,560	35.2	49.1	-0.002	-1.93	-0.66	-0.93	-1.93
VBS 355 - 570	0.61			POR	0.11	323,560	35.2	57.9	0.10	323,560	31.3	51.5	0.012	11.12	3.91	6.45	11.12
VBS 35 - 570	1.32			POR	0.11	323,560	34.5	26.1	0.10	323,560	31.3	23.6	0.010	9.41	3.25	2.45	9.41
VBS 35 - 355	0.72	NOx-N-D	mg/L	POR	0.40	323,560	129.6	181.0	0.39	323,560	127.7	178.3	0.006	1.46	1.89	2.64	1.46
VBS 355 - 570	0.61			POR	0.39	323,560	127.7	210.4	0.35	323,560	113.9	187.6	0.043	10.87	13.89	22.88	10.87
VBS 35 - 570	1.32			POR	0.40	323,560	129.6	98.0	0.35	323,560	113.9	86.0	0.049	12.17	15.78	11.92	12.17
VBS 35 - 355	0.72	OrgN	mg/L	POR	0.07	323,560	23.5	32.8	0.09	323,560	30.5	42.6	-0.022	-30.01	-7.05	-9.84	-30.01
VBS 355 - 570	0.61			POR	0.09	323,560	30.5	50.3	0.23	323,560	74.4	122.5	-0.136	-143.58	-43.84	-72.23	-143.58
VBS 35 - 570	1.32			POR	0.07	323,560	23.5	17.8	0.23	323,560	74.4	56.2	-0.157	-216.67	-50.89	-38.46	-216.67
VBS 35 - 355	0.72	TKN	mg/L	POR	0.18	323,560	56.6	79.1	0.20	323,560	64.3	89.8	-0.024	-13.62	-7.71	-10.77	-13.62
VBS 355 - 570	0.61			POR	0.20	323,560	64.3	106.0	0.33	323,560	105.4	173.6	-0.127	-63.76	-41.03	-67.59	-63.76
VBS 35 - 570	1.32			POR	0.18	323,560	56.6	42.8	0.33	323,560	105.4	79.6	-0.151	-86.07	-48.74	-36.83	-86.07
VBS 35 - 355	0.72	TN	mg/L	POR	0.58	323,560	187.1	261.2	0.59	323,560	192.1	268.1	-0.015	-2.67	-4.99	-6.96	-2.67
VBS 355 - 570	0.61			POR	0.59	323,560	192.1	316.4	0.68	323,560	218.4	359.8	-0.081	-13.71	-26.34	-43.38	-13.71
VBS 35 - 570	1.32			POR	0.58	323,560	187.1	141.4	0.68	323,560	218.4	165.0	-0.097	-16.74	-31.32	-23.67	-16.74
VBS 35 - 355	0.72	OrthoP	mg/L	POR	0.07	323,560	22.9	32.0	0.07	323,560	23.0	32.1	0.000	-0.21	-0.05	-0.07	-0.21
VBS 355 - 570	0.61			POR	0.07	323,560	23.0	37.9	0.07	323,560	23.5	38.7	-0.002	-2.28	-0.52	-0.86	-2.28
VBS 35 - 570	1.32			POR	0.07	323,560	22.9	17.3	0.07	323,560	23.5	17.8	-0.002	-2.49	-0.57	-0.43	-2.49
VBS 35 - 355	0.72	TP	mg/L	POR	0.08	323,560	26.4	36.9	0.08	323,560	25.6	35.8	0.002	3.06	0.81	1.13	3.06
VBS 355 - 570	0.61			POR	0.08	323,560	25.6	42.2	0.09	323,560	29.7	48.9	-0.013	-15.92	-4.08	-6.72	-15.92
VBS 35 - 570	1.32			POR	0.08	323,560	26.4	20.0	0.09	323,560	29.7	22.4	-0.010	-12.38	-3.27	-2.47	-12.38

4.3.3 Human Use

4.3.3.1 Total Human Use

Blue Spring State Park supplied attendance data for the period-of-record (POR) from January 1983 through December 2008 (**Table 4-29, Figures 4-32 and 4-33**). For Water Year 2007/2008, the total number of people visiting the park was 391,694 comprised of 42,190 overnight and 349,504 daily visitors. Over the entire POR, the total number of people visiting the park averaged 329,535 per year or 27,463 per month. The annual visitor count has ranged from a low of 246,097 in 1983 to a high of 451,220 in 2007 (**Figure 4-34**). Over the POR, approximately 91% of those visitors were in the park for day use only.

Human use is seasonal with two apparent peaks of activity (**Figures 4-33 and 4-35**): the colder months during high periods of manatee use in the spring run (December to March) and the summer period when the spring and adjacent river are most popular for swimming and boating activities. Average monthly park attendance totals for daily visitors ranged from a maximum of 46,282 day visitors in January to a minimum of 10,739 in October. For overnight visitors the average monthly park attendance ranged from a maximum of 3,995 in March to a minimum of 1,426 during September (**Figure 4-35**). The monthly total visitor count has ranged from 3,742 during September 2004 to 76,889 during January 2003 over the 26-year period of data collection.

TABLE 4-29.
Monthly statistics for the numbers of overnight, day, and total visitors utilizing Blue Spring State Park (FDEP data).

Statistics	Overnight Visitors (#)	Day Visitors (#)	Total (#)
Average	2,573	24,889	27,463
Median	2,546	22,631	25,558
Maximum	5,496	73,926	76,889
Minimum	218	3,524	3,742
Std Dev	901	11,818	12,245
Count	312	312	312
Std Err	51	669	693

Period of Record: 1/1983 - 12/2008

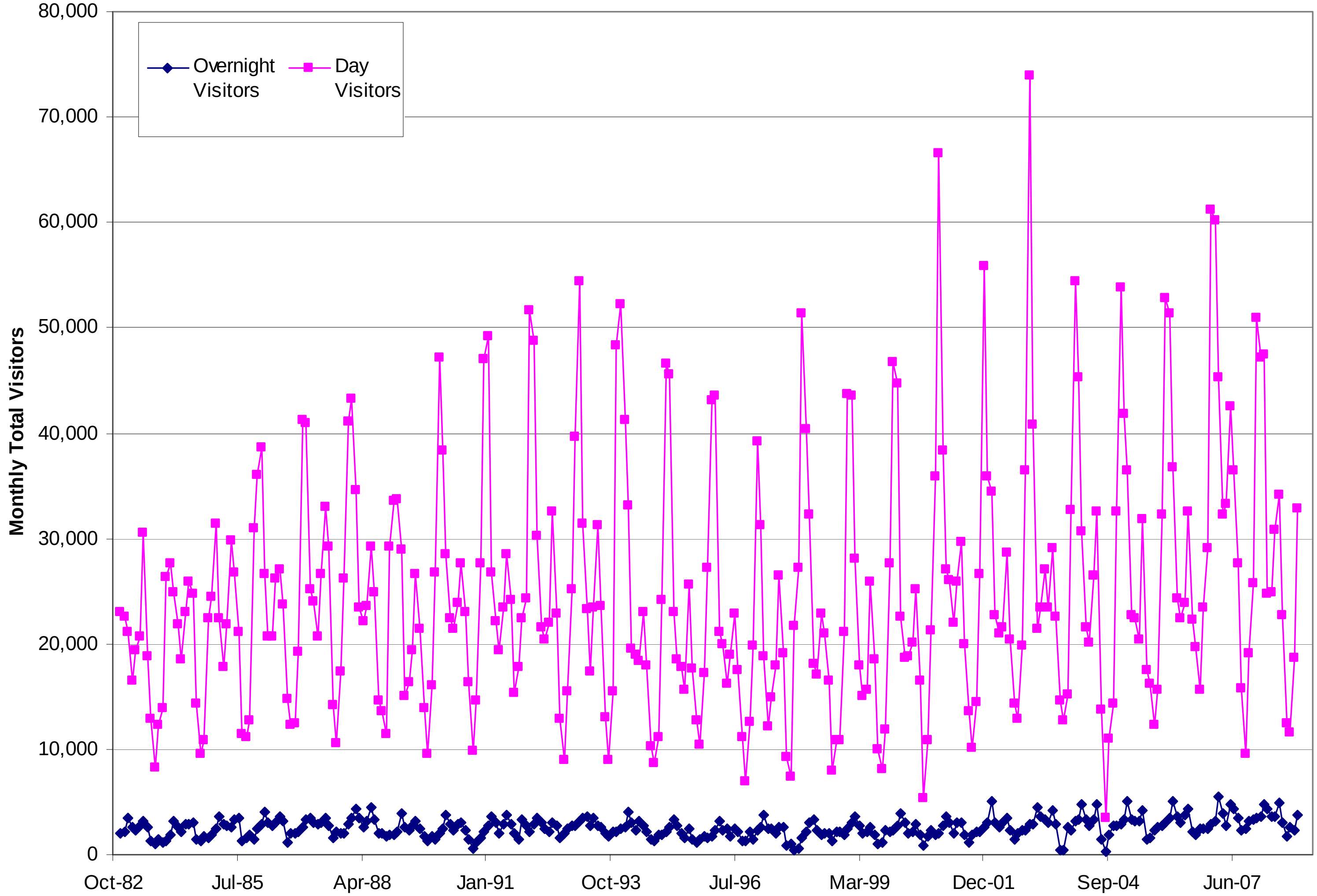


FIGURE 4-32. Monthly total overnight and daily visitors to Blue Spring State Park.

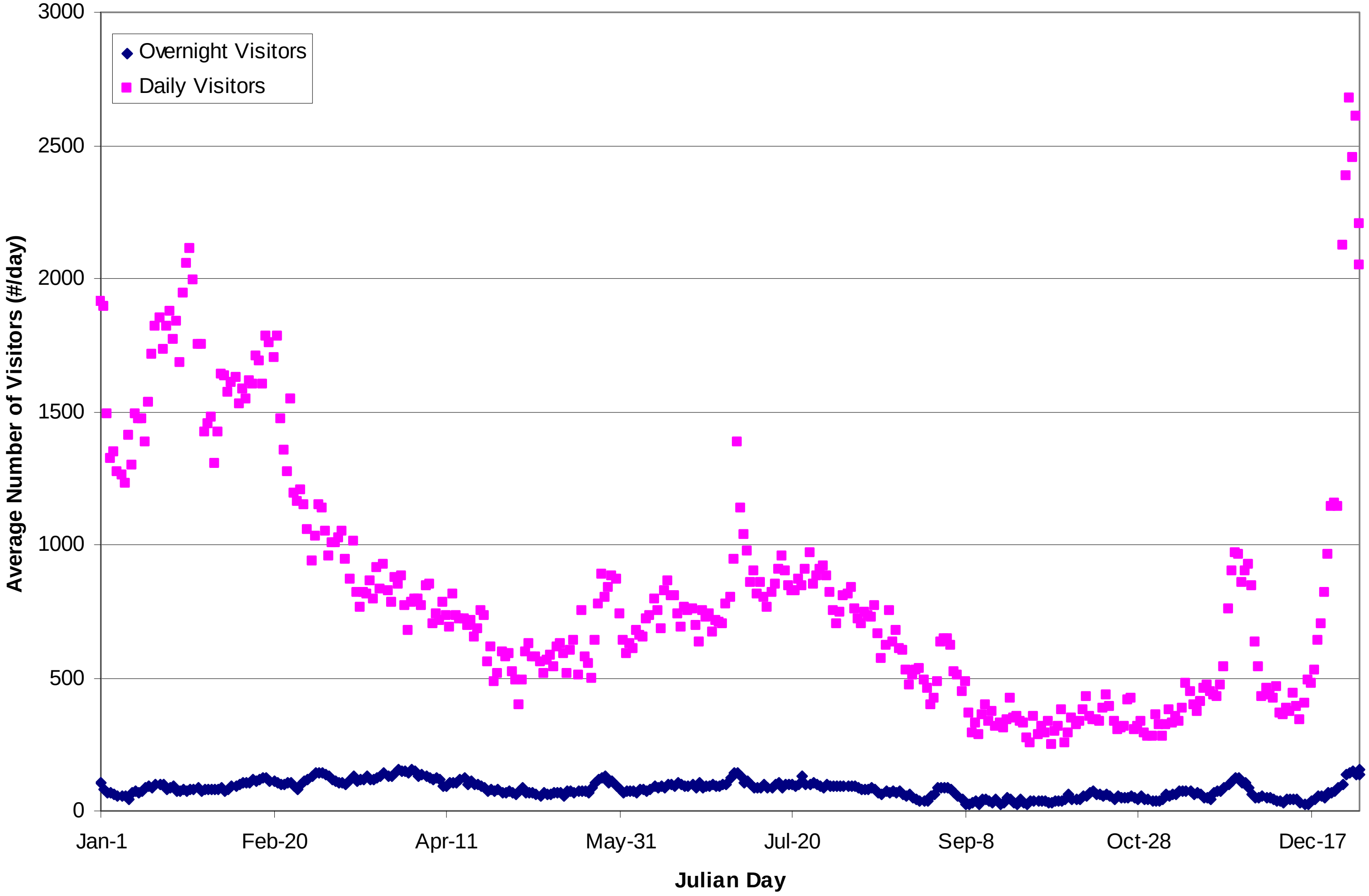


FIGURE 4-33. Average number of overnight and daily visitors to Blue Spring State Park (January 1, 1990 - September 4, 2006)

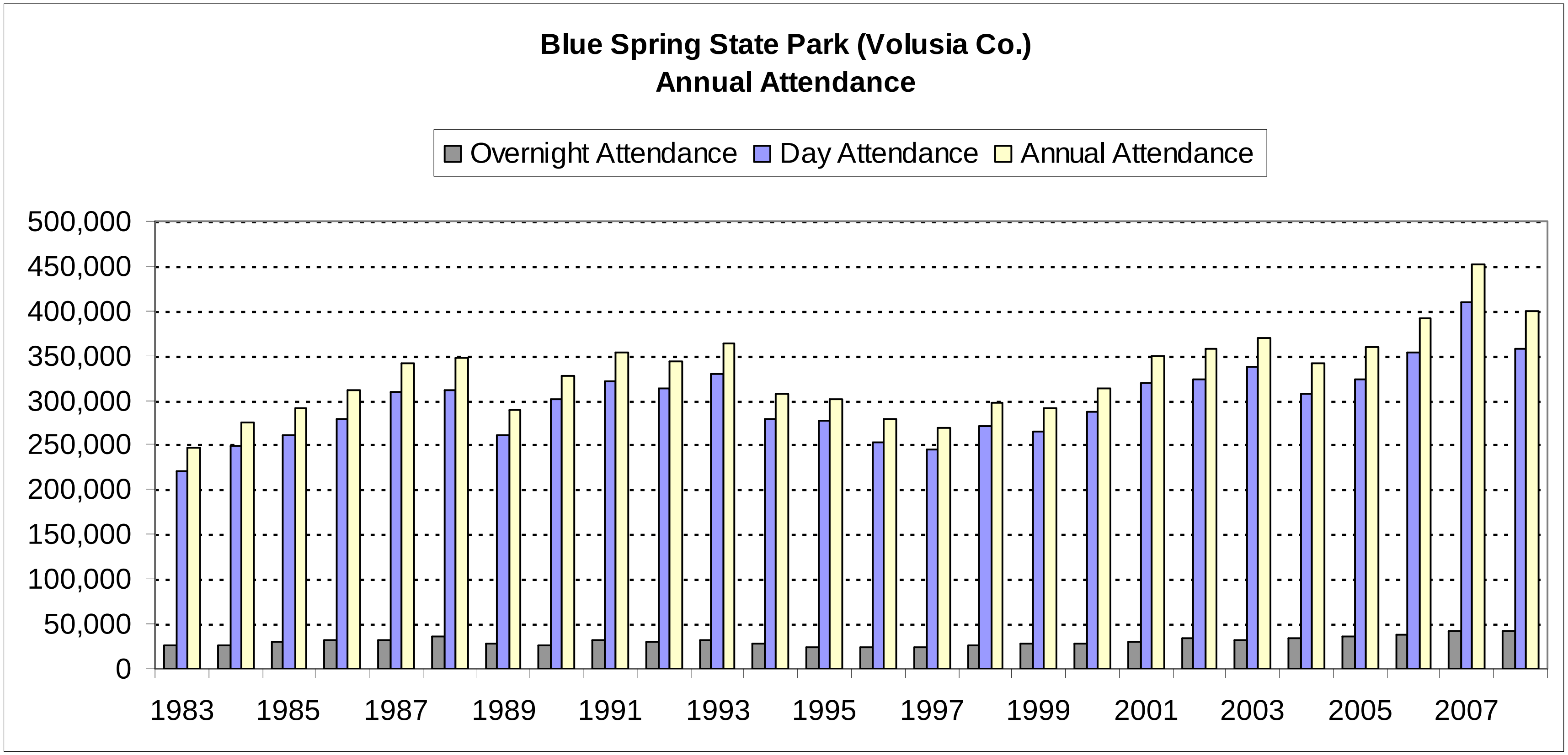


FIGURE 4-34. Total number of overnight and daily visitors to Blue Spring State Park (1983 - 2008).

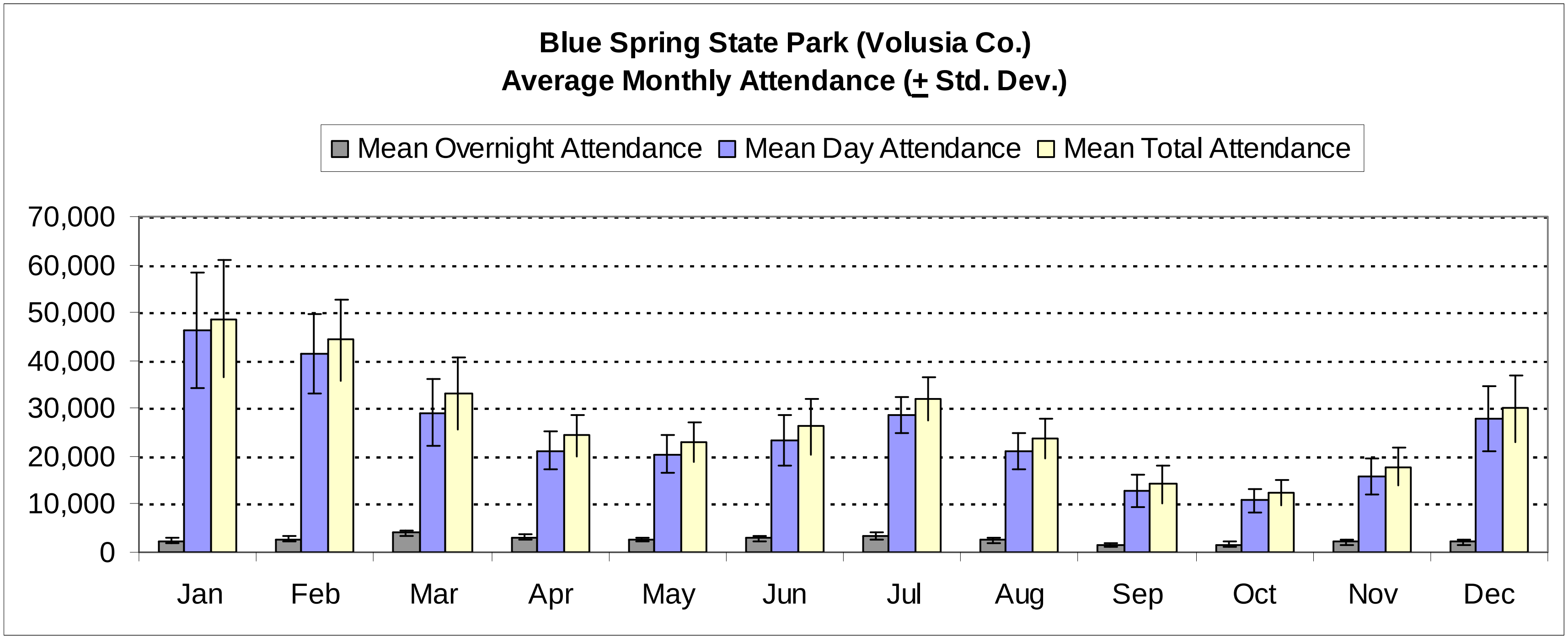


FIGURE 4-35. Monthly average (with Std. Dev.) of overnight and daily visitors to Blue Spring State Park (1983 - 2008).

4.3.3.2 Water-Oriented Public Uses

Blue Spring State Park (Volusia County) is open year round from 8 AM to sunset and rarely has unscheduled closings (Bob Rundle, Blue Spring State Park manager, personal communication, 2008).

Seasonal data analyses indicate that key human use activities at the Blue Spring State Park are associated with manatee observations from November to March and swimming and snorkeling during the spring and summer seasons (WSI 2007a).

Detailed human-use activity counts were conducted on two weekdays at Blue Spring State Park during the warmer season during 2008. **Figures 4-36** and **4-37** illustrate the observed distribution of human uses on May 23 and June 24, 2008, including water-contact and water-view activities observed in the vicinity of the swimming area. Total human use was observed to be lowest in the morning hours and increased throughout the day, with an apparent maximum between 12:45 and 14:15 on the two days. Water contact activities were generally higher during mid-day. The highest number of people recorded in the swimming area at one time on these two days was 44 individuals. The highest number of people observed during these counts was 147. The predominant water contact activities observed at Blue Spring were: bathing, floating, swimming, and snorkeling. On both occasions water was too deep in the swimming area for wading. The water-view activities that had the highest recorded uses on these dates were: standing on the dock, sunbathing, picnicking, and walking on the boardwalks (**Figure 4-38**).

Bonn and Bell (2003) prepared a detailed economic assessment of four Florida state parks with major artesian springs. Blue Spring was one of the systems evaluated by user surveys in late 2002. In fiscal year 2002, there were 337,356 visitors to the park. About 65% of these individuals were estimated to be from outside of Volusia County.

Dr. Mark Bonn (2008) conducted a follow up survey during 2008 at Blue Spring (**Appendix L**). Results from 400 participants substantiate that Blue Spring State Park is a prime destination for people seeking to observe wild manatees.

Based upon those comparable questions from the 2003 study, several interesting observations were found. First, average party size increased from 3.3 persons per party in 2003 to 4.0 persons per party during 2008. Also the categories, “first time visitors” (50.8% in 2008 vs. 38.9% in 2003) and “plan to return” (65.3% in 2008 vs. 35.6% in 2003) both saw increases between 2003 and 2008. Over 31% of all visitors indicated they planned to return within six months, up from 10% in 2003. Another 29% indicated they would return within 12 months, up from 20.6% in 2003. When asked about the main purpose of the visit, “viewing manatees” dropped from 64.8% to 32.3%, although 93% of all visitors indicated they participated in “watching manatees”. Most respondents (58.9%) in 2008 heard about the park from family or friends which represented a large increase from 2003 numbers (18.9%). Survey results suggest that use of the Internet as an information source dropped from 4.8% in 2003 to 1.1% in 2008.

A more diverse ethnic group of visitors were reported during in 2008 compared to 2003. Most other demographic characteristics changed very little except for income which documented a steep decline in the percentages of visitors earning $50,000-$79,999 per household per year (45.1% of total park visitors in 2003 vs. 17.3% in 2008). This change may reflect the large increase in the category of "no answer", which increased from 10% in 2003 to 52.8% in 2008.

A series of questions were asked about the result of increased well-pumping in the area and the reduction of flow from Blue Spring. Slight differences in the responses from 2003 and 2008 were observed, but overall the support for protection of flows remained remarkably high. A question addressed: "Do you believe it is in the public interest to reduce spring flow in state parks to meet public water supply need?" It was documented that 75.3% answered "no" in 2008, down slightly from 82.4% in 2003. Respondents were also willing to support local government in the development of alternative water sources to protect spring flow at 86.5% in 2008, down slightly from 97% in 2003. When asked if they would be willing to pay more on their monthly utility bill to support alternative water sources rather than reduce flow, 73.5% answered "yes" in 2008, down slightly from 79.5% in 2003.

A series of new questions were added to the 2008 survey designed to gain visitor opinions pertaining to reduced water flow levels and their impact upon the aesthetics, activities, and overall on-site park experience. Because these questions were new, visitor responses to these questions asked in 2008 were not able to be compared to the 2003 study. The first set of questions addressed flow loss. Specifically, visitors indicated as a group average, that a loss of about 10.3% of water flow would be considered significant harm to the aesthetics of the spring. Visitors also similarly indicated that a flow loss of 10.4% would be considered significant harm to swimming and diving-related activities. Finally, visitors indicated that an 11.9% loss of water flow would be significant harm to their positive experience visiting the park.

One newly developed category of questions included in the 2008 study asked if responding visitors had been to the park prior to 2003. Most (71.3%) indicated they had not. The study found that 27% of responding visitors had indeed visited the park prior to 2003. Of this 27% of respondents that had visited the park prior to 2003, a series of questions were developed to measure responses of swimmers, divers and walkers to their perceived change in park water quality and water depth.

Of these repeat visitors, when swimmers were asked if water clarity was "better", "about the same", or "worse"; equal percentages replied water clarity was either "about the same" or "worse" (40.7%). Among SCUBA divers, the majority (53.8%) indicated that water clarity was "about the same"; while among walkers the majority (41.1%) indicated the water clarity was "worse". With respect to water depth, 50% of all responding swimmers that had visited the park prior to 2003 indicated that water depth had gotten "worse". Most SCUBA divers (46.2%) thought water depth was "about the same", and the majority of walkers (64.8%) indicated water depth had gotten "worse".

A final question related to "satisfaction with the overall visit to the spring". Compared with 2003 respondents, overall satisfaction actually increased to 4.6 in 2008, up from 4.3 in 2003, using a scale of 1-5 with 5 being highest. This indicates that despite critical issues related to the environment, visitors are increasingly more pleased with their on-site experience. **Appendix L** provides detailed information by overall visitors, winter visitors and summer visitors.

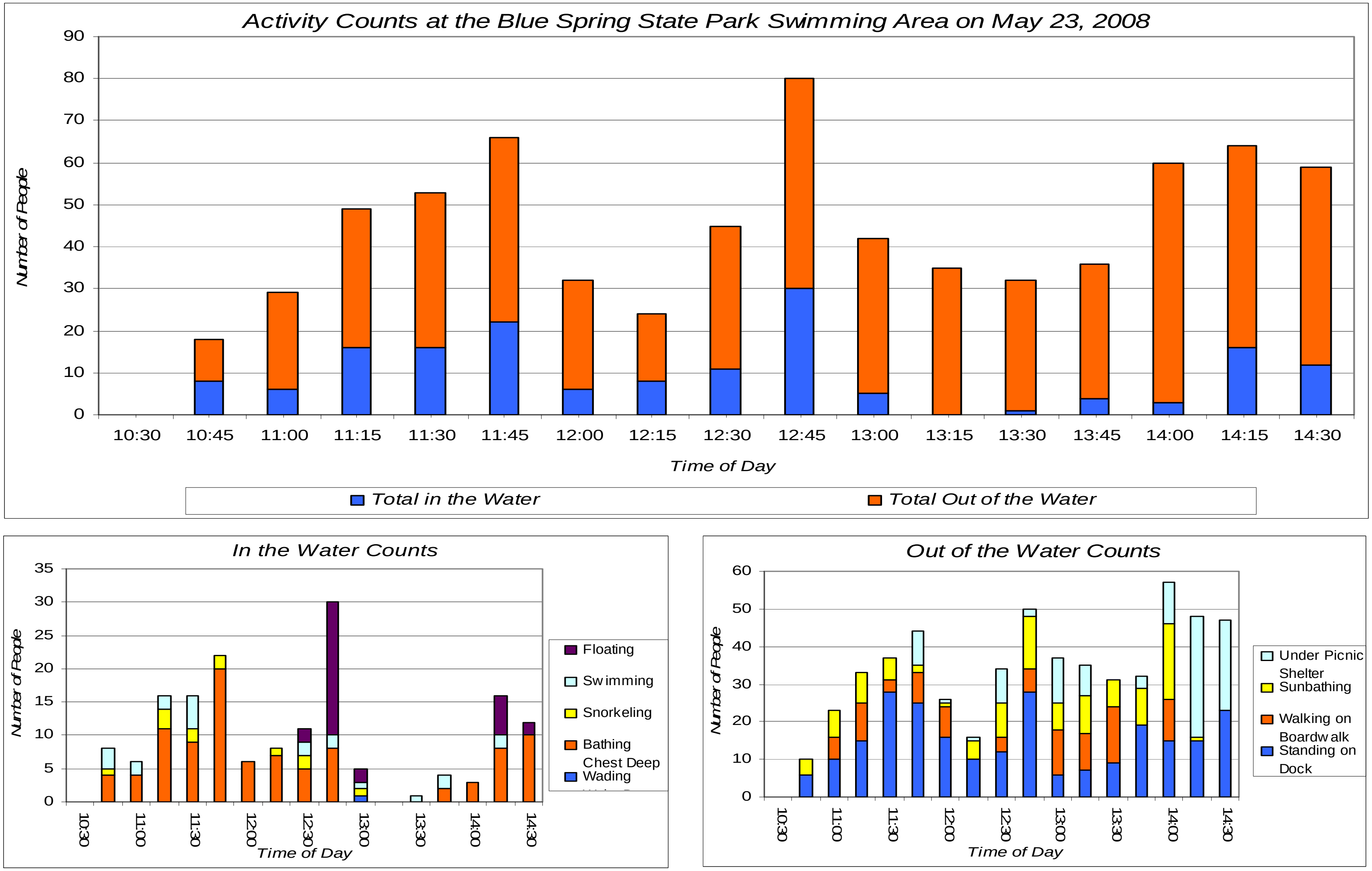


FIGURE 4-36. Blue Spring State Park human use and recreational counts conducted on May 23, 2008.

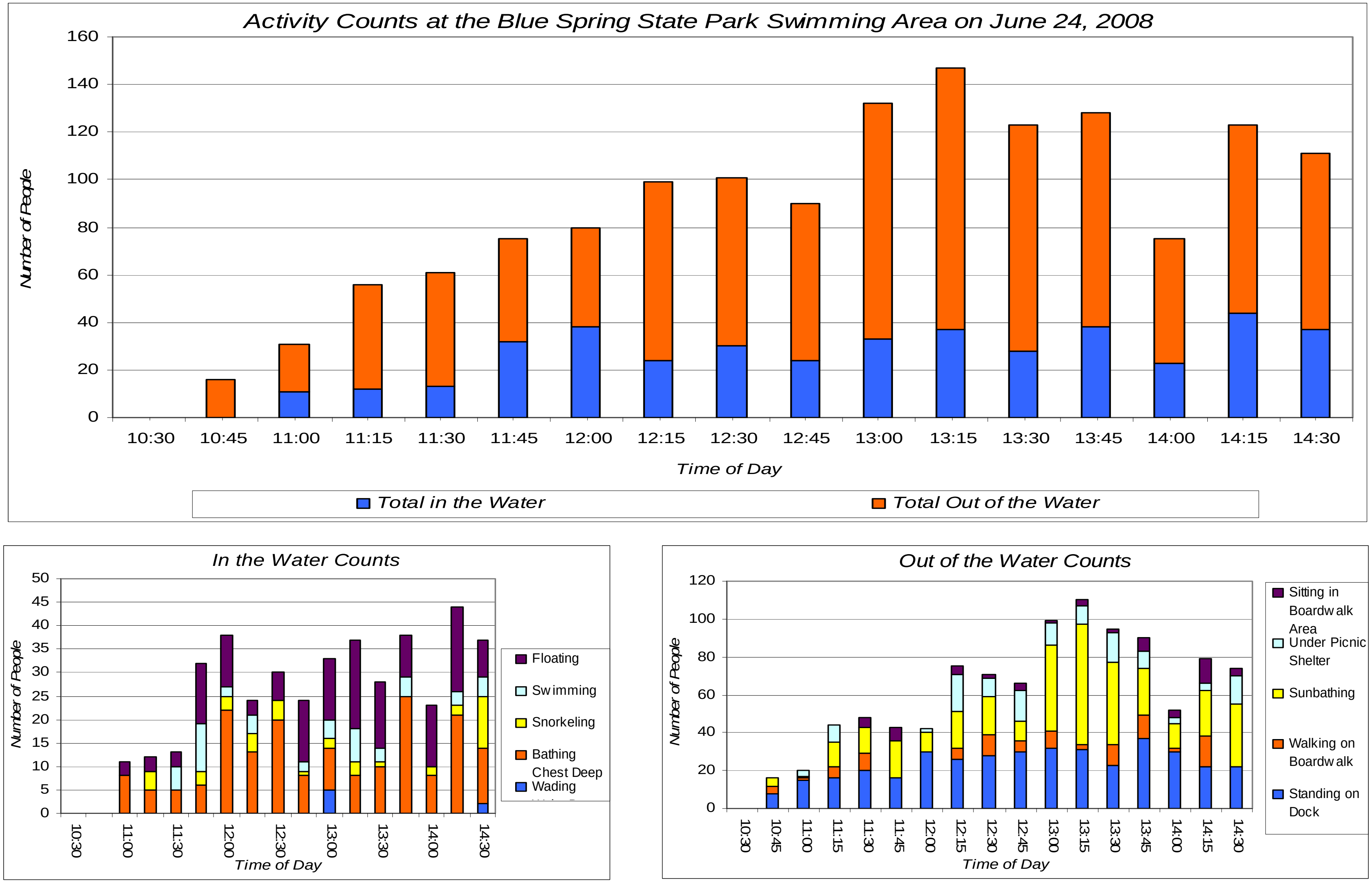


FIGURE 4-37. Blue Spring State Park human use and recreational counts conducted on June 24, 2008.

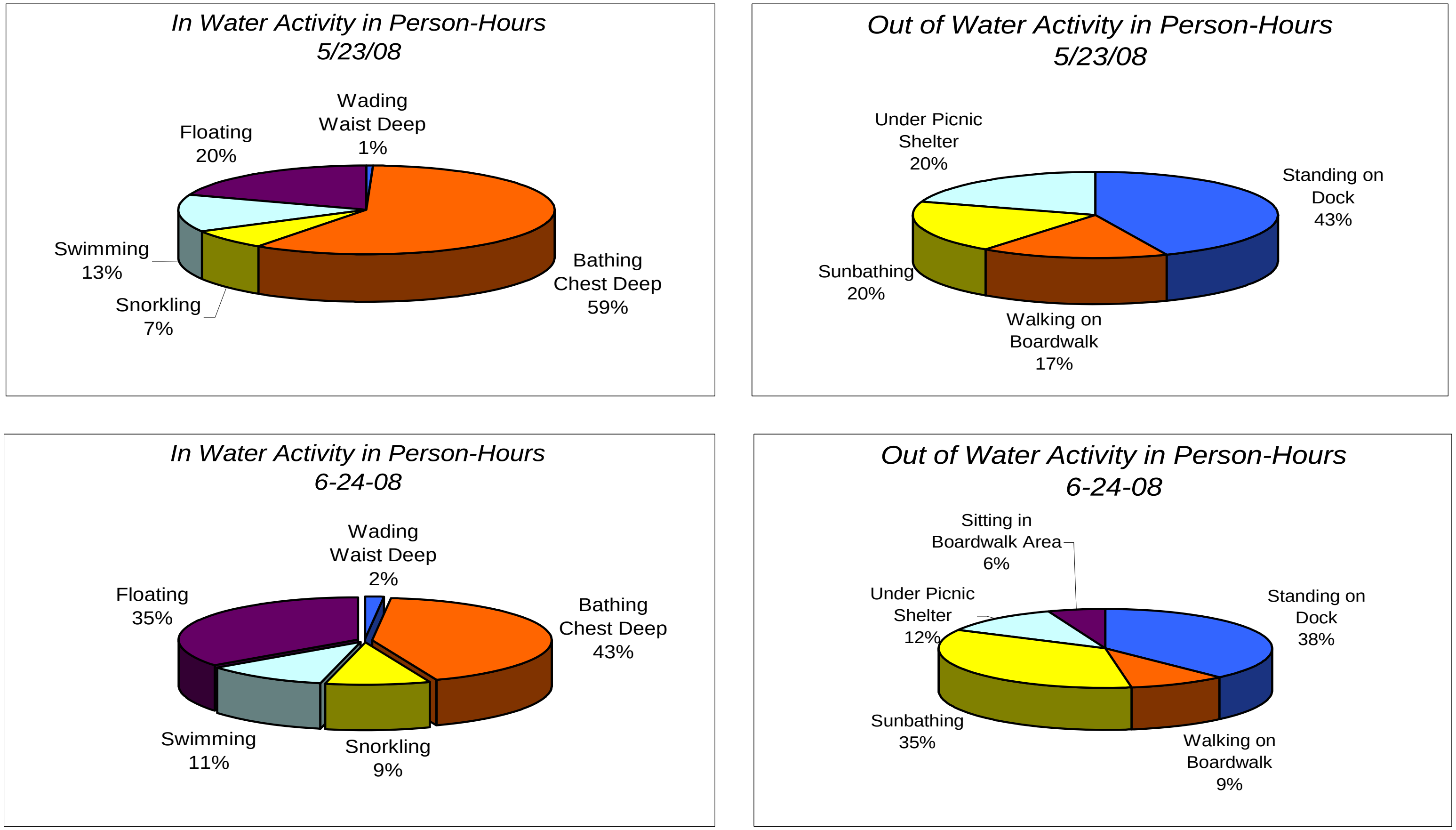


FIGURE 4-38. Comparison of Blue Spring State Park recreational activity (by person hours) for May 23 and June 24, 2008.

5.0 Protection of Water Resource Values

5.1 Inventory of Existing Uses

The purpose of this monitoring effort is to determine whether the Blue Spring MFR is adequately protective of the following WRVs (Section 62-40.473, FAC):

1. Recreation in and on the water (62-40.473 (1) (a), FAC)
2. Fish and wildlife habitats and the passage of fish (62-40.473 (1) (b), FAC)
3. Estuarine resources (62-40.473 (1) (c), FAC)
4. Transfer of detrital material (62-40.473 (1) (d), FAC)
5. Maintenance of freshwater storage and supply (62-40.473 (1) (e), FAC)
6. Aesthetic and scenic attributes (62-40.473 (1) (f), FAC)
7. Filtration and absorption of nutrients and other pollutants (62-40.473 (1) (g), FAC)
8. Sediment loads (62-40.473 (1) (h), FAC)
9. Water quality (62-40.473 (1) (i), FAC)
10. Navigation (62-40.473 (1) (j), FAC)

Of the ten WRVs listed above, Nos. 3, 5, and 10 are not considered to be directly relevant to this water resources evaluation for Blue Spring (WSI 2007a). The other seven WRVs are clearly relevant and have been included in the monitoring protocol described in the earlier sections of this report. While the primary basis for the Blue Spring MFR was to allow expansion of the manatee populations during the winter cold months, additional environmental data are now available to allow a preliminary quantitative assessment for some of the other WRVs as well. This section provides a summary of these preliminary results.

5.2 Preliminary Assessment of Water Resource Values

Existing discharge data for Blue Spring appear to indicate a gradual reduction in average annual flows over the past three decades. The proportion of this reduction that is due to consumptive uses versus weather effects has not been determined. Nevertheless, these declining discharges in combination with quantitative data for various WRVs may provide clues concerning possible cause and effect relationships.

5.2.1 Recreation In and On the Water (62-40.473 (1) (a), FAC)

The results summarized in Section 4 above indicate that human recreational uses at Blue Spring are substantial. They appear to be related to two primary attributes of this spring:

- It is the premier public access manatee viewing area in Florida

- It is a beautiful and convenient environmental setting in a state park that includes other recreational activities such as swimming, nature study, cultural/historical resources, and access to the St. Johns River.

Based on the quantitative results reported in this study there was no evidence found that indicates that public use at Blue Spring is correlated with spring discharge within the existing range of flows (see **Figure 5-1**). It can certainly be hypothesized that a marked reduction of flows in this spring would ultimately lead to reduced recreational use of this natural resource due to the following likely associated changes:

- Cold weather manatee use would be reduced;
- Water clarity would decrease and summer water temperatures increase and would be less suitable to attract swimmers and scuba divers to the spring and spring run;
- The aesthetics of the spring and spring run would be reduced due to the above factors.

The actual flow reduction at Blue Spring that might lead to reduced recreational use of this spring system has not been quantified.

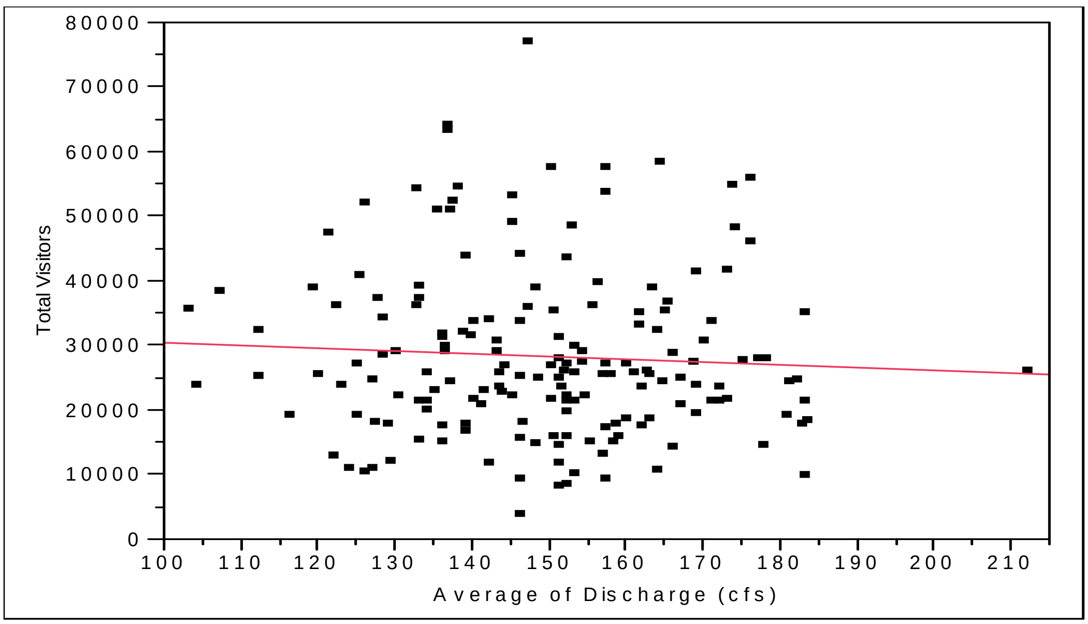


FIGURE 5-1. Relationship between Blue Spring discharge and total monthly visitors over the period from 1982 through 2008.

5.2.2 Fish and Wildlife Habitats and the Passage of Fish (62-40.473 (1) (b), FAC)

A relatively long record of data for manatees, fish, and macroinvertebrates are available from Blue Spring and summarized in this report. Extensive new wildlife use data have also been collected for this first-year WRV study, including aquatic plant and algal communities, snails, turtles, and overall community metabolism. Correlations between these parameters and spring discharge and levels were examined to see if there are any significant relationships.

There is a positive correlation (however, not statistically significant) between monthly average spring discharge data and monthly manatee use at Blue Spring (**Figure 5-2**).

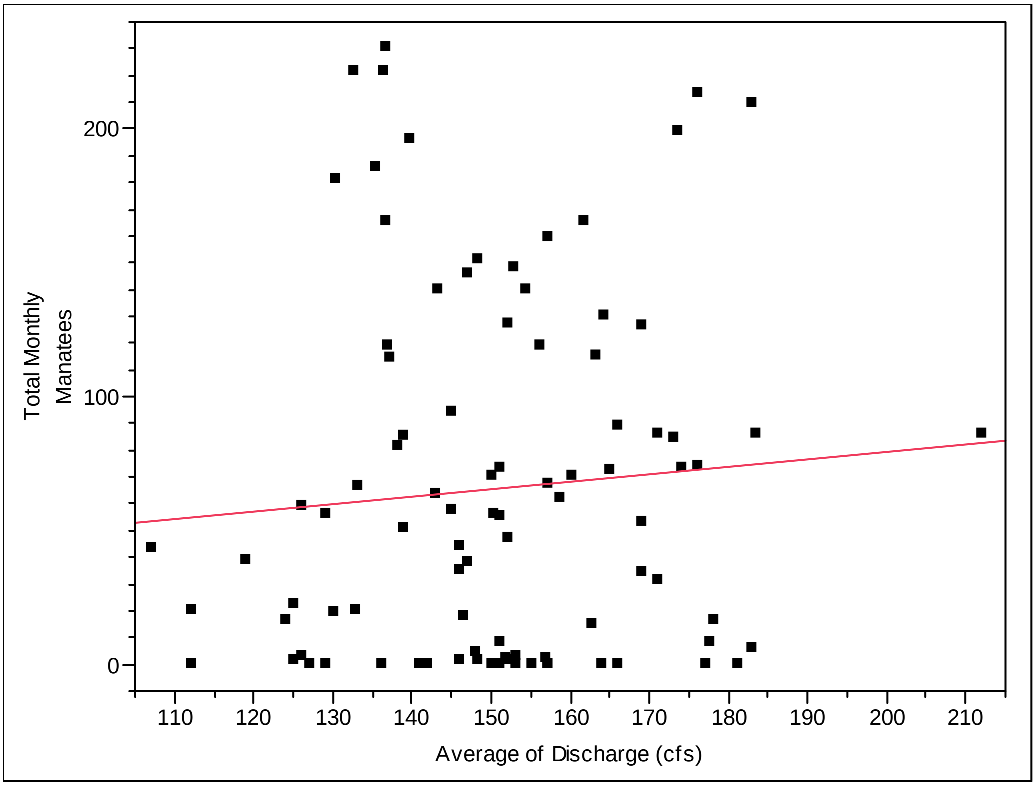


FIGURE 5-2. Relationship between monthly average Blue Spring discharge and monthly total manatees observed in the Spring Run over the period from 1983 through 2008.

The Stream Condition Index (SCI) is utilized by FDEP to detect large-scale effects of habitat changes on populations of aquatic invertebrates. A growing record of these analyses has been accumulated for Blue Spring during the current year of monitoring as well as in the proceeding 7 years. **Figure 5-3** illustrates an interesting correlation between spring discharge and SCI at Blue Spring. This graph illustrates an apparent co-variation of these two variables that may require additional analysis ($R^2 = 0.77$, $p<0.002$). Within the range of the data collected to date, SCI drops to relatively low levels at flows less than 150 cfs.

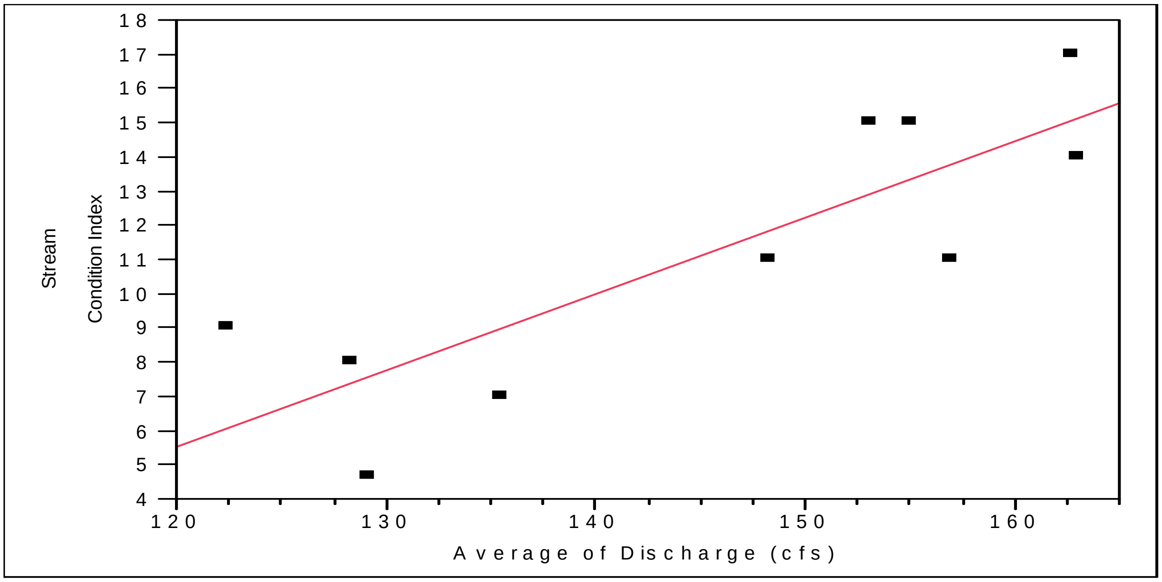


FIGURE 5-3. Relationship between quarterly average Blue Spring discharge and Stream Condition Index in the Spring Run over the period from 2000 through 2008.

Four quarters of quantitative fish data were collected during this study. Correlation analysis found a highly significant (R^2 = 0.99) inverse relationship between spring discharge and overall fish species diversity (**Figure 5-4**). A similar inverse relationship was found between fish species diversity and stage (R^2 =0.85). Highest fish diversity was observed during periods of lower flow and stage, at least within the range of observed flows (minimum flow was about 132 cfs). Fish density showed no consistent correlation to flows or stage.

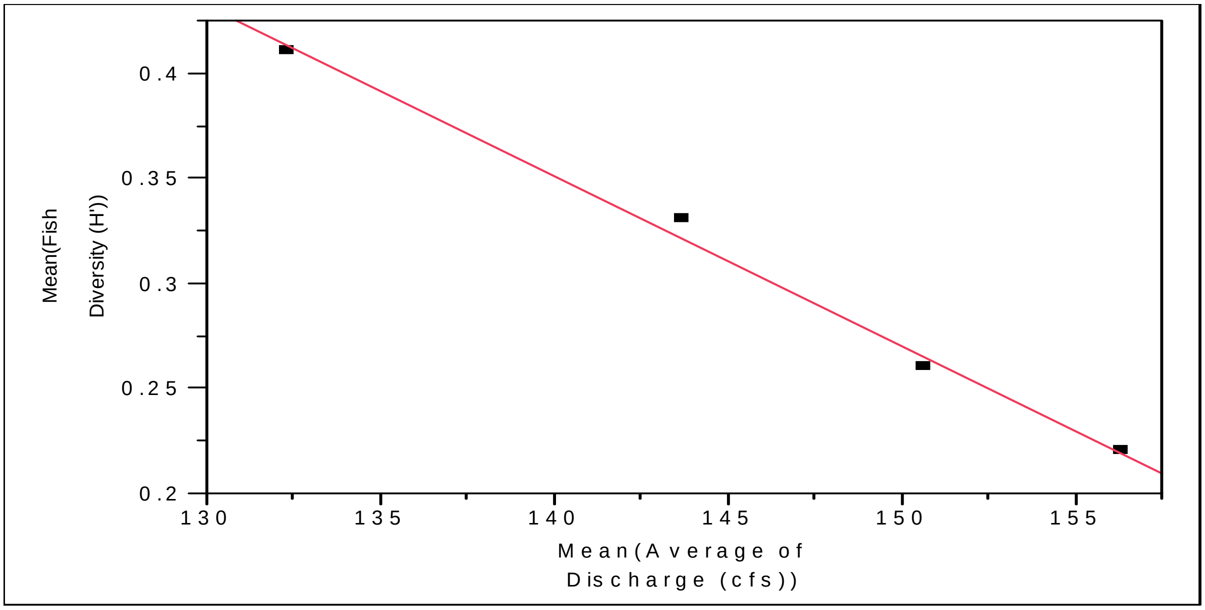


FIGURE 5-4. Relationship between quarterly average Blue Spring discharge and fish species diversity in the Spring Run during the 2007 / 2008 Water Year.

There was no readily discernable relationship found between snail or turtle density and spring discharge during the first year of monitoring.

Ecosystem metabolism parameters did not show a significant relationship with spring discharge within the relatively narrow range of flows observed during this first study year (**Figures 5-5** to **5-7**). Overall gross primary productivity (**Figure 5-5**) and community respiration (**Figure 5-6**) for the entire spring boil and spring run reach (Main Boil to VBS 570) were slightly higher at low flows than at high flows, although the two segments responded differently. The ecological efficiency in both segments was positively correlated with flow but the overall spring run showed a weakly negative correlation (**Figure 5-7**).

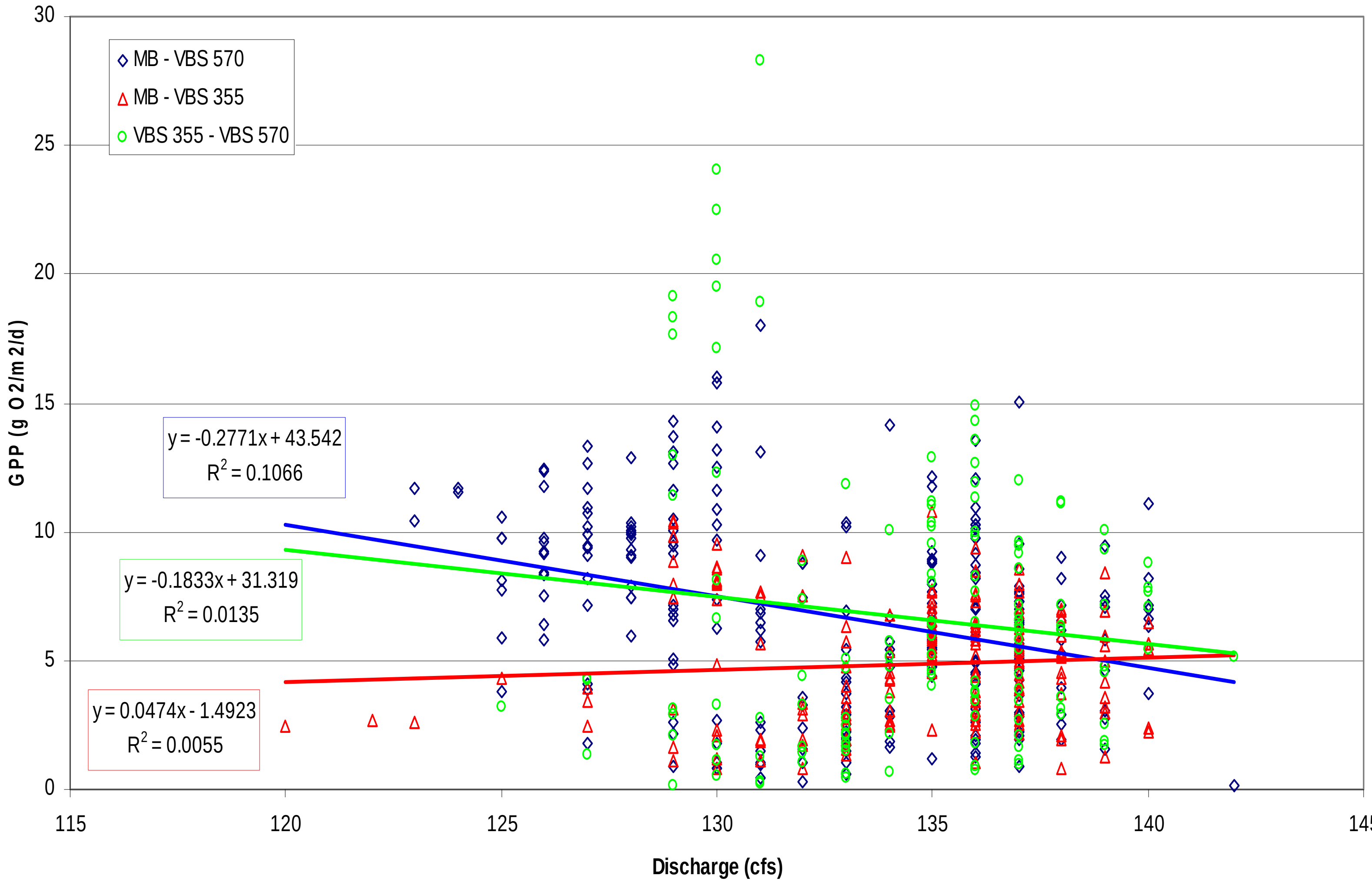


FIGURE 5-5. Relationship between daily average Blue Spring discharge and ecosystem gross primary productivity in the Spring Run segments during the 2007 / 2008 Water Year.

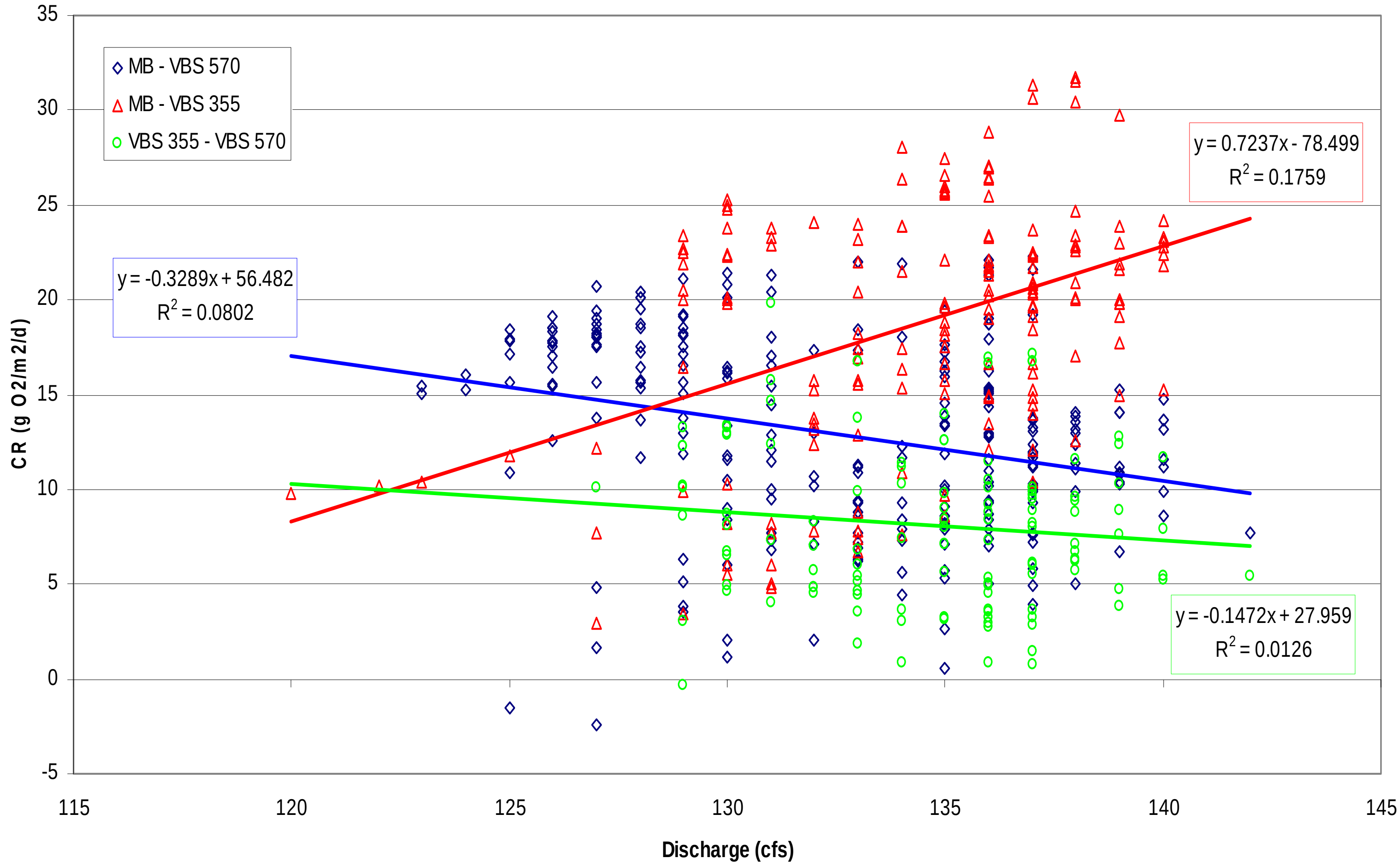


FIGURE 5-6. Relationship between daily average Blue Spring discharge and community respiration in the Spring Run segments during the 2007 / 2008 Water Year.

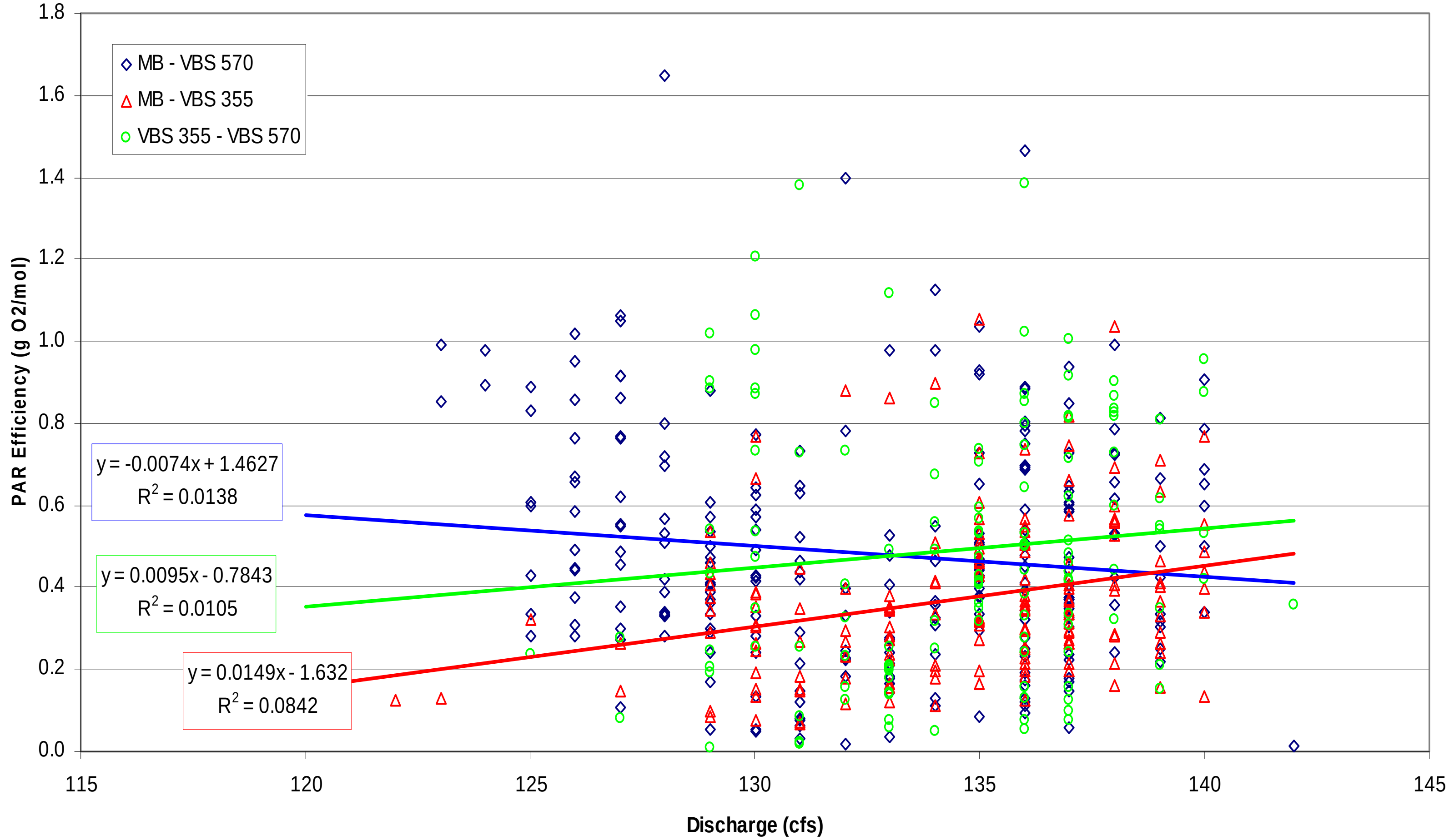


FIGURE 5-7. Relationship between daily average Blue Spring discharge and ecosystem efficiency in the Spring Run segments during the 2007 / 2008 Water Year.

5.2.3 Transfer of Detrital Material (62-40.473 (1) (d), FAC)

No significant relationships were observed between the downstream export of particulate material and the corresponding discharge values. This is likely due to the large variation in particulate export rates that appear to be dependent on in-water recreation. During periods of intense human recreation (summer swimming period) particulate export rates were much higher, regardless of discharge rate for the spring. It is likely that downstream export of any materials in the water column would be enhanced by spring discharge.

Water clarity as measured by the horizontal visibility of a Secchi disk was positively correlated to discharge ($R^2 = 0.40$), however the relation was not statistically significant ($p = 0.25$, **Figure 5-8**). This correlation and statistical significance may be improved by collecting more horizontal Secchi readings under a variety of discharge rates.

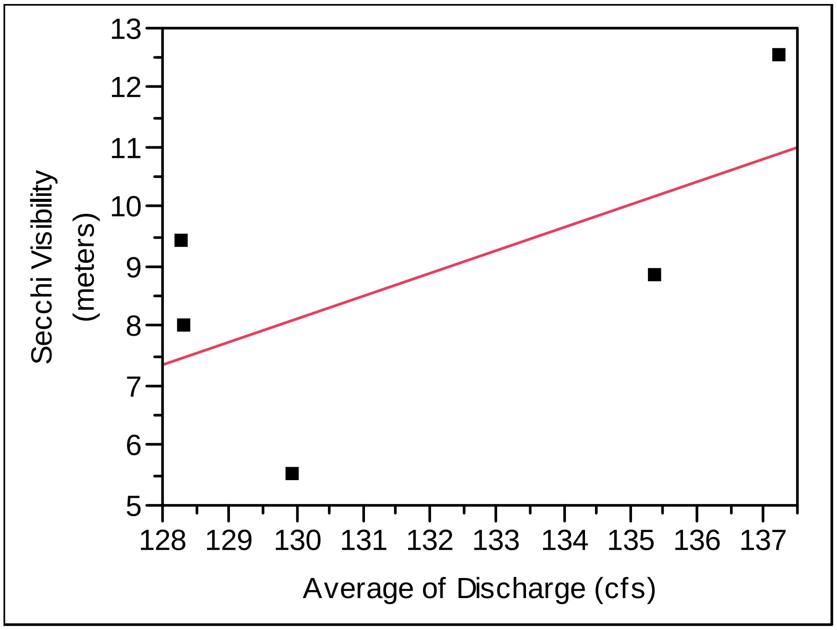


FIGURE 5-8. Relationship between horizontal Secchi visibility and the corresponding average Blue Spring discharge during the 2007 / 2008 Water Year.

5.2.4 Aesthetic and Scenic Attributes (62-40.473 (1) (f), FAC)

The questionnaire studies conducted by Dr. Mark Bonn during 2003 and 2008 provide the best source of information concerning protection of "aesthetic and scenic attributes" at Blue Spring. Despite the approximate average 0.2% annual flow decline at the spring the public was generally more pleased with their overall experience at Blue Spring in 2008 compared to 2003. This was likely due to the number of visitors who come to the state park to view manatees and the increasing number of manatees during every year on record. When asked what flow reduction might result in a significant loss of aesthetic and scenic attributes for the spring and spring run, the public felt on average that a 10 to 12 percent reduction would be excessive. However, less than one half of the questionnaire respondents had previously visited the spring.

5.2.5 Filtration and Absorption of Nutrients and Other Pollutants (62-40.473 (1) (g), FAC)

Assimilation rates for nitrogen and phosphorus compounds were measured during the study year. Nutrient assimilation rates were generally positive for ammonium and nitrate nitrogen and near zero or negative (nutrient gain from runoff and erosion) for organic nitrogen and phosphorus. Correlation analyses were conducted to look for a possible relationship between spring discharge and nitrate and ammonium assimilation. A weak positive correlation (R^2 =0.14) between discharge and ammonium assimilation was observed (**Figure 5-9**). No relationship (R^2 =0.005) between discharge and nitrate nitrogen assimilation was evident over the range of flows experienced during this study (**Figure 5-10**).

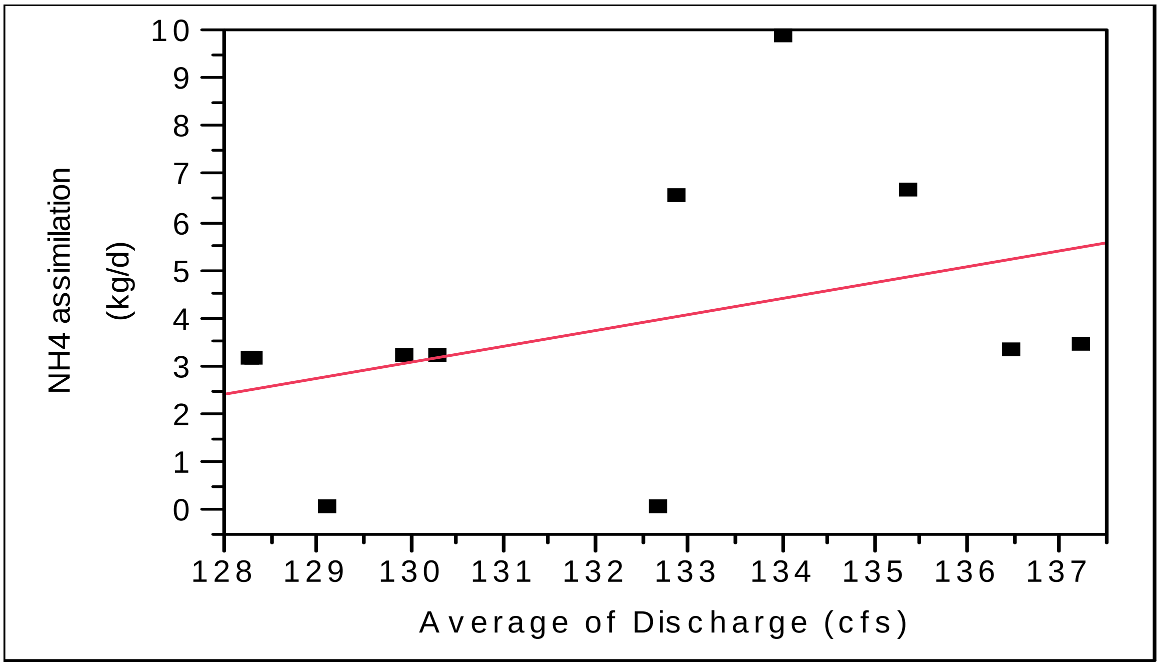


FIGURE 5-9. Relationship between monthly average Blue Spring discharge and ammonium-nitrogen assimilation in the Spring Run during the 2007 / 2008 Water Year.

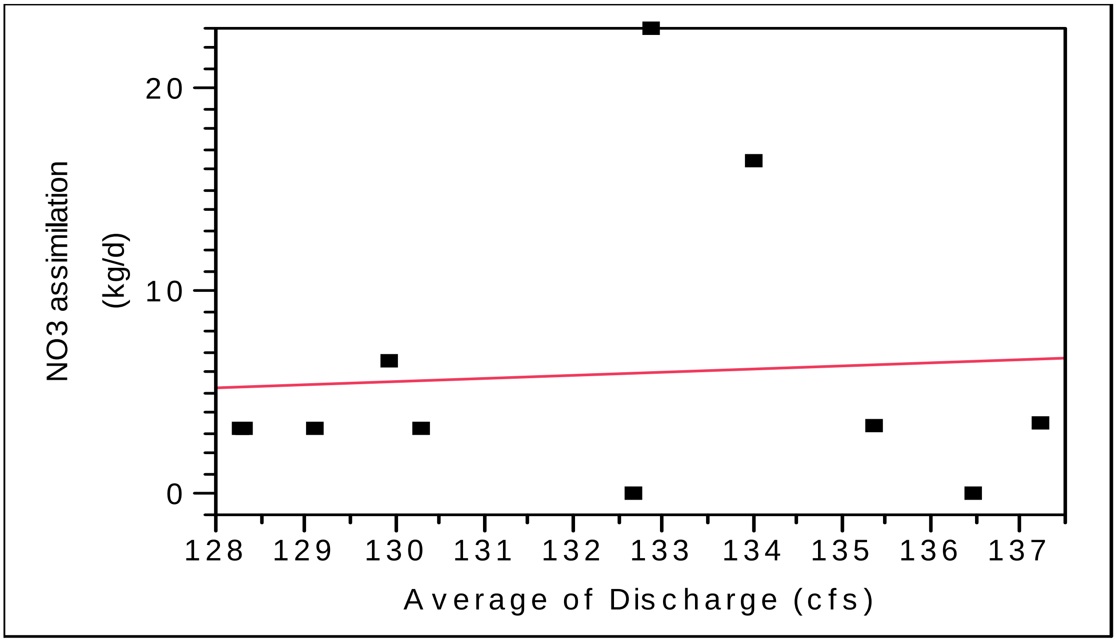


FIGURE 5-10. Relationship between monthly average Blue Spring discharge and nitrate-nitrogen assimilation in the Spring Run during the 2007 / 2008 Water Year.

5.2.6 Sediment loads (62-40.473 (1) (h), FAC)

As noted in section 5.2.3, there were no significant relationships observed between the downstream export of particulate material and the corresponding discharge values. This is likely due to the large variation in particulate export rates that appear to be dependent on in-water recreation.

5.2.7 Water Quality (62-40.473 (1) (i), FAC)

The long-term data set for Blue Spring water quality was correlated with discharge to look for possible relationships (**Figures 5-11** to **5-14**). Several significant correlations were observed. The following water quality parameters were positively correlated with discharge: nitrate and total nitrogen. Several relatively conservative water quality parameters were negatively correlated with discharge: chloride, total dissolved solids, specific conductance, hardness, alkalinity, and ammonium. Water quality parameters that showed no correlation with flow over the range of observed data included the following: water temperature, pH, color, organic nitrogen, and phosphorus. If these correlations hold true over a broader range of spring flows, it is possible that low flows below those authorized by the Blue Spring MFR may result in lower nitrate nitrogen concentrations while possibly exceeding the specific conductance water quality standard.

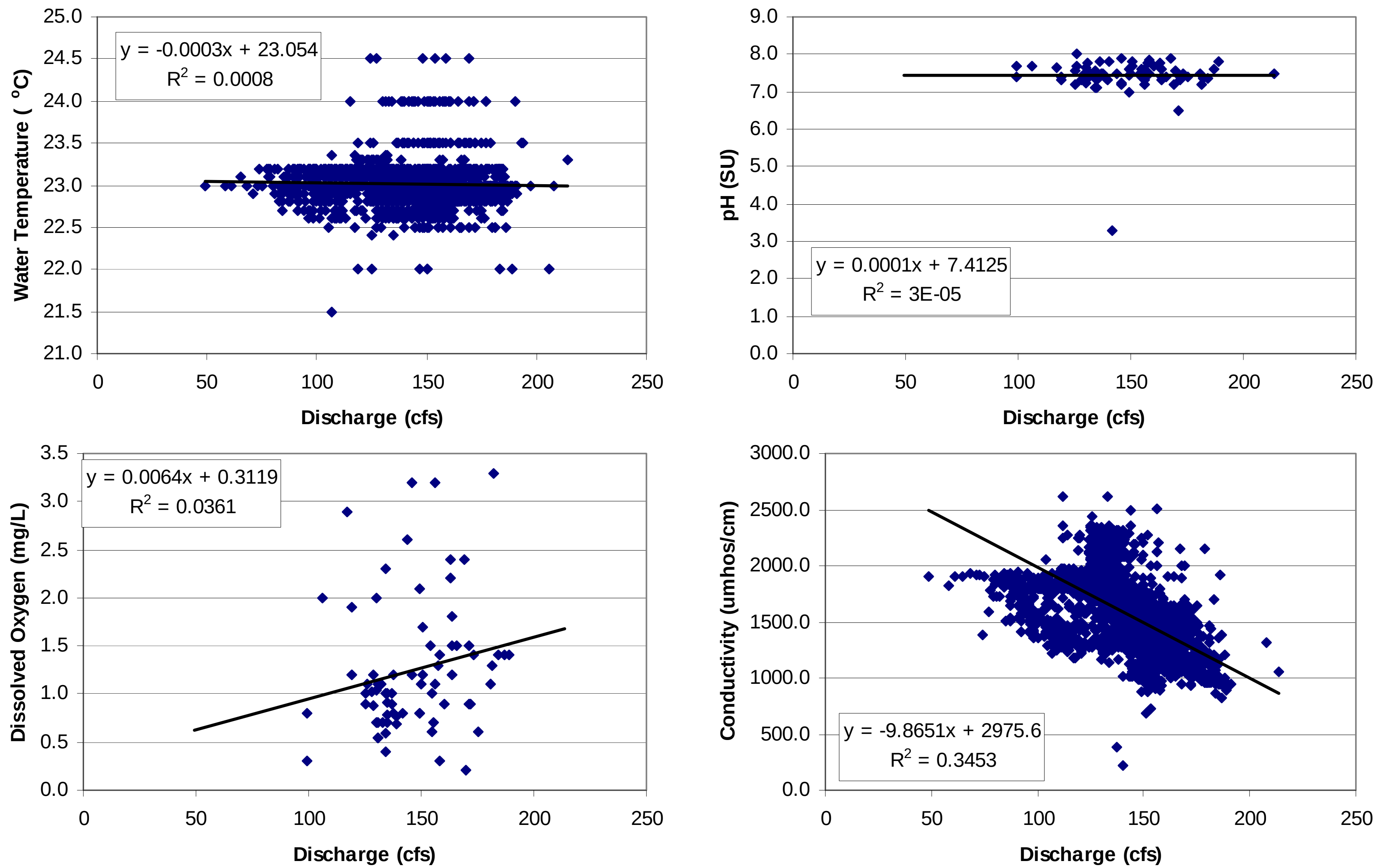


FIGURE 5-11. Blue Spring – Correlation analysis of discharge and water temperature, pH, dissolved oxygen, and specific conductance (data from USGS).

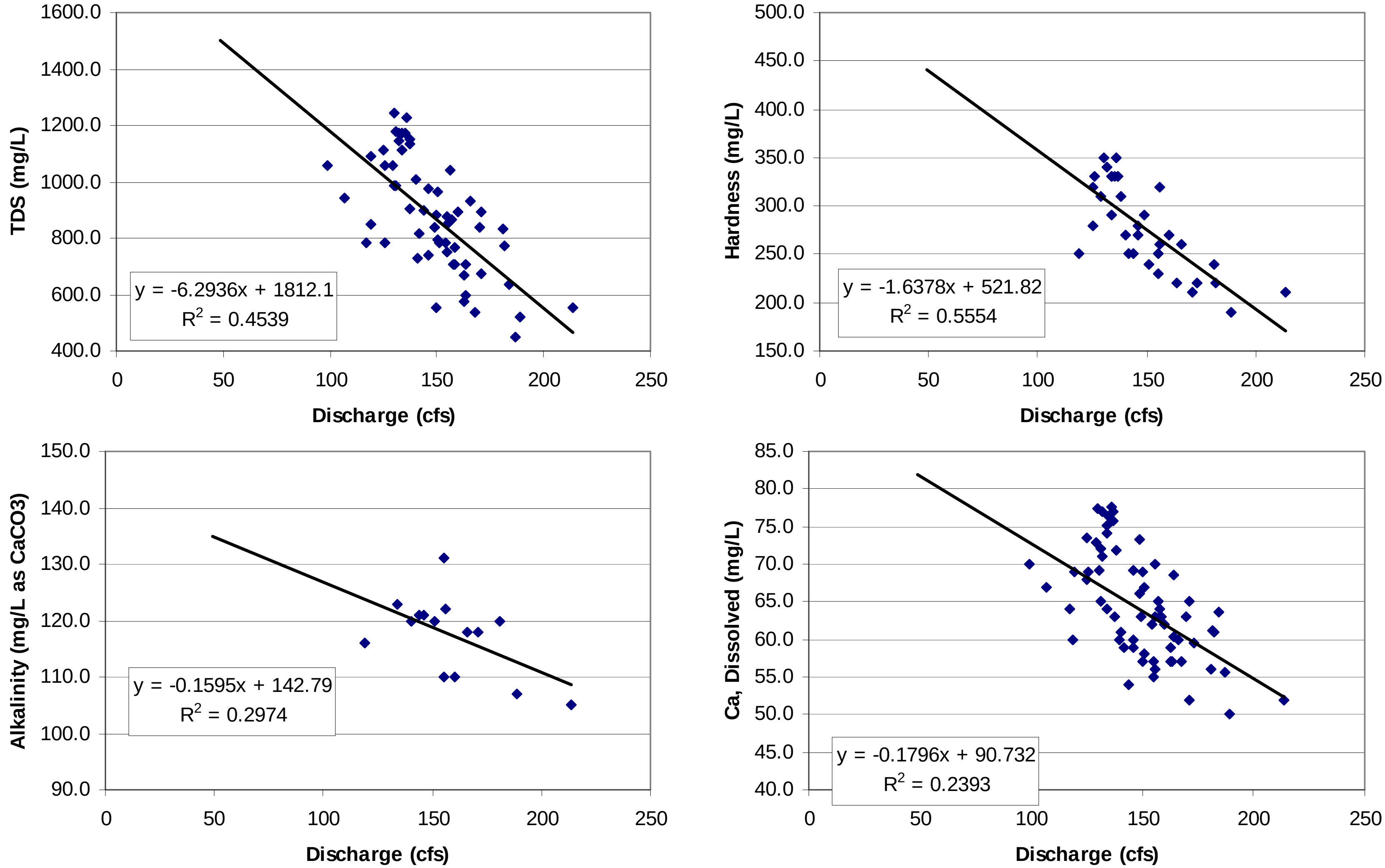


FIGURE 5-12. Blue Spring – Correlation analysis of discharge and total dissolved solids, hardness, alkalinity, and calcium (data from USGS).

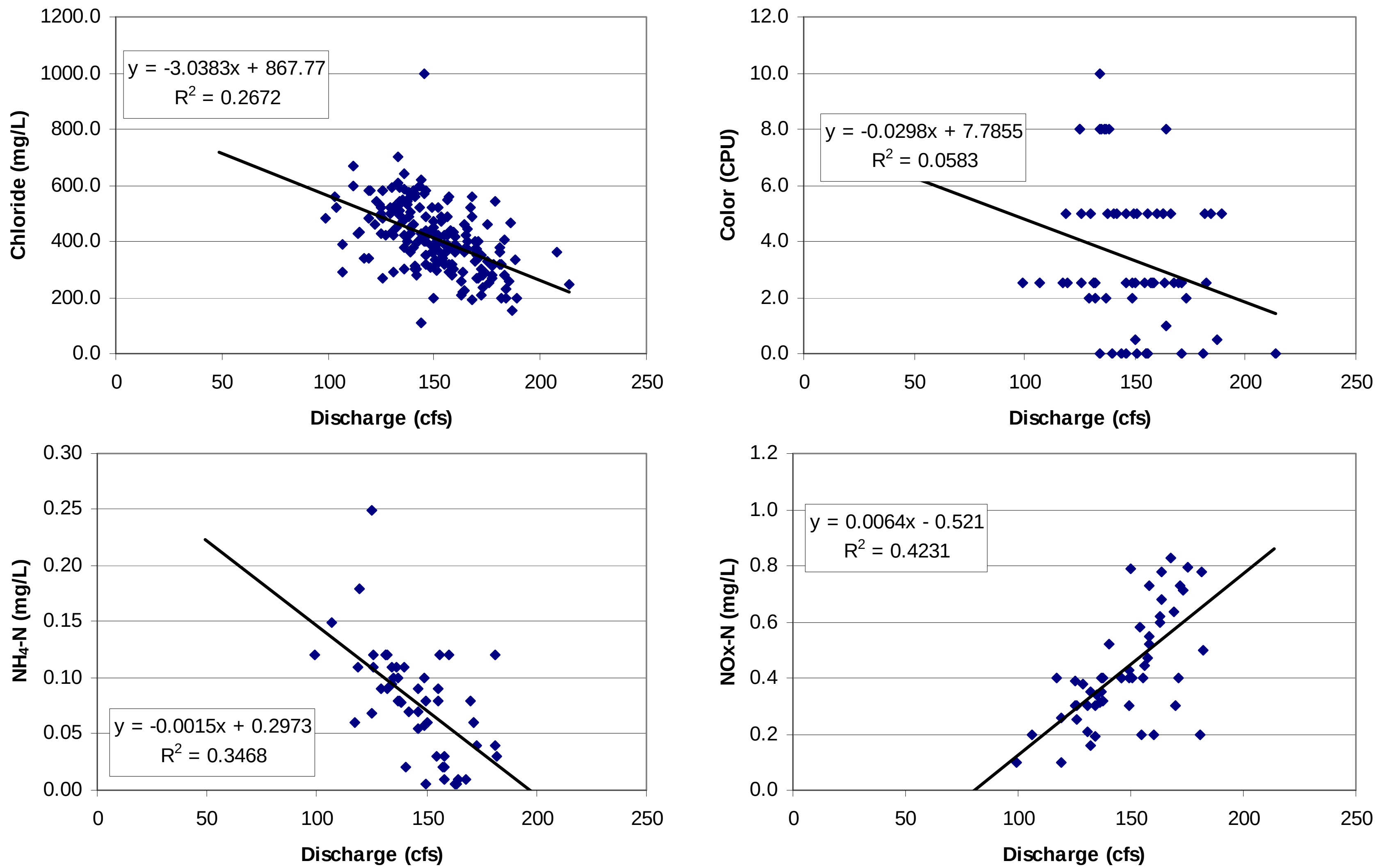


FIGURE 5-13. Blue Spring – Correlation analysis of discharge and chloride, color, ammonia, and nitrate (data from USGS).

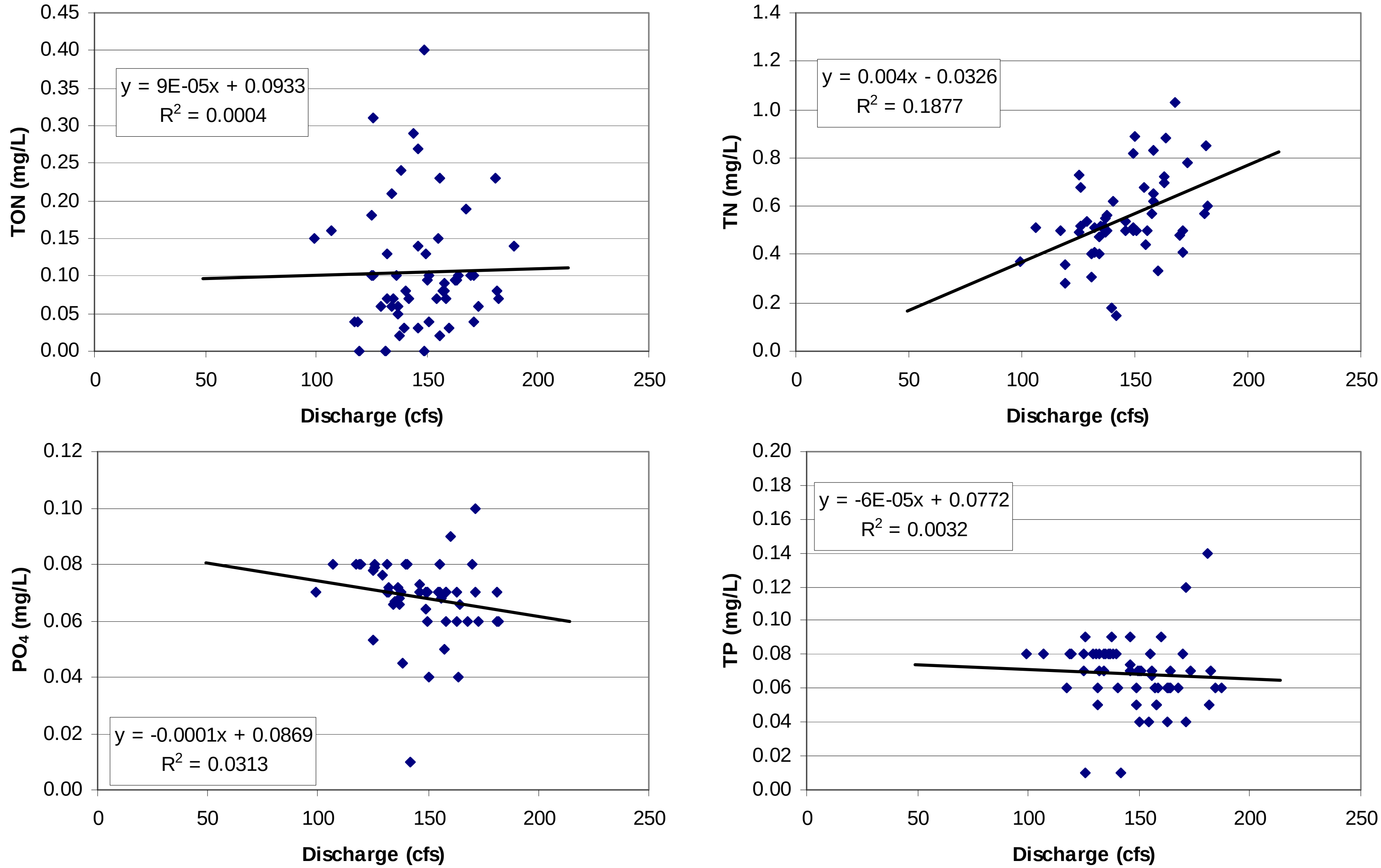


FIGURE 5-14. Blue Spring – Correlation analysis of discharge and total organic nitrogen, total nitrogen, orthophosphate, and total phosphorus (data from USGS).

6.0 Summary, Conclusions, and Recommendations

6.1 Compliance with the Blue Spring MFR Requirements

Quantitative monitoring of the relevant WRVs has resulted in several preliminary observations. Specific areas of possible interest include the following:

- The increasing trend in manatee use of Blue Spring as a winter, warm water refuge necessitated that the District adopt a phased minimum flow regime for Blue Spring to accommodate the anticipated increase in the West Indian Manatee population. Because the observed maximum daily manatee count has exceeded projected counts by approximately 23%, on average, during the last three manatee seasons, the District recommends that the MFR computational process be verified in 2011, based on the most current data. The District will use this information to evaluate whether an amendment to the applicable provision of Chapter 40C-8, FAC, is warranted.
- Data appear to indicate that the Stream Condition Index (widely used by FDEP to assess the health of freshwater aquatic ecosystems) is significantly improved with increased flows.
- Although fish diversity increases somewhat at lower flows within the narrow range observed during the study, this variation is likely due to seasonal changes.
- Ecosystem metabolism data collected during this year may indicate a slight reduction in ecological efficiency of the aquatic producers with declining flows. Community respiration in the upper portion of the spring reach also appears to be dependent on flow, possibly indicating a reduced biological activity when flows are lower.
- Lower flows appear to result in the discharge of greater proportions of older and saltier water from the aquifer feeding Blue Spring. This effect may lead to a negative impact on freshwater organisms dependent on low salinities but may actually contribute to higher fish diversity in the run, presumably due to a greater influx of salt tolerant species.
- Lower flows also appear to create a possible water quality benefit by having lower nitrate nitrogen concentrations, once again presumably due to older water escaping from the aquifer.

6.2 Additional Specific Conclusions

6.2.1 Assessment of manatee body condition/health

Refine and update the protocols and evaluation scales to assess the level of cold stress skin lesions and general manatee body condition and health, and construct a database to permanently store field observations. Additionally, the analytical process to assess future cold stress impacts should be thoroughly described.

6.2.2 Remote Sensing of Manatee Occurrence - Manatee Distribution and Packing Densities

Design and implement a systematic manatee season monitoring protocol to quantify manatee packing density and manatee distribution patterns within the Blue Spring Run with hand-held digital cameras. Remote sensing surveys should be collected to coincide with the annual statewide manatee Synoptic Surveys. These data should be used to verify the manatee carrying capacity model developed by the District. The sampling protocol will be established through cooperative efforts of the District, DEP, FWC, and USFWS.

6.2.3 FDEP Conclusions

The poor quality macroinvertebrate community present at Blue Spring appeared to be due to low dissolved oxygen and elevated conductivity (both natural conditions) as well as from algal smothering (related to anthropogenic nitrate-nitrate enrichment in the springshed). SCI scores indicated impairment for each sampling station and date.

While both genera of the endemic snails, *Aphaostracon sp*. and *Floridobia sp.* were identified in samples from the Upper Site, and *Floridobia sp*. from the Middle and Lower Sites, species level identifications were not confirmed due to the variability and difficulty in identifying reproductive structures in preserved specimens.

6.2.4 Fish Community

Florida springs are physically more stable than most lotic water bodies, with constant flow, stable water temperature, and relatively consistent water chemistry (Whitford 1956; Hubbs 1995). Streams, on the other hand, present a highly variable matrix of habitat types that, in turn, produce a patchily distributed fish assemblage (Gorman and Karr 1978; Kessler *et al.* 1995; McKinsey and Chapman 1998; Dibble and Harrel 2000). Springs, while comparatively stable, commonly exhibit oxygen concentrations that are low enough to cause stress to many fish species (Bennett 1971; Matthews 1998). The water discharged from many springs, and Blue Spring in particular, can be virtually anoxic due to its groundwater origins. However, dissolved oxygen concentrations can increase with distance in a spring run due to both atmospheric diffusion and photosynthesis of aquatic plants (Odum 1956; Bayster 1996; McKinsey and Chapman 1998). This oxygen gradient can impose a predictable and consistent pattern in the distribution of fish species, as has been observed at Beecher Springs and Singing Springs (Odum and Caldwell 1955; McKinsey and Chapman 1998). Poeciliids typically dominate the low-oxygen headspring and less hypoxic tolerant species accumulate down the length of the run, increasing diversity (Odum and Caldwell 1955; McKinsey and Chapman 1998). However, some small species, *e.g.*, killifish, may be less abundant downstream where potential predator densities are higher, producing an incomplete turnover of species along the length of the run (Odum and Caldwell 1955).

This pattern of increasing diversity along the length of the run with increases in dissolved oxygen can be related to the morphology of the species. Poeciliids possess upturned terminal mouths that allow them to use the air-water interface (McLane 1955; Odum and Caldwell 1955; McKinsey and Chapman 1998), which may be more highly oxygenated than the rest of the water column (Lewis 1970). Species that are typically abundant just downstream from the headspring, such as fundulids and minnows, require higher oxygen concentrations than poeciliids, but their small size allows these fish to use microhabitats with higher oxygen concentrations, such as shallow algal beds (McLane 1955). Larger species, such as centrarchids and gar, occur further downstream where oxygen concentrations are higher (Odum and Caldwell 1955; McKinsey and Chapman 1998). Even though some of these larger species can gulp air (*e.g.*, gar) to supplement the oxygen that they obtain from the water, areas with lower dissolved oxygen concentrations are more stressful to large fish (Wootton 1990).

Similar patterns in fish assemblage composition were observed for Blue Spring. In general, high densities and biomass at the headspring were due to large populations of poeciliids, particularly mosquitofish. Lower densities and biomasses, but higher diversity at stations 2-3 were due to the addition of fundulids, minnows, small centrarchids, etc. to the assemblage and the absence of large predators, such as gar. Finally, the low densities, but high biomasses and diversity at the last two stations represent the presence of larger species with the occasional killifish or mosquitofish. Furthermore, the annual values and the patterns of density, diversity, and functional composition of the fish assemblage in 2007-2008 were comparable to the previous study conducted from 2000-2004. Therefore, this data set represents a good baseline against which to compare the fish abundance and composition patterns under reduced flow regimes.

However, beneath these broad patterns, densities of individual species in Blue Spring varied greatly. Several factors likely contribute to the variability of the fish assemblage. First, the connection with the St. Johns River, which could provide large numbers of immigrants to the spring, likely contributes to the variability in the fish assemblage. Some species were observed only sporadically (*e.g.*, inland silversides) and several species have been observed only on one occasion (snook, *Centropomus undecimalis*; flagfish, *Jordanella floridae*; bluespotted sunfish, *Enneacanthus gloriosus*; blackbanded darter, *Percina nigrofasciata*; and brown hoplo; *Hoplosternum littorale*). Even individuals of relatively common species may use the run sporadically; large predators, like tarpon, gar, and largemouth bass, may have home ranges that are larger than the run (Hill and Grossman 1987). Second, these large predators can easily traverse the length of the run to feed on small fish due to the spring's wide and deep morphology. Sporadic presence or patchy distribution of large predators can have huge effect on the assemblage of smaller prey species, as has been observed in Oklahoma streams (Matthews *et al.* 1994). Although large predatory fish were rarely observed at the uppermost sampling stations, upstream, a large group of tarpon (n=43) was documented at the boil during the fall season of 2007. And overall, twenty species have been observed in the boil since 2000 despite the overwhelming predominance of mosquitofish and sailfin mollies at this station. Most of those twenty species were observed on only one or two occasions, but clearly fish move throughout the run to some degree. Finally, the fish assemblage may be inherently somewhat stochastic. Many species have extensive breeding seasons and/or have multiple spawning events (McLane 1955). Uneven reproductive events, particularly by species which produce large number of offspring, and/or reproduce often, can contribute to the variability in the fish assemblage of Blue Spring.

Given the uniquely stable nature of spring runs (Odum 1956), the fish assemblage may deviate from this baseline with the perturbation of a reduction in discharge. A reduction in discharge should affect flow rate rather than stage (Rouhani *et al*. 2007) and therefore, the retention time of water in the run. An increase in retention time may directly affect 1) the exposure of the oxygen-poor water to oxygen-producing aquatic plants and 2) the exposure of algae to nutrient-enriched spring water. First, an increase in dissolved oxygen may allow species with higher oxygen requirements, such as largemouth bass, more opportunity to foray into regions near the boil, reducing the effectiveness of these areas as refuges. Second, an increase in algal density with an increase in retention of nutrient-rich water (Notestein *et al.* 2003) would appear to provide more invertebrate habitat, but increases in nitrate concentrations in Florida springs have been associated with proliferation of cyanobacteria, such as *Oscillatoria sp*. and *Lyngbya sp* (Stevenson *et al.* 2007). Filamentous cyanobacteria may provide suboptimal habitat for invertebrates in comparison to the filamentous cyanophytes and diatoms that proliferate at lower nutrient concentrations (Biggs 1996). Although the fish species that numerically dominate the fish assemblage are invertebrate generalists (McLane 1955) and most of the invertebrates on which they prey are fairly tolerant *e.g.*, *Chironomus*, (Fox and Taylor 1955, Cowell *et al*. 2004), a change in the density and composition of invertebrates could affect fish assemblage structure. Finally, several exotic species are prominent in Blue Spring. Some species, such as the relatively rare Pacu, may have little overall effect on ecosystem structure and function, but others may have more broad-reaching effects. Both blue tilapia and sailfin suckermouth catfish occasionally enter the run en masse and both species disrupt the substrate either through nest formation or feeding (Courtenay and Robins 1973; Nico and Martin 2001). Grass carp, while relatively few in number and sporadically observed, may impact native fish species indirectly through habitat and resource modification while feeding (Bain 1993). These perturbations may have synergistic effects with the changes in water retention time, water chemistry, and potential faunal changes that may occur with a reduction in discharge.

As seen in the 2000-2004 surveys, fish density and diversity were correlated with dissolved oxygen in 2007-2008. Density of small species (poeciliids and fundulids) was negatively correlated with dissolved oxygen, whereas density of larger species (all species except shiners, silversides, fundulids, and poeciliids) was positively correlated with dissolved oxygen (**Figure 6-1**). Biomass was correlated with dissolved oxygen negatively for small species) and positively for larger fish (**Figure 6-2**). Diversity also was highly correlated with dissolved oxygen; higher diversity occurred at sites with higher dissolved oxygen (**Figure 6-3**).

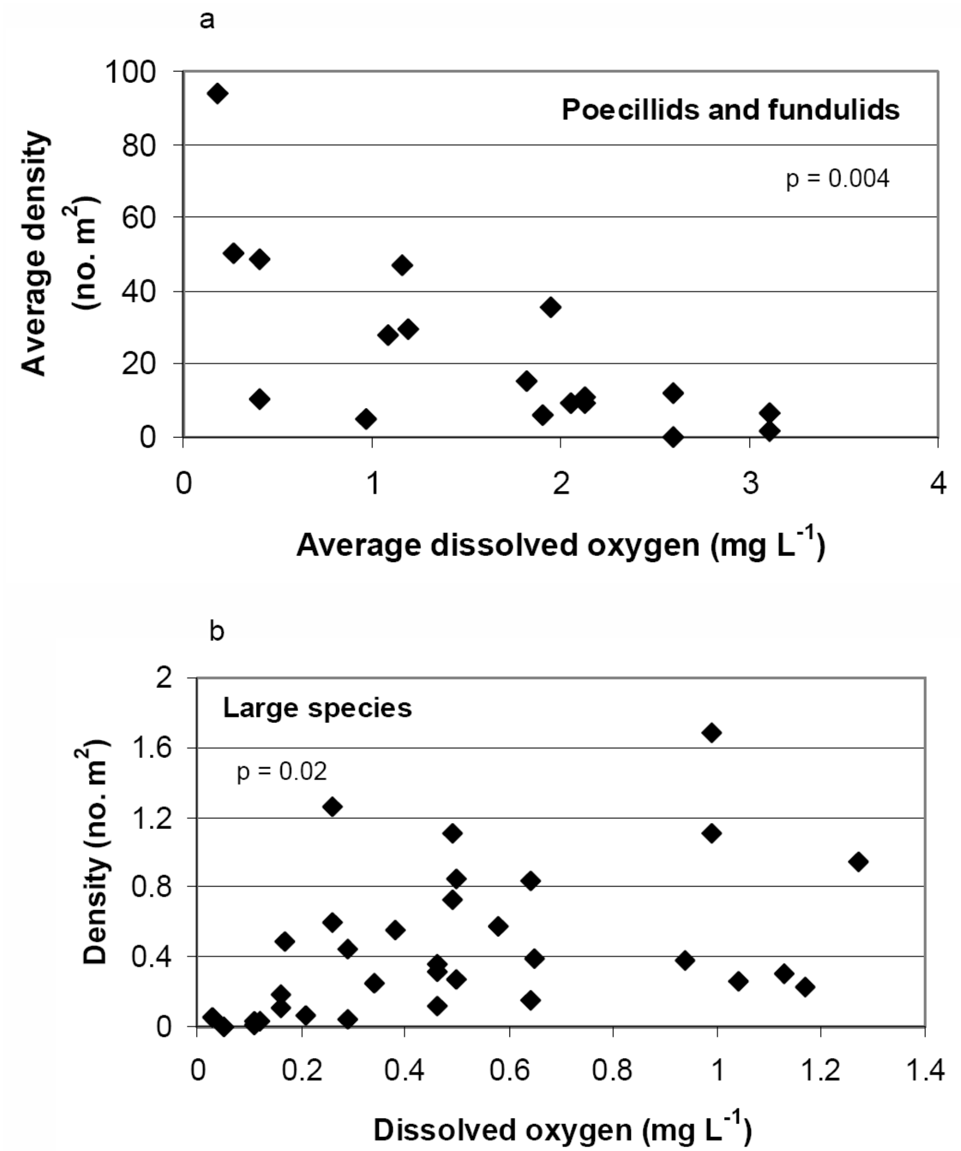


FIGURE 6-1. Relationships between poeciliid and fundulid density with dissolved oxygen (a) and between large species (all species except shiners, silversides, fundulids, and poeciliids) density and dissolved oxygen (b) for Blue Spring in 2007-2008. Data points represent the sum of all species at one station on one date (from Work and Gibbs 2008).

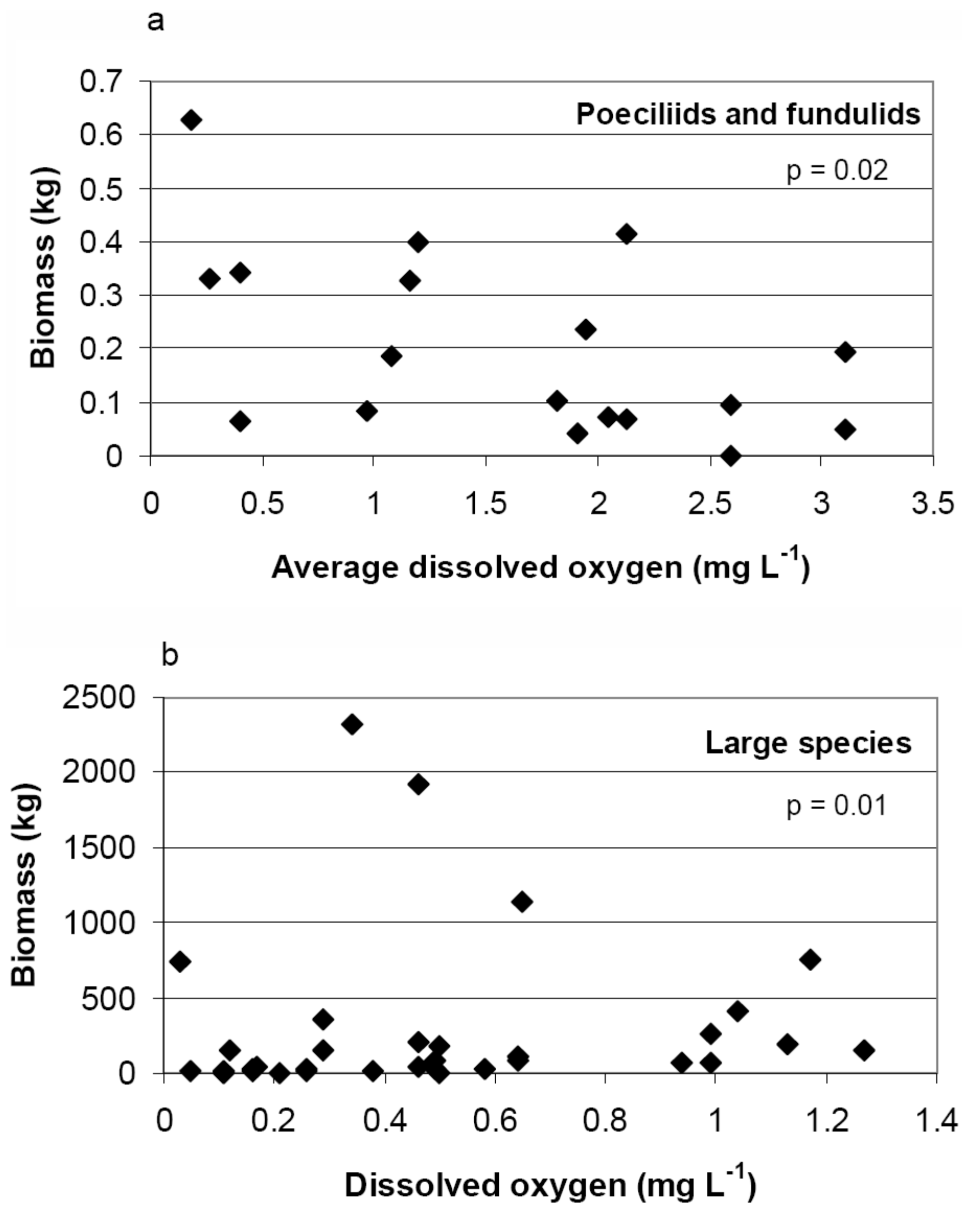


FIGURE 6-2. Relationships between poeciliid and fundulid biomass with dissolved oxygen (a) and between large species (all species except shiners, silversides, fundulids, and poeciliids) biomass and dissolved oxygen (b) for Blue Spring in 2007-2008. Data points represent the sum of all species at one station on one date (from Work and Gibbs 2008).

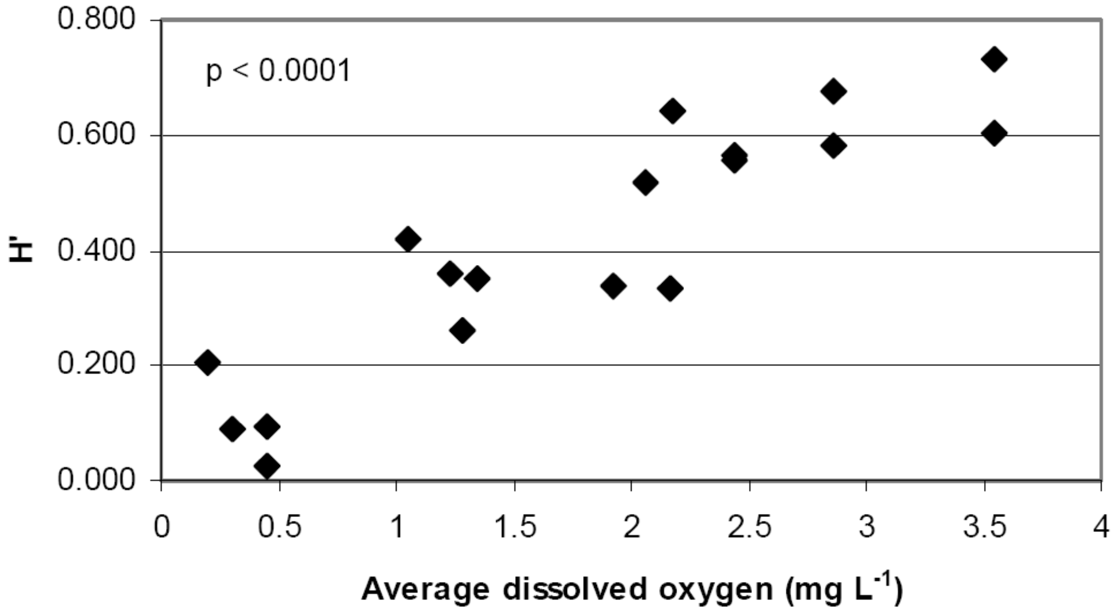


FIGURE 6-3. Relationship between fish diversity and dissolved oxygen for Blue Spring in 2007-2008. Data points represent the diversity of all species at one station on one date (from Work and Gibbs 2008).

6.2.5 Aquatic Turtle Community

It is difficult to predict how changes in the spring flow rate will impact turtle populations. Not only is flow rate likely to change, but water chemistry may also change. Changes in aquatic vegetation and algae are likely to impact populations of herbivorous species, and two of the three most abundant species in the run are herbivorous. Introduced species including armored catfish have also recently entered the run in large numbers and may also impact turtle populations, either by competition for food with herbivorous species, or in the case of the loggerhead musk turtle by impacting their preferred prey (snails). In the face of a variety of environmental changes it will be difficult to ascribe changes in turtle populations to any single cause. It is often difficult to understand environmental impacts on extremely long-lived species like turtles. Changes in reproductive rates, for example, may take many years to produce large changes in population size since successful recruitment to most turtle populations is usually low, and high survivorship among adults can mask several years of diminished reproduction. To understand the extent and causes of changes in turtle populations in the Blue Spring Run, stronger baseline data will be necessary than four sampling periods.

6.3 Data Collection Recommendations

Springs and spring runs are as close to steady-state or constant environments as any aquatic ecosystem in Florida (Odum 1957a). As such, some measurements can be made once or a few times and then be used to reliably predict future conditions. A good example is water temperature in a spring boil (thermostatic). Another example is water chemistry (chemostatic). Even more complex whole ecosystem measurements such as GPP are remarkably consistent (see the comparison above between the recent data and Odum's measurement 50 years earlier).

The understanding of relations between spring discharge and WRVs will be enhanced through the continued collection of empirical data from Blue Spring. The established schedule of long-term sampling at this site will support the collection of these data. Long-term sampling will incorporate intensive sampling every five years and base-line monitoring during interim time periods. Benefits to adhering to this sampling plan include: 1) stochastic weather events (*e.g.,* hurricanes and droughts) are more likely to be captured and therefore expand the range of conditions under which data may be extrapolated; 2) the response of Blue Spring to springshed conditions can be observed; and 3) the manatee population utilizing Blue Spring Run during the winter season appears to be increasing and maintaining an adequate thermal refuge will continue to remain a priority. Based on the results included in this report it appears that all existing sampling techniques are justified and should continue to be pursued on at least a five-year schedule.

There is no doubt that increased knowledge about the relationship of Blue Spring discharge to the various WRVs would be accelerated through more frequent monitoring for some parameters. Water clarity in spring ecosystems can be assessed through horizontal Secchi measures and monthly or quarterly monitoring of this parameter could be easily accomplished. Water quality parameters are especially sensitive to flow changes and are among the most cost effective measurements to collect. For this reason it is recommended that quarterly water quality sampling at all three stations be continued each year. These data would be significantly enhanced if a continuous record of dissolved oxygen and specific conductance were added to the USGS recording data station. For this reason it is recommended that the existing data sonde be upgraded to include dissolved oxygen to the list of parameters collected. In terms of biological data there are two faunal groups that appear to be most responsive to flows. These are the macroinvertebrates and the fish. For this reason it is recommended that macroinvertebrate and fish monitoring be extended to quarterly in every year rather than one year in five.

Based on these considerations, the revised recommended monitoring plan for Blue Spring is summarized in **Table 6-1**. This plan still includes the most intensive sampling during every fifth water year but also includes a reasonable level of routine sampling during every year.

TABLE 6-1. Summary of the revised recommended monitoring plan for Blue Spring.

Parameter Group	Subcategory	SOP	Sampling Locations	Frequency	Description
Physical & Chemical Conditions Monitoring					
Hydrological & meteorological	Spring discharge	USGS (Shelton 2005)	VBS 520-330	Daily and Monthly	Monthly and daily spring discharges and daily spring stages
	Bottom temperature profile	Provisional	VBS 630-460	Hourly	Hourly spring run bottom temperatures recorded at 10 meter (m) intervals
	Weather data		Near spring run	Hourly	Continuous measurements of air temperature, barometric pressure, St. Johns River temperature upstream of confluence with Blue Spring, precipitation, relative humidity, insolation, and photosynthetically active radiation (PAR)
Water Quality	Field Meters	DEP FT 1000, 1100, 1200, 1400, 1500, 1700 USGS (Kroening 2003*)	VBS 10, 330, 520	Monthly, during intensive sampling (one year in five), and quarterly during intervening years	Water temperature, pH, specific conductance, conductivity, dissolved oxygen, light penetration - one sample per event
	Recording Data Sondes	DEP FT 1900	VBS 35, 355, 570	Six times, one year in five; Hourly at VBS 330	Water temperature, pH, specific conductance, conductivity, dissolved oxygen - continuous hourly values for about 2 weeks per event; hourly temperature, conductivity, and dissolved oxygen at VBS 330 (USGS station)
	Analytical Parameters	DEP FS 2000, 2100 (Kroening 2003*)	VBS 10, 330, 520	Monthly, during intensive sampling (one year in five), and quarterly at VBS 330 during intervening years	Calcium, silica, sulphate, magnesium, chlorides, sodium, alkalinity, ammonia N, nitrate+nitrite N, total kjeldahl N, ortho P, total dissolved P, total P - grab samples
Bottom contour mapping	Bathymetric mapping	Provisional	Spring run	NA	Spring run bottom contour elevation mapping
Manatee Population and Behavior Monitoring					
Manatee population	Manatee biology	Provisional	Spring run	Daily, November - March	Monitor individual manatee attendance and provide maximum one-day count. Refine/update the protocols and evaluation scales to assess the level of cold stress skin lesions and the general manatee body condition/health be refined, and construct a database to permanently store field observations.
Remote sensing	Manatee biology	NA	Spring run	Daily, November - March	Quantify manatee packing density and manatee distribution patterns with hand-held digital cameras.
Water Resource Values Monitoring					
General Biological Structure	Periphyton / Algae	DEP FS 7000, LT 7000	VBS 10-110, 210-310, 420-520	Quarterly, one year in five	Percent cover and macroscopic analysis of dominant phyla
	Plants	Provisional	VBS 10-110, 210-310, 420-520	Quarterly, one year in five	Percent cover of aquatic macrophytes and canopy
	Macroinvertebrates	DEP FT 3000	VBS 10-110, 210-310, 420-520	Quarterly all years	Species diversity and dominance estimates
	Mollusks	Provisional	VBS 10-110, 210-310, 420-520	Quarterly, one year in five	Species diversity and dominance estimates
	Fish	Provisional	VBS 10-110, 110-210, 210-310, 310-410, 410-520	Quarterly all years	Species diversity and dominance estimates
	Turtles	Provisional	VBS 10-110, 110-210, 210-310, 310-410, 410-520	Quarterly, one year in five	Species diversity and dominance estimates
Ecosystem Function	Ecosystem metabolism	Provisional	VBS 35-355, 355-5720	Six times, one year in five	Gross and net primary productivity, community respiration, P/R ratio, ecological efficiency
	Particulate export	Provisional	VBS 10-330, 330-520	Six times, one year in five	Net export of particulate matter (inorganic and organic)
	Oxygen Diffusion	Provisional	VBS 10-330, 330-520	Six times, one year in five	Needed to correct upstream-downstream dissolved oxygen rate-of-change estimates for atmospheric oxygen exchanges
	Pollutant assimilation	Provisional	VBS 10-330, 330-520	Monthly, one year in five	Net changes of mass loads of nitrate N, total N, ortho P, and total P
Human Use	Total human use	Provisional	Spring boil and run	One year in five	Human-use days associated with the park and the spring run
	Water contact use	Provisional	Spring boil and run	One year in five	Human-use days for water contact activities (wading, swimming, snorkeling, scuba diving, etc.)
	Aesthetics	Provisional	Spring boil and run	One year in five and monthly/quarterly for Secchi	Qualitative exit surveys of visitors and horizontal Secchi disk measures for water clarity.

* http://water.usgs.gov/owq/FieldManual/

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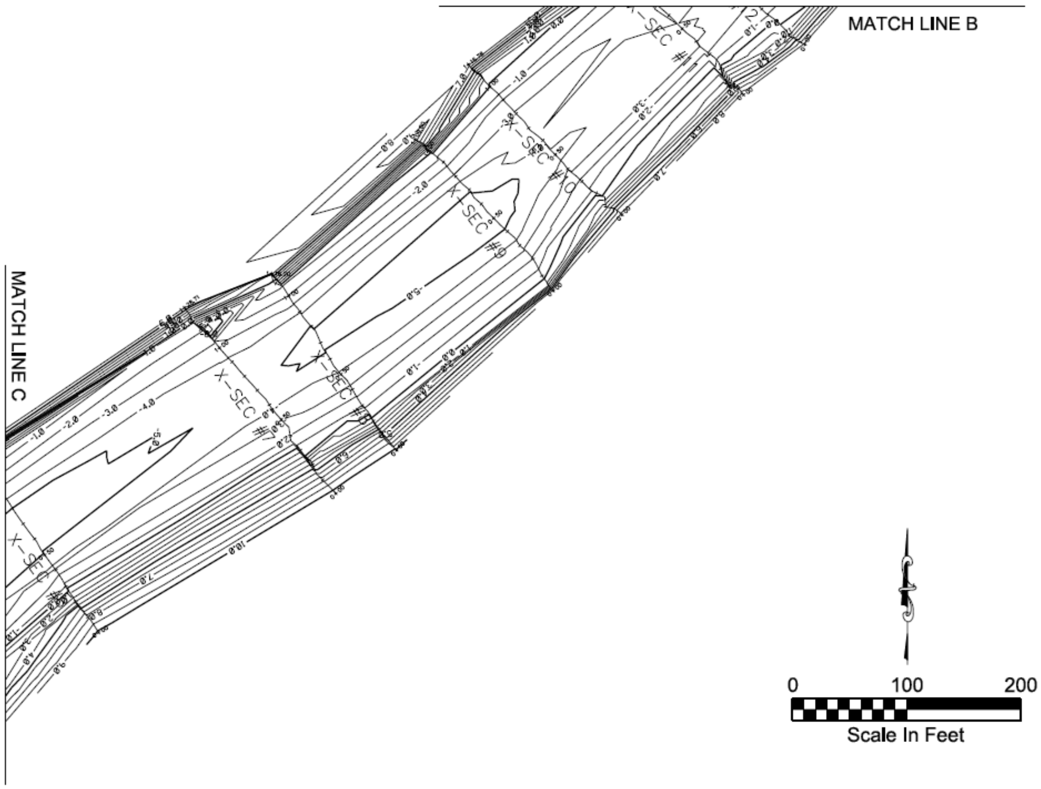
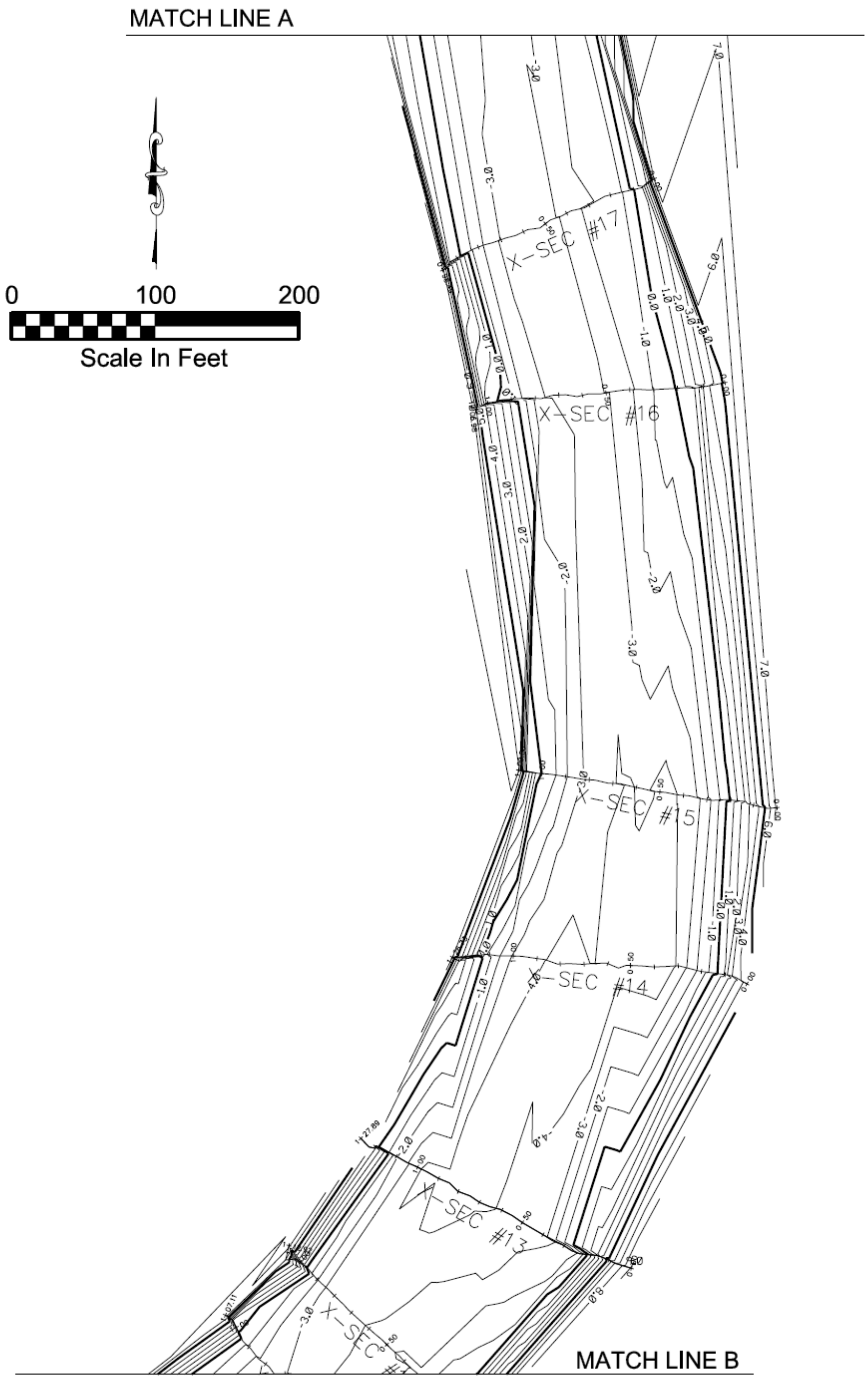
Appendix A

Blue Spring and Blue Spring Run Bathymetry and Transect Cross-Sections (from SJRWMD Division of Surveying Services)

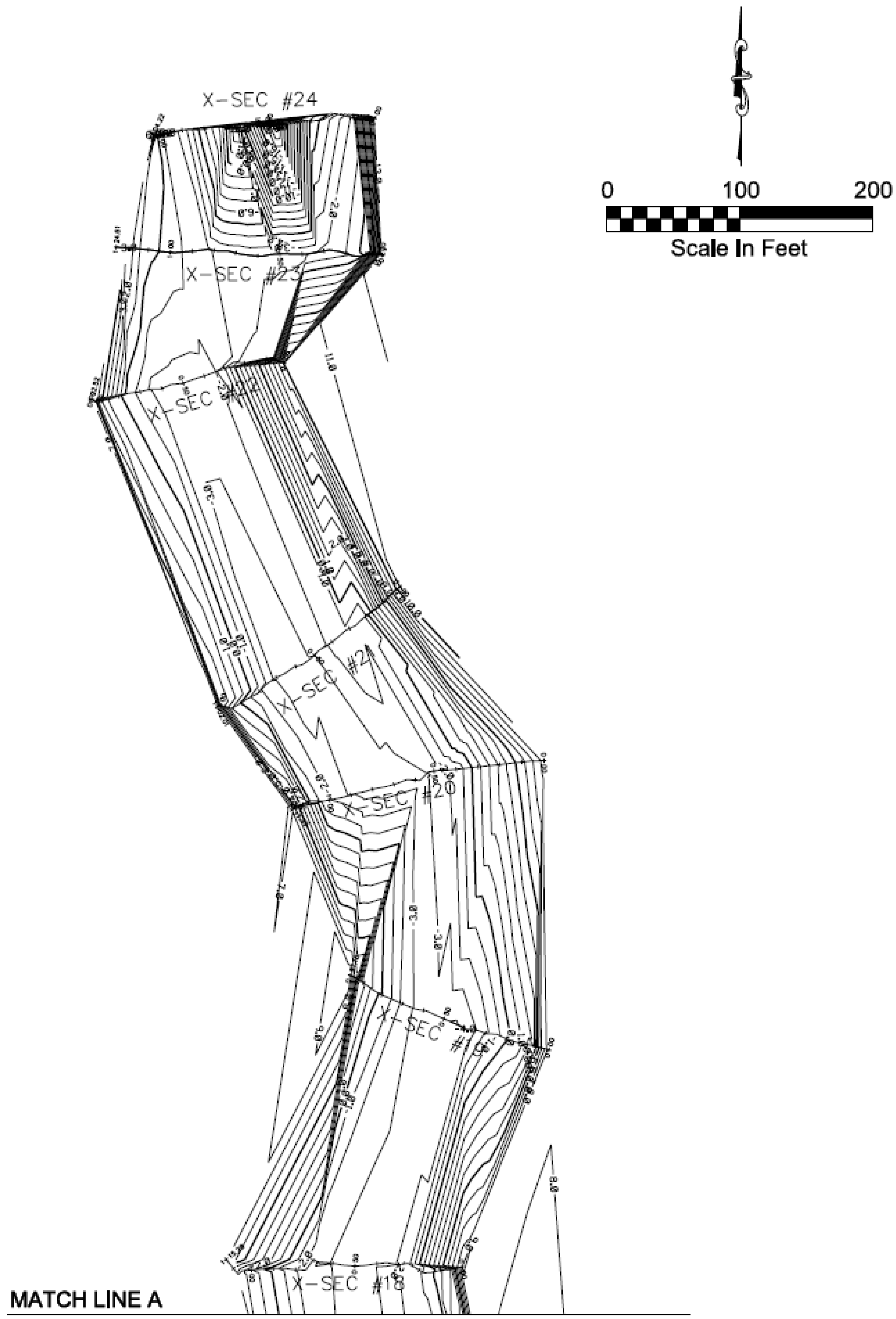
APPENDIX A. Blue Spring Run bathymetry cross-sections 1 through 5 (from SJRWMD).



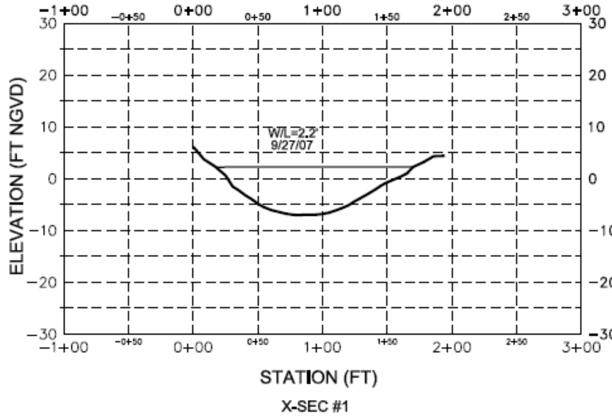
APPENDIX A. Blue Spring Run bathymetry cross-sections 6 through 11 (from SJRWMD).

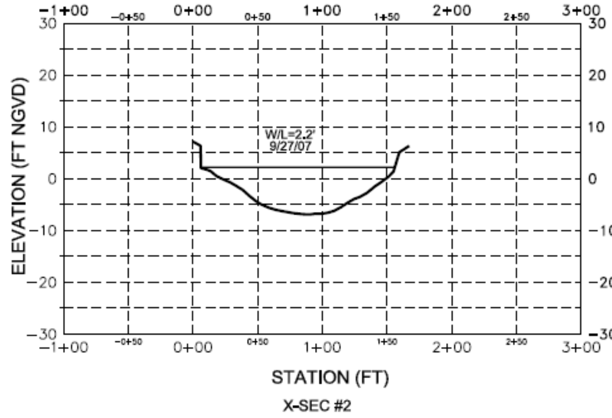


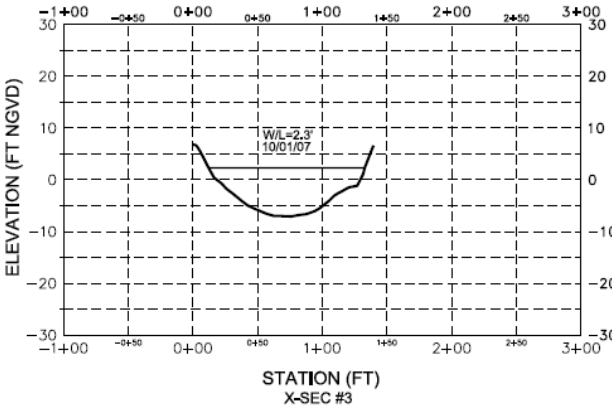
APPENDIX A. Blue Spring Run bathymetry cross-sections 12 through 17 (from SJRWMD).

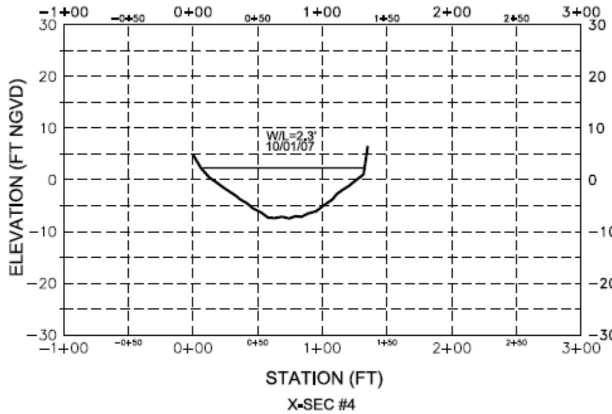


APPENDIX A. Blue Spring and Blue Spring Run bathymetry cross-sections 18 through 24 (from SJRWMD).

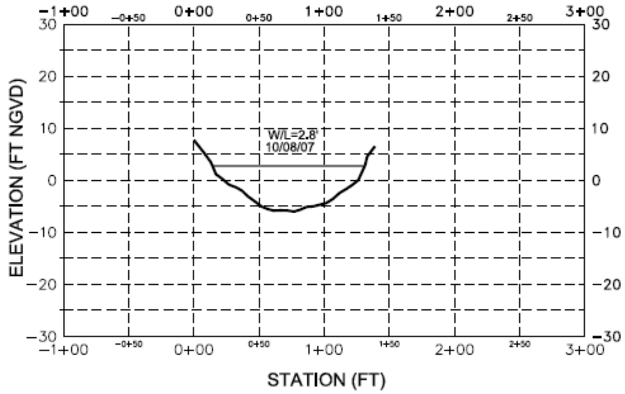








APPENDIX A. Blue Spring Run bathymetry cross-sections 1 through 4 (from SJRWMD).



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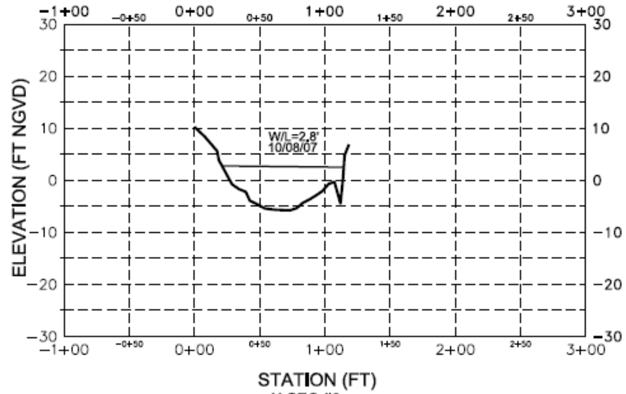

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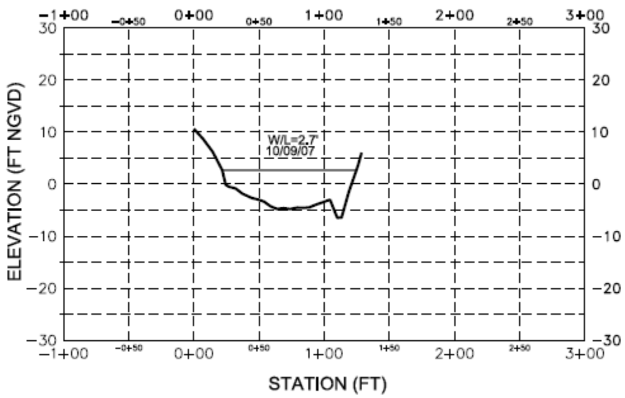

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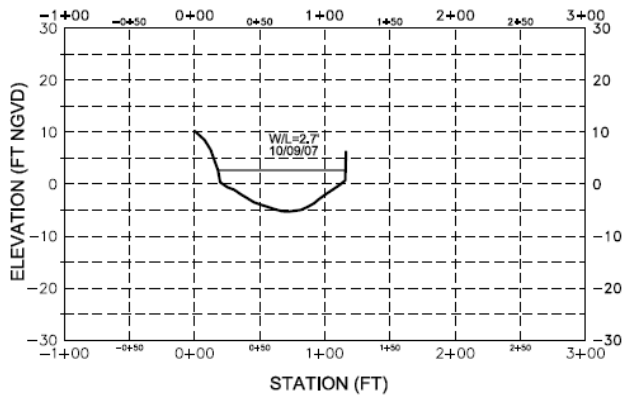
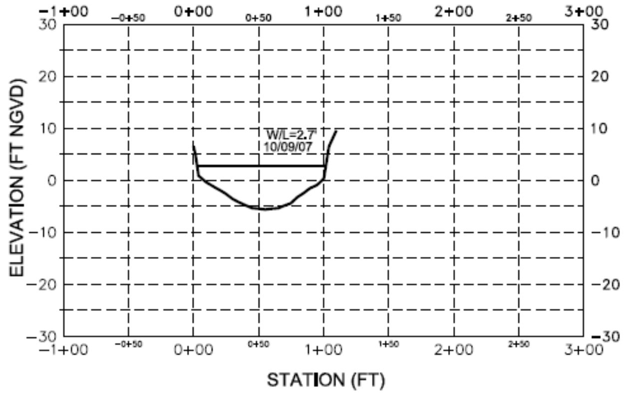


X-SEC #8

APPENDIX A. Blue Spring Run bathymetry cross-sections 5 through 8 (from SJRWMD).



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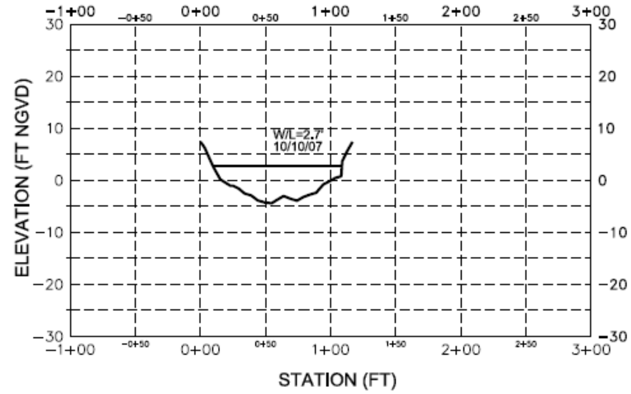

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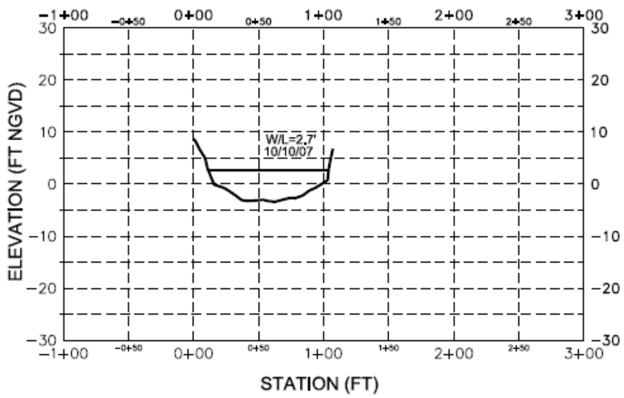

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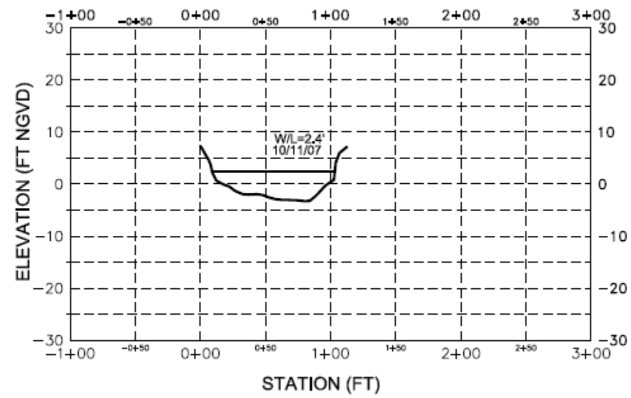

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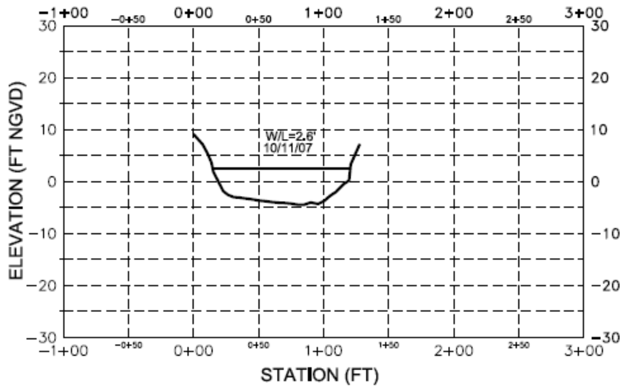
APPENDIX A. Blue Spring Run bathymetry cross-sections 9 through 12 (from SJRWMD).



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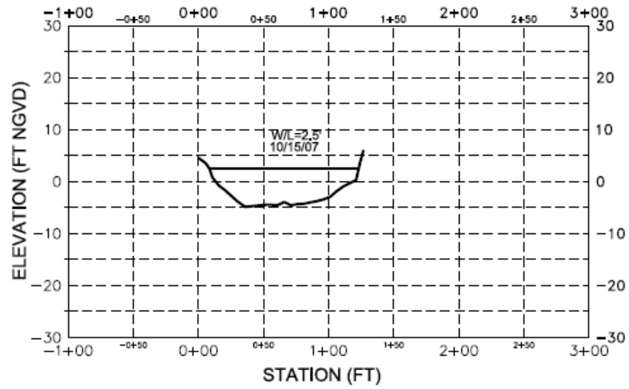

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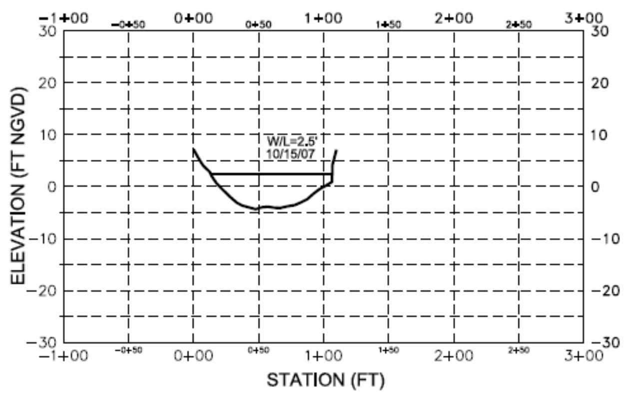

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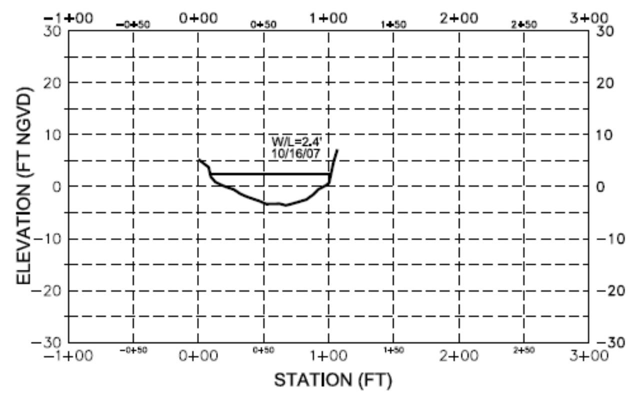

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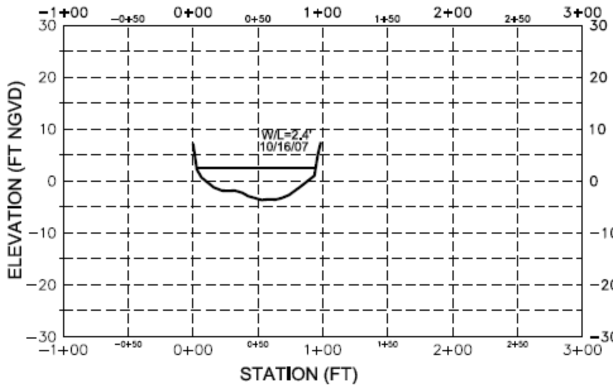
APPENDIX A. Blue Spring Run bathymetry cross-sections 13 through 16 (from SJRWMD).



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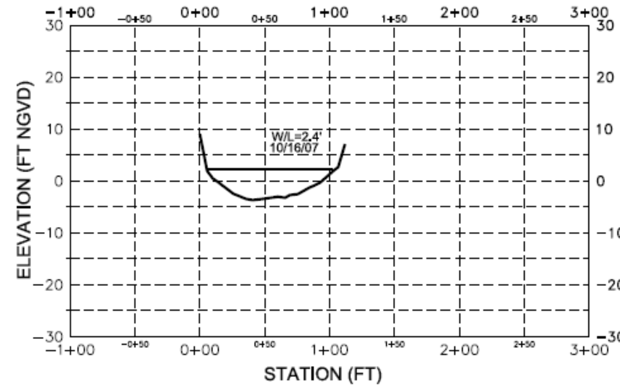

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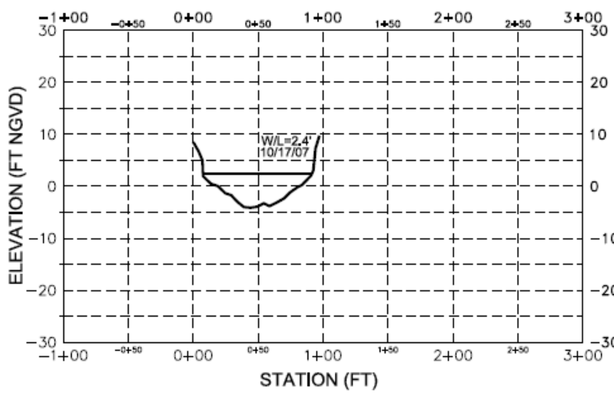

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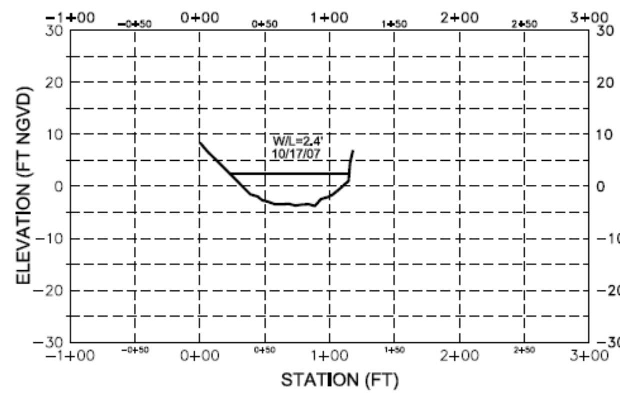

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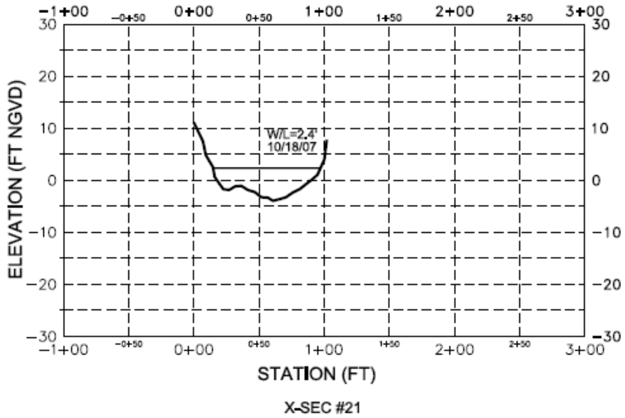
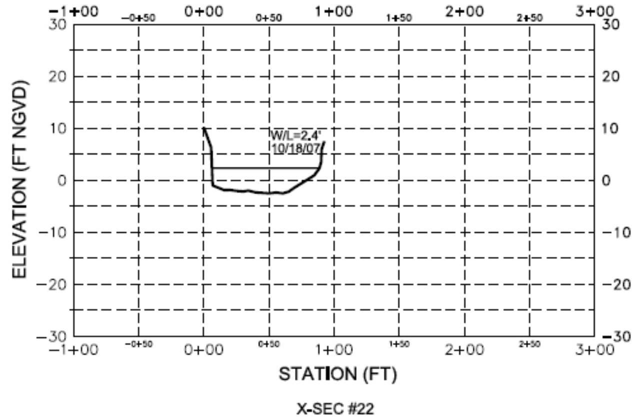
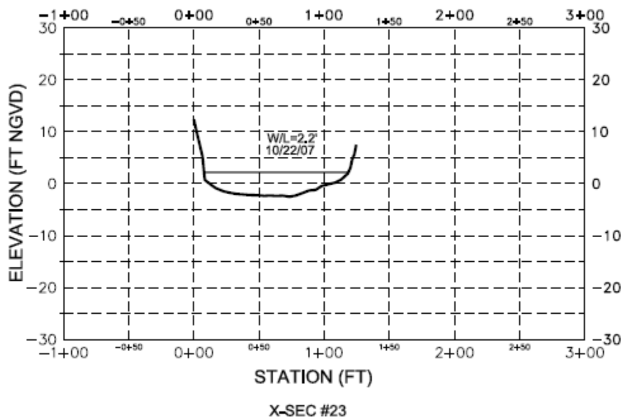
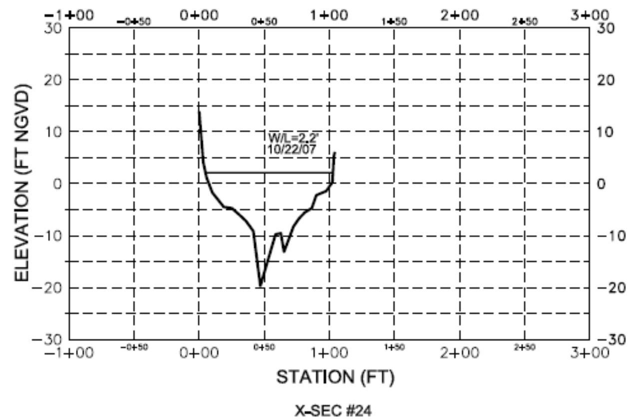
APPENDIX A. Blue Spring Run bathymetry cross-sections 17 through 20 (from SJRWMD).









APPENDIX A. Blue Spring and Blue Spring Run bathymetry cross-sections 21 through 24 (from SJRWMD).

Appendix B

Blue Spring Water Quality Data (from USGS and WSI)

APPENDIX B. Blue Spring water quality data (from USGS and WSI).

GROUP DESC	PARAMETER	PARAMETER_UNITS	MMDDYY	VBS-10	VBS-35	VBS-355	VBS-500	VBS-570	VBS-620
DISSOLVED OXYGEN	DO	%	12/18/07		0.00	12.0		19.0	
			2/25/08		0.00	11.0		16.0	
			7/22/08		13.0	13.0		13.0	
			8/27/08		3.00	7.00		23.0	
			11/13/07		1.20	6.35		6.83	
			11/27/07	0.300	1.10	8.45		9.90	
			12/6/07		1.00	6.80		11.7	
			12/20/07			8.00		10.9	
			1/22/08		1.30	6.50		9.70	
			3/18/08		1.60	8.90		12.9	
			4/1/08		1.50	9.20		14.1	
			5/8/08		1.65	10.5		15.2	
			5/23/08		1.70	12.3		25.7	
			6/24/08		2.15	12.2		20.8	
			7/8/08		1.60	10.7		17.1	56.5
			8/5/08		5.40	11.9	15.3	19.5	
			8/29/08		2.05	6.45		6.60	
	DO	mg/L	11/13/07		0.110	0.538		0.580	
			11/27/07	0.020	0.100	0.700		0.840	
			12/6/07		0.080	0.590		0.990	
			12/20/07			0.680		0.930	
			1/22/08		0.110	0.550		0.830	
			3/18/08		0.140	0.760		1.09	
			4/1/08		0.130	0.780		1.19	
			5/8/08		0.140	0.880		1.29	
			5/23/08		0.140	1.04		2.18	
			6/24/08		0.185	1.03		1.81	
			7/8/08		0.140	0.910		1.44	4.36
			8/5/08		0.457	1.01	1.29	1.64	
			8/29/08		0.175	0.550		0.515	
			10/29/07		0.100	0.400		0.500	
			11/29/07		0.100	0.700		0.800	
			12/18/07		0.100	1.00		1.60	
			1/30/08		0.00	1.10		0.800	
			2/25/08		0.100	0.900		1.40	
			3/31/08		0.100				
			4/28/08		0.100	0.700		1.10	
			5/29/08		0.200	1.00		1.40	
			6/25/08		0.200	1.20		1.90	
			7/22/08		1.10	1.10		1.10	
			8/27/08		0.200	0.600		1.80	
			9/30/08		0.500	0.700		0.800	
FLOW	Flow-Inst	cfs	10/29/07		134			132	
			11/29/07		127			130	
			12/18/07		135			140	
			1/30/08		135			137	
			2/25/08		141	139		139	
			3/31/08		139			135	
			4/28/08		125	128		127	
			5/29/08		121	126		127	
			6/25/08		130	130		131	
			7/22/08		128	130		130	
			8/27/08		117	117		135	
			9/30/08		136	136		136	

APPENDIX B. Blue Spring water quality data (from USGS and WSI).

GROUP DESC	PARAMETER	PARAMETER_UNITS	MMDDYY	VBS-10	VBS-35	VBS-355	VBS-500	VBS-570	VBS-620
GENERAL INORGANIC	Cl-T	mg/L	10/29/07		540	540		538	
			11/29/07		549	549		549	
			12/18/07		533	533		522	
			1/30/08		526	534		534	
			2/25/08		547	545		545	
			3/31/08		585	584		594	
			4/28/08		590	591		592	
			5/29/08		521	519		520	
			6/25/08		492	497		493	
			7/22/08		543	271		497	
			8/27/08		562	519		283	
			9/30/08		221	223		165	
	CO2	mg/L	10/29/07		13.0	13.0		13.0	
			11/29/07		14.0	13.0		13.0	
			12/18/07		14.0	13.0		13.0	
			1/30/08		18.0	15.0		16.0	
			2/25/08		16.0	15.0		15.0	
			3/31/08		10.0				
			4/28/08		7.50	6.90		6.60	
			5/29/08		16.0	13.0		13.0	
			6/25/08		17.0	15.0		13.0	
			7/22/08		16.0	16.0		14.0	
			8/27/08		21.0	17.0		38.0	
			9/30/08		15.0	15.0		17.0	
	F-D	mg/L	10/29/07		0.100	0.090		0.090	
			11/29/07		0.070	0.070		0.070	
			12/18/07		0.140	0.120		0.150	
			1/30/08		0.090	0.090		0.100	
			2/25/08		0.090	0.110		0.090	
			3/31/08		0.100	0.110		0.110	
			4/28/08		0.070	0.090		0.070	
			5/29/08		0.090	0.100		0.090	
			6/25/08		0.090	0.080		0.080	
			7/22/08		0.130	0.105		0.150	
			8/27/08		0.110	0.100		0.090	
			9/30/08		0.060	0.060		0.070	
	Hardness	mg/L as CaCO3	10/29/07		320	330		330	
			11/29/07		330	330		320	
			12/18/07		340	330		330	
			1/30/08		330	340		330	
			2/25/08		330	330		340	
			3/31/08		340	350		340	
			4/28/08		340	350		350	
			5/29/08		320	320		320	
			6/25/08		320	310		310	
			7/22/08		330	330		310	
			8/27/08		330	310		180	
			9/30/08		230	230		170	
	Si-D	mg/L	10/29/07		7.35	8.76		8.69	
			11/29/07		8.65	8.73		8.39	
			12/18/07		8.73	8.74		8.67	
			1/30/08		8.77	8.72		8.73	
			2/25/08		8.67	8.61		8.61	
			3/31/08		8.70	8.70		8.56	
			4/28/08		8.51	8.46		8.42	
			5/29/08		8.33	8.34		8.10	
			6/25/08		8.28	8.01		7.98	
			7/22/08		7.76	3.88		6.96	
			8/27/08		8.11	7.77		6.59	
			9/30/08		7.82	7.78		7.97	
	SO4	mg/L	10/29/07		88.4	88.3		88.4	
			11/29/07		87.6	87.9		87.4	
			12/18/07		86.8	86.7		87.0	
			1/30/08		88.2	88.3		88.3	
			2/25/08		86.8	86.5		86.8	
			3/31/08		90.5	90.7		90.8	
			4/28/08		94.5	94.7		94.7	
			5/29/08		83.8	83.8		83.9	
			6/25/08		71.7	72.0		71.6	
			7/22/08		89.9	44.9		97.9	
			8/27/08		92.8	89.2		55.1	
			9/30/08		37.7	37.3		27.5	

APPENDIX B. Blue Spring water quality data (from USGS and WSI).

GROUP DESC	PARAMETER	PARAMETER_UNITS	MMDDYY	VBS-10	VBS-35	VBS-355	VBS-500	VBS-570	VBS-620
METAL	Ca-D	mg/L	10/29/07		71.3	75.2		73.9	
			11/29/07		74.8	76.3		74.2	
			12/18/07		76.1	76.9		75.5	
			1/30/08		76.2	76.9		76.6	
			2/25/08		75.1	75.7		76.0	
			3/31/08		76.6	77.7		76.5	
			4/28/08		76.3	77.5		77.1	
			5/29/08		73.5	73.4		73.0	
			6/25/08		72.9	72.9		72.3	
			7/22/08		74.2	37.3		71.7	
			8/27/08		74.2	68.3		42.2	
			9/30/08		64.2	65.0		47.4	
	K-D	mg/L	10/29/07		9.98	10.5		10.4	
			11/29/07		10.2	10.2		9.92	
			12/18/07		10.3	10.0		10.2	
			1/30/08		10.2	10.2		10.2	
			2/25/08		10.2	10.4		10.3	
			3/31/08		11.2	11.1		11.0	
			4/28/08		10.8	11.1		10.9	
			5/29/08		9.72	9.63		9.63	
			6/25/08		10.1	10.0		10.0	
			7/22/08		10.9	5.36		10.1	
			8/27/08		10.7	9.93		6.55	
			9/30/08		4.93	5.14		4.87	
	Mg-D	mg/L	10/29/07		33.2	35.4		34.6	
			11/29/07		34.3	34.0		32.8	
			12/18/07		35.1	34.1		34.7	
			1/30/08		34.5	34.5		34.2	
			2/25/08		34.6	35.1		35.1	
			3/31/08		36.5	36.8		36.4	
			4/28/08		36.8	37.2		37.1	
			5/29/08		32.9	32.9		33.0	
			6/25/08		32.1	31.7		32.0	
			7/22/08		34.7	17.2		32.6	
			8/27/08		35.4	32.4		18.9	
			9/30/08		16.6	16.9		12.7	
	NA-D	mg/L	10/29/07		277	291		286	
			11/29/07		281	286		277	
			12/18/07		274	277		273	
			1/30/08		283	285		285	
			2/25/08		286	288		290	
			3/31/08		300	304		299	
			4/28/08		289	300		298	
			5/29/08		262	263		266	
			6/25/08		259	259		258	
			7/22/08		282	141		256	
			8/27/08		307	279		156	
			9/30/08		122	123		92.1	
	NA-T	%	10/29/07		65.0	65.0		65.0	
			11/29/07		64.0	64.0		64.0	
			12/18/07		63.0	64.0		63.0	
			1/30/08		64.0	64.0		64.0	
			2/25/08		64.0	64.0		64.0	
			3/31/08		65.0	65.0		65.0	
			4/28/08		64.0	64.0		64.0	
			5/29/08		63.0	63.0		64.0	
			6/25/08		63.0	63.0		63.0	
			7/22/08		64.0	64.0		63.0	
			8/27/08		66.0	66.0		64.0	
			9/30/08		53.0	53.0		53.0	
	SAR	ratio	10/29/07		6.80	6.90		6.90	
			11/29/07		6.80	6.80		6.70	
			12/18/07		6.50	6.60		6.50	
			1/30/08		6.80	6.80		6.80	
			2/25/08		6.80	6.90		6.90	
			3/31/08		7.10	7.10		7.00	
			4/28/08		6.80	7.00		7.00	
			5/29/08		6.40	6.40		6.50	
			6/25/08		6.40	6.40		6.30	
			7/22/08		6.80	6.70		6.30	
			8/27/08		7.30	7.00		5.00	
			9/30/08		3.50	3.50		3.10	

APPENDIX B. Blue Spring water quality data (from USGS and WSI).

GROUP DESC	PARAMETER	PARAMETER_UNITS	MMDDYY	VBS-10	VBS-35	VBS-355	VBS-500	VBS-570	VBS-620
METAL	SR-D	µg/L	10/29/07		1,150	1,220		1,190	
			11/29/07		1,180	1,170		1,190	
			12/18/07		1,160	1,180		1,150	
			1/30/08		1,200	1,200		1,200	
			2/25/08		1,190	1,200		1,200	
			3/31/08		1,260	1,280		1,260	
			4/28/08		1,220	1,240		1,260	
			5/29/08		1,120	1,120		1,140	
			6/25/08		1,210	1,200		1,200	
			7/22/08		1,240	620		1,290	
			8/27/08		1,180	1,100		818	
			9/30/08		654	671		611	
NITROGEN	NH4-N	mg/L	10/29/07		0.120	0.110		0.120	
			11/29/07		0.110	0.100		0.100	
			12/18/07		0.090	0.080		0.080	
			1/30/08		0.100	0.090		0.100	
			2/25/08		0.120	0.100		0.100	
			3/31/08		0.120	0.110		0.110	
			4/28/08		0.120			0.110	
			5/29/08		0.100	0.250		0.090	
			6/25/08		0.100	0.090		0.090	
			7/22/08		0.120	0.110		0.100	
			8/27/08		0.140	0.120		0.110	
			9/30/08		0.040	0.040		0.050	
	NOx-N-D	mg/L	10/29/07		0.310	0.300		0.300	
			11/29/07		0.350	0.340		0.340	
			12/18/07		0.390	0.400		0.390	
			1/30/08		0.340	0.350		0.340	
			2/25/08		0.360	0.350		0.350	
			3/31/08		0.320	0.310		0.310	
			4/28/08		0.300			0.280	
			5/29/08		0.390	0.390		0.380	
			6/25/08		0.390	0.380		0.380	
			7/22/08		0.310	0.300		0.240	
			8/27/08		0.210	0.200		0.160	
			9/30/08		1.13	1.10		0.750	
	OrgN	mg/L	10/29/07		0.060	0.060		0.060	
			11/29/07		0.070	0.070		0.080	
			12/18/07		0.080	0.060		0.060	
			1/30/08		0.050	0.070		0.060	
			2/25/08		0.090	0.050		0.060	
			3/31/08		0.100	0.100		0.090	
			4/28/08		0.080			0.080	
			5/29/08		0.080	0.100		0.080	
			6/25/08		0.070	0.060		0.080	
			7/22/08		0.070	0.100		0.820	
			8/27/08		0.100	0.230		0.700	
			9/30/08			0.130		0.570	
	TKN	mg/L	10/29/07		0.170	0.170		0.170	
			11/29/07		0.180	0.180		0.190	
			12/18/07		0.160	0.140		0.140	
			1/30/08		0.140	0.160		0.160	
			2/25/08		0.200	0.140		0.160	
			3/31/08		0.210	0.210		0.200	
			4/28/08		0.200			0.190	
			5/29/08		0.180	0.340		0.170	
			6/25/08		0.170	0.150		0.170	
			7/22/08		0.190	0.210		0.910	
			8/27/08		0.240	0.350		0.810	
			9/30/08		0.060	0.130		0.620	
	TN	mg/L	10/29/07		0.480	0.470		0.470	
			11/29/07		0.530	0.520		0.530	
			12/18/07		0.560	0.550		0.530	
			1/30/08		0.490	0.510		0.500	
			2/25/08		0.560	0.490		0.510	
			3/31/08		0.530	0.520		0.500	
			4/28/08		0.500			0.470	
			5/29/08		0.580	0.730		0.550	
			6/25/08		0.550	0.540		0.550	
			7/22/08		0.500	0.520		1.10	
			8/27/08		0.450	0.550		0.970	
			9/30/08		1.20	1.20		1.40	

APPENDIX B. Blue Spring water quality data (from USGS and WSI).

GROUP DESC	PARAMETER	PARAMETER_UNITS	MMDDYY	VBS-10	VBS-35	VBS-355	VBS-500	VBS-570	VBS-620
PHOSPHORUS	OrthoP	mg/L	10/29/07		0.065	0.066		0.063	
			11/29/07		0.060	0.067		0.065	
			12/18/07		0.070	0.066		0.065	
			1/30/08		0.071	0.072		0.072	
			2/25/08		0.070	0.068		0.067	
			3/31/08		0.070	0.072		0.066	
			4/28/08		0.071			0.069	
			5/29/08		0.078	0.078		0.076	
			6/25/08		0.077	0.076		0.079	
			7/22/08		0.081	0.079		0.063	
			8/27/08		0.072	0.072		0.069	
			9/30/08		0.066	0.065		0.118	
	PO4-T	mg/L as PO4	10/29/07		0.200	0.202		0.192	
			11/29/07		0.183	0.205		0.200	
			12/18/07		0.214	0.203		0.201	
			1/30/08		0.216	0.221		0.221	
			2/25/08		0.215	0.210		0.205	
			3/31/08		0.214	0.220		0.204	
			4/28/08		0.217			0.212	
			5/29/08		0.240	0.239		0.232	
			6/25/08		0.236	0.233		0.244	
			7/22/08		0.249	0.241		0.193	
			8/27/08		0.222	0.220		0.213	
			9/30/08		0.202	0.200		0.361	
	TDP	mg/L	10/29/07		0.060	0.060		0.060	
			11/29/07		0.060	0.060		0.060	
			12/18/07		0.060	0.060		0.070	
			1/30/08		0.080	0.070		0.070	
			2/25/08		0.070	0.070		0.060	
			3/31/08		0.070	0.080		0.080	
			4/28/08		0.090			0.080	
			5/29/08		0.070	0.070		0.070	
			6/25/08		0.080	0.080		0.080	
			7/22/08		0.070	0.070		0.070	
			8/27/08		0.080	0.070		0.080	
			9/30/08		0.060	0.070		0.120	
	TP	mg/L	10/29/07		0.070	0.070		0.070	
			11/29/07		0.080	0.080		0.070	
			12/18/07		0.080	0.080		0.080	
			1/30/08		0.070	0.080		0.080	
			2/25/08		0.070	0.080		0.070	
			3/31/08		0.080	0.080		0.080	
			4/28/08		0.080			0.080	
			5/29/08		0.080	0.080		0.090	
			6/25/08		0.090	0.080		0.080	
			7/22/08		0.090	0.090		0.150	
			8/27/08		0.130	0.080		0.110	
			9/30/08		0.060	0.070		0.140	
PHYSICAL	Alk-D	mg/L as CaCO3	4/28/08		23.0			23.0	
	Color	CPU	10/29/07		8.00	8.00		10.0	
			11/29/07		8.00	8.00		10.0	
			12/18/07		5.00	8.00		8.00	
			1/30/08		2.00	2.00		2.00	
			2/25/08		2.00	2.00		1.00	
			3/31/08		2.00	8.00		5.00	
			4/28/08		2.00	5.00		8.00	
			5/29/08		10.0	8.00		8.00	
			6/25/08		5.00	2.00		5.00	
			7/22/08		5.00	5.00		25.0	
			8/27/08		5.00	25.0		125	
			9/30/08		50.0	5.00		100	
	Depth	m	11/13/07		1.51	1.16		2.71	
			11/27/07		1.25	1.60		2.53	
			1/22/08		1.08	1.11		1.95	
			3/18/08		0.893	0.972		2.16	
			4/1/08		0.930	1.07		2.24	
			5/8/08		1.10	1.00		2.13	
			5/23/08		0.640	1.19		0.939	
			6/24/08		0.945	0.792		1.89	
			7/8/08		0.792	0.610		1.25	3.05
			8/5/08		1.07	1.30	1.60	1.00	
			8/29/08		2.53	2.80		2.68	
	ORP	mV	6/24/08		-33.5	-38.6		-48.7	
			7/8/08		-81.5	-87.0		-88.5	-94.0

APPENDIX B. Blue Spring water quality data (from USGS and WSI).

GROUP DESC	PARAMETER	PARAMETER_UNITS	MMDDYY	VBS-10	VBS-35	VBS-355	VBS-500	VBS-570	VBS-620
PHYSICAL	pH	SU	10/29/07		7.30	7.40		7.40	
			11/13/07		7.39	7.43		7.36	
			11/27/07	7.45	7.44	7.44		7.75	
			11/29/07		7.30	7.30		7.30	
			12/6/07		7.42	7.43		7.46	
			12/18/07		7.30	7.30		7.40	
			12/20/07						
			1/22/08		7.40	7.35		7.35	
			1/30/08		7.20	7.30		7.30	
			2/25/08		7.30	7.30		7.30	
			3/18/08		7.33	7.35		7.31	
			3/31/08		7.50				
			4/1/08		7.34	7.35		7.37	
			4/28/08		7.60	7.60		7.70	
			5/8/08		7.31	7.32		7.28	
			5/23/08		7.21	7.25		7.35	
			5/29/08		7.30	7.30		7.30	
			6/24/08		7.26	7.34		7.39	
			6/25/08		7.20	7.30		7.30	
			7/8/08		7.30	7.32		7.41	7.79
			7/22/08		7.30	7.30		7.30	
			8/5/08		7.04	7.10	7.12	7.13	
			8/27/08		7.20	7.20		6.60	
			8/29/08		7.26	7.14		7.68	
	Secchi	m	7/8/08						1.80
			8/29/08					0.518	
	SpCond	umhos/cm	11/13/07		2,170	2,170		2,169	
			11/27/07	2,114	2,114	2,115		2,113	
			12/6/07		2,116	2,116		2,116	
			12/20/07			1,928		1,929	
			1/22/08		2,048	2,048		2,047	
			3/18/08		2,237	2,236		2,235	
			4/1/08		2,254	2,255		2,254	
			5/8/08		2,192	2,191		2,191	
			5/23/08		2,150	2,149		2,149	
			6/24/08		2,056	2,058		2,059	
			7/8/08		2,122	2,122		2,125	1,913
			8/5/08		2,011	2,013	2,013	1,981	
			8/29/08		1,958	1,719		1,121	
			10/29/07		2,150	2,140		2,150	
			11/29/07		2,140	2,140		2,140	
			12/18/07		2,080	2,070		2,080	
			1/30/08		2,100	2,100		2,100	
			2/25/08		2,180	2,190		2,190	
			3/31/08		2,250				
			4/28/08		2,260	2,260		2,250	
			5/29/08		2,090	2,090		2,090	
			6/25/08		2,000	2,000		2,000	
			7/22/08		2,170	2,170		2,170	
			8/27/08		2,150	2,140		692	
			9/30/08		1,070	1,080		781	
	Stage	ft	10/29/07		2.07			2.08	
			11/13/07					7.91	
			11/27/07					7.26	
			11/29/07		1.75			1.69	
			12/6/07					6.82	
			12/18/07		1.00			0.990	
			12/20/07					6.45	
			1/22/08					6.67	
			1/30/08		1.16			1.15	
			2/25/08		0.430	0.430		0.440	
			3/18/08			0.560		6.04	
			3/31/08		0.590			0.610	
			4/1/08			0.670		6.15	
			4/28/08		0.900	0.890		0.900	
			5/8/08			0.545		6.04	
			5/29/08		0.620	0.590		0.610	
			6/24/08			0.400		5.89	
			6/25/08		0.330	0.330		0.320	
			7/8/08			0.270		5.76	
			7/22/08		1.13	1.13		1.14	
			8/5/08			1.38		6.89	
			8/27/08		5.66	5.66		5.71	
			9/30/08		5.34	5.34		5.37	

APPENDIX B. Blue Spring water quality data (from USGS and WSI).

GROUP DESC	PARAMETER	PARAMETER_UNITS	MMDDYY	VBS-10	VBS-35	VBS-355	VBS-500	VBS-570	VBS-620
PHYSICAL	Turb	NTU	10/29/07		0.00	0.00		0.00	
			11/29/07		0.00	0.00		0.00	
			12/18/07		0.00	0.00		0.00	
			1/30/08		0.00	0.00		0.00	
			2/25/08		0.00	0.00		0.00	
			3/31/08		0.00				
			4/28/08		0.00	0.00		0.00	
			6/25/08			0.100		0.00	
			7/22/08		0.00	0.00			
			8/27/08					1.90	
SOLID	TDS	mg/L	10/29/07		1,190	1,200		1,190	
			11/29/07		1,190	1,190		1,190	
			12/18/07		1,150	1,150		1,140	
			1/30/08		1,150	1,160		1,160	
			2/25/08		1,160	1,160		1,150	
			3/31/08		1,220	1,240		1,240	
			4/28/08		1,280	1,280		1,310	
			5/29/08		1,140	1,140		1,130	
			6/25/08		1,100	1,080		1,090	
			7/22/08		1,230	613		1,140	
			8/27/08		1,220	1,130		679	
			9/30/08		575	574		451	
			10/29/07		1,120	1,140		1,130	
			11/29/07		1,140	1,150		1,130	
			12/18/07		1,120	1,120		1,100	
			1/30/08		1,120	1,130		1,130	
			2/25/08		1,140	1,140		1,150	
			3/31/08		1,200	1,210		1,210	
			4/28/08		1,120	1,210		1,130	
			5/29/08		1,080	1,080		1,090	
			6/25/08		1,040	1,040		1,040	
			7/22/08		1,140	1,130		1,050	
			8/27/08		1,190	1,090		614	
			9/30/08		564	568		424	
TEMPERATURE	Wtr Temp	C	10/29/07		22.9	22.9		22.9	
			11/13/07		23.1	23.1		23.0	
			11/27/07	23.1	23.1	23.1		23.1	
			11/29/07		22.9	23.0		23.0	
			12/6/07		23.1	23.1		23.1	
			12/18/07		22.9	22.9		23.0	
			12/20/07			23.1		23.0	
			1/22/08		23.1	23.1		23.1	
			1/30/08		22.9	23.0		23.0	
			2/25/08		22.9	23.0		23.1	
			3/18/08		23.1	23.1		23.1	
			3/31/08		22.9				
			4/1/08		23.1	23.1		23.2	
			4/28/08		22.9	22.9		22.9	
			5/8/08		23.1	23.2		23.2	
			5/23/08		23.1	23.2		23.5	
			5/29/08		22.9	23.1		23.2	
			6/24/08		23.1	23.2		23.5	
			6/25/08		22.9	23.0		23.2	
			7/8/08		23.1	23.2		23.4	26.8
			7/22/08		23.1	23.1		23.1	
			8/5/08		23.1	23.3	23.4	23.8	
			8/27/08		22.9	23.2		27.6	
			8/29/08		23.1	23.7		26.4	
			9/30/08		22.8	22.8		24.4	

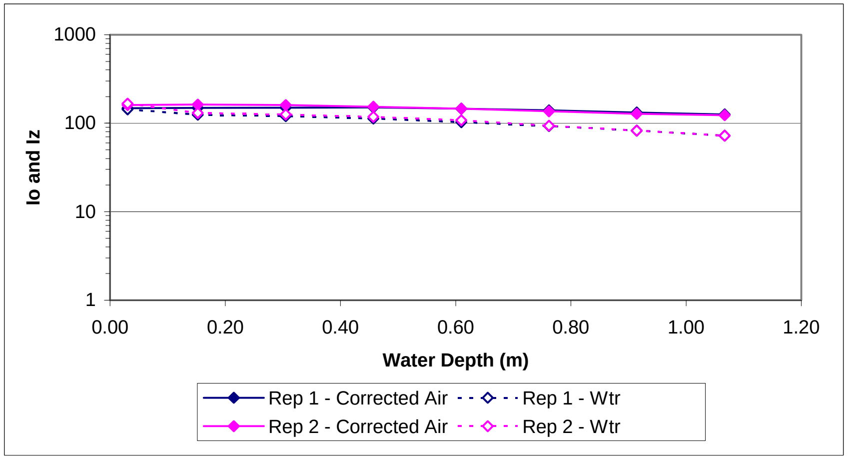
Appendix C

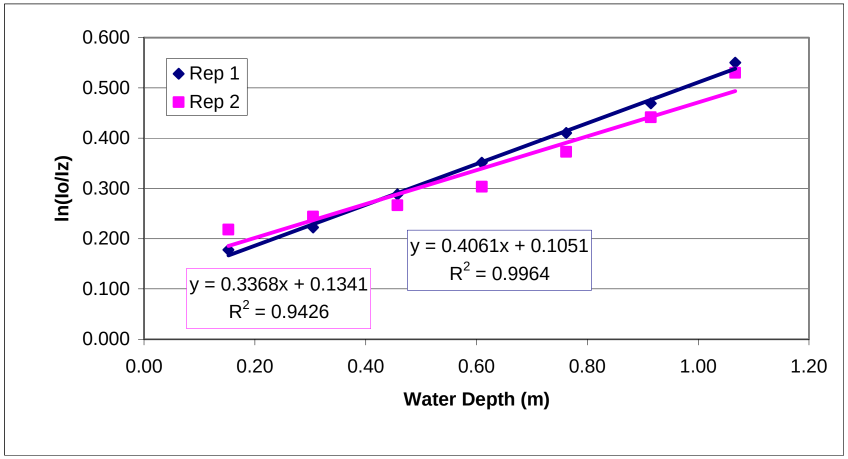
Blue Spring Light Attenuation Detail and Summaries (from WSI)

VOLUSIA BLUE SPRING MFR LIGHT ATTENUATION ESTIMATES - VBS 35 - 11/27/2007 14:00

Depth (m)	Replicate 1						Depth (m)	Replicate 2					
z	corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	z	corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
0.03	147.4	157.9	143.1	4.96			0.03	160.0	170.9	166.8	5.12		
0.15	149.2	159.8	124.9	4.83	0.178	1.167	0.15	162.4	173.4	130.6	4.87	0.218	1.430
0.30	149.9	160.5	120.0	4.79	0.222	0.730	0.30	160.7	171.6	125.9	4.84	0.244	0.800
0.46	150.2	160.8	112.6	4.72	0.288	0.630	0.46	153.7	164.4	117.7	4.77	0.267	0.583
0.61	145.9	156.4	102.7	4.63	0.351	0.576	0.61	146.3	156.8	108.0	4.68	0.303	0.498
0.76	139.8	150.1	92.8	4.53	0.410	0.538	0.76	136.1	146.3	93.7	4.54	0.373	0.490
0.91	132.0	142.1	82.6	4.41	0.469	0.513	0.91	127.9	137.9	82.3	4.41	0.441	0.483
1.07	125.6	135.5	72.5	4.28	0.550	0.516	1.07	123.0	132.8	72.4	4.28	0.530	0.497

k (diffuse attenuation coefficient = slope, m-1)		0.406	k (diffuse attenuation coefficient = slope, m-1)		0.337
k average		0.667	k average		0.683
percent transmittance @	1.0 meter	66.63	percent transmittance @	1.0 meter	71.40
Birgean Percentile Absorption (1m)		33.37	Birgean Percentile Absorption (1m)		28.60



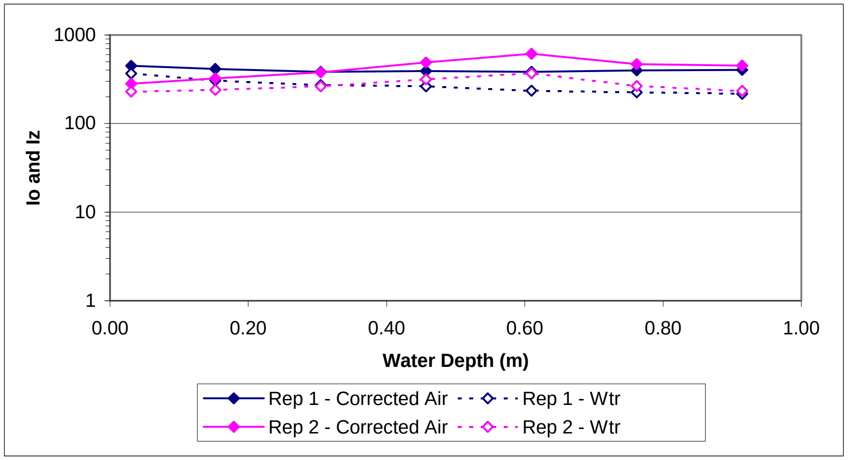


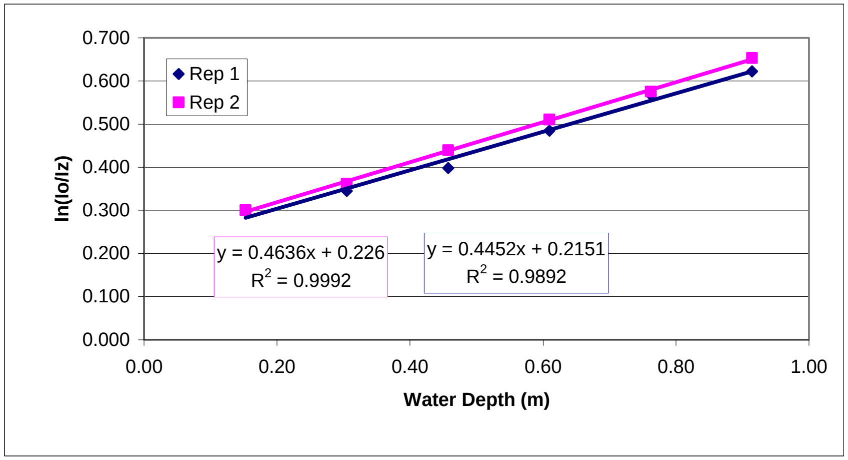
APPENDIX C. Blue Spring light attenuation detail.

VOLUSIA BLUE SPRING MFR LIGHT ATTENUATION ESTIMATES - VBS 35 - 1/22/2008 14:22

Depth (m)	Replicate 1						Depth (m)	Replicate 2					
z	corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	z	corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
0.03	449.7	469.4	367.3	5.91			0.03	282.3	296.9	229.8	5.44		
0.15	412.2	430.8	305.9	5.72	0.298	1.957	0.15	322.6	338.5	238.9	5.48	0.300	1.972
0.30	384.0	401.7	272.0	5.61	0.345	1.131	0.30	378.1	395.7	263.3	5.57	0.362	1.188
0.46	391.1	409.0	262.7	5.57	0.398	0.870	0.46	490.9	511.9	316.4	5.76	0.439	0.961
0.61	382.2	399.9	235.4	5.46	0.485	0.795	0.61	613.5	638.2	368.3	5.91	0.510	0.837
0.76	397.7	415.9	225.5	5.42	0.567	0.745	0.76	469.6	489.9	264.2	5.58	0.575	0.755
0.91	402.8	421.1	216.2	5.38	0.622	0.680	0.91	450.2	469.9	234.3	5.46	0.653	0.714

Replicate 1			Replicate 2		
k (diffuse attenuation coefficient = slope, m-1)		0.445	k (diffuse attenuation coefficient = slope, m-1)		0.464
k average		1.030	k average		1.071
percent transmittance @	1.0 meter	64.07	percent transmittance @	1.0 meter	62.90
Birgean Percentile Absorption (1m)		35.93	Birgean Percentile Absorption (1m)		37.10



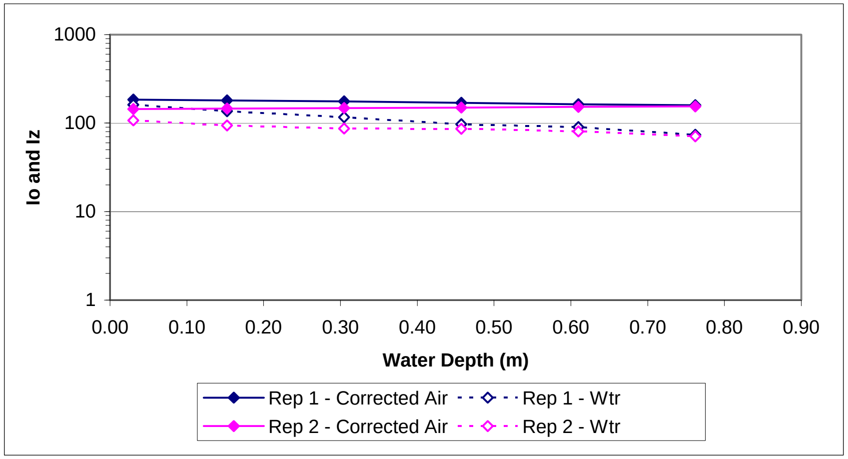


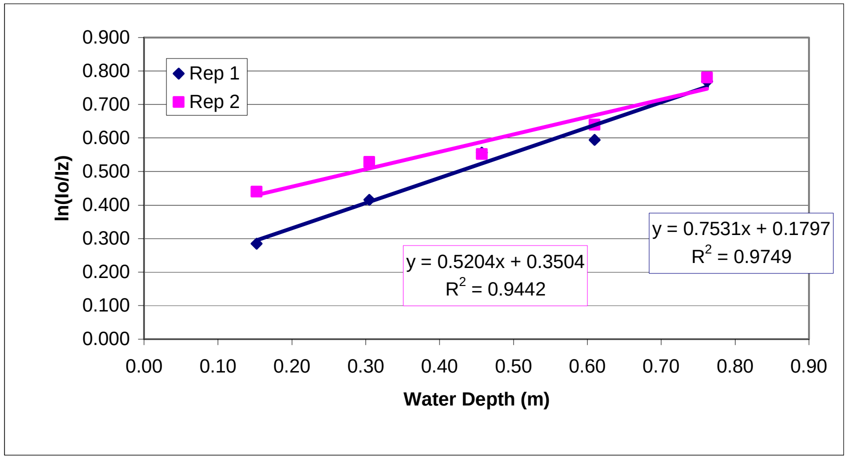
APPENDIX C. Blue Spring light attenuation detail.

VOLUSIA BLUE SPRING MFR LIGHT ATTENUATION ESTIMATES - VBS 35 - 2/06/2008 14:18

Depth (m) z	Replicate 1 corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	Depth (m) z	Replicate 2 corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
0.03	183.6	195.2	161.7	5.09			0.03	144.4	154.9	107.5	4.68		
0.15	181.0	192.6	136.2	4.91	0.285	1.867	0.15	146.2	156.7	94.2	4.54	0.440	2.887
0.30	176.7	188.1	116.6	4.76	0.416	1.363	0.30	147.4	157.9	86.9	4.46	0.529	1.735
0.46	170.0	181.2	97.4	4.58	0.557	1.217	0.46	149.7	160.3	86.2	4.46	0.552	1.208
0.61	163.3	174.3	90.1	4.50	0.595	0.975	0.61	152.4	163.1	80.4	4.39	0.640	1.049
0.76	159.2	170.1	73.8	4.30	0.769	1.009	0.76	154.8	165.6	70.9	4.26	0.781	1.025

k (diffuse attenuation coefficient = slope, m-1)		0.753	k (diffuse attenuation coefficient = slope, m-1)		0.520
k average		1.286	k average		1.581
percent transmittance @	1.0 meter	47.09	percent transmittance @	1.0 meter	59.43
Birgean Percentile Absorption (1m)		52.91	Birgean Percentile Absorption (1m)		40.57



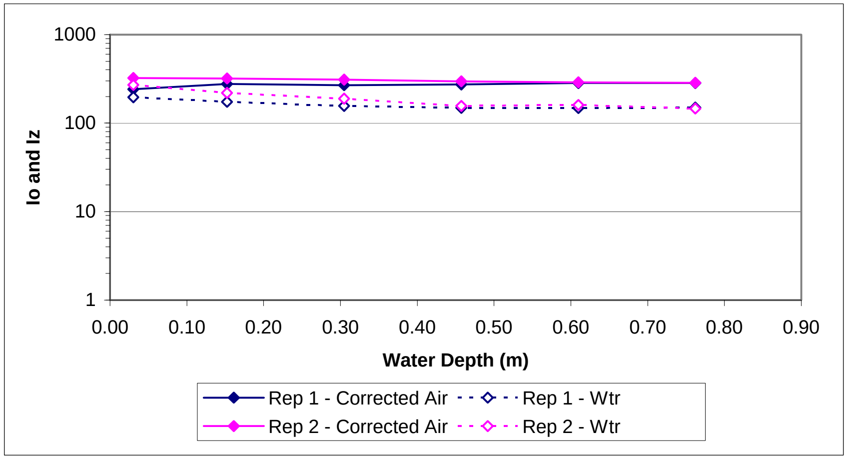


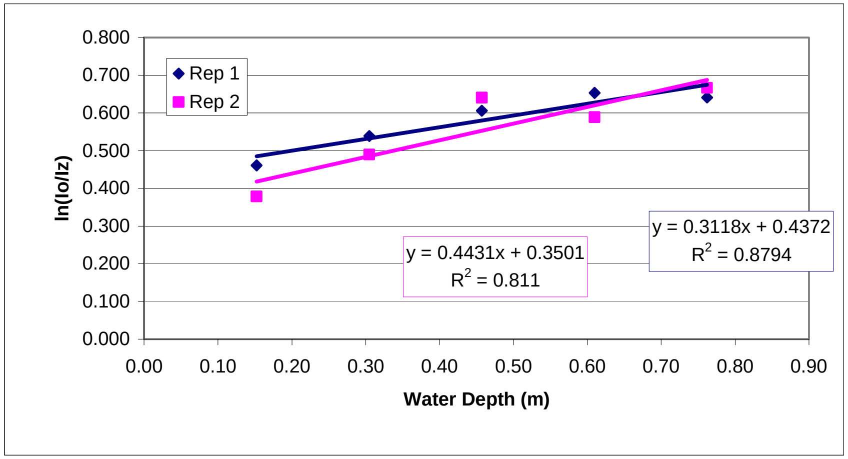
APPENDIX C. Blue Spring light attenuation detail.

VOLUSIA BLUE SPRING MFR LIGHT ATTENUATION ESTIMATES - VBS 35 - 3/18/2008 12:05

	Replicate 1							Replicate 2					
Depth (m) z	corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	Depth (m) z	corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
0.03	241.2	254.6	196.4	5.28			0.03	324.3	340.2	270.4	5.60		
0.15	275.9	290.4	174.1	5.16	0.461	3.022	0.15	319.9	335.7	219.1	5.39	0.379	2.484
0.30	267.8	282.0	156.3	5.05	0.538	1.767	0.30	308.8	324.2	189.2	5.24	0.490	1.607
0.46	272.6	286.9	148.7	5.00	0.606	1.325	0.46	296.6	311.7	156.4	5.05	0.640	1.400
0.61	283.9	298.6	147.8	5.00	0.653	1.071	0.61	288.8	303.6	160.3	5.08	0.589	0.965
0.76	284.0	298.7	149.6	5.01	0.641	0.841	0.76	285.0	299.7	146.3	4.99	0.667	0.875

k (diffuse attenuation coefficient = slope, m-1)		0.312	k (diffuse attenuation coefficient = slope, m-1)		0.443
k average		1.605	k average		1.466
percent transmittance @	1.0 meter	73.21	percent transmittance @	1.0 meter	64.21
Birgean Percentile Absorption (1m)		26.79	Birgean Percentile Absorption (1m)		35.79



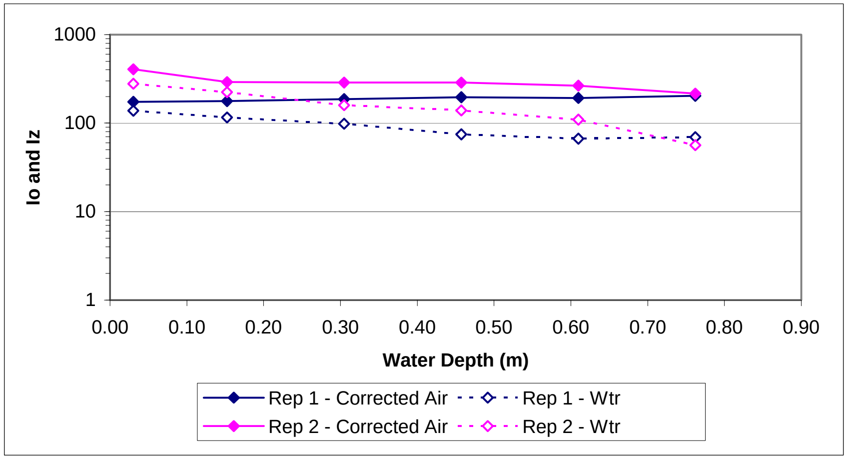


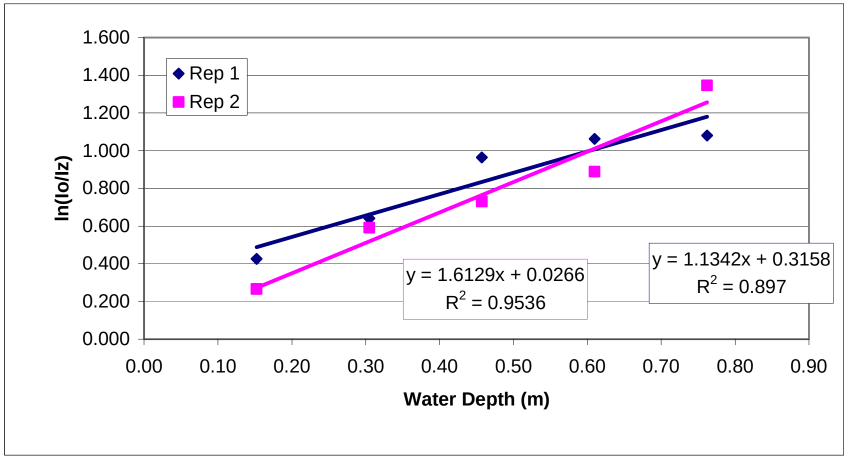
APPENDIX C. Blue Spring light attenuation detail.

VOLUSIA BLUE SPRING MFR LIGHT ATTENUATION ESTIMATES - VBS 35 - 4/1/2008 12:55

Depth (m) z	Replicate 1 corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	Depth (m) z	Replicate 2 corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
0.03	173.9	185.3	137.8	4.93			0.03	406.1	424.5	278.5	5.63		
0.15	177.6	189.1	116.0	4.75	0.426	2.796	0.15	291.2	306.1	223.3	5.41	0.265	1.742
0.30	186.5	198.2	98.3	4.59	0.640	2.101	0.30	287.1	301.9	159.0	5.07	0.591	1.939
0.46	195.6	207.6	74.6	4.31	0.964	2.108	0.46	287.9	302.7	138.8	4.93	0.730	1.596
0.61	192.7	204.6	66.6	4.20	1.062	1.743	0.61	265.5	279.6	109.2	4.69	0.888	1.457
0.76	203.9	216.2	69.3	4.24	1.079	1.416	0.76	215.9	228.5	56.2	4.03	1.346	1.766

Replicate 1			Replicate 2		
k (diffuse attenuation coefficient = slope, m-1)		1.134	k (diffuse attenuation coefficient = slope, m-1)		1.613
k average		2.033	k average		1.700
percent transmittance @	1.0 meter	32.17	percent transmittance @	1.0 meter	19.93
Birgean Percentile Absorption (1m)		67.83	Birgean Percentile Absorption (1m)		80.07



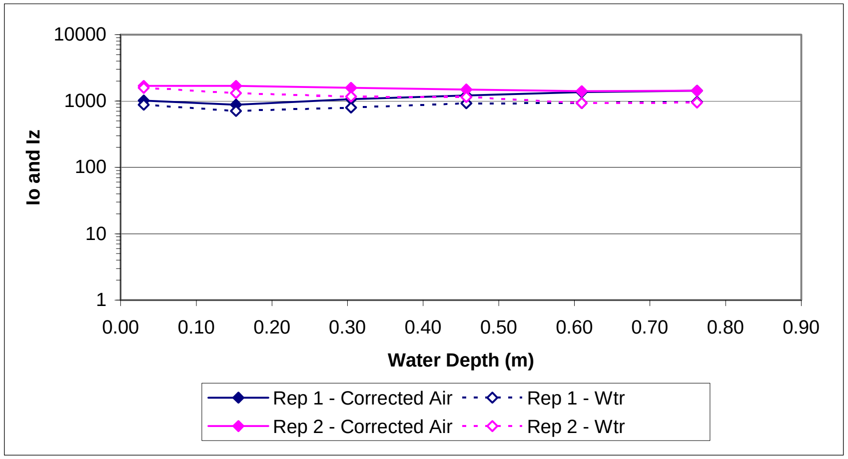


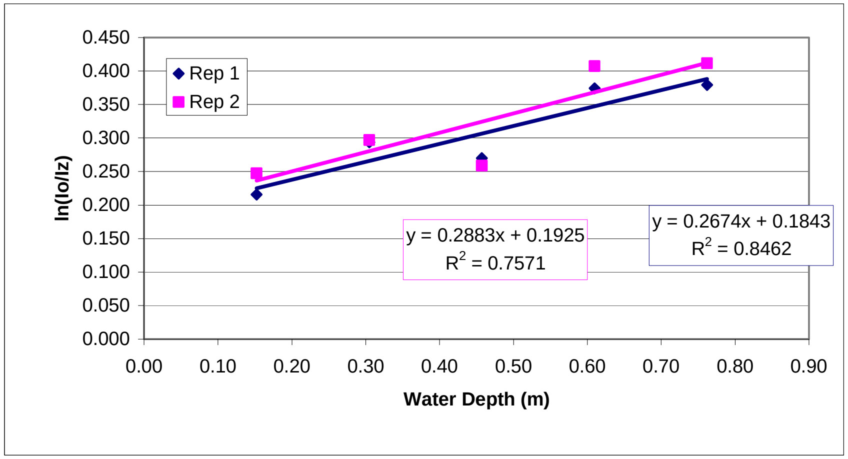
APPENDIX C. Blue Spring light attenuation detail.

VOLUSIA BLUE SPRING MFR LIGHT ATTENUATION ESTIMATES - VBS 35 - 5/8/2008 13:10

Depth (m) z	Replicate 1 corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	Depth (m) z	Replicate 2 corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
0.03	1,012.0	1,048.8	881.8	6.78			0.03	1,686.5	1,743.8	1,571.7	7.36		
0.15	877.8	910.5	707.5	6.56	0.216	1.415	0.15	1,684.5	1,741.8	1,315.7	7.18	0.247	1.622
0.30	1,063.4	1,101.8	792.7	6.68	0.294	0.964	0.30	1,573.9	1,627.8	1,169.7	7.06	0.297	0.974
0.46	1,205.1	1,247.8	920.1	6.82	0.270	0.590	0.46	1,485.6	1,536.8	1,146.7	7.04	0.259	0.566
0.61	1,351.7	1,398.8	929.8	6.83	0.374	0.614	0.61	1,401.1	1,449.8	932.3	6.84	0.407	0.668
0.76	1,421.5	1,470.8	972.9	6.88	0.379	0.498	0.76	1,428.3	1,477.8	946.5	6.85	0.411	0.540

k (diffuse attenuation coefficient = slope, m-1)		0.267	k (diffuse attenuation coefficient = slope, m-1)		0.288
k average		0.816	k average		0.874
percent transmittance @	1.0 meter	76.54	percent transmittance @	1.0 meter	74.96
Birgean Percentile Absorption (1m)		23.46	Birgean Percentile Absorption (1m)		25.04





APPENDIX C. Blue Spring light attenuation detail.

APPENDIX C. Blue Spring light attenuation detail.

VOLUSIA BLUE SPRING MFR LIGHT ATTENUATION ESTIMATES - VBS 35 - 5/23/2008 11:50 to 12:39

Depth (m)	Replicate 1					
	corr	raw				
z	Air (Io)	Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
0.67	375.7	393.2	159.3	5.07	0.858	1.280
0.67	423.0	441.9	166.7	5.12	0.931	1.389
0.67	377.2	394.7	174.2	5.16	0.773	1.152
0.67	398.9	417.1	214.3	5.37	0.621	0.927
0.67	373.7	391.1	210.1	5.35	0.576	0.859
0.67	396.4	414.5	222.7	5.41	0.577	0.860
0.67	370.5	387.8	221.4	5.40	0.515	0.768
0.67	384.6	402.4	227.4	5.43	0.526	0.784
0.67	386.5	404.3	222.7	5.41	0.551	0.822
0.67	382.3	400.0	234.1	5.46	0.491	0.732
0.67	358.3	375.3	214.1	5.37	0.515	0.768
0.67	348.2	364.9	205.5	5.33	0.528	0.787
0.67	313.5	329.1	208.2	5.34	0.409	0.611
0.67	340.2	356.6	211.9	5.36	0.474	0.706
0.67	432.0	451.2	226.2	5.42	0.647	0.965
0.67	395.8	413.9	233.0	5.45	0.530	0.790
0.67	421.8	440.7	243.5	5.49	0.550	0.820
0.67	406.5	424.9	246.1	5.51	0.502	0.748
0.67	421.0	439.9	225.6	5.42	0.624	0.931
0.67	365.3	382.5	205.9	5.33	0.574	0.855
0.67	464.7	484.9	255.7	5.54	0.597	0.891
0.67	485.9	506.7	318.9	5.76	0.421	0.628
0.67	433.1	452.3	276.3	5.62	0.449	0.670
0.67	442.3	461.8	285.9	5.66	0.436	0.651
0.67	430.7	449.9	257.2	5.55	0.516	0.769
0.67	818.9	849.9	646.7	6.47	0.236	0.352
0.67	905.7	939.3	608.5	6.41	0.398	0.593
0.67	874.6	907.3	451.0	6.11	0.662	0.988
0.67	711.2	738.9	398.3	5.99	0.580	0.865
0.67	624.0	649.1	311.9	5.74	0.694	1.034
0.67	656.1	682.1	323.4	5.78	0.707	1.055
0.67	642.0	667.6	329.9	5.80	0.666	0.993
0.67	587.6	611.5	318.2	5.76	0.613	0.915
0.67	713.3	741.1	305.0	5.72	0.850	1.267
0.67	961.6	996.9	341.7	5.83	1.035	1.543
0.67	1,450.7	1,500.8	394.7	5.98	1.302	1.941
0.67	1,800.0	1,860.8	407.9	6.01	1.485	2.214
0.67	759.9	789.1	277.0	5.62	1.009	1.505
0.67	2,133.9	2,204.8	296.9	5.69	1.972	2.941
0.67	1,728.2	1,786.8	287.2	5.66	1.795	2.677
0.67	1,581.7	1,635.8	465.2	6.14	1.224	1.825
0.67	2,019.4	2,086.8	416.6	6.03	1.578	2.354
0.67	1,454.5	1,504.8	407.3	6.01	1.273	1.898
0.67	1,375.0	1,422.8	311.5	5.74	1.485	2.214
0.67	1,972.8	2,038.8	648.8	6.48	1.112	1.659
0.67	1,923.3	1,987.8	1,081.7	6.99	0.576	0.858
0.67	1,982.5	2,048.8	1,152.7	7.05	0.542	0.809
0.67	1,996.1	2,062.8	946.8	6.85	0.746	1.112
0.67	1,989.3	2,055.8	690.3	6.54	1.058	1.578
0.67	1,440.0	1,489.8	38.0	3.64	3.636	5.422

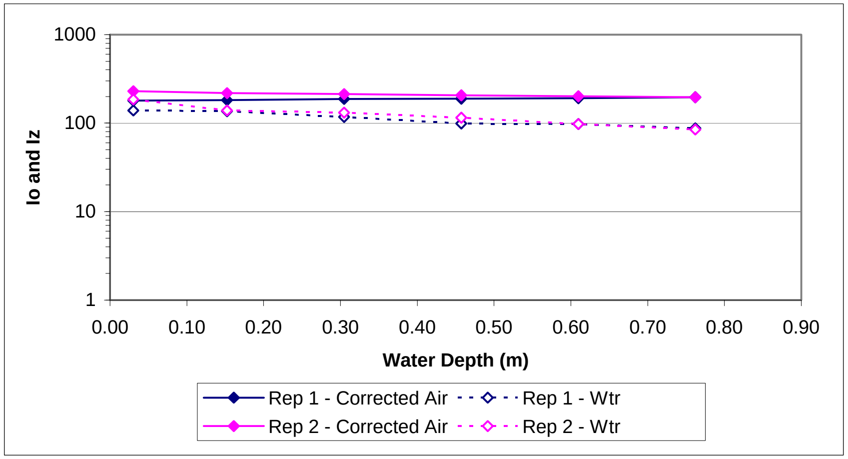
k (diffuse attenuation coefficient = slope, m-1)		0.000
k average		1.236
	average w/o suspect values -->	0.865
percent transmittance @	1.0 meter	100.00
Birgean Percentile Absorption (1m)		0.00

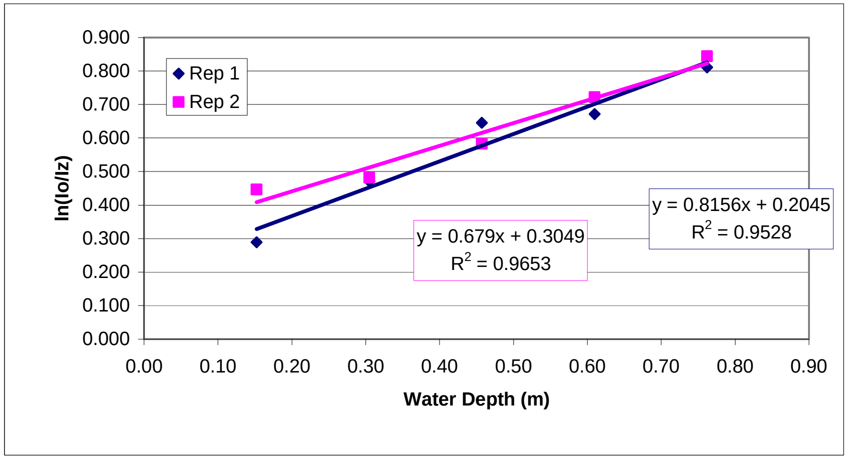
Note: suspect values in red

VOLUSIA BLUE SPRING MFR LIGHT ATTENUATION ESTIMATES - VBS 35 - 6/24/2008 11:40

Depth (m) z	Replicate 1 corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	Depth (m) z	Replicate 2 corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
0.03	180.0	191.5	138.4	4.93			0.03	228.7	241.7	184.7	5.22		
0.15	181.6	193.2	136.0	4.91	0.289	1.898	0.15	217.5	230.2	139.2	4.94	0.446	2.929
0.30	187.5	199.3	117.1	4.76	0.471	1.545	0.30	212.4	224.9	131.2	4.88	0.482	1.580
0.46	189.0	200.8	99.1	4.60	0.645	1.411	0.46	206.1	218.4	115.0	4.74	0.583	1.276
0.61	190.8	202.7	97.5	4.58	0.671	1.101	0.61	201.4	213.6	97.9	4.58	0.722	1.184
0.76	196.4	208.4	87.3	4.47	0.811	1.064	0.76	196.3	208.3	84.4	4.44	0.844	1.107

k (diffuse attenuation coefficient = slope, m-1)		0.816	k (diffuse attenuation coefficient = slope, m-1)		0.679
k average		1.404	k average		1.615
percent transmittance @	1.0 meter	44.24	percent transmittance @	1.0 meter	50.71
Birgean Percentile Absorption (1m)		55.76	Birgean Percentile Absorption (1m)		49.29



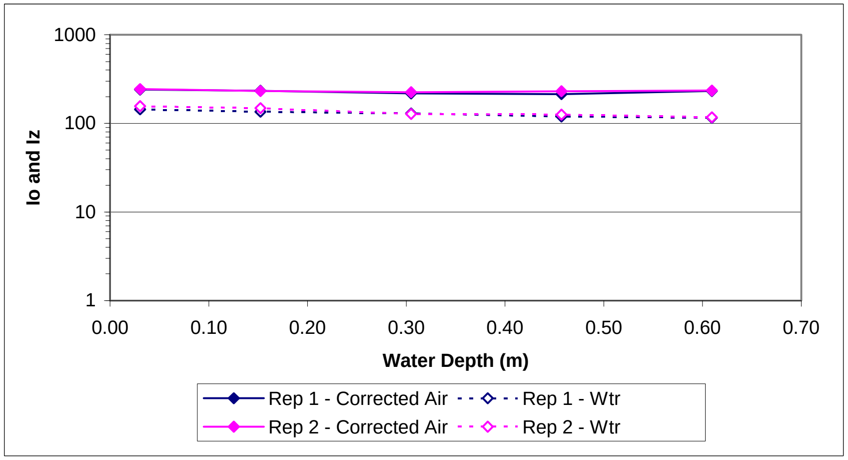


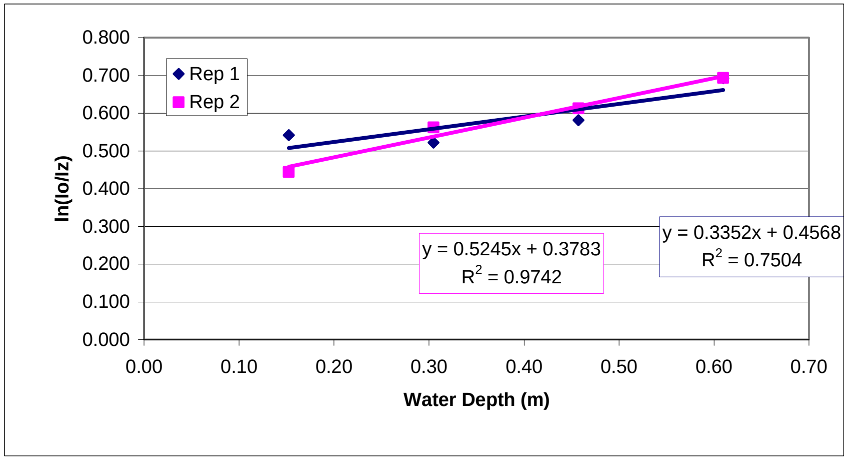
APPENDIX C. Blue Spring light attenuation detail.

VOLUSIA BLUE SPRING MFR LIGHT ATTENUATION ESTIMATES - VBS 35 - 7/08/2008 10:50

Depth (m) z	Replicate 1 corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	Depth (m) z	Replicate 2 corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
0.03	241.2	254.6	144.2	4.97			0.03	244.0	257.5	156.2	5.05		
0.15	233.3	246.5	135.7	4.91	0.542	3.557	0.15	232.1	245.2	148.9	5.00	0.444	2.912
0.30	218.3	231.0	129.5	4.86	0.522	1.713	0.30	224.8	237.7	128.1	4.85	0.562	1.845
0.46	213.4	225.9	119.3	4.78	0.581	1.271	0.46	231.0	244.1	125.2	4.83	0.613	1.340
0.61	231.9	245.0	116.0	4.75	0.693	1.136	0.61	235.1	248.3	117.5	4.77	0.694	1.138

k (diffuse attenuation coefficient = slope, m-1)		0.335	k (diffuse attenuation coefficient = slope, m-1)		0.524
k average		1.919	k average		1.809
percent transmittance @	1.0 meter	71.52	percent transmittance @	1.0 meter	59.19
Birgean Percentile Absorption (1m)		28.48	Birgean Percentile Absorption (1m)		40.81



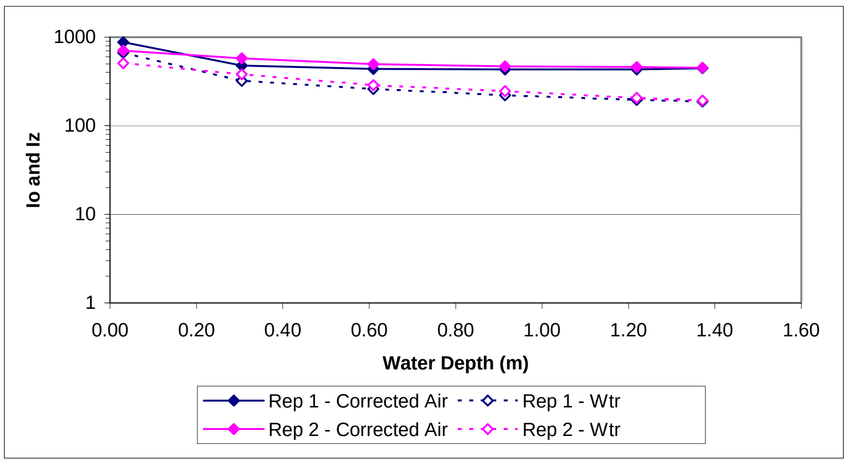


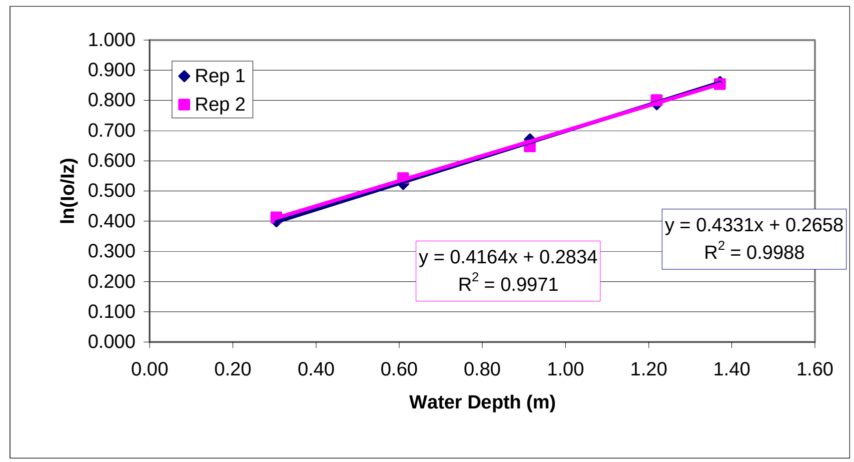
APPENDIX C. Blue Spring light attenuation detail.

VOLUSIA BLUE SPRING MFR LIGHT ATTENUATION ESTIMATES - VBS 35 - 8/05/2008 12:18

Depth (m)	Replicate 1						Depth (m)	Replicate 2					
	corr	raw						corr	raw				
z	Air (Io)	Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	z	Air (Io)	Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
0.03	877.1	909.8	664.6	6.50			0.03	705.4	732.9	508.9	6.23		
0.30	478.3	498.9	320.9	5.77	0.399	1.309	0.30	576.6	600.2	381.8	5.94	0.412	1.353
0.61	437.8	457.2	259.4	5.56	0.523	0.859	0.61	494.7	515.8	287.6	5.66	0.542	0.890
0.91	430.8	450.0	220.2	5.39	0.671	0.734	0.91	469.5	489.8	245.6	5.50	0.648	0.709
1.22	431.8	451.0	196.4	5.28	0.788	0.646	1.22	459.0	479.0	206.1	5.33	0.801	0.657
1.37	445.1	464.7	188.1	5.24	0.861	0.628	1.37	450.6	470.4	191.8	5.26	0.854	0.623

k (diffuse attenuation coefficient = slope, m-1)		0.433	k (diffuse attenuation coefficient = slope, m-1)		0.416
k average		0.835	k average		0.846
percent transmittance @	1.0 meter	64.85	percent transmittance @	1.0 meter	65.94
Birgean Percentile Absorption (1m)		35.15	Birgean Percentile Absorption (1m)		34.06

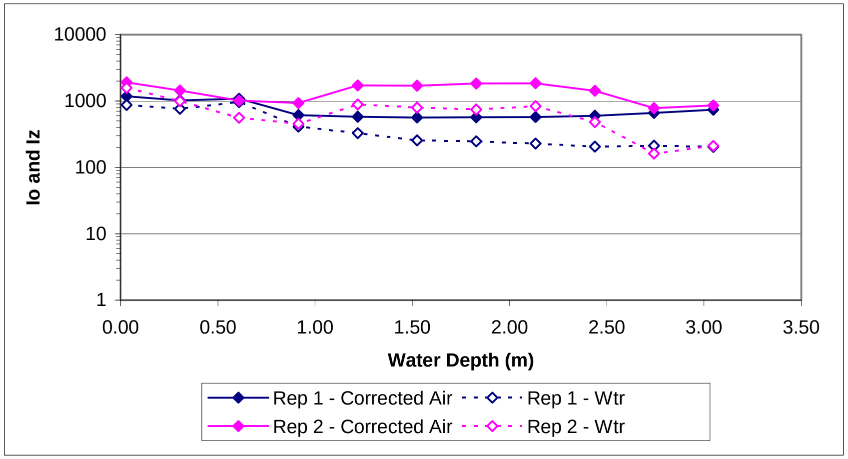


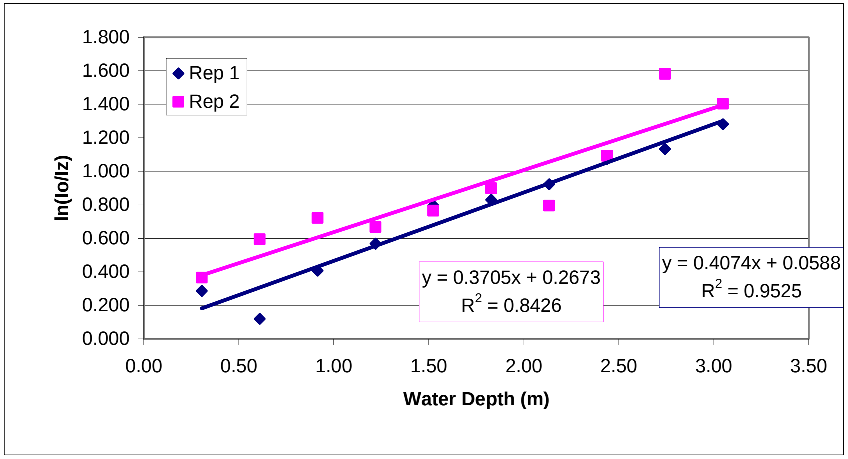


APPENDIX C. Blue Spring light attenuation detail.

Depth (m)	Replicate 1						Depth (m)	Replicate 2					
z	corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	z	corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
0.03	1,172.3	1,214.0	872.4	6.77			0.03	1,911.8	1,976.0	1,574.0	7.36		
0.30	1,017.0	1,054.0	764.2	6.64	0.286	0.938	0.30	1,433.4	1,483.0	995.0	6.90	0.365	1.198
0.61	1,081.1	1,120.0	959.2	6.87	0.120	0.196	0.61	1,012.2	1,049.0	558.6	6.33	0.594	0.975
0.91	615.2	640.0	409.5	6.01	0.407	0.445	0.91	931.9	966.3	453.1	6.12	0.721	0.789
1.22	579.6	603.3	328.6	5.79	0.568	0.465	1.22	1,719.7	1,778.0	882.8	6.78	0.667	0.547
1.52	566.3	589.6	255.5	5.54	0.796	0.522	1.52	1,707.0	1,765.0	794.9	6.68	0.764	0.502
1.83	566.5	589.8	247.1	5.51	0.830	0.454	1.83	1,829.3	1,891.0	744.3	6.61	0.899	0.492
2.13	573.5	597.0	227.9	5.43	0.923	0.433	2.13	1,852.6	1,915.0	836.1	6.73	0.796	0.373
2.44	599.5	623.8	204.9	5.32	1.074	0.440	2.44	1,432.4	1,482.0	480.5	6.17	1.092	0.448
2.74	661.1	687.3	212.9	5.36	1.133	0.413	2.74	779.6	809.4	160.4	5.08	1.581	0.576
3.05	735.1	763.5	204.1	5.32	1.281	0.420	3.05	857.2	889.3	210.6	5.35	1.404	0.461

Replicate 1			Replicate 2		
k (diffuse attenuation coefficient = slope, m-1)		0.407	k (diffuse attenuation coefficient = slope, m-1)		0.370
k average		0.473	k average		0.636
percent transmittance @	1.0 meter	66.54	percent transmittance @	1.0 meter	69.04
Birgean Percentile Absorption (1m)		33.46	Birgean Percentile Absorption (1m)		30.96



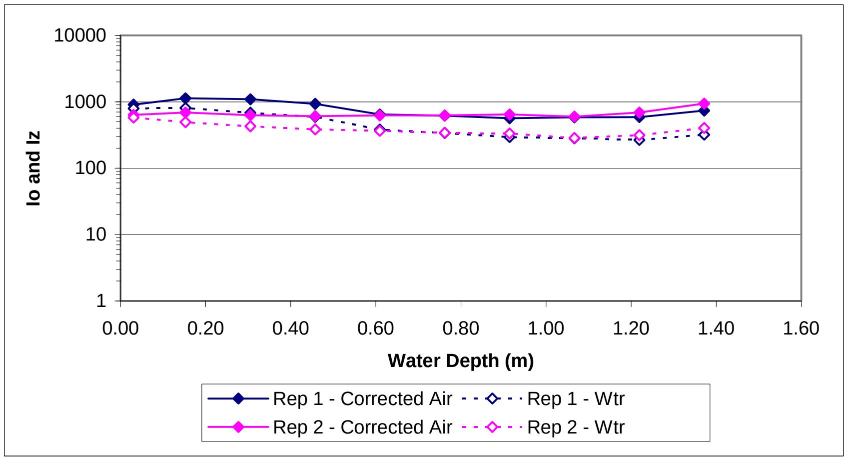


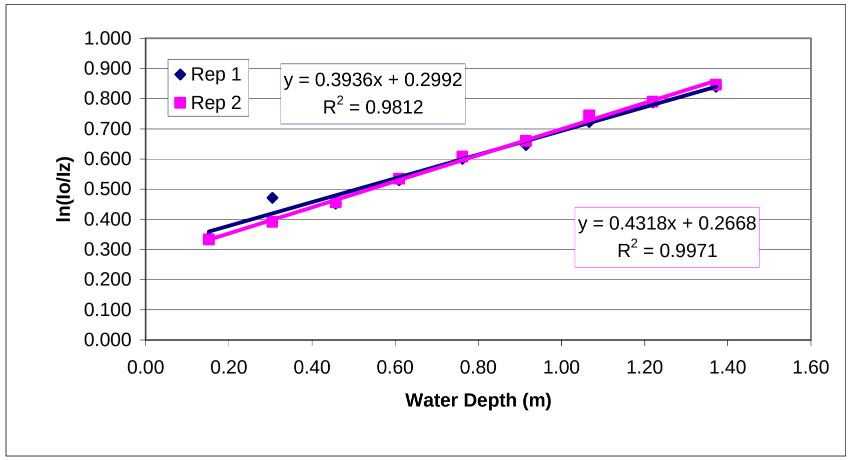
APPENDIX C. Blue Spring light attenuation detail.

VOLUSIA BLUE SPRING MFR LIGHT ATTENUATION ESTIMATES - VBS 355 - 11/27/2007 12:15

Depth (m)	Replicate 1						Depth (m)	Replicate 2					
	corr	raw						corr	raw				
z	Air (Io)	Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	z	Air (Io)	Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
0.03	907.8	941.5	793.3	6.68			0.03	635.2	660.6	580.1	6.36		
0.15	1,132.5	1,173.0	805.0	6.69	0.341	2.240	0.15	689.6	716.6	494.1	6.20	0.333	2.187
0.30	1,094.7	1,134.0	683.1	6.53	0.472	1.547	0.30	630.8	656.0	426.6	6.06	0.391	1.283
0.46	931.8	966.2	592.8	6.38	0.452	0.989	0.46	605.9	630.4	384.0	5.95	0.456	0.998
0.61	645.6	671.3	380.1	5.94	0.530	0.869	0.61	622.9	647.9	365.0	5.90	0.534	0.877
0.76	618.7	643.6	339.4	5.83	0.600	0.788	0.76	626.1	651.2	340.8	5.83	0.608	0.798
0.91	562.2	585.4	294.6	5.69	0.646	0.707	0.91	642.5	668.1	332.2	5.81	0.660	0.721
1.07	582.6	606.4	282.7	5.64	0.723	0.678	1.07	598.3	622.6	284.2	5.65	0.744	0.698
1.22	585.7	609.6	266.4	5.58	0.788	0.646	1.22	690.3	717.3	313.4	5.75	0.790	0.648
1.37	738.5	767.0	319.0	5.77	0.839	0.612	1.37	938.3	972.9	402.6	6.00	0.846	0.617

k (diffuse attenuation coefficient = slope, m-1)		0.394	k (diffuse attenuation coefficient = slope, m-1)		0.432
k average		1.008	k average		0.981
percent transmittance @	1.0 meter	67.46	percent transmittance @	1.0 meter	64.93
Birgean Percentile Absorption (1m)		32.54	Birgean Percentile Absorption (1m)		35.07



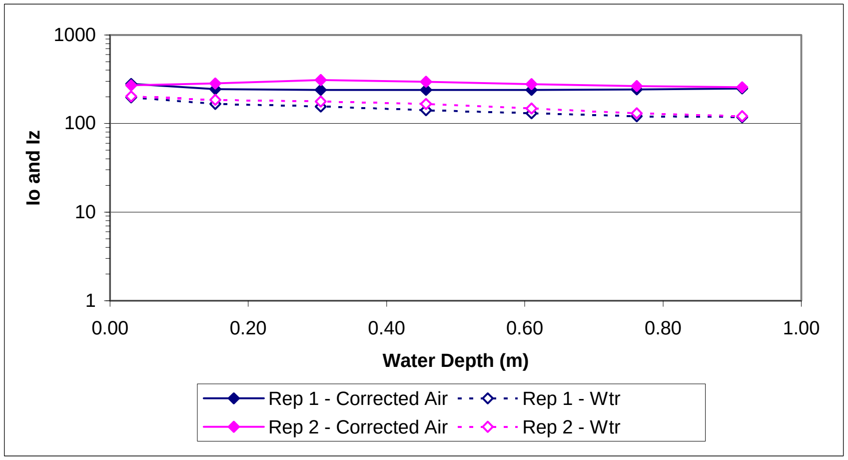


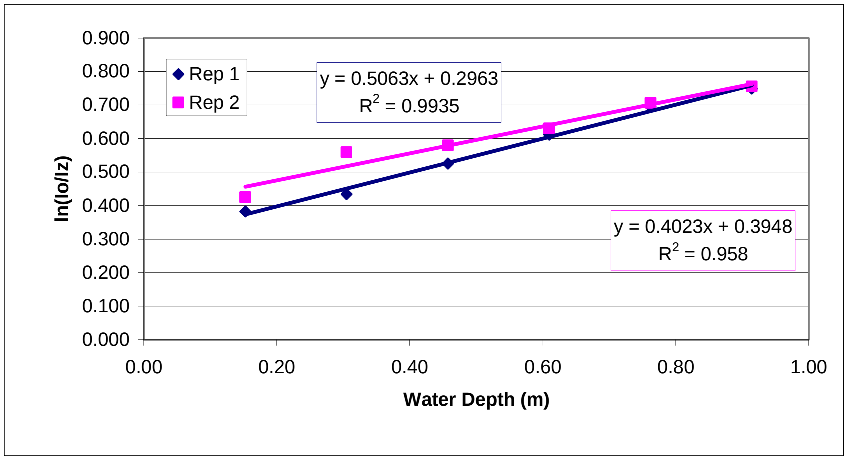
APPENDIX C. Blue Spring light attenuation detail.

VOLUSIA BLUE SPRING MFR LIGHT ATTENUATION ESTIMATES - VBS 355 - 1/22/2008 15:25

Depth (m) z	Replicate 1 corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	Depth (m) z	Replicate 2 corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
0.03	280.8	295.4	197.5	5.29			0.03	270.5	284.8	201.7	5.31		
0.15	244.4	257.9	166.7	5.12	0.383	2.511	0.15	283.3	298.0	185.2	5.22	0.425	2.790
0.30	240.1	253.5	155.6	5.05	0.434	1.424	0.30	309.8	325.3	177.1	5.18	0.559	1.835
0.46	238.9	252.2	141.2	4.95	0.526	1.150	0.46	296.2	311.3	166.0	5.11	0.579	1.267
0.61	239.7	253.1	130.0	4.87	0.612	1.004	0.61	278.4	292.9	148.2	5.00	0.630	1.034
0.76	242.6	256.0	121.1	4.80	0.695	0.912	0.76	264.2	278.3	130.3	4.87	0.707	0.928
0.91	249.2	262.8	117.8	4.77	0.749	0.819	0.91	256.9	270.8	120.7	4.79	0.755	0.826

k (diffuse attenuation coefficient = slope, m-1)		0.506	k (diffuse attenuation coefficient = slope, m-1)		0.402
k average		1.303	k average		1.447
percent transmittance @	1.0 meter	60.27	percent transmittance @	1.0 meter	66.88
Birgean Percentile Absorption (1m)		39.73	Birgean Percentile Absorption (1m)		33.12



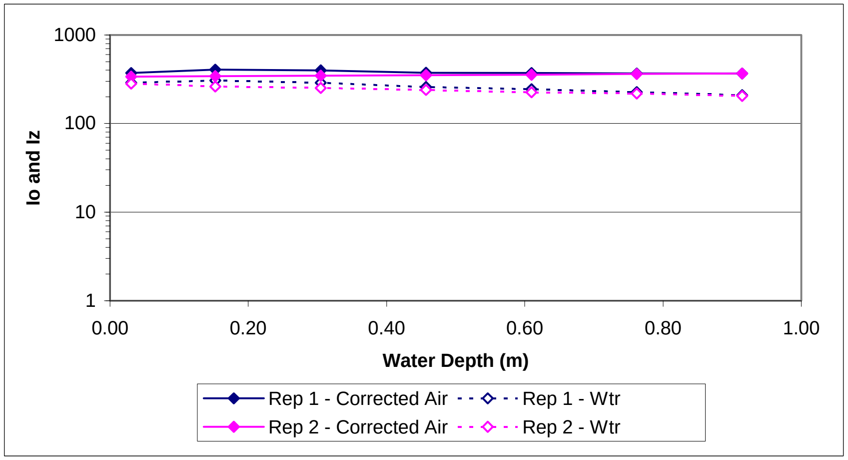


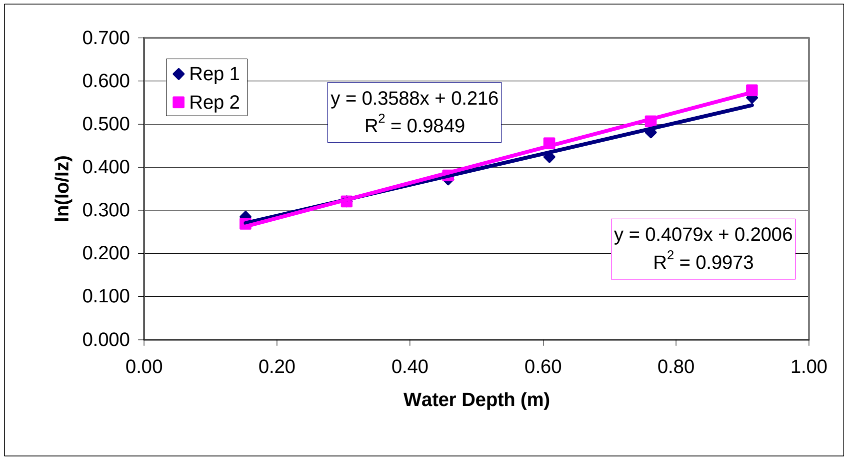
APPENDIX C. Blue Spring light attenuation detail.

VOLUSIA BLUE SPRING MFR LIGHT ATTENUATION ESTIMATES - VBS 355 - 2/06/2008 13:25

Depth (m) z	Replicate 1 corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	Depth (m) z	Replicate 2 corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
0.03	372.0	389.4	289.0	5.67			0.03	338.5	354.9	282.6	5.64		
0.15	406.0	424.4	305.2	5.72	0.285	1.873	0.15	342.2	358.7	261.5	5.57	0.269	1.765
0.30	397.7	415.9	288.6	5.67	0.321	1.052	0.30	347.6	364.2	252.3	5.53	0.320	1.051
0.46	374.2	391.6	258.0	5.55	0.372	0.813	0.46	351.5	368.2	240.2	5.48	0.381	0.832
0.61	371.8	389.2	243.4	5.49	0.424	0.695	0.61	355.5	372.4	225.6	5.42	0.455	0.746
0.76	367.1	384.3	226.9	5.42	0.481	0.631	0.76	361.5	378.5	217.9	5.38	0.506	0.664
0.91	366.1	383.3	208.8	5.34	0.562	0.614	0.91	365.9	383.1	205.3	5.32	0.578	0.632

k (diffuse attenuation coefficient = slope, m-1)		0.359	k (diffuse attenuation coefficient = slope, m-1)		0.408
k average		0.946	k average		0.949
percent transmittance @	1.0 meter	69.85	percent transmittance @	1.0 meter	66.50
Birgean Percentile Absorption (1m)		30.15	Birgean Percentile Absorption (1m)		33.50



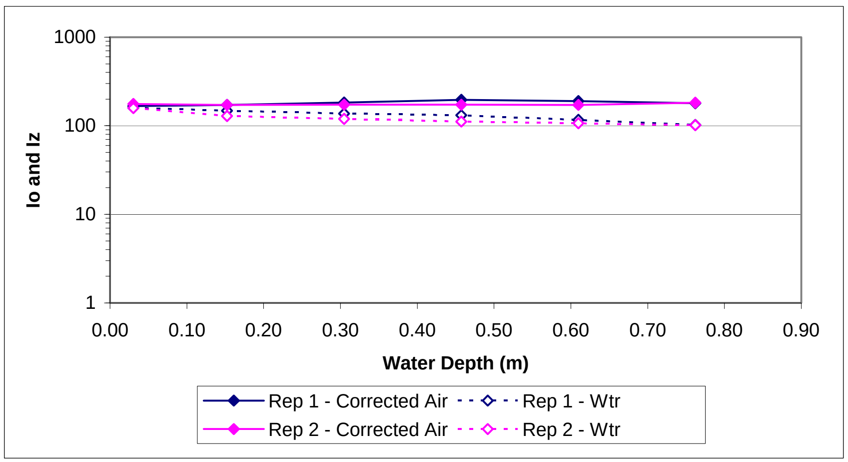


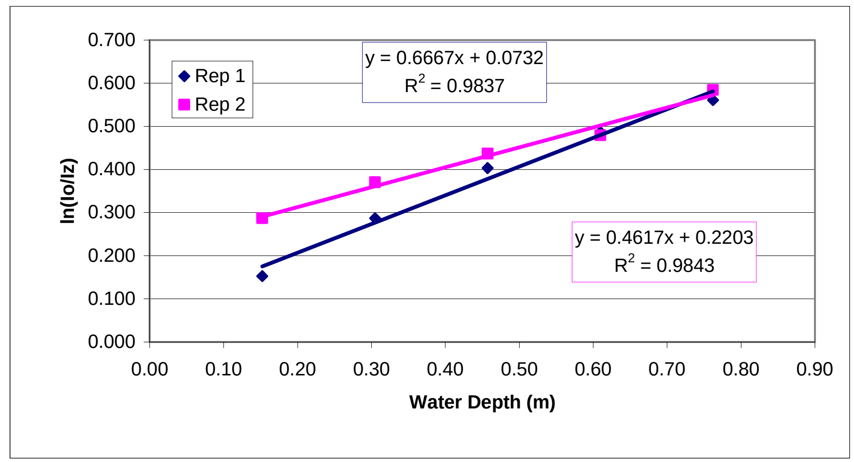
APPENDIX C. Blue Spring light attenuation detail.

VOLUSIA BLUE SPRING MFR LIGHT ATTENUATION ESTIMATES - VBS 355 - 3/18/2008 11:10

Depth (m)	Replicate 1						Depth (m)	Replicate 2					
z	corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	z	corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
0.03	166.8	177.9	159.6	5.07			0.03	176.5	187.9	158.2	5.06		
0.15	171.8	183.1	147.5	4.99	0.153	1.001	0.15	172.0	183.3	129.1	4.86	0.287	1.883
0.30	182.9	194.5	137.3	4.92	0.287	0.940	0.30	173.2	184.5	119.6	4.78	0.370	1.214
0.46	195.8	207.8	130.8	4.87	0.403	0.882	0.46	172.7	184.0	111.6	4.71	0.437	0.955
0.61	189.7	201.5	116.6	4.76	0.487	0.798	0.61	172.1	183.4	106.6	4.67	0.479	0.786
0.76	179.4	190.9	102.4	4.63	0.561	0.736	0.76	181.7	193.3	101.3	4.62	0.584	0.767

k (diffuse attenuation coefficient = slope, m-1)		0.667	k (diffuse attenuation coefficient = slope, m-1)		0.462
k average		0.872	k average		1.121
percent transmittance @	1.0 meter	51.34	percent transmittance @	1.0 meter	63.02
Birgean Percentile Absorption (1m)		48.66	Birgean Percentile Absorption (1m)		36.98



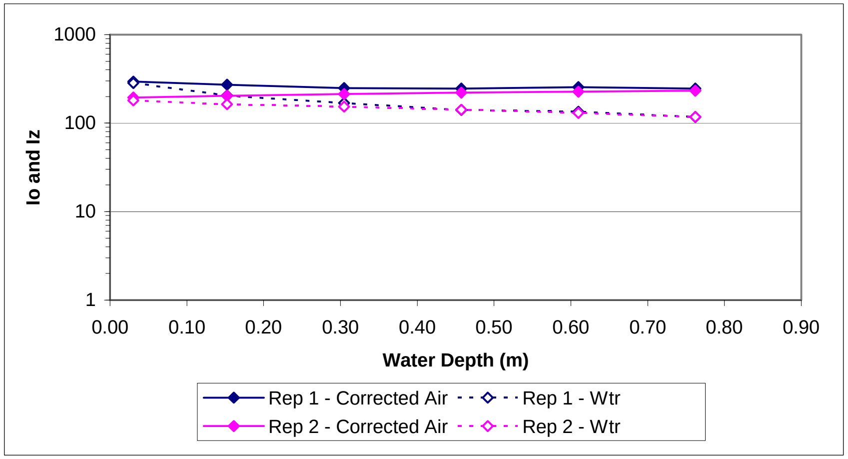


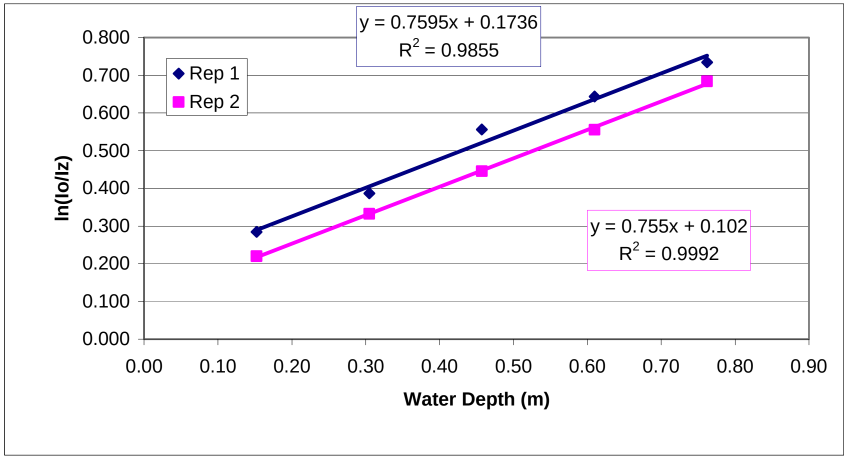
APPENDIX C. Blue Spring light attenuation detail.

VOLUSIA BLUE SPRING MFR LIGHT ATTENUATION ESTIMATES - VBS 355 - 4/1/2008 12:18

Depth (m) z	Replicate 1 corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	Depth (m) z	Replicate 2 corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
0.03	294.7	309.7	283.6	5.65			0.03	194.6	206.6	180.7	5.20		
0.15	272.3	286.6	204.9	5.32	0.284	1.865	0.15	203.5	215.7	163.3	5.10	0.220	1.443
0.30	248.1	261.7	168.6	5.13	0.386	1.267	0.30	213.3	225.8	153.0	5.03	0.332	1.089
0.46	245.5	259.0	140.8	4.95	0.556	1.216	0.46	221.2	234.0	141.7	4.95	0.445	0.974
0.61	255.8	269.6	134.4	4.90	0.643	1.055	0.61	226.5	239.4	130.0	4.87	0.555	0.910
0.76	244.9	258.4	117.5	4.77	0.734	0.964	0.76	231.6	244.7	116.9	4.76	0.684	0.897

k (diffuse attenuation coefficient = slope, m-1)		0.759	k (diffuse attenuation coefficient = slope, m-1)		0.755
k average		1.273	k average		1.063
percent transmittance @	1.0 meter	46.79	percent transmittance @	1.0 meter	47.00
Birgean Percentile Absorption (1m)		53.21	Birgean Percentile Absorption (1m)		53.00



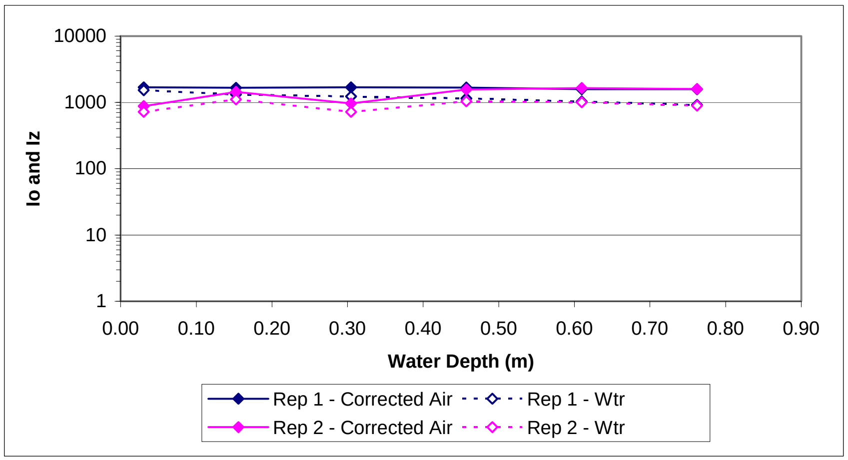


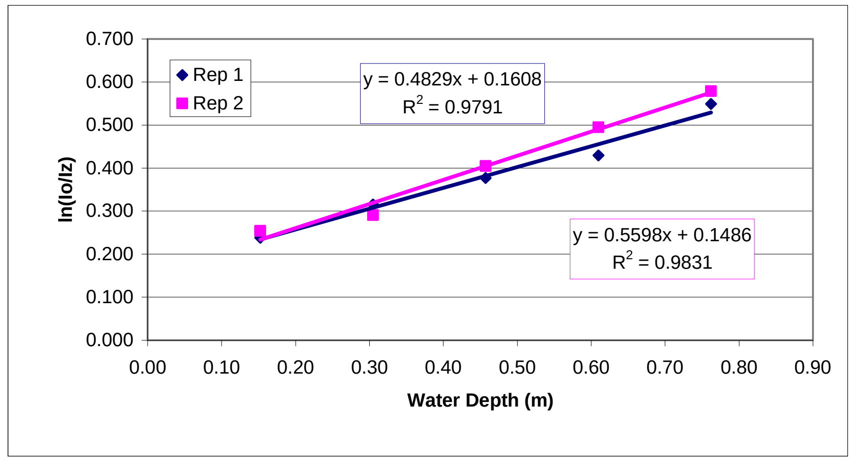
APPENDIX C. Blue Spring light attenuation detail.

VOLUSIA BLUE SPRING MFR LIGHT ATTENUATION ESTIMATES - VBS 355 - 5/8/2008 12:06

Depth (m) z	Replicate 1 corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	Depth (m) z	Replicate 2 corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
0.03	1685.5	1742.8	1522.7	7.33			0.03	880.5	913.3	716.0	6.57		
0.15	1660.3	1716.8	1308.7	7.18	0.238	1.561	0.15	1437.1	1486.8	1114.7	7.02	0.254	1.667
0.30	1679.7	1736.8	1225.7	7.11	0.315	1.034	0.30	959.6	994.8	717.5	6.58	0.291	0.954
0.46	1667.1	1723.8	1143.7	7.04	0.377	0.824	0.46	1558.4	1611.8	1039.7	6.95	0.405	0.885
0.61	1578.7	1632.8	1027.7	6.94	0.429	0.704	0.61	1642.8	1698.8	1001.7	6.91	0.495	0.812
0.76	1579.7	1633.8	912.5	6.82	0.549	0.720	0.76	1595.2	1649.8	894.5	6.80	0.579	0.759

k (diffuse attenuation coefficient = slope, m-1)		0.483	k (diffuse attenuation coefficient = slope, m-1)		0.560
k average		0.969	k average		1.015
percent transmittance @	1.0 meter	61.70	percent transmittance @	1.0 meter	57.13
Birgean Percentile Absorption (1m)		38.30	Birgean Percentile Absorption (1m)		42.87





APPENDIX C. Blue Spring light attenuation detail.

APPENDIX C. Blue Spring light attenuation detail.

VOLUSIA BLUE SPRING MFR LIGHT ATTENUATION ESTIMATES - VBS 355 - 5/23/2008 11:05 TO 11:38

Depth (m)	Replicate 1					
	corr	raw				
z	Air (Io)	Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
0.91	409.8	428.3	413.0	6.02	-0.008	-0.009
0.93	280.9	295.5	211.8	5.36	0.282	0.305
0.93	191.3	203.2	454.2	6.12	-0.865	-0.933
0.93	211.1	223.6	582.9	6.37	-1.016	-1.096
0.93	248.5	262.1	304.3	5.72	-0.203	-0.219
0.93	156.0	166.8	159.5	5.07	-0.022	-0.024
0.93	154.0	164.8	209.0	5.34	-0.305	-0.329
0.93	129.7	139.7	134.7	4.90	-0.038	-0.041
0.93	41.5	48.9	107.6	4.68	-0.951	-1.027
0.93	56.5	64.3	96.7	4.57	-0.538	-0.581
0.93	59.1	66.9	87.1	4.47	-0.388	-0.419
0.93	71.2	79.4	74.4	4.31	-0.044	-0.048
0.93	79.5	88.0	75.6	4.33	0.051	0.055
0.93	85.4	94.1	79.1	4.37	0.078	0.084
0.93	99.4	108.5	85.2	4.44	0.155	0.167
0.93	136.0	146.2	101.2	4.62	0.296	0.319
0.93	138.5	148.8	109.5	4.70	0.235	0.254
0.93	127.4	137.4	46.0	3.83	1.018	1.099
0.93	144.2	154.7	121.9	4.80	0.168	0.182
0.93	222.7	235.5	134.3	4.90	0.506	0.546
0.93	118.4	128.1	80.5	4.39	0.386	0.416
0.93	73.9	82.2	82.7	4.41	-0.112	-0.120
0.93	94.8	103.8	84.5	4.44	0.116	0.125
0.93	100.3	109.4	133.0	4.89	-0.282	-0.305

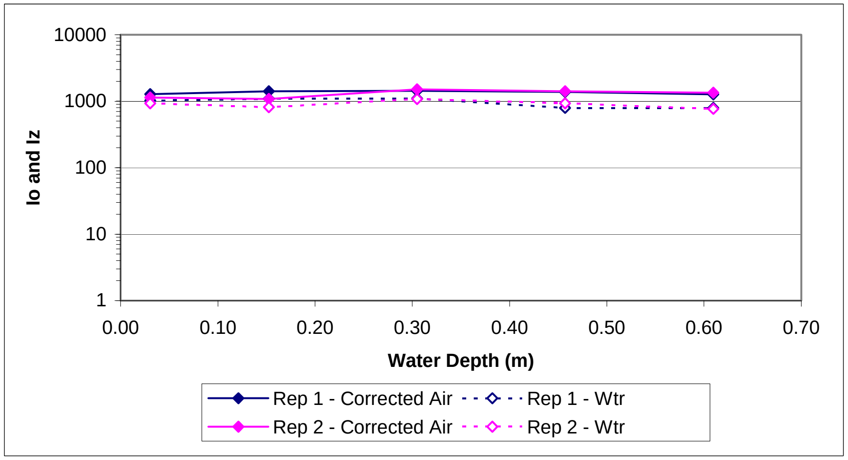
k (diffuse attenuation coefficient = slope, m-1)		0.000
k average		-0.067
	average w/o suspect values -->	0.411
percent transmittance @	1.0 meter	100.00
Birgean Percentile Absorption (1m)		0.00

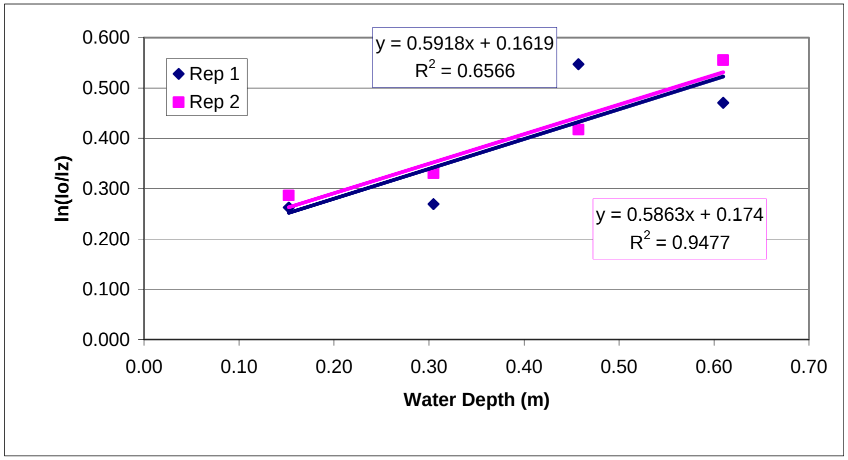
Note: suspect values in red

VOLUSIA BLUE SPRING MFR LIGHT ATTENUATION ESTIMATES - VBS 355 - 6/24/2008 12:16

Depth (m) z	Replicate 1 corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	Depth (m) z	Replicate 2 corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
0.03	1282.9	1328.0	1019.0	6.93			0.03	1136.4	1177.0	929.0	6.83		
0.15	1415.9	1465.0	1089.0	6.99	0.263	1.722	0.15	1082.0	1121.0	812.6	6.70	0.286	1.879
0.30	1440.2	1490.0	1100.0	7.00	0.269	0.884	0.30	1507.1	1559.0	1083.0	6.99	0.330	1.084
0.46	1377.1	1425.0	796.8	6.68	0.547	1.197	0.46	1414.0	1463.0	931.5	6.84	0.417	0.913
0.61	1271.3	1316.0	794.1	6.68	0.471	0.772	0.61	1342.1	1389.0	770.3	6.65	0.555	0.911

k (diffuse attenuation coefficient = slope, m-1)		0.592	k (diffuse attenuation coefficient = slope, m-1)		0.586
k average		1.144	k average		1.197
percent transmittance @	1.0 meter	55.33	percent transmittance @	1.0 meter	55.64
Birgean Percentile Absorption (1m)		44.67	Birgean Percentile Absorption (1m)		44.36



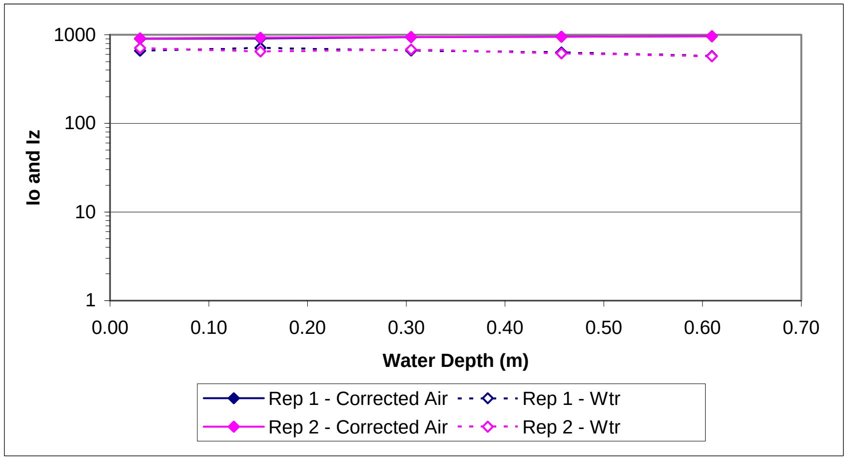


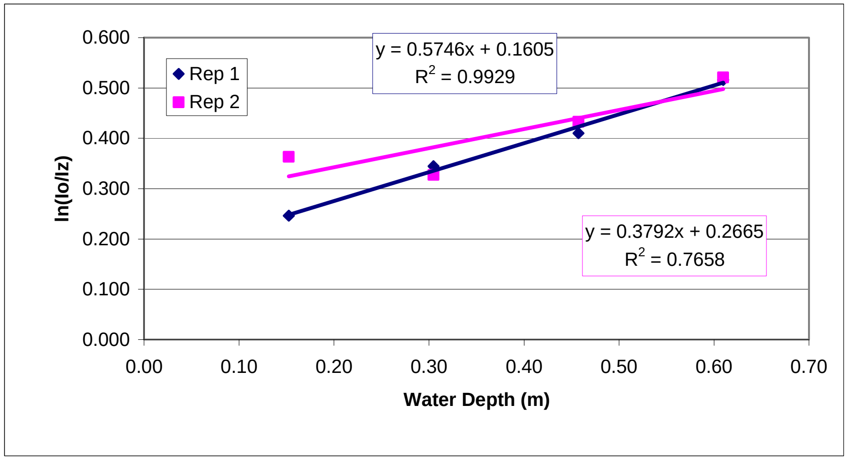
APPENDIX C. Blue Spring light attenuation detail.

VOLUSIA BLUE SPRING MFR LIGHT ATTENUATION ESTIMATES - VBS 355 - 7/08/2008 11:20

Depth (m) z	Replicate 1 corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	Depth (m) z	Replicate 2 corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
0.03	906.2	939.8	662.5	6.50			0.03	910.9	944.6	706.7	6.56		
0.15	912.5	946.3	713.2	6.57	0.246	1.617	0.15	930.3	964.6	646.9	6.47	0.363	2.384
0.30	937.2	971.8	664.2	6.50	0.344	1.130	0.30	946.3	981.1	682.1	6.53	0.327	1.074
0.46	953.2	988.2	632.3	6.45	0.410	0.898	0.46	951.5	986.5	617.4	6.43	0.433	0.946
0.61	964.6	1000.0	575.6	6.36	0.516	0.847	0.61	962.8	998.1	571.9	6.35	0.521	0.854

k (diffuse attenuation coefficient = slope, m-1)		0.575	k (diffuse attenuation coefficient = slope, m-1)		0.379
k average		1.123	k average		1.315
percent transmittance @	1.0 meter	56.29	percent transmittance @	1.0 meter	68.44
Birgean Percentile Absorption (1m)		43.71	Birgean Percentile Absorption (1m)		31.56



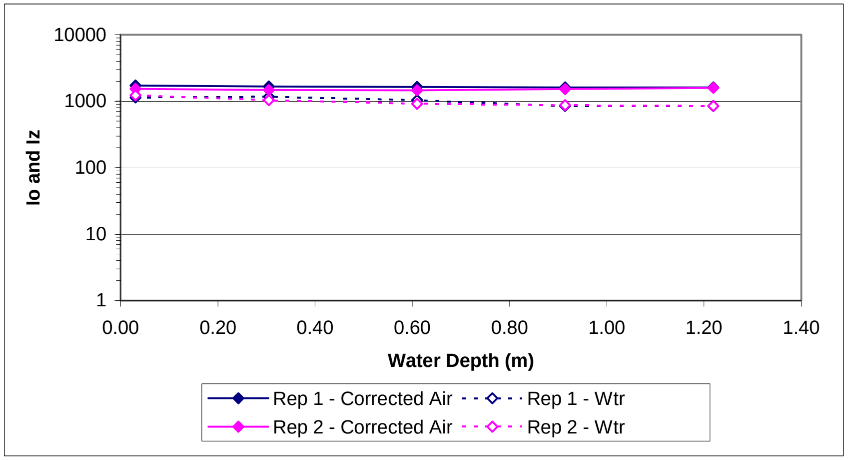


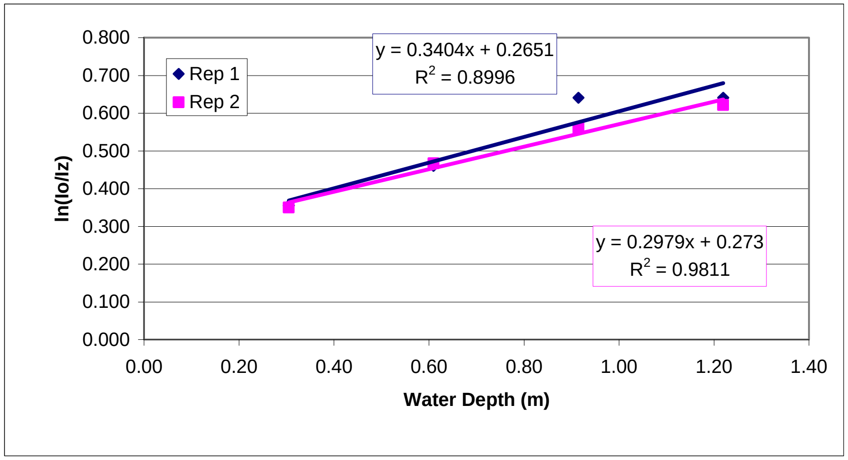
APPENDIX C. Blue Spring light attenuation detail.

VOLUSIA BLUE SPRING MFR LIGHT ATTENUATION ESTIMATES - VBS 355 - 8/05/2008 12:28

Depth (m) z	Replicate 1 corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	Depth (m) z	Replicate 2 corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
0.03	1726.5	1785.0	1137.0	7.04			0.03	1539.2	1592.0	1224.0	7.11		
0.30	1669.2	1726.0	1170.0	7.06	0.355	1.166	0.30	1479.0	1530.0	1042.0	6.95	0.350	1.149
0.61	1639.1	1695.0	1034.0	6.94	0.461	0.756	0.61	1459.6	1510.0	914.8	6.82	0.467	0.766
0.91	1613.9	1669.0	850.2	6.75	0.641	0.701	0.91	1524.6	1577.0	870.1	6.77	0.561	0.613
1.22	1612.9	1668.0	849.5	6.74	0.641	0.526	1.22	1587.7	1642.0	852.7	6.75	0.622	0.510

Replicate 1			Replicate 2		
k (diffuse attenuation coefficient = slope, m-1)		0.340	k (diffuse attenuation coefficient = slope, m-1)		0.298
k average		0.787	k average		0.760
percent transmittance @	1.0 meter	71.15	percent transmittance @	1.0 meter	74.24
Birgean Percentile Absorption (1m)		28.85	Birgean Percentile Absorption (1m)		25.76

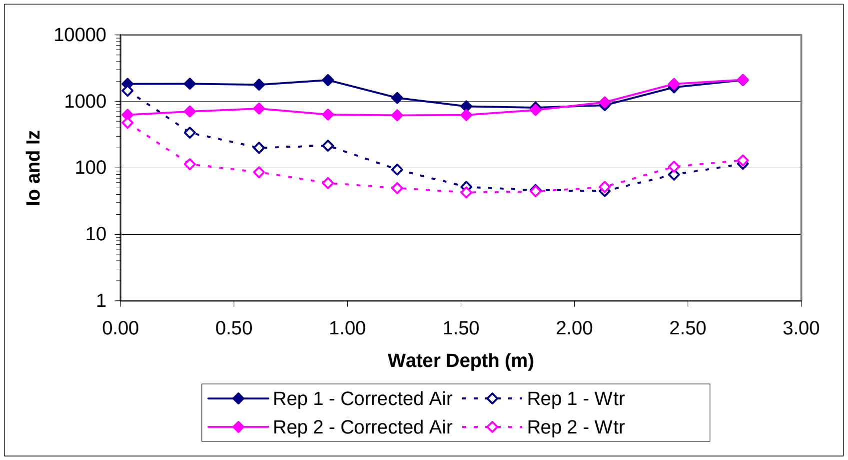


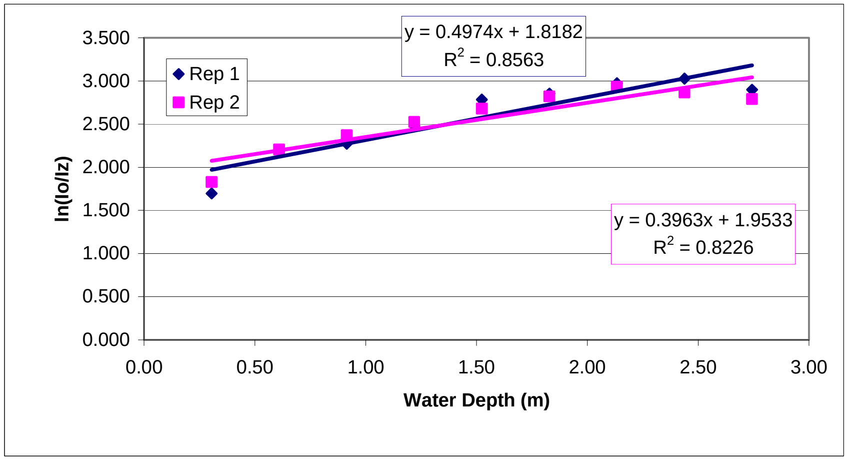


APPENDIX C. Blue Spring light attenuation detail.

Depth (m) z	Replicate 1 corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	Depth (m) z	Replicate 2 corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
0.03	1830.3	1892.0	1448.0	7.28			0.03	628.4	653.6	478.6	6.17		
0.30	1842.9	1905.0	337.7	5.82	1.697	5.567	0.30	706.9	734.4	113.5	4.73	1.829	6.001
0.61	1794.4	1855.0	200.6	5.30	2.191	3.594	0.61	779.6	809.4	86.0	4.45	2.205	3.617
0.91	2095.2	2165.0	215.8	5.37	2.273	2.486	0.91	631.6	656.9	59.0	4.08	2.370	2.592
1.22	1125.7	1166.0	94.0	4.54	2.483	2.036	1.22	617.6	642.4	49.5	3.90	2.525	2.071
1.52	839.8	871.4	51.9	3.95	2.785	1.827	1.52	622.8	647.8	42.8	3.76	2.678	1.757
1.83	806.0	836.6	46.4	3.84	2.855	1.561	1.83	744.4	773.1	44.4	3.79	2.820	1.542
2.13	876.9	909.6	44.7	3.80	2.976	1.395	2.13	973.4	1009.0	51.8	3.95	2.933	1.374
2.44	1628.4	1684.0	78.9	4.37	3.027	1.241	2.44	1840.0	1902.0	104.7	4.65	2.866	1.176
2.74	2101.1	2171.0	115.6	4.75	2.900	1.057	2.74	2118.5	2189.0	130.1	4.87	2.790	1.017

Replicate 1			Replicate 2		
k (diffuse attenuation coefficient = slope, m-1)		0.497	k (diffuse attenuation coefficient = slope, m-1)		0.396
k average		2.307	k average		2.350
percent transmittance @	1.0 meter	60.81	percent transmittance @	1.0 meter	67.28
Birgean Percentile Absorption (1m)		39.19	Birgean Percentile Absorption (1m)		32.72

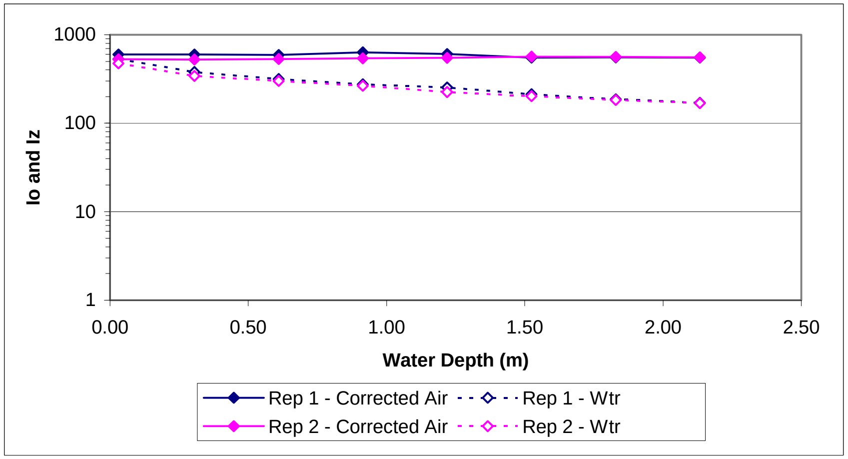


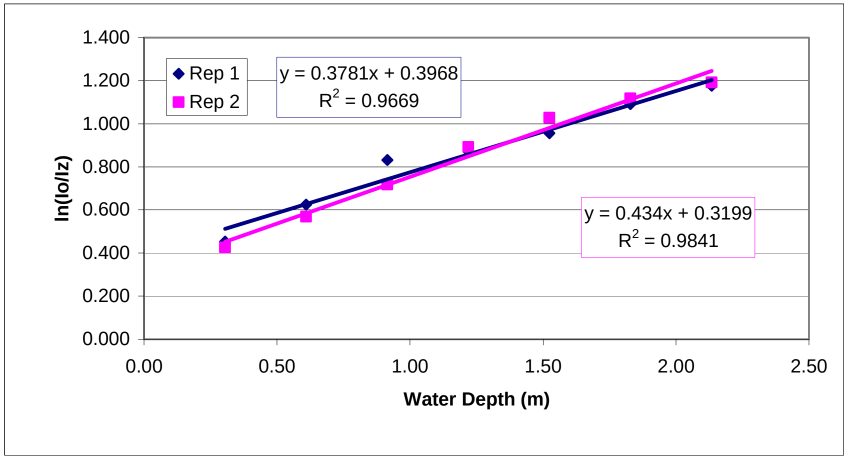


APPENDIX C. Blue Spring light attenuation detail.

Depth (m) z	Replicate 1 corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	Depth (m) z	Replicate 2 corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
0.03	596.7	620.9	529.4	6.27			0.03	527.3	549.4	473.9	6.16		
0.30	596.7	620.9	379.4	5.94	0.453	1.486	0.30	524.7	546.7	342.7	5.84	0.426	1.397
0.61	591.2	615.2	316.4	5.76	0.625	1.025	0.61	529.6	551.8	299.7	5.70	0.569	0.934
0.91	631.0	656.2	274.6	5.62	0.832	0.910	0.91	542.5	565.1	264.7	5.58	0.718	0.785
1.22	604.2	628.6	252.8	5.53	0.871	0.715	1.22	549.0	571.7	224.8	5.42	0.893	0.732
1.52	552.3	575.2	212.4	5.36	0.956	0.627	1.52	564.2	587.4	201.9	5.31	1.028	0.674
1.83	554.5	577.4	186.2	5.23	1.091	0.597	1.83	561.0	584.1	183.4	5.21	1.118	0.611
2.13	550.6	573.4	169.8	5.13	1.176	0.551	2.13	555.7	578.7	168.8	5.13	1.192	0.558

k (diffuse attenuation coefficient = slope, m-1)		0.378	k (diffuse attenuation coefficient = slope, m-1)		0.434
k average		0.844	k average		0.813
percent transmittance @	1.0 meter	68.52	percent transmittance @	1.0 meter	64.79
Birgean Percentile Absorption (1m)		31.48	Birgean Percentile Absorption (1m)		35.21



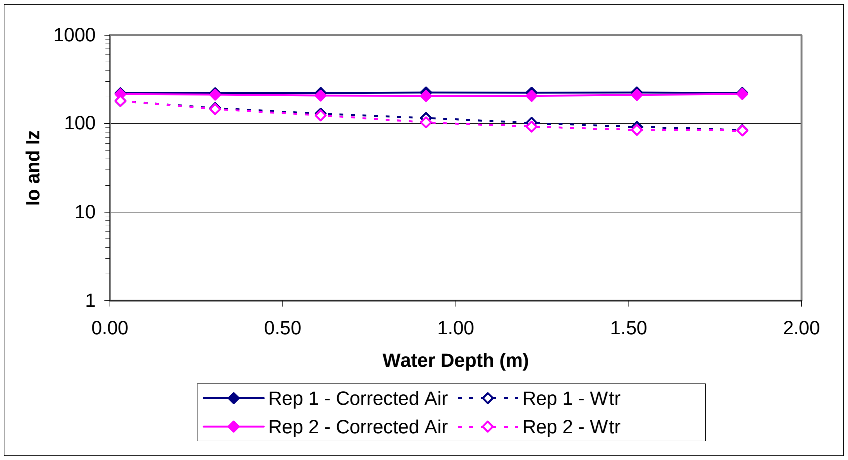


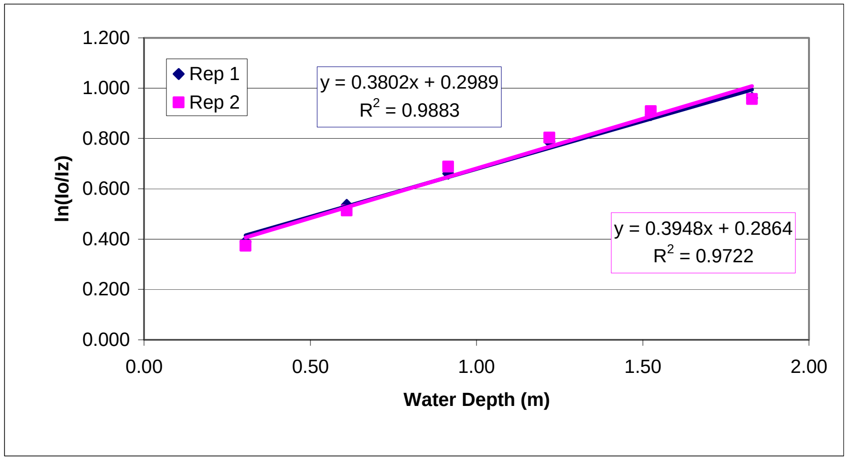
APPENDIX C. Blue Spring light attenuation detail.

VOLUSIA BLUE SPRING MFR LIGHT ATTENUATION ESTIMATES - VBS 570 - 1/22/2008 16:09

Depth (m)	Replicate 1						Depth (m)	Replicate 2					
	corr	raw						corr	raw				
z	Air (Io)	Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	z	Air (Io)	Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
0.03	220.4	233.2	180.6	5.20			0.03	215.5	228.1	181.2	5.20		
0.30	221.0	233.8	149.7	5.01	0.390	1.278	0.30	212.7	225.2	146.3	4.99	0.374	1.227
0.61	221.6	234.4	129.7	4.87	0.536	0.879	0.61	207.8	220.2	124.3	4.82	0.514	0.843
0.91	224.3	237.2	115.9	4.75	0.660	0.722	0.91	206.3	218.6	103.6	4.64	0.689	0.753
1.22	223.9	236.8	101.9	4.62	0.787	0.646	1.22	206.5	218.8	92.5	4.53	0.803	0.659
1.52	224.4	237.3	91.9	4.52	0.893	0.586	1.52	211.6	224.1	85.3	4.45	0.908	0.596
1.83	221.9	234.7	84.9	4.44	0.961	0.526	1.83	216.9	229.6	83.3	4.42	0.957	0.523

k (diffuse attenuation coefficient = slope, m-1)		0.380	k (diffuse attenuation coefficient = slope, m-1)		0.395
k average		0.773	k average		0.767
percent transmittance @	1.0 meter	68.37	percent transmittance @	1.0 meter	67.38
Birgean Percentile Absorption (1m)		31.63	Birgean Percentile Absorption (1m)		32.62



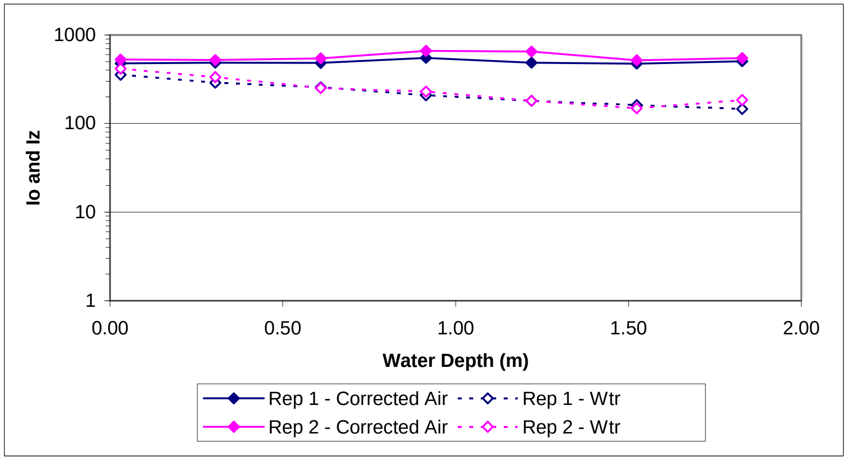


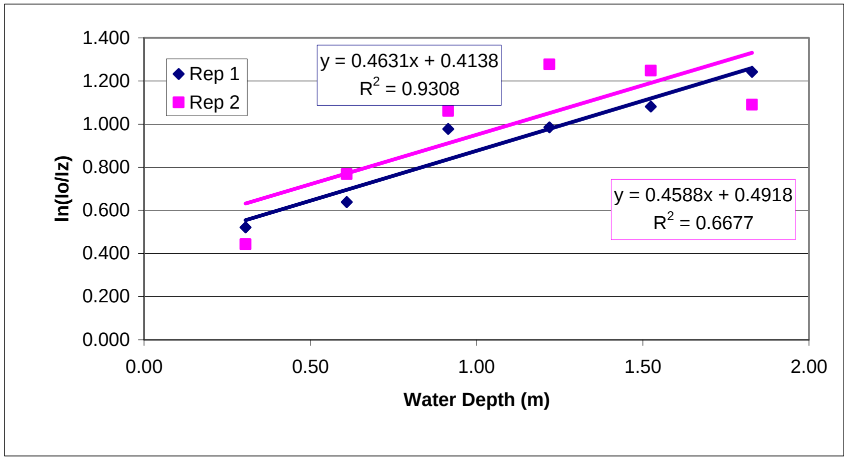
APPENDIX C. Blue Spring light attenuation detail.

VOLUSIA BLUE SPRING MFR LIGHT ATTENUATION ESTIMATES - VBS 570 - 2/06/2008 12:40

	Replicate 1							Replicate 2					
Depth (m) z	corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	Depth (m) z	corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
0.03	476.6	497.2	355.2	5.87			0.03	526.7	548.8	416.5	6.03		
0.30	485.7	506.5	288.3	5.66	0.522	1.711	0.30	519.4	541.3	333.6	5.81	0.443	1.453
0.61	484.7	505.5	255.9	5.54	0.639	1.048	0.61	542.8	565.4	251.9	5.53	0.768	1.259
0.91	552.8	575.7	208.0	5.34	0.978	1.069	0.91	662.0	688.2	229.0	5.43	1.062	1.161
1.22	485.1	505.9	181.1	5.20	0.985	0.808	1.22	648.4	674.2	180.8	5.20	1.277	1.048
1.52	475.4	495.9	161.2	5.08	1.081	0.710	1.52	519.0	540.8	149.0	5.00	1.248	0.819
1.83	504.3	525.7	145.6	4.98	1.242	0.679	1.83	549.0	571.8	184.5	5.22	1.091	0.596

k (diffuse attenuation coefficient = slope, m-1)		0.463	k (diffuse attenuation coefficient = slope, m-1)		0.459
k average		1.004	k average		1.056
percent transmittance @	1.0 meter	62.94	percent transmittance @	1.0 meter	63.20
Birgean Percentile Absorption (1m)		37.06	Birgean Percentile Absorption (1m)		36.80



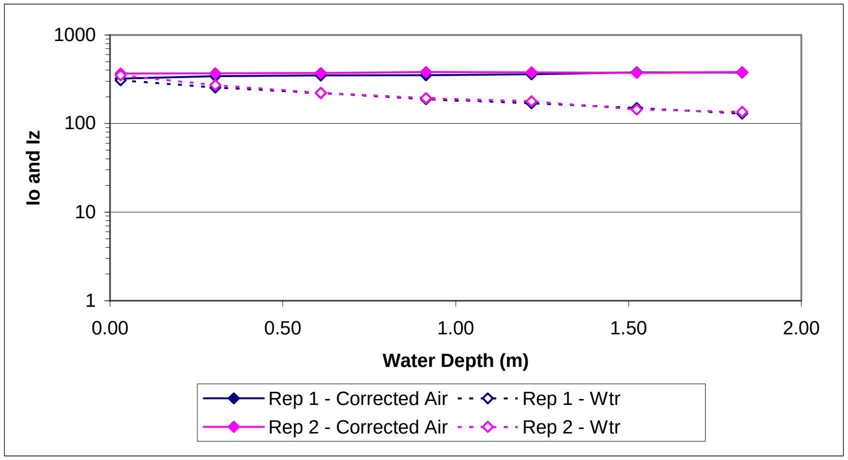


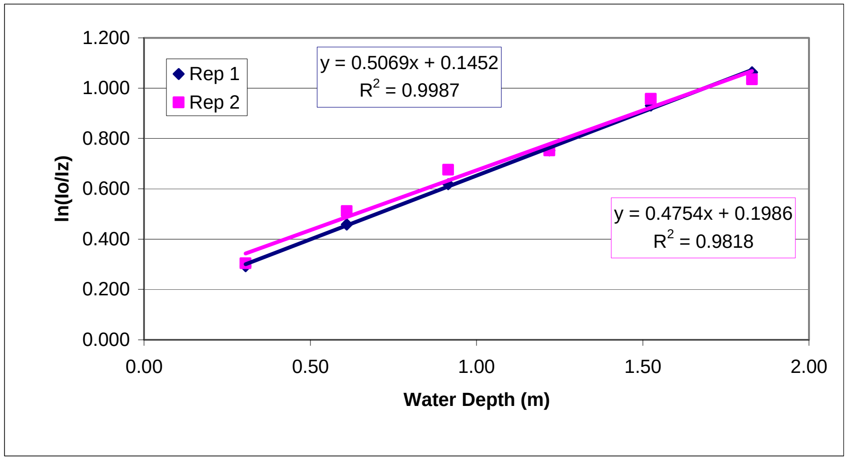
APPENDIX C. Blue Spring light attenuation detail.

VOLUSIA BLUE SPRING MFR LIGHT ATTENUATION ESTIMATES - VBS 570 - 3/18/2008 10:08

Depth (m) z	Replicate 1 corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	Depth (m) z	Replicate 2 corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
0.03	321.6	337.4	307.7	5.73			0.03	367.6	384.8	350.7	5.86		
0.30	341.5	357.9	254.9	5.54	0.292	0.959	0.30	368.3	385.6	271.8	5.61	0.304	0.997
0.61	348.2	364.8	220.2	5.39	0.458	0.751	0.61	370.6	387.9	222.4	5.40	0.511	0.838
0.91	350.5	367.2	188.8	5.24	0.619	0.677	0.91	381.2	398.8	193.9	5.27	0.676	0.739
1.22	360.9	377.9	170.1	5.14	0.752	0.617	1.22	378.6	396.2	178.5	5.18	0.752	0.617
1.52	378.8	396.4	149.3	5.01	0.931	0.611	1.52	374.8	392.3	143.9	4.97	0.957	0.628
1.83	375.3	392.8	129.6	4.86	1.063	0.581	1.83	382.0	399.7	135.7	4.91	1.035	0.566

k (diffuse attenuation coefficient = slope, m-1)		0.507	k (diffuse attenuation coefficient = slope, m-1)		0.475
k average		0.699	k average		0.731
percent transmittance @	1.0 meter	60.24	percent transmittance @	1.0 meter	62.16
Birgean Percentile Absorption (1m)		39.76	Birgean Percentile Absorption (1m)		37.84



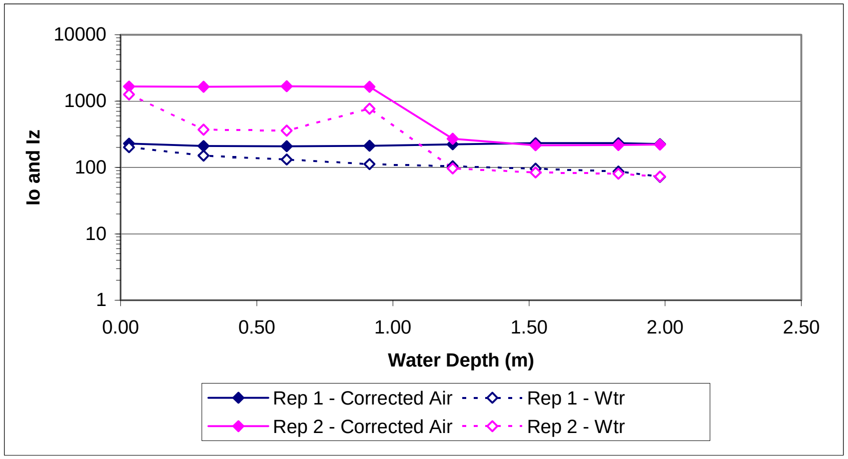


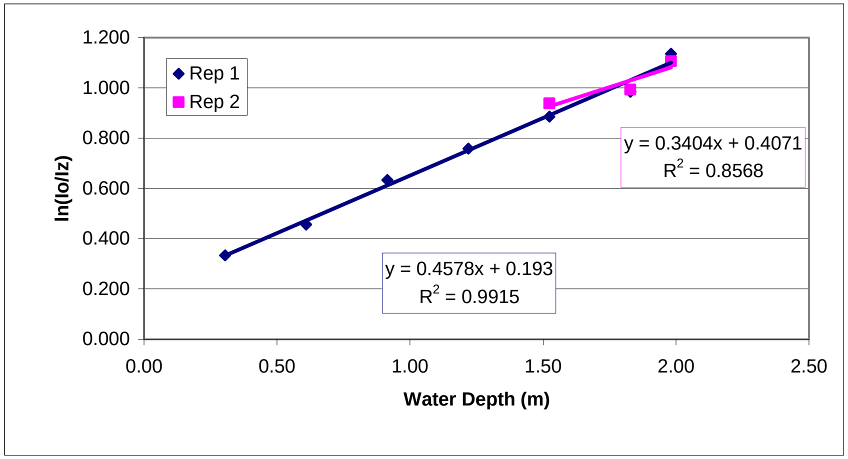
APPENDIX C. Blue Spring light attenuation detail.

VOLUSIA BLUE SPRING MFR LIGHT ATTENUATION ESTIMATES - VBS 570 - 4/1/2008 11:25

Depth (m)	Replicate 1						Depth (m)	Replicate 2					
z	corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	z	corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
0.03	229.5	242.5	201.5	5.31			0.03	1663.2	1719.8	1253.7	7.13		
0.30	210.7	223.2	151.0	5.02	0.333	1.094	0.30	1647.7	1703.8	370.3	5.91	1.493	4.898
0.61	208.4	220.8	132.0	4.88	0.457	0.749	0.61	1670.0	1726.8	359.8	5.89	1.535	2.518
0.91	211.4	223.9	112.2	4.72	0.634	0.693	0.91	1639.9	1695.8	766.3	6.64	0.761	0.832
1.22	222.9	235.7	104.4	4.65	0.758	0.622	1.22	270.9	285.2	96.5	4.57	1.032	0.847
1.52	232.1	245.2	95.7	4.56	0.886	0.581	1.52	214.9	227.5	84.1	4.43	0.938	0.616
1.83	232.8	245.9	87.0	4.47	0.984	0.538	1.83	216.7	229.4	80.3	4.39	0.993	0.543
1.98	225.2	238.1	72.3	4.28	1.136	0.573	1.98	220.3	233.1	72.9	4.29	1.106	0.558

k (diffuse attenuation coefficient = slope, m-1)		0.458	k (diffuse attenuation coefficient = slope, m-1)		0.340
k average		0.693	k average		0.572
percent transmittance @	1.0 meter	63.27	percent transmittance @	1.0 meter	71.15
Birgean Percentile Absorption (1m)		36.73	Birgean Percentile Absorption (1m)		28.85



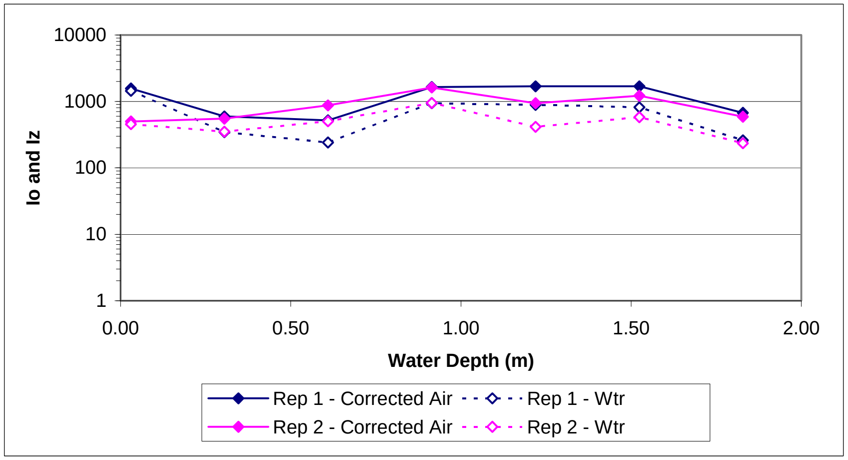


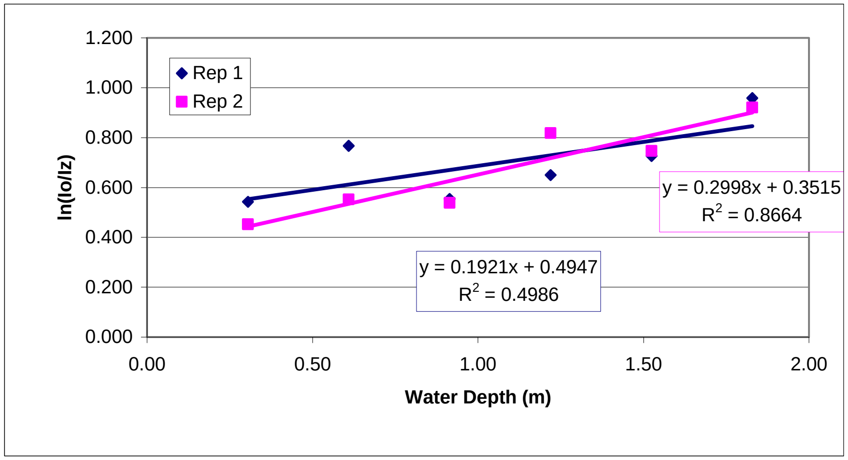
APPENDIX C. Blue Spring light attenuation detail.

VOLUSIA BLUE SPRING MFR LIGHT ATTENUATION ESTIMATES - VBS 570 - 5/8/2008 11:26

	Replicate 1							Replicate 2					
Depth (m) z	corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	Depth (m) z	corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
0.03	1570.0	1623.8	1434.7	7.27			0.03	496.7	517.9	452.4	6.11		
0.30	591.3	615.3	343.6	5.84	0.543	1.781	0.30	552.3	575.1	351.2	5.86	0.453	1.485
0.61	518.0	539.8	240.5	5.48	0.767	1.259	0.61	872.9	905.5	502.5	6.22	0.552	0.906
0.91	1639.9	1695.8	942.2	6.85	0.554	0.606	0.91	1618.5	1673.8	944.4	6.85	0.539	0.589
1.22	1691.3	1748.8	883.5	6.78	0.649	0.533	1.22	941.8	976.5	415.5	6.03	0.818	0.671
1.52	1689.4	1746.8	816.9	6.71	0.727	0.477	1.52	1221.6	1264.8	579.3	6.36	0.746	0.490
1.83	673.3	699.8	258.3	5.55	0.958	0.524	1.83	587.0	610.9	233.9	5.45	0.920	0.503

k (diffuse attenuation coefficient = slope, m-1)		0.192	k (diffuse attenuation coefficient = slope, m-1)		0.300
k average		0.863	k average		0.774
percent transmittance @	1.0 meter	82.52	percent transmittance @	1.0 meter	74.09
Birgean Percentile Absorption (1m)		17.48	Birgean Percentile Absorption (1m)		25.91





APPENDIX C. Blue Spring light attenuation detail.

APPENDIX C. Blue Spring light attenuation detail.

VOLUSIA BLUE SPRING MFR LIGHT ATTENUATION ESTIMATES - VBS 570 - 5/23/2008 13:04 TO 13:52

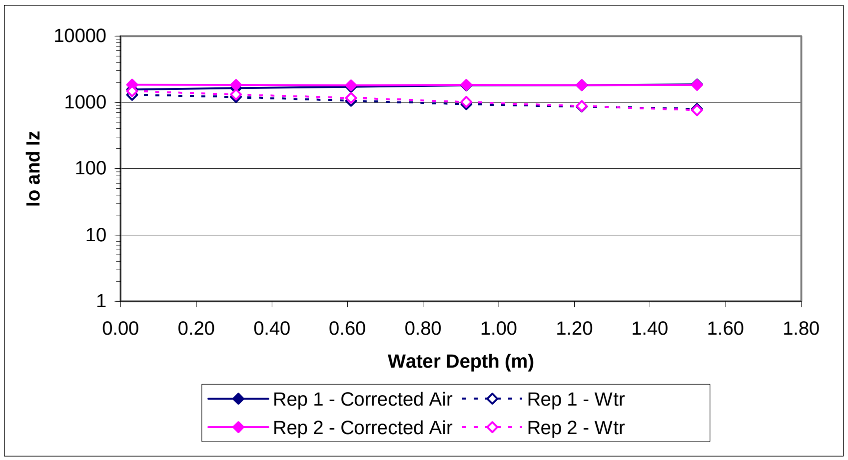
Depth (m)	Replicate 1					
z	corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
2.03	424.5	443.5	175.3	5.17		
2.03	419.8	438.6	175.0	5.16	0.875	0.432
2.03	391.0	409.0	106.5	4.67	1.301	0.642
2.03	346.1	362.7	118.0	4.77	1.076	0.531
2.03	236.4	249.7	115.8	4.75	0.714	0.352
2.03	305.9	321.3	106.3	4.67	1.057	0.522
2.03	408.8	427.3	145.2	4.98	1.035	0.511
2.03	513.5	535.2	169.3	5.13	1.110	0.548
2.03	591.2	615.3	219.3	5.39	0.992	0.489
2.03	951.7	986.7	340.2	5.83	1.029	0.508
2.03	1041.1	1078.8	284.0	5.65	1.299	0.641
2.03	1036.2	1073.8	367.2	5.91	1.038	0.512
2.03	1201.2	1243.8	576.1	6.36	0.735	0.363
2.03	1093.5	1132.8	408.3	6.01	0.985	0.486
2.03	1006.2	1042.8	344.3	5.84	1.072	0.529
2.03	902.4	935.9	288.4	5.66	1.141	0.563
2.03	1258.5	1302.8	343.0	5.84	1.300	0.641
2.03	1404.1	1452.8	374.7	5.93	1.321	0.652
2.03	1278.9	1323.8	411.8	6.02	1.133	0.559
2.03	926.4	960.6	329.1	5.80	1.035	0.511
2.03	604.4	628.9	222.3	5.40	1.000	0.494
2.03	548.8	571.6	161.7	5.09	1.222	0.603
2.03	518.0	539.8	185.7	5.22	1.026	0.506
2.03	1041.1	1078.8	362.8	5.89	1.054	0.520
2.03	686.2	713.1	225.1	5.42	1.115	0.550
2.03	495.7	516.8	162.4	5.09	1.116	0.551
2.03	469.4	489.8	181.1	5.20	0.953	0.470
2.03	443.1	462.7	159.9	5.07	1.020	0.503
2.03	447.9	467.6	135.4	4.91	1.197	0.590
2.03	488.4	509.3	146.8	4.99	1.202	0.593
2.03	586.4	610.3	223.0	5.41	0.967	0.477
2.03	2048.5	2116.8	875.6	6.77	0.850	0.419
2.03	876.4	909.1	177.0	5.18	1.600	0.789
2.03	1034.3	1071.8	286.4	5.66	1.284	0.634

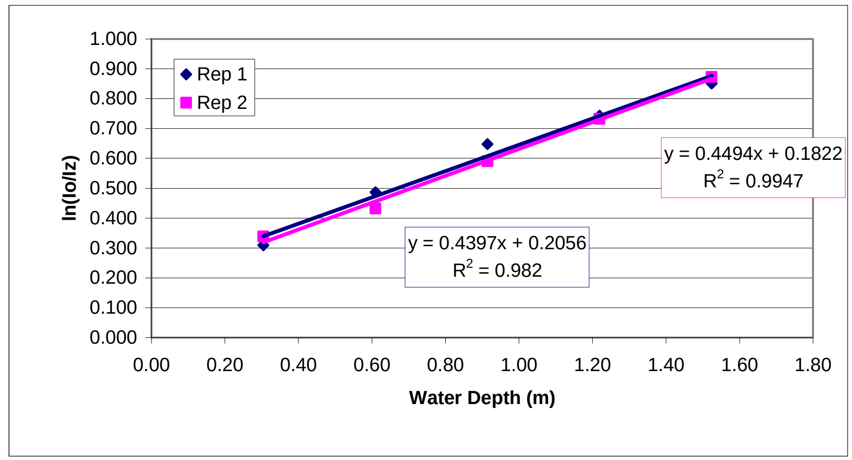
k (diffuse attenuation coefficient = slope, m-1)		0.000
k average		0.536
percent transmittance @	1.0 meter	100.00
Birgean Percentile Absorption (1m)		0.00

VOLUSIA BLUE SPRING MFR LIGHT ATTENUATION ESTIMATES - VBS 570 - 6/24/2008 13:25

Depth (m)	Replicate 1						Depth (m)	Replicate 2					
z	corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	z	corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
0.03	1569.2	1623.0	1305.0	7.17			0.03	1850.7	1913.0	1479.0	7.30		
0.30	1639.1	1695.0	1203.0	7.09	0.309	1.015	0.30	1834.2	1896.0	1308.0	7.18	0.338	1.109
0.61	1714.8	1773.0	1054.0	6.96	0.487	0.798	0.61	1797.3	1858.0	1167.0	7.06	0.432	0.708
0.91	1795.4	1856.0	939.5	6.85	0.648	0.708	0.91	1826.4	1888.0	1012.0	6.92	0.590	0.646
1.22	1817.7	1879.0	864.7	6.76	0.743	0.609	1.22	1821.6	1883.0	875.6	6.77	0.733	0.601
1.52	1863.3	1926.0	795.4	6.68	0.851	0.559	1.52	1829.3	1891.0	764.4	6.64	0.873	0.573

k (diffuse attenuation coefficient = slope, m-1)		0.440	k (diffuse attenuation coefficient = slope, m-1)		0.449
k average		0.738	k average		0.727
percent transmittance @	1.0 meter	64.43	percent transmittance @	1.0 meter	63.80
Birgean Percentile Absorption (1m)		35.57	Birgean Percentile Absorption (1m)		36.20



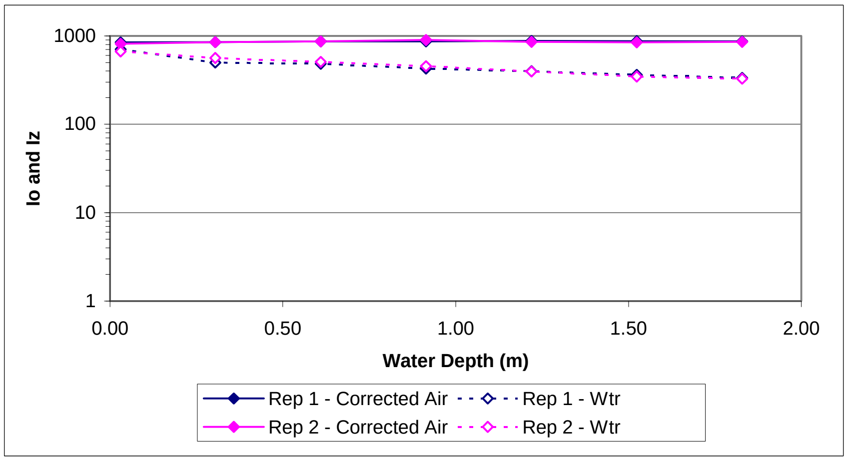


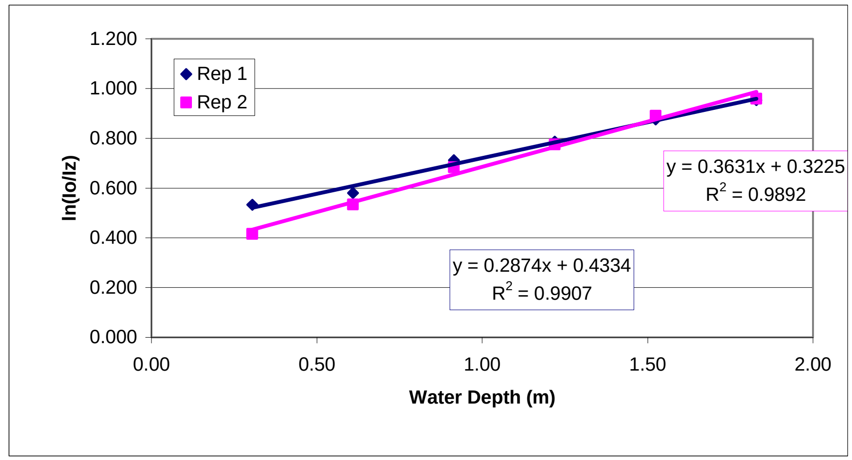
APPENDIX C. Blue Spring light attenuation detail.

VOLUSIA BLUE SPRING MFR LIGHT ATTENUATION ESTIMATES - VBS 570 - 7/8/2008 12:38

Depth (m)	Replicate 1						Depth (m)	Replicate 2					
z	corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	z	corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
0.03	841.8	873.4	702.7	6.55			0.03	815.0	845.8	664.8	6.50		
0.30	851.7	883.7	500.0	6.21	0.533	1.748	0.30	851.1	883.0	561.3	6.33	0.416	1.366
0.61	864.1	896.4	483.8	6.18	0.580	0.951	0.61	866.9	899.3	508.1	6.23	0.534	0.876
0.91	866.2	898.6	425.1	6.05	0.712	0.778	0.91	897.9	931.3	453.1	6.12	0.684	0.748
1.22	875.8	908.5	399.0	5.99	0.786	0.645	1.22	857.5	889.6	395.0	5.98	0.775	0.636
1.52	870.6	903.1	362.4	5.89	0.876	0.575	1.52	846.0	877.8	347.2	5.85	0.891	0.584
1.83	864.3	896.6	333.2	5.81	0.953	0.521	1.83	853.0	885.0	327.0	5.79	0.959	0.524

k (diffuse attenuation coefficient = slope, m-1)		0.287	k (diffuse attenuation coefficient = slope, m-1)		0.363
k average		0.870	k average		0.789
percent transmittance @	1.0 meter	75.02	percent transmittance @	1.0 meter	69.55
Birgean Percentile Absorption (1m)		24.98	Birgean Percentile Absorption (1m)		30.45



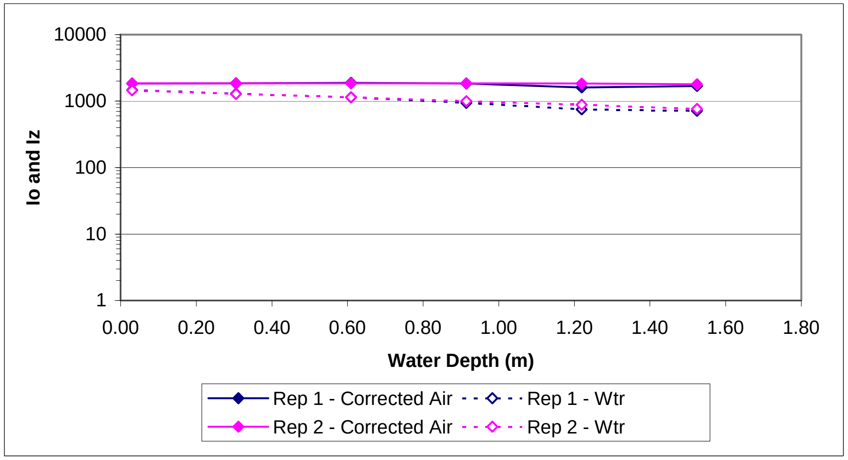


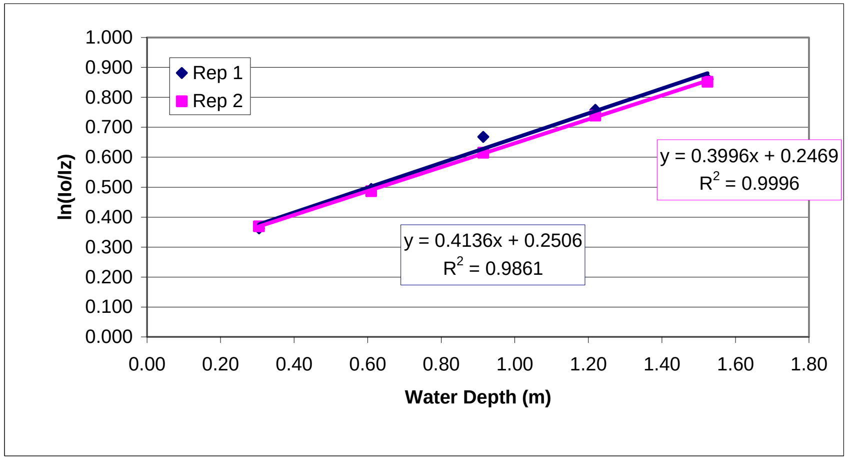
APPENDIX C. Blue Spring light attenuation detail.

VOLUSIA BLUE SPRING MFR LIGHT ATTENUATION ESTIMATES - VBS 500* - 8/05/2008 12:28

Depth (m)	Replicate 1						Depth (m)	Replicate 2					
z	corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	z	corr Air (Io)	raw Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
0.03	1838.1	1900.0	1467.0	7.29			0.03	1849.7	1912.0	1455.0	7.28		
0.30	1850.7	1913.0	1288.0	7.16	0.362	1.189	0.30	1851.7	1914.0	1280.0	7.15	0.369	1.211
0.61	1872.0	1935.0	1142.0	7.04	0.494	0.811	0.61	1852.6	1915.0	1139.0	7.04	0.486	0.798
0.91	1835.2	1897.0	940.8	6.85	0.668	0.731	0.91	1841.0	1903.0	995.4	6.90	0.615	0.672
1.22	1598.4	1653.0	748.8	6.62	0.758	0.622	1.22	1832.2	1894.0	875.2	6.77	0.739	0.606
1.52	1691.5	1749.0	715.2	6.57	0.861	0.565	1.52	1783.7	1844.0	760.8	6.63	0.852	0.559

Replicate 1			Replicate 2		
k (diffuse attenuation coefficient = slope, m-1)		0.414	k (diffuse attenuation coefficient = slope, m-1)		0.400
k average		0.783	k average		0.769
percent transmittance @	1.0 meter	66.12	percent transmittance @	1.0 meter	67.06
Birgean Percentile Absorption (1m)		33.88	Birgean Percentile Absorption (1m)		32.94





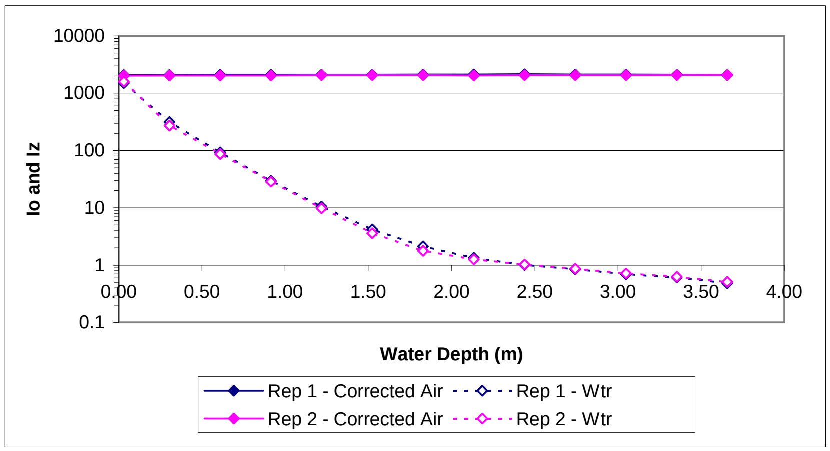
* measured at VBS-500 instead of VBS-570 due to tannin stained water from St. Johns River

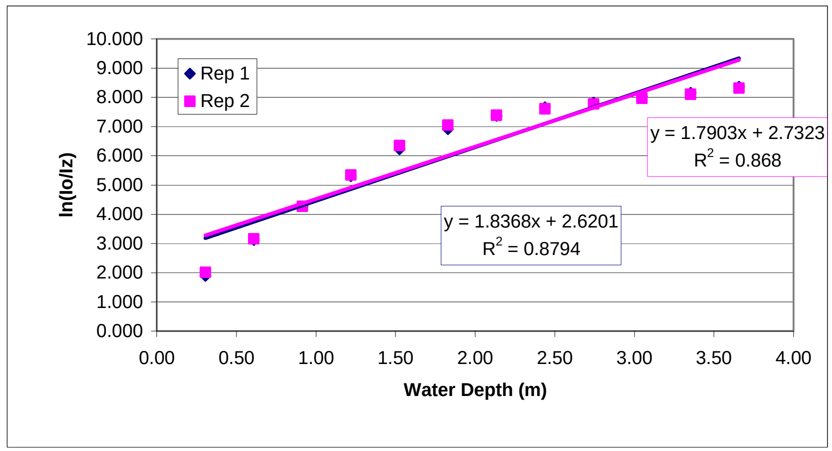
APPENDIX C. Blue Spring light attenuation detail.

VOLUSIA BLUE SPRING MFR LIGHT ATTENUATION ESTIMATES - VBS 570 - 8/29/2008 13:30

Depth (m)	Replicate 1						Depth (m)	Replicate 2					
	corr	raw						corr	raw				
z	Air (Io)	Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	z	Air (Io)	Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)
0.03	2058.4	2127.0	1504.0	7.32			0.03	2029.3	2097.0	1597.0	7.38		
0.30	2088.5	2158.0	313.5	5.75	1.896	6.222	0.30	2037.0	2105.0	272.0	5.61	2.013	6.606
0.61	2097.2	2167.0	92.7	4.53	3.119	5.116	0.61	2039.9	2108.0	86.9	4.46	3.156	5.178
0.91	2108.8	2179.0	29.5	3.39	4.268	4.668	0.91	2044.8	2113.0	28.6	3.35	4.269	4.669
1.22	2105.0	2175.0	10.5	2.35	5.302	4.348	1.22	2053.5	2122.0	9.8	2.28	5.343	4.382
1.52	2107.9	2178.0	4.2	1.43	6.222	4.083	1.52	2060.3	2129.0	3.6	1.28	6.350	4.167
1.83	2122.4	2193.0	2.1	0.75	6.910	3.779	1.83	2057.4	2126.0	1.8	0.57	7.054	3.857
2.13	2121.5	2192.0	1.3	0.29	7.366	3.453	2.13	2048.7	2117.0	1.3	0.24	7.390	3.464
2.44	2131.2	2202.0	1.0	0.00	7.662	3.142	2.44	2060.3	2129.0	1.0	0.02	7.606	3.119
2.74	2118.5	2189.0	0.8	-0.17	7.825	2.853	2.74	2061.3	2130.0	0.9	-0.14	7.773	2.834
3.05	2113.7	2184.0	0.7	-0.36	8.019	2.631	3.05	2061.3	2130.0	0.7	-0.34	7.970	2.615
3.35	2107.9	2178.0	0.6	-0.50	8.153	2.432	3.35	2073.9	2143.0	0.6	-0.47	8.108	2.418
3.66	2088.5	2158.0	0.5	-0.72	8.366	2.287	3.66	2082.6	2152.0	0.5	-0.68	8.317	2.274

k (diffuse attenuation coefficient = slope, m-1)		1.837	k (diffuse attenuation coefficient = slope, m-1)		1.790
k average		3.751	k average		3.799
percent transmittance @	1.0 meter	15.93	percent transmittance @	1.0 meter	16.69
Birgean Percentile Absorption (1m)		84.07	Birgean Percentile Absorption (1m)		83.31





* tannin stained water from St. Johns River present

APPENDIX C. Blue Spring light attenuation detail.

Appendix D

Blue Spring Field and Physical Parameters (from FDEP)

APPENDIX D. Blue Spring field and physical parameters (from FDEP).

FIELD ID	DATE / TIME SAMPLED	ANALYSIS	COMPONENT	RESULT	UNITS	REMARK (A = average)	TEMPERATURE (C)	SPECIFIC CONDUCTANCE (umhos/cm)	PH	DISSOLVED OXYGEN (mg/L)
VOLUSIA BLUE SPRINGS UPPER	10/10/2007 11:15	DTM-QL-C	Periphyton-Qualitative-# Diatom Taxa	32	# Taxa		23.12	n/a	6.38	4.81
VOLUSIA BLUE SPRINGS UPPER	10/10/2007 11:15	MI-FW-QLDC	Macroinvert-FW-Qual-DipnetX20-#Taxa-Rep2	14	# Taxa		23.12	n/a	6.38	4.81
VOLUSIA BLUE SPRINGS UPPER	10/10/2007 11:15	MI-FW-QNNC	Macroinvert-FW-Quan-NatSubstr-# Taxa	2	# Taxa		23.12	n/a	6.38	4.81
VOLUSIA BLUE SPRINGS UPPER	10/10/2007 11:15	PRN-QL-C	Periphyton-Qualitative-# Wet Taxa	13	#Taxa		23.12	n/a	6.38	4.81
VOLUSIA BLUE SPRINGS UPPER	10/10/2007 11:15	SED-PSZ-LS	Sediment Particle Size, %, 0.063-0.125mm	1.39	% vol <2mm		23.12	n/a	6.38	4.81
VOLUSIA BLUE SPRINGS UPPER	10/10/2007 11:15	SED-PSZ-LS	Sediment Particle Size, %, 0.125-0.25 mm	20.2	% vol <2mm		23.12	n/a	6.38	4.81
VOLUSIA BLUE SPRINGS UPPER	10/10/2007 11:15	SED-PSZ-LS	Sediment Particle Size, %, 0.25-0.5 mm	46.5	% vol <2mm		23.12	n/a	6.38	4.81
VOLUSIA BLUE SPRINGS UPPER	10/10/2007 11:15	SED-PSZ-LS	Sediment Particle Size, %, 0.5-2.0 mm	27.9	% vol <2mm		23.12	n/a	6.38	4.81
VOLUSIA BLUE SPRINGS UPPER	10/10/2007 11:15	SED-PSZ-LS	Sediment Particle Size, %, <0.063 mm	4.03	% vol <2mm		23.12	n/a	6.38	4.81
VOLUSIA BLUE SPRINGS UPPER	10/10/2007 11:15	SED-PSZ-LS	Sediment Particle Size, %, >2.0 mm	7.4	%tot drywt		23.12	n/a	6.38	4.81
VOLUSIA BLUE SPRINGS UPPER	10/10/2007 11:15	S-TKN	Kjeldahl Nitrogen	710	mg N/Kg		23.12	n/a	6.38	4.81
VOLUSIA BLUE SPRINGS UPPER	10/10/2007 11:15	S-TP	Total-P	1.90E+03	mg P/Kg		23.12	n/a	6.38	4.81
VOLUSIA BLUE SPRINGS UPPER	2/12/2008 12:05	DTM-QL-C	Periphyton-Qualitative-# Diatom Taxa	26	# Taxa		23.10	2014	7.14	1.90
VOLUSIA BLUE SPRINGS UPPER	2/12/2008 12:05	MI-FW-QLDC	Macroinvert-FW-Qual-DipnetX20-#Taxa-Rep2	15	# Taxa		23.10	2014	7.14	1.90
VOLUSIA BLUE SPRINGS UPPER	2/12/2008 12:05	MI-FW-QNNC	Macroinvert-FW-Quan-NatSubstr-# Taxa	3	# Taxa		23.10	2018	7.20	5.50
VOLUSIA BLUE SPRINGS UPPER	2/12/2008 12:05	PRN-QL-C	Periphyton-Qualitative-# Wet Taxa	14	#Taxa		23.10	2014	7.14	1.90
VOLUSIA BLUE SPRINGS UPPER	2/12/2008 12:05	SED-PSZ-LS	Sediment Particle Size, %, 0.063-0.125mm	2.62	% vol <2mm		23.10	2014	7.14	1.90
VOLUSIA BLUE SPRINGS UPPER	2/12/2008 12:05	SED-PSZ-LS	Sediment Particle Size, %, 0.125-0.25 mm	16.3	% vol <2mm		23.10	2014	7.14	1.90
VOLUSIA BLUE SPRINGS UPPER	2/12/2008 12:05	SED-PSZ-LS	Sediment Particle Size, %, 0.25-0.5 mm	42.4	% vol <2mm		23.10	2014	7.14	1.90
VOLUSIA BLUE SPRINGS UPPER	2/12/2008 12:05	SED-PSZ-LS	Sediment Particle Size, %, 0.5-2.0 mm	32.6	% vol <2mm		23.10	2014	7.14	1.90
VOLUSIA BLUE SPRINGS UPPER	2/12/2008 12:05	SED-PSZ-LS	Sediment Particle Size, %, <0.063 mm	6.14	% vol <2mm		23.10	2014	7.14	1.90
VOLUSIA BLUE SPRINGS UPPER	2/12/2008 12:05	SED-PSZ-LS	Sediment Particle Size, %, >2.0 mm	61	%tot drywt		23.10	2014	7.14	1.90
VOLUSIA BLUE SPRINGS UPPER	2/12/2008 12:05	S-TKN	Kjeldahl Nitrogen	290	mg N/Kg		23.10	2014	7.14	1.90
VOLUSIA BLUE SPRINGS UPPER	2/12/2008 12:05	S-TP	Total-P	1.70E+03	mg P/Kg		23.10	2014	7.14	1.90
VOLUSIA BLUE SPRINGS UPPER	6/23/2008 16:45	DTM-QL-C	Periphyton-Qualitative-# Diatom Taxa	34	# Taxa		23.12	1996	7.21	1.87
VOLUSIA BLUE SPRINGS UPPER	6/23/2008 16:45	MI-FW-QLDC	Macroinvert-FW-Qual-DipnetX20-#Taxa-Rep2	17	# Taxa		23.12	1996	7.21	1.87
VOLUSIA BLUE SPRINGS UPPER	6/23/2008 16:45	MI-FW-QNNC	Macroinvert-FW-Quan-NatSubstr-# Taxa	5	# Taxa		23.12	1996	7.21	1.87
VOLUSIA BLUE SPRINGS UPPER	6/23/2008 16:45	PRN-QL-C	Periphyton-Qualitative-# Wet Taxa	9	#Taxa		23.12	1996	7.21	1.87
VOLUSIA BLUE SPRINGS UPPER	6/23/2008 17:15	SED-PSZ-LS	Sediment Particle Size, %, 0.063-0.125mm	1.5	% vol <2mm		23.12	1996	7.21	1.87
VOLUSIA BLUE SPRINGS UPPER	6/23/2008 17:15	SED-PSZ-LS	Sediment Particle Size, %, 0.125-0.25 mm	25.3	% vol <2mm		23.12	1996	7.21	1.87
VOLUSIA BLUE SPRINGS UPPER	6/23/2008 17:15	SED-PSZ-LS	Sediment Particle Size, %, 0.25-0.5 mm	54.5	% vol <2mm		23.12	1996	7.21	1.87
VOLUSIA BLUE SPRINGS UPPER	6/23/2008 17:15	SED-PSZ-LS	Sediment Particle Size, %, 0.5-2.0 mm	14.9	% vol <2mm		23.12	1996	7.21	1.87
VOLUSIA BLUE SPRINGS UPPER	6/23/2008 17:15	SED-PSZ-LS	Sediment Particle Size, %, <0.063 mm	3.71	% vol <2mm		23.12	1996	7.21	1.87
VOLUSIA BLUE SPRINGS UPPER	6/23/2008 17:15	SED-PSZ-LS	Sediment Particle Size, %, >2.0 mm	69	%tot drywt		23.12	1996	7.21	1.87
VOLUSIA BLUE SPRINGS UPPER	6/23/2008 17:15	S-TKN	Kjeldahl Nitrogen	290	mg N/Kg		23.12	1996	7.21	1.87
VOLUSIA BLUE SPRINGS UPPER	6/23/2008 17:15	S-TP	Total-P	1.50E+03	mg P/Kg		23.12	1996	7.21	1.87
VOLUSIA BLUE SPRINGS UPPER	11/5/2008 14:00	DTM-QL-C	Periphyton-Qualitative-# Diatom Taxa	47	# Taxa		23.00	942	7.24	1.77
VOLUSIA BLUE SPRINGS UPPER	11/5/2008 14:00	MI-FW-QLDC	Macroinvert-FW-Qual-DipnetX20-#Taxa-Rep2	13	# Taxa		23.00	942	7.24	1.77
VOLUSIA BLUE SPRINGS UPPER	11/5/2008 14:00	PRN-QL-C	Periphyton-Qualitative-# Wet Taxa	9	#Taxa		23.00	942	7.24	1.77
VOLUSIA BLUE SPRINGS UPPER	11/5/2008 15:45	MI-FW-QNNC	Macroinvert-FW-Quan-NatSubstr-# Taxa	5	# Taxa		23.00	942	7.24	1.77
VOLUSIA BLUE SPRINGS UPPER	11/5/2008 16:00	SED-PSZ-LS	Sediment Particle Size, %, 0.063-0.125mm	4.18	% vol <2mm		23.00	942	7.24	1.77
VOLUSIA BLUE SPRINGS UPPER	11/5/2008 16:00	SED-PSZ-LS	Sediment Particle Size, %, 0.125-0.25 mm	32.3	% vol <2mm		23.00	942	7.24	1.77
VOLUSIA BLUE SPRINGS UPPER	11/5/2008 16:00	SED-PSZ-LS	Sediment Particle Size, %, 0.25-0.5 mm	42.3	% vol <2mm		23.00	942	7.24	1.77
VOLUSIA BLUE SPRINGS UPPER	11/5/2008 16:00	SED-PSZ-LS	Sediment Particle Size, %, 0.5-2.0 mm	9.33	% vol <2mm		23.00	942	7.24	1.77
VOLUSIA BLUE SPRINGS UPPER	11/5/2008 16:00	SED-PSZ-LS	Sediment Particle Size, %, <0.063 mm	11.9	% vol <2mm		23.00	942	7.24	1.77
VOLUSIA BLUE SPRINGS UPPER	11/5/2008 16:00	SED-PSZ-LS	Sediment Particle Size, %, >2.0 mm	1.3	%tot drywt		23.00	942	7.24	1.77
VOLUSIA BLUE SPRINGS UPPER	11/5/2008 16:00	S-TKN	Kjeldahl Nitrogen	410	mg N/Kg		23.00	942	7.24	1.77
VOLUSIA BLUE SPRINGS UPPER	11/5/2008 16:00	S-TP	Total-P	2.40E+03	mg P/Kg		23.00	942	7.24	1.77

APPENDIX D. Blue Spring field and physical parameters (from FDEP).

FIELD ID	DATE / TIME SAMPLED	ANALYSIS	COMPONENT	RESULT	UNITS	REMARK (A = average)	TEMPERATURE (C)	SPECIFIC CONDUCTANCE (umhos/cm)	PH	DISSOLVED OXYGEN (mg/L)
VOLUSIA BLUE SPRINGS MIDDLE	10/10/2007 14:50	DTM-QL-C	Periphyton-Qualitative-# Diatom Taxa	37	# Taxa		23.36	n/a	6.60	3.59
VOLUSIA BLUE SPRINGS MIDDLE	10/10/2007 14:50	MI-FW-QLDC	Macroinvert-FW-Qual-DipnetX20-#Taxa-Rep2	12	# Taxa		23.36	n/a	6.60	3.59
VOLUSIA BLUE SPRINGS MIDDLE	10/10/2007 14:50	MI-FW-QNNC	Macroinvert-FW-Quan-NatSubstr-# Taxa	5	# Taxa		23.36	n/a	6.60	3.59
VOLUSIA BLUE SPRINGS MIDDLE	10/10/2007 14:50	PRN-QL-C	Periphyton-Qualitative-# Wet Taxa	17	#Taxa		23.36	n/a	6.60	3.59
VOLUSIA BLUE SPRINGS MIDDLE	10/10/2007 14:50	SED-PSZ-LS	Sediment Particle Size, %, 0.063-0.125mm	4.28	% vol <2mm		23.36	n/a	6.60	3.59
VOLUSIA BLUE SPRINGS MIDDLE	10/10/2007 14:50	SED-PSZ-LS	Sediment Particle Size, %, 0.125-0.25 mm	46.1	% vol <2mm		23.36	n/a	6.60	3.59
VOLUSIA BLUE SPRINGS MIDDLE	10/10/2007 14:50	SED-PSZ-LS	Sediment Particle Size, %, 0.25-0.5 mm	38.7	% vol <2mm		23.36	n/a	6.60	3.59
VOLUSIA BLUE SPRINGS MIDDLE	10/10/2007 14:50	SED-PSZ-LS	Sediment Particle Size, %, 0.5-2.0 mm	4.01	% vol <2mm		23.36	n/a	6.60	3.59
VOLUSIA BLUE SPRINGS MIDDLE	10/10/2007 14:50	SED-PSZ-LS	Sediment Particle Size, %, <0.063 mm	6.9	% vol <2mm		23.36	n/a	6.60	3.59
VOLUSIA BLUE SPRINGS MIDDLE	10/10/2007 14:50	SED-PSZ-LS	Sediment Particle Size, %, >2.0 mm	3.5	%tot drywt		23.36	n/a	6.60	3.59
VOLUSIA BLUE SPRINGS MIDDLE	10/10/2007 14:50	S-TKN	Kjeldahl Nitrogen	1.40E+03	mg N/Kg		23.36	n/a	6.60	3.59
VOLUSIA BLUE SPRINGS MIDDLE	10/10/2007 14:50	S-TP	Total-P	2.70E+03	mg P/Kg		23.36	n/a	6.60	3.59
VOLUSIA BLUE SPRINGS MIDDLE	2/12/2008 14:30	DTM-QL-C	Periphyton-Qualitative-# Diatom Taxa	32	# Taxa		23.10	2018	7.20	5.50
VOLUSIA BLUE SPRINGS MIDDLE	2/12/2008 14:30	MI-FW-QLDC	Macroinvert-FW-Qual-DipnetX20-#Taxa-Rep2	11	# Taxa		23.10	2018	7.20	5.50
VOLUSIA BLUE SPRINGS MIDDLE	2/12/2008 14:30	MI-FW-QNNC	Macroinvert-FW-Quan-NatSubstr-# Taxa	3	# Taxa		23.10	2014	7.14	1.90
VOLUSIA BLUE SPRINGS MIDDLE	2/12/2008 14:30	PRN-QL-C	Periphyton-Qualitative-# Wet Taxa	15	#Taxa		23.10	2018	7.20	5.50
VOLUSIA BLUE SPRINGS MIDDLE	2/12/2008 14:30	SED-PSZ-LS	Sediment Particle Size, %, 0.063-0.125mm	3.29	% vol <2mm	A	23.10	2018	7.20	5.50
VOLUSIA BLUE SPRINGS MIDDLE	2/12/2008 14:30	SED-PSZ-LS	Sediment Particle Size, %, 0.125-0.25 mm	44	% vol <2mm	A	23.10	2018	7.20	5.50
VOLUSIA BLUE SPRINGS MIDDLE	2/12/2008 14:30	SED-PSZ-LS	Sediment Particle Size, %, 0.25-0.5 mm	42	% vol <2mm	A	23.10	2018	7.20	5.50
VOLUSIA BLUE SPRINGS MIDDLE	2/12/2008 14:30	SED-PSZ-LS	Sediment Particle Size, %, 0.5-2.0 mm	6.24	% vol <2mm	A	23.10	2018	7.20	5.50
VOLUSIA BLUE SPRINGS MIDDLE	2/12/2008 14:30	SED-PSZ-LS	Sediment Particle Size, %, <0.063 mm	4.4	% vol <2mm	A	23.10	2018	7.20	5.50
VOLUSIA BLUE SPRINGS MIDDLE	2/12/2008 14:30	SED-PSZ-LS	Sediment Particle Size, %, >2.0 mm	2.8	%tot drywt	A	23.10	2018	7.20	5.50
VOLUSIA BLUE SPRINGS MIDDLE	2/12/2008 14:30	S-TKN	Kjeldahl Nitrogen	1.10E+03	mg N/Kg		23.10	2018	7.20	5.50
VOLUSIA BLUE SPRINGS MIDDLE	2/12/2008 14:30	S-TP	Total-P	2.40E+03	mg P/Kg		23.10	2018	7.20	5.50
VOLUSIA BLUE SPRINGS MIDDLE	6/24/2008 10:50	DTM-QL-C	Periphyton-Qualitative-# Diatom Taxa	38	# Taxa		23.19	1992	7.25	1.05
VOLUSIA BLUE SPRINGS MIDDLE	6/24/2008 10:50	MI-FW-QLDC	Macroinvert-FW-Qual-DipnetX20-#Taxa-Rep2	16	# Taxa		23.19	1992	7.25	1.05
VOLUSIA BLUE SPRINGS MIDDLE	6/24/2008 10:50	MI-FW-QNNC	Macroinvert-FW-Quan-NatSubstr-# Taxa	8	# Taxa		23.19	1992	7.25	1.05
VOLUSIA BLUE SPRINGS MIDDLE	6/24/2008 10:50	PRN-QL-C	Periphyton-Qualitative-# Wet Taxa	12	#Taxa		23.19	1992	7.25	1.05
VOLUSIA BLUE SPRINGS MIDDLE	6/24/2008 11:20	SED-PSZ-LS	Sediment Particle Size, %, 0.063-0.125mm	2.07	% vol <2mm	A	23.19	1992	7.25	1.05
VOLUSIA BLUE SPRINGS MIDDLE	6/24/2008 11:20	SED-PSZ-LS	Sediment Particle Size, %, 0.125-0.25 mm	22.7	% vol <2mm	A	23.19	1992	7.25	1.05
VOLUSIA BLUE SPRINGS MIDDLE	6/24/2008 11:20	SED-PSZ-LS	Sediment Particle Size, %, 0.25-0.5 mm	44.5	% vol <2mm	A	23.19	1992	7.25	1.05
VOLUSIA BLUE SPRINGS MIDDLE	6/24/2008 11:20	SED-PSZ-LS	Sediment Particle Size, %, 0.5-2.0 mm	27.1	% vol <2mm	A	23.19	1992	7.25	1.05
VOLUSIA BLUE SPRINGS MIDDLE	6/24/2008 11:20	SED-PSZ-LS	Sediment Particle Size, %, <0.063 mm	3.62	% vol <2mm	A	23.19	1992	7.25	1.05
VOLUSIA BLUE SPRINGS MIDDLE	6/24/2008 11:20	SED-PSZ-LS	Sediment Particle Size, %, >2.0 mm	35	%tot drywt	A	23.19	1992	7.25	1.05
VOLUSIA BLUE SPRINGS MIDDLE	6/24/2008 11:20	S-TKN	Kjeldahl Nitrogen	490	mg N/Kg		23.19	1992	7.25	1.05
VOLUSIA BLUE SPRINGS MIDDLE	6/24/2008 11:20	S-TP	Total-P	3.10E+03	mg P/Kg		23.19	1992	7.25	1.05
VOLUSIA BLUE SPRINGS MIDDLE	11/5/2008 17:00	DTM-QL-C	Periphyton-Qualitative-# Diatom Taxa	37	# Taxa		22.90	938	7.39	1.57
VOLUSIA BLUE SPRINGS MIDDLE	11/5/2008 17:00	MI-FW-QLDC	Macroinvert-FW-Qual-DipnetX20-#Taxa-Rep2	18	# Taxa		22.90	938	7.39	1.57
VOLUSIA BLUE SPRINGS MIDDLE	11/5/2008 17:00	PRN-QL-C	Periphyton-Qualitative-# Wet Taxa	13	#Taxa		22.90	938	7.39	1.57
VOLUSIA BLUE SPRINGS MIDDLE	11/6/2008 10:00	MI-FW-QNNC	Macroinvert-FW-Quan-NatSubstr-# Taxa	6	# Taxa		22.90	938	7.39	1.57
VOLUSIA BLUE SPRINGS MIDDLE	11/6/2008 10:15	SED-PSZ-LS	Sediment Particle Size, %, 0.063-0.125mm	3.46	% vol <2mm	A	22.90	938	7.39	1.57
VOLUSIA BLUE SPRINGS MIDDLE	11/6/2008 10:15	SED-PSZ-LS	Sediment Particle Size, %, 0.125-0.25 mm	40.2	% vol <2mm	A	22.90	938	7.39	1.57
VOLUSIA BLUE SPRINGS MIDDLE	11/6/2008 10:15	SED-PSZ-LS	Sediment Particle Size, %, 0.25-0.5 mm	45.8	% vol <2mm	A	22.90	938	7.39	1.57
VOLUSIA BLUE SPRINGS MIDDLE	11/6/2008 10:15	SED-PSZ-LS	Sediment Particle Size, %, 0.5-2.0 mm	6.78	% vol <2mm	A	22.90	938	7.39	1.57
VOLUSIA BLUE SPRINGS MIDDLE	11/6/2008 10:15	SED-PSZ-LS	Sediment Particle Size, %, <0.063 mm	3.76	% vol <2mm	A	22.90	938	7.39	1.57
VOLUSIA BLUE SPRINGS MIDDLE	11/6/2008 10:15	SED-PSZ-LS	Sediment Particle Size, %, >2.0 mm	4.4	%tot drywt		22.90	938	7.39	1.57
VOLUSIA BLUE SPRINGS MIDDLE	11/6/2008 10:15	S-TKN	Kjeldahl Nitrogen	190	mg N/Kg		22.90	938	7.39	1.57
VOLUSIA BLUE SPRINGS MIDDLE	11/6/2008 10:15	S-TP	Total-P	2.90E+03	mg P/Kg		22.90	938	7.39	1.57

APPENDIX D. Blue Spring field and physical parameters (from FDEP).

FIELD ID	DATE / TIME SAMPLED	ANALYSIS	COMPONENT	RESULT	UNITS	REMARK (A = average)	TEMPERATURE (C)	SPECIFIC CONDUCTANCE (umhos/cm)	PH	DISSOLVED OXYGEN (mg/L)
VOLUSIA BLUE SPRINGS LOWER	10/10/2007 15:52	DTM-QL-C	Periphyton-Qualitative-# Diatom Taxa	34	# Taxa		23.36	n/a	6.21	3.52
VOLUSIA BLUE SPRINGS LOWER	10/10/2007 15:52	MI-FW-QLDC	Macroinvert-FW-Qual-DipnetX20-#Taxa-Rep2	11	# Taxa		23.36	n/a	6.21	3.52
VOLUSIA BLUE SPRINGS LOWER	10/10/2007 15:52	MI-FW-QNNC	Macroinvert-FW-Quan-NatSubstr-# Taxa	5	# Taxa		23.36	n/a	6.21	3.52
VOLUSIA BLUE SPRINGS LOWER	10/10/2007 15:52	PRN-QL-C	Periphyton-Qualitative-# Wet Taxa	10	#Taxa		23.36	n/a	6.21	3.52
VOLUSIA BLUE SPRINGS LOWER	10/10/2007 15:52	SED-PSZ-LS	Sediment Particle Size, %, 0.063-0.125mm	4.97	% vol <2mm		23.36	n/a	6.21	3.52
VOLUSIA BLUE SPRINGS LOWER	10/10/2007 15:52	SED-PSZ-LS	Sediment Particle Size, %, 0.125-0.25 mm	38.4	% vol <2mm		23.36	n/a	6.21	3.52
VOLUSIA BLUE SPRINGS LOWER	10/10/2007 15:52	SED-PSZ-LS	Sediment Particle Size, %, 0.25-0.5 mm	41.1	% vol <2mm		23.36	n/a	6.21	3.52
VOLUSIA BLUE SPRINGS LOWER	10/10/2007 15:52	SED-PSZ-LS	Sediment Particle Size, %, 0.5-2.0 mm	11	% vol <2mm		23.36	n/a	6.21	3.52
VOLUSIA BLUE SPRINGS LOWER	10/10/2007 15:52	SED-PSZ-LS	Sediment Particle Size, %, <0.063 mm	4.52	% vol <2mm		23.36	n/a	6.21	3.52
VOLUSIA BLUE SPRINGS LOWER	10/10/2007 15:52	SED-PSZ-LS	Sediment Particle Size, %, >2.0 mm	5	%tot drywt		23.36	n/a	6.21	3.52
VOLUSIA BLUE SPRINGS LOWER	10/10/2007 15:52	S-TKN	Kjeldahl Nitrogen	370	mg N/Kg		23.36	n/a	6.21	3.52
VOLUSIA BLUE SPRINGS LOWER	10/10/2007 15:52	S-TP	Total-P	2.60E+03	mg P/Kg		23.36	n/a	6.21	3.52
VOLUSIA BLUE SPRINGS LOWER	2/12/2008 0:00		LOWER SECTION NOT SAMPLED DUE TO PRESENCE OF MANATEES							
VOLUSIA BLUE SPRINGS LOWER	6/24/2008 13:05	DTM-QL-C	Periphyton-Qualitative-# Diatom Taxa	35	# Taxa		23.35	1981	7.34	1.89
VOLUSIA BLUE SPRINGS LOWER	6/24/2008 13:05	MI-FW-QLDC	Macroinvert-FW-Qual-DipnetX20-#Taxa-Rep2	9	# Taxa		23.35	1981	7.34	1.89
VOLUSIA BLUE SPRINGS LOWER	6/24/2008 13:05	PRN-QL-C	Periphyton-Qualitative-# Wet Taxa	8	#Taxa		23.35	1981	7.34	1.89
VOLUSIA BLUE SPRINGS LOWER	6/24/2008 13:35	SED-PSZ-LS	Sediment Particle Size, %, 0.063-0.125mm	8.51	% vol <2mm		23.35	1981	7.34	1.89
VOLUSIA BLUE SPRINGS LOWER	6/24/2008 13:35	SED-PSZ-LS	Sediment Particle Size, %, 0.125-0.25 mm	47.8	% vol <2mm		23.35	1981	7.34	1.89
VOLUSIA BLUE SPRINGS LOWER	6/24/2008 13:35	SED-PSZ-LS	Sediment Particle Size, %, 0.25-0.5 mm	29.3	% vol <2mm		23.35	1981	7.34	1.89
VOLUSIA BLUE SPRINGS LOWER	6/24/2008 13:35	SED-PSZ-LS	Sediment Particle Size, %, 0.5-2.0 mm	7.58	% vol <2mm		23.35	1981	7.34	1.89
VOLUSIA BLUE SPRINGS LOWER	6/24/2008 13:35	SED-PSZ-LS	Sediment Particle Size, %, <0.063 mm	6.83	% vol <2mm		23.35	1981	7.34	1.89
VOLUSIA BLUE SPRINGS LOWER	6/24/2008 13:35	SED-PSZ-LS	Sediment Particle Size, %, >2.0 mm	1	%tot drywt		23.35	1981	7.34	1.89
VOLUSIA BLUE SPRINGS LOWER	6/24/2008 13:35	S-TKN	Kjeldahl Nitrogen	510	mg N/Kg		23.35	1981	7.34	1.89
VOLUSIA BLUE SPRINGS LOWER	6/24/2008 13:35	S-TP	Total-P	2.80E+03	mg P/Kg		23.35	1981	7.34	1.89
VOLUSIA BLUE SPRINGS LOWER	6/24/2008 17:15	MI-FW-QNNC	Macroinvert-FW-Quan-NatSubstr-# Taxa	4.00E+00	# Taxa					
VOLUSIA BLUE SPRINGS LOWER	11/6/2008 10:50	DTM-QL-C	Periphyton-Qualitative-# Diatom Taxa	52	# Taxa		23.06	940	7.58	1.79
VOLUSIA BLUE SPRINGS LOWER	11/6/2008 10:50	MI-FW-QLDC	Macroinvert-FW-Qual-DipnetX20-#Taxa-Rep2	25	# Taxa		23.06	940	7.58	1.79
VOLUSIA BLUE SPRINGS LOWER	11/6/2008 10:50	MI-FW-QNNC	Macroinvert-FW-Quan-NatSubstr-# Taxa	5	# Taxa		23.06	940	7.58	1.79
VOLUSIA BLUE SPRINGS LOWER	11/6/2008 10:50	PRN-QL-C	Periphyton-Qualitative-# Wet Taxa	9	#Taxa		23.06	940	7.58	1.79
VOLUSIA BLUE SPRINGS LOWER	11/6/2008 11:30	SED-PSZ-LS	Sediment Particle Size, %, 0.063-0.125mm	4.74	% vol <2mm		23.06	940	7.58	1.79
VOLUSIA BLUE SPRINGS LOWER	11/6/2008 11:30	SED-PSZ-LS	Sediment Particle Size, %, 0.125-0.25 mm	39.6	% vol <2mm		23.06	940	7.58	1.79
VOLUSIA BLUE SPRINGS LOWER	11/6/2008 11:30	SED-PSZ-LS	Sediment Particle Size, %, 0.25-0.5 mm	40.4	% vol <2mm		23.06	940	7.58	1.79
VOLUSIA BLUE SPRINGS LOWER	11/6/2008 11:30	SED-PSZ-LS	Sediment Particle Size, %, 0.5-2.0 mm	10.3	% vol <2mm		23.06	940	7.58	1.79
VOLUSIA BLUE SPRINGS LOWER	11/6/2008 11:30	SED-PSZ-LS	Sediment Particle Size, %, <0.063 mm	4.95	% vol <2mm		23.06	940	7.58	1.79
VOLUSIA BLUE SPRINGS LOWER	11/6/2008 11:30	SED-PSZ-LS	Sediment Particle Size, %, >2.0 mm	1.4	%tot drywt		23.06	940	7.58	1.79
VOLUSIA BLUE SPRINGS LOWER	11/6/2008 11:30	S-TKN	Kjeldahl Nitrogen	450	mg N/Kg		23.06	940	7.58	1.79
VOLUSIA BLUE SPRINGS LOWER	11/6/2008 11:30	S-TP	Total-P	3.00E+03	mg P/Kg		23.06	940	7.58	1.79

APPENDIX D. Blue Spring sediment analysis results (from FDEP).

DATE SAMPLED	SITE LOCATION	FIELD ID	COMPONENT	RESULT	REMARK	UNITS	MDL	PQL	SAMPLE ID	ANALYSIS
6/23/2008 17:15	VOLUSIA BLUE	UPPER	Arsenic	0.30	IQ	mg/Kg	0.10	0.40	1175839	S-ICPMS
6/23/2008 17:15	VOLUSIA BLUE	UPPER	Cadmium	0.13	IQ	mg/Kg	0.05	0.20	1175839	S-ICPMS
6/23/2008 17:15	VOLUSIA BLUE	UPPER	Chromium	3.28	Q	mg/Kg	0.25	0.99	1175839	S-ICPMS
6/23/2008 17:15	VOLUSIA BLUE	UPPER	Copper	0.27	IQ	mg/Kg	0.25	0.99	1175839	S-ICPMS
6/23/2008 17:15	VOLUSIA BLUE	UPPER	Lead	0.74	IQ	mg/Kg	0.37	1.50	1175839	S-ICPMS
6/23/2008 17:15	VOLUSIA BLUE	UPPER	Nickel	0.65	IQ	mg/Kg	0.25	0.99	1175839	S-ICPMS
6/24/2008 11:20	VOLUSIA BLUE	MIDDLE	Arsenic	0.64	Q	mg/Kg	0.10	0.39	1175840	S-ICPMS
6/24/2008 11:20	VOLUSIA BLUE	MIDDLE	Cadmium	0.20	Q	mg/Kg	0.05	0.20	1175840	S-ICPMS
6/24/2008 11:20	VOLUSIA BLUE	MIDDLE	Chromium	4.15	Q	mg/Kg	0.25	0.98	1175840	S-ICPMS
6/24/2008 11:20	VOLUSIA BLUE	MIDDLE	Copper	0.55	IQ	mg/Kg	0.25	0.98	1175840	S-ICPMS
6/24/2008 11:20	VOLUSIA BLUE	MIDDLE	Lead	1.10	IQ	mg/Kg	0.37	1.50	1175840	S-ICPMS
6/24/2008 11:20	VOLUSIA BLUE	MIDDLE	Nickel	1.14	Q	mg/Kg	0.25	0.98	1175840	S-ICPMS
6/24/2008 13:35	VOLUSIA BLUE	LOWER	Arsenic	0.56	Q	mg/Kg	0.10	0.40	1175841	S-ICPMS
6/24/2008 13:35	VOLUSIA BLUE	LOWER	Cadmium	0.19	IQ	mg/Kg	0.05	0.20	1175841	S-ICPMS
6/24/2008 13:35	VOLUSIA BLUE	LOWER	Chromium	4.60	Q	mg/Kg	0.25	0.99	1175841	S-ICPMS
6/24/2008 13:35	VOLUSIA BLUE	LOWER	Copper	0.66	IQ	mg/Kg	0.25	0.99	1175841	S-ICPMS
6/24/2008 13:35	VOLUSIA BLUE	LOWER	Lead	1.80	Q	mg/Kg	0.37	1.50	1175841	S-ICPMS
6/24/2008 13:35	VOLUSIA BLUE	LOWER	Nickel	0.72	IQ	mg/Kg	0.25	0.99	1175841	S-ICPMS
11/5/2008 16:05	VOLUSIA BLUE	UPPER	Arsenic	0.53		mg/Kg	0.10	0.39	1175842	S-ICPMS
11/5/2008 16:05	VOLUSIA BLUE	UPPER	Cadmium	0.16	I	mg/Kg	0.05	0.20	1175842	S-ICPMS
11/5/2008 16:05	VOLUSIA BLUE	UPPER	Chromium	5.87		mg/Kg	0.25	0.98	1175842	S-ICPMS
11/5/2008 16:05	VOLUSIA BLUE	UPPER	Copper	0.53	I	mg/Kg	0.25	0.98	1175842	S-ICPMS
11/5/2008 16:05	VOLUSIA BLUE	UPPER	Lead	1.20	I	mg/Kg	0.37	1.50	1175842	S-ICPMS
11/5/2008 16:05	VOLUSIA BLUE	UPPER	Nickel	0.93	I	mg/Kg	0.25	0.98	1175842	S-ICPMS
11/6/2008 10:20	VOLUSIA BLUE	MIDDLE	Arsenic	1.10		mg/Kg	0.10	0.40	1175843	S-ICPMS
11/6/2008 10:20	VOLUSIA BLUE	MIDDLE	Cadmium	0.19	I	mg/Kg	0.05	0.20	1175843	S-ICPMS
11/6/2008 10:20	VOLUSIA BLUE	MIDDLE	Chromium	4.19		mg/Kg	0.25	0.99	1175843	S-ICPMS
11/6/2008 10:20	VOLUSIA BLUE	MIDDLE	Copper	0.60	I	mg/Kg	0.25	0.99	1175843	S-ICPMS
11/6/2008 10:20	VOLUSIA BLUE	MIDDLE	Lead	1.10	I	mg/Kg	0.37	1.50	1175843	S-ICPMS
11/6/2008 10:20	VOLUSIA BLUE	MIDDLE	Nickel	0.84	I	mg/Kg	0.25	0.99	1175843	S-ICPMS
11/6/2008 11:35	VOLUSIA BLUE	LOWER	Arsenic	0.41		mg/Kg	0.10	0.39	1175844	S-ICPMS
11/6/2008 11:35	VOLUSIA BLUE	LOWER	Cadmium	0.14	I	mg/Kg	0.05	0.20	1175844	S-ICPMS
11/6/2008 11:35	VOLUSIA BLUE	LOWER	Chromium	3.66		mg/Kg	0.25	0.98	1175844	S-ICPMS
11/6/2008 11:35	VOLUSIA BLUE	LOWER	Copper	0.59	I	mg/Kg	0.25	0.98	1175844	S-ICPMS
11/6/2008 11:35	VOLUSIA BLUE	LOWER	Lead	1.20	I	mg/Kg	0.37	1.50	1175844	S-ICPMS
11/6/2008 11:35	VOLUSIA BLUE	LOWER	Nickel	0.61	I	mg/Kg	0.25	0.98	1175844	S-ICPMS

"I" *Calculated value below practical quantification limit (PQL)*

"Q" *Sample held beyond the accepted holding time. This code shall be used if the value is derived from a sample that was prepared or analyzed after the approved holding time restrictions for sample preparation or analysis.*

FDEP sediment quality assessment guidelines (threshold effect levels- TEL, in mg/kg) applicable to coastal waters (from FDEP 1994):

Arsenic	7.24
Cadmium	0.68
Chromium	52.30
Copper	18.70
Lead	30.20
Nickel	15.90

APPENDIX D. Blue Spring sediment analysis summary results (from FDEP).

FIELD ID	COMPONENT	N Rows	Average Result (mg/kg)
UPPER	Arsenic	2	0.42
UPPER	Cadmium	2	0.15
UPPER	Chromium	2	4.58
UPPER	Copper	2	0.40
UPPER	Lead	2	0.97
UPPER	Nickel	2	0.79
MIDDLE	Arsenic	2	0.87
MIDDLE	Cadmium	2	0.20
MIDDLE	Chromium	2	4.17
MIDDLE	Copper	2	0.58
MIDDLE	Lead	2	1.10
MIDDLE	Nickel	2	0.99
LOWER	Arsenic	2	0.49
LOWER	Cadmium	2	0.17
LOWER	Chromium	2	4.13
LOWER	Copper	2	0.63
LOWER	Lead	2	1.50
LOWER	Nickel	2	0.67

COMPONENT	N Rows	Average Result (mg/kg)
Arsenic	6	0.59
Cadmium	6	0.17
Chromium	6	4.29
Copper	6	0.53
Lead	6	1.19
Nickel	6	0.82

APPENDIX D. FDEP sediment quality assessment guidelines (threshold effect levels- TEL, in mg/kg) applicable to coastal waters (from FDEP 1994).

Arsenic	7.24
Cadmium	0.68
Chromium	52.30
Copper	18.70
Lead	30.20
Nickel	15.90

APPENDIX D. Vascular aquatic vegetation survey results from Blue Spring ("D" means that species was dominant, Lower Site was not sampled in 2/12/08 due to manatee presence) (from FDEP).

Linear Stream Vegetation Survey Results	Upper Site				Middle Site				Lower Site		
HERBACEOUS SPECIES	**10/10/07**	**2/12/08**	**6/23/08**	**11/5/08**	**10/10/07**	**2/12/08**	**6/24/08**	**11/6/08**	**10/10/07**	**6/24/08**	**11/6/08**
Alternanthera philoxeroides	4	5	4	3	8	4	6	7	6	6	9
Aster carolinianus								1	1		
Azolla caroliniana								5			4
Bacopa monnieri	2		1				1				
Bidens pilosa					4						
Cephalanthus occidentalis		5									
Commelina diffusa		2				2			2	6	
Diodia virginiana				1							
Echinochloa crusgalli	8		9		5	7	2		5		
Eichhornia crassipes											5
Eupatorium capillifolium					2				1		
Hydrocotyl sp.	8	8	6	6	10	10	7	10	8	6	9
Lemna minor	10	6	7	2	10	4		7	9	10	7
Ludwigia repens		2		3	1				1	1	
Ludwigia sp.			1		1						
Luziola fluitans					1		2		2	10	
Mikania scandens	1	1	2	1	4	2			4		
Najas guadalupensis	D(10)	9	8	2	7	1	9	2	4	4	3
Nephrolepis sp.									6		
Nuphar luteum					2				3	2	1
Nymphaea odorata								2			
Panicum rigidulum		1			2						
Paspalum floridanum		3			1						
Paspalum repens		2			2				2	1	3
Phyla nodiflora		3			2						
Pistia stratioides								7		1	9
Pluchea sp.						1			1		
Poaceae sp.											6
Pontederia sp.	1					2			1		
Salvinia minima	10	3	4	1	10	5		7	9	8	9
Samolus parviflorus	3	10	2	2							1
Spirodela sp.	1				10				9		
Spirodela polyrhiza			2	1						9	
Typha latifolia	1										
Wolffiella spp.								8			
WOODY SPECIES											
Acer rubrum					1						1
Baccharis sp.					6		2		6		
Cephalanthus occidentalis	9		10	7, D(2)	7	4	4	3	5	2	3
Gleditsia aquatica	1		1	1		5					
Itea virginica		1			2						
Liquidambar styraciflua					1			1			2
Myrica cerifera	1	1		1	3	1		4			
Quercus nigra	1					2					1
Sabel palmetto	6	9	1	10	5	1	4	7	4		5
Salix carolina					1			1	1		2
Ulmus americana					1				1		

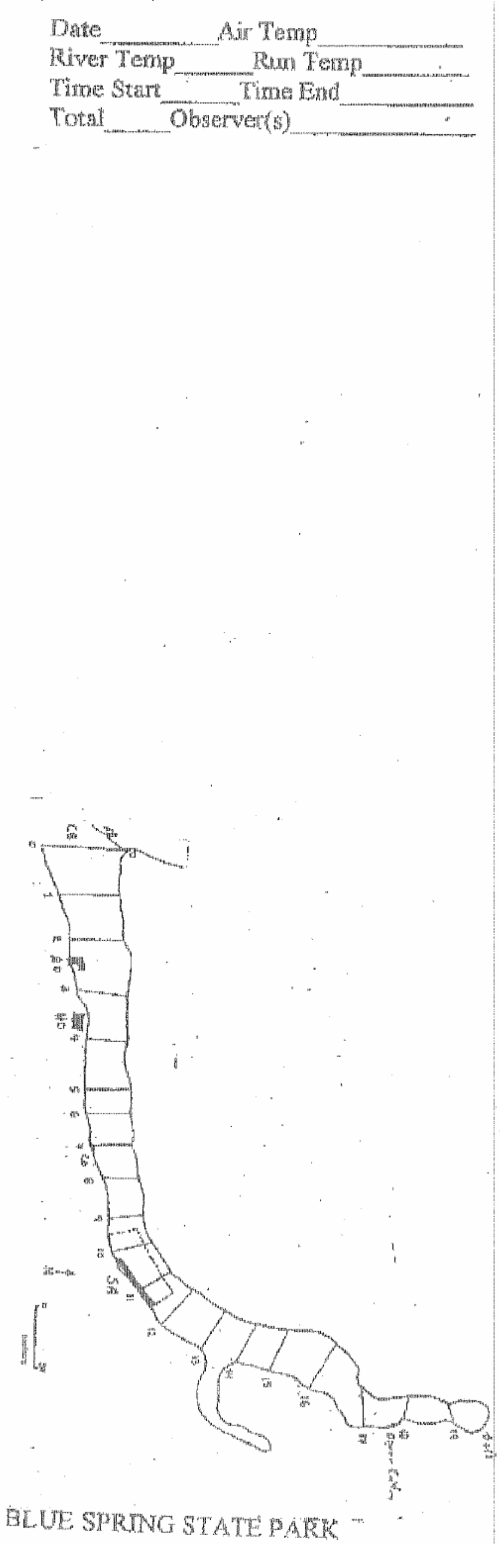
APPENDIX D. Blue Springs riparian canopy cover estimates (from FDEP).

Segment	Date	Average Canopy Cover (%)
UPPER	10/10/2007	21.8
UPPER	2/12/2008	43.8
UPPER	6/23/2008	49.1
UPPER	11/5/2008	33.8
MIDDLE	10/10/2007	3.7
MIDDLE	2/12/2008	n/a
MIDDLE	6/24/2008	27.4
MIDDLE	11/6/2008	2.2
LOWER	10/10/2007	n/a
LOWER	2/12/2008	n/a
LOWER	6/24/2008	25.2
LOWER	11/6/2008	11.9
Average		**24.3**

Appendix E

Blue Spring State Park Manatee Survey (from BSSP)

APPENDIX E. Blue Spring State Park manatee survey map illustrates the 20 zones delineated by the USGS Sirenia Project (from FDEP).



Appendix F

Blue Spring Macroinvertebrate and Habitat Assessment (from FDEP)

APPENDIX F. Blue Spring macroinvertebrate and habitat assessment data (from FDEP).

Volusia Blue- Upper Site	10/10/2007		2/12/2008		6/23/2008		11/5/2008	
Summary Statistics								
Stream Condition Index 2007 (value)	4 A		8 A		11 A		9 A	
Stream Condition Index 2007 (category) *	Impaired		Impaired		Impaired		Impaired	
Stream Condition Index Metrics	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
Number of Total Taxa	15	14	12	15	17	17	14	13
Number of Ephemeroptera Taxa	0	0	0	0	0	0	0	0
Number of Trichoptera Taxa	0	0	0	0	1	1	0	0
Number of Clinger Taxa	0	0	0	0	0	0	0	0
Number of Long-lived Taxa	0	0	0	0	0	0	0	0
Number of Sensitive Taxa	1	1	1	1	1	1	1	1
Percent of Dominant Taxon	67.6	45.3	34.5	22.2	33.1	43.1	30.2	42.6
Percent Suspension Feeders and Filterers	1.0	0.0	0.0	0.3	2.8	1.6	1.7	4.2
Percent of Tanytarsini Individuals	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0
Percent of Very Tolerant Individuals	17.9	40.9	61.4	56.4	20.4	16.3	37.6	37.4
Total Number of Individuals	151	159	145	149	142	153	149	155
Community Composition: Percent of total								
Dominant Taxon (name)	Hyalella azteca	Hyalella azteca	Limnodrilus hoffmeisteri	Limnodrilus hoffmeisteri	Floridobia	Floridobia	Chironomus	Hydrobiidae
Amphipoda	67.6	45.3	15.9	17.5	36.6	35.3	20.8	14.2
Coleoptera	0.0	0.0	0.0	0.0	2.1	1.3	0.0	0.0
Diptera	6.6	3.1	14.5	22.2	13.4	6.5	36.9	35.5
Gastropoda	10.6	23.9	17.2	22.2	35.9	47.1	30.2	45.2
Isopoda	0.7	2.5	3.5	2.0	2.8	2.0	0.7	1.9
Oligochaeta	4.6	11.3	46.9	33.6	2.8	1.3	4.7	0.7
Functional Feeding Groups: Percent of total								
Browser-Grazers	0.3	1.3	1.7	1.0	4.6	1.6	0.3	1.0
Burrowing Deposit Feeders	4.6	11.3	46.9	33.6	2.8	1.3	4.7	0.7
Piercers	0.0	0.0	0.0	0.0	1.1	0.7	0.0	0.0
Predators	6.6	10.1	2.1	2.7	3.5	5.6	1.3	0.0
Scavengers	0.3	1.3	1.7	1.0	4.6	1.6	0.3	1.0
Scrapers	2.7	23.9	17.2	22.2	35.9	47.1	0.7	2.6
Shredders	34.4	22.6	7.9	8.7	16.9	17.7	14.8	9.7
Surface Deposit Feeders	47.4	25.8	22.4	30.5	27.1	22.2	73.5	79.7
Suspension Feeders	1.0	0.0	0.0	0.3	2.8	1.6	1.7	4.2
Unknown	2.0	2.5	0.0	0.0	0.7	0.7	2.7	1.3

A - Value reported is the mean of two determinations

* SCI_2007 categories from Table LT 7200-2 of Draft DEP-SOP-002/01 as referenced in Draft Quality Assurance Rule (62-160 F.A.C.), September 17, 2007: Values 0 ≤ 34 are Category III; Values 35 < 67 are Category II; Values 68 ≤ 100 are Category I

APPENDIX F. Blue Spring macroinvertebrate and habitat assessment data (from FDEP).

Volusia Blue- Middle Site	10/10/2007		2/12/2008		6/24/2008		11/6/2008	
Summary Statistics								
Stream Condition Index 2007 (value)	4 A		6 A		9 A		11 A	
Stream Condition Index 2007 (category) *	Impaired		Impaired		Impaired		Impaired	
Stream Condition Index Metrics	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
Number of Total Taxa	11	11	14	11	14	16	16	18
Number of Ephemeroptera Taxa	0	0	0	0	0	0	0	1
Number of Trichoptera Taxa	0	0	0	0	0	1	0	0
Number of Clinger Taxa	0	0	0	0	0	0	0	0
Number of Long-lived Taxa	0	0	0	0	0	0	0	0
Number of Sensitive Taxa	0	0	0	0	0	0	1	1
Percent of Dominant Taxon	48.3	42.8	24.1	36.0	23.4	40.6	31.3	45.6
Percent Suspension Feeders and Filterers	1.0	0.7	1.6	1.7	1.0	2.1	5.0	4.7
Percent of Tanytarsini Individuals	0.0	0.0	0.0	0.0	0.0	0.0	1.3	1.9
Percent of Very Tolerant Individuals	24.8	27.6	74.7	64.0	19.6	21.0	75.6	75.0
Total Number of Individuals	145	145	158	150	158	143	160	160
Community Composition: Percent of total								
Dominant Taxon (name)	Hyalella azteca	Hyalella azteca	Chironomus	Pyrgophorus platyrachis	Littoridinops monroensis	Hyalella azteca	Pyrgophorus platyrachis	Pyrgophorus platyrachis
Amphipoda	48.3	42.8	7.6	7.3	17.7	42.0	18.8	18.1
Diptera	4.8	6.9	27.2	14.7	12.0	11.2	25.0	16.3
Ephemeroptera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
Gastropoda	25.5	32.4	39.9	62.0	65.2	32.9	33.1	48.1
Isopoda	0.0	0.0	0.0	0.0	0.0	0.0	3.1	1.3
Odonata	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0
Oligochaeta	15.2	13.8	21.5	14.7	3.2	10.5	12.5	10.6
Pelecypoda	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0
Trichoptera	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0
Trombidiformes	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0
Functional Feeding Groups: Percent of total								
Browser-Grazers	0.0	0.0	0.0	0.0	0.3	0.7	1.6	0.6
Burrowing Deposit Feeders	15.2	13.8	21.5	14.7	3.2	10.5	12.5	10.6
Piercers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Predators	5.5	3.1	3.8	0.7	1.9	1.1	6.9	5.6
Scavengers	0.0	0.0	0.0	0.0	0.3	0.7	1.6	0.6
Scrapers	0.7	32.4	39.9	62.0	65.2	32.9	33.1	48.4
Shredders	24.8	21.4	3.8	3.7	8.5	20.3	9.4	9.1
Surface Deposit Feeders	52.8	27.2	29.4	17.3	19.6	29.7	29.4	19.1
Suspension Feeders	1.0	0.7	1.6	1.7	1.0	2.1	5.0	4.7
Unknown	0.0	0.7	0.0	0.0	0.0	1.4	0.6	1.3

A - Value reported is the mean of two determinations

* SCI_2007 categories from Table LT 7200-2 of Draft DEP-SOP-002/01 as referenced in Draft Quality Assurance Rule (62-160 F.A.C.), September 17, 2007: Values 0 ≤ 34 are Category III; Values 35 < 67 are Category II; Values 68 ≤ 100 are Category I

APPENDIX F. Blue Spring macroinvertebrate and habitat assessment data (from FDEP).

Volusia Blue- Lower Site	10/10/2007		2/12/2008	6/24/2008		11/6/2008	
Summary Statistics							
Stream Condition Index 2007 (value)	6 A		not sampled due to manatee presence	4 A		15 A	
Stream Condition Index 2007 (category) *	Impaired			Impaired		Impaired	
Stream Condition Index Metrics	Rep 1	Rep 2		Rep 1	Rep 2	Rep 1	Rep 2
Number of Total Taxa	9	11		10	10	20	24
Number of Ephemeroptera Taxa	0	0		0	0	0	0
Number of Trichoptera Taxa	0	0		0	0	0	0
Number of Clinger Taxa	0	0		0	0	0	0
Number of Long-lived Taxa	0	0		0	0	0	0
Number of Sensitive Taxa	0	0		0	0	0	1
Percent of Dominant Taxon	32.9	31.8		55.6	46.2	27.2	27.7
Percent Suspension Feeders and Filterers	1.3	0.7		2.2	1.7	3.3	5.0
Percent of Tanytarsini Individuals	0.0	0.0		0.0	0.0	1.3	2.5
Percent of Very Tolerant Individuals	74.1	67.6		31.9	11.7	47.0	42.1
Total Number of Individuals	158	148		160	145	151	159
Community Composition: Percent of total							
Dominant Taxon (name)	Limnodrilus hoffmeisteri	Pyrgophorus platyrachis	not sampled due to manatee presence	Hyalella azteca	Hyalella azteca	Hyalella azteca	Hyalella azteca
Amphipoda	10.1	10.8		55.6	46.2	27.2	27.7
Coleoptera	0.0	0.0		0.0	0.0	0.0	0.6
Diptera	5.7	8.1		12.5	15.9	19.9	18.2
Gastropoda	45.6	48.0		23.8	31.7	13.3	10.7
Isopoda	0.0	0.0		0.0	0.0	0.0	0.6
Odonata	0.0	0.0		0.0	0.0	3.3	3.1
Oligochaeta	33.5	27.7		6.3	2.1	31.8	34.6
Functional Feeding Groups: Percent of total							
Browser-Grazers	0.0	0.0	not sampled due to manatee presence	0.0	0.0	0.0	0.3
Burrowing Deposit Feeders	33.5	27.7		6.3	2.1	31.8	34.6
Piercers	0.0	0.0		0.0	0.0	0.0	0.0
Predators	5.1	4.7		3.1	5.9	7.0	5.7
Scavengers	0.0	0.0		0.0	0.0	0.0	0.3
Scrapers	45.6	48.0		23.8	0.0	13.3	11.0
Shredders	5.1	5.4		27.8	23.1	14.2	15.1
Surface Deposit Feeders	9.5	12.8		36.9	67.2	27.8	25.5
Suspension Feeders	1.3	0.7		2.2	1.7	3.3	5.0
Unknown	0.0	0.0		0.0	0.0	2.7	2.5

A - Value reported is the mean of two determinations

* SCI_2007 categories from Table LT 7200-2 of Draft DEP-SOP-002/01 as referenced in Draft Quality Assurance Rule (62-160 F.A.C.), September 17, 2007: Values 0 ≤ 34 are Category III; Values 35 < 67 are Category II; Values 68 ≤ 100 are Category I

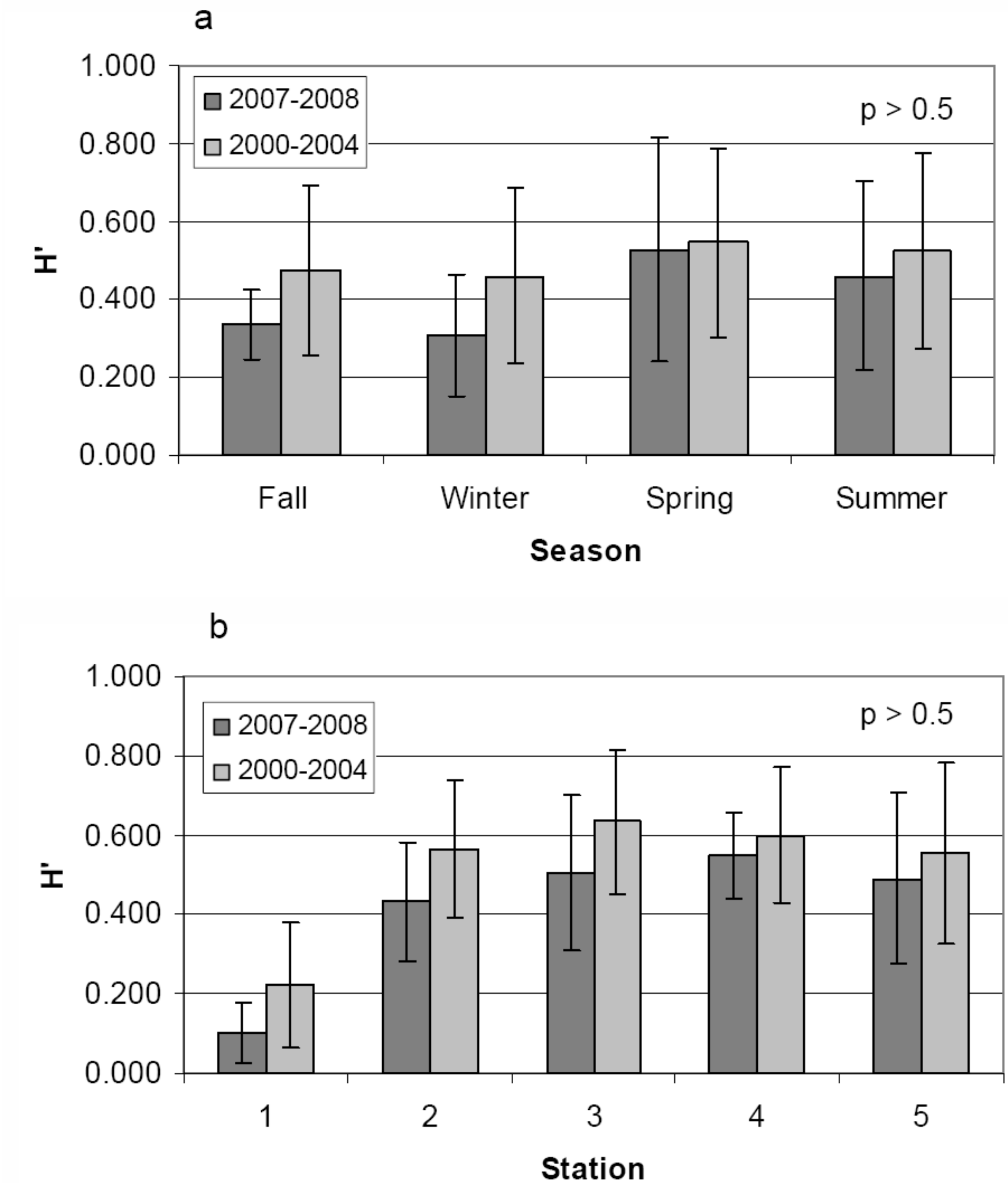
APPENDIX F. Blue Spring historical FDEP stream condition index (SCI) scores (from FDEP 2008).

Old SCI Scores	
October 17, 2000	15
March 21, 2001	15
October 16, 2001	15
April 17, 2002	15
October 21, 2002	15
May 19, 2003	17
October 14, 2003	11
April 20, 2004	11

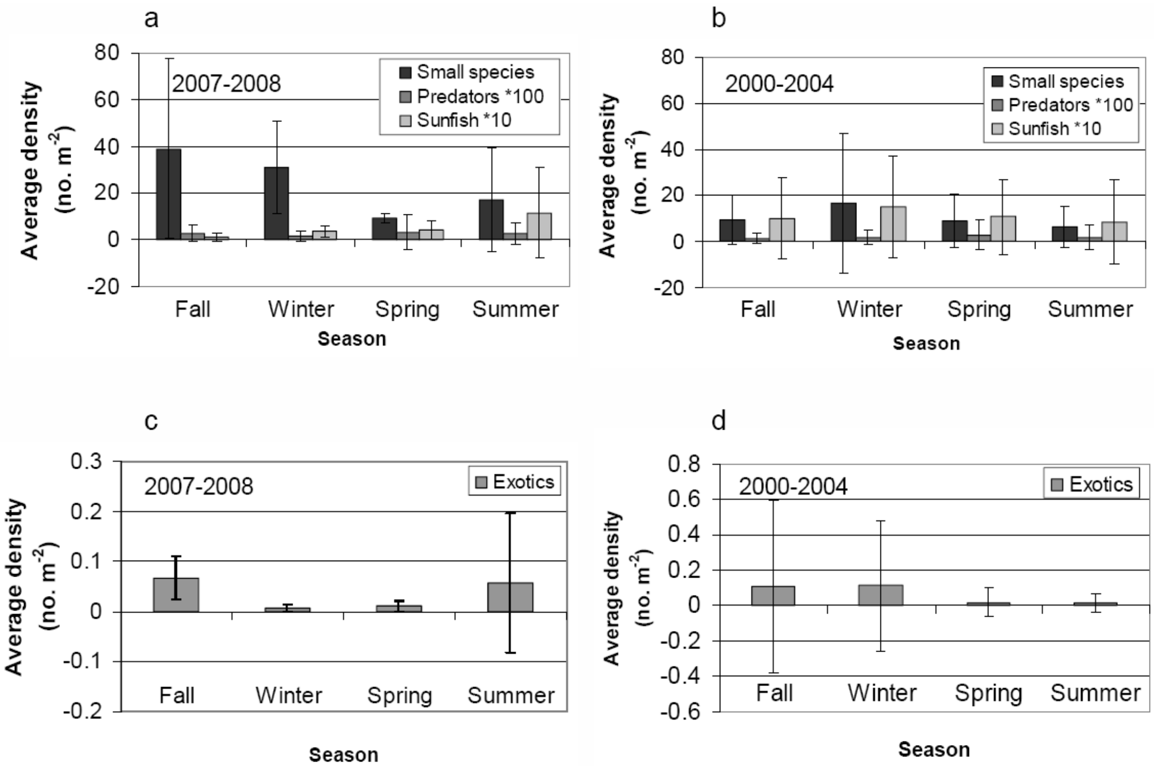
Recalibrated SCI Scores	
April 26, 2005	17
May 24, 2006	14
May 8, 2007	9

Appendix G

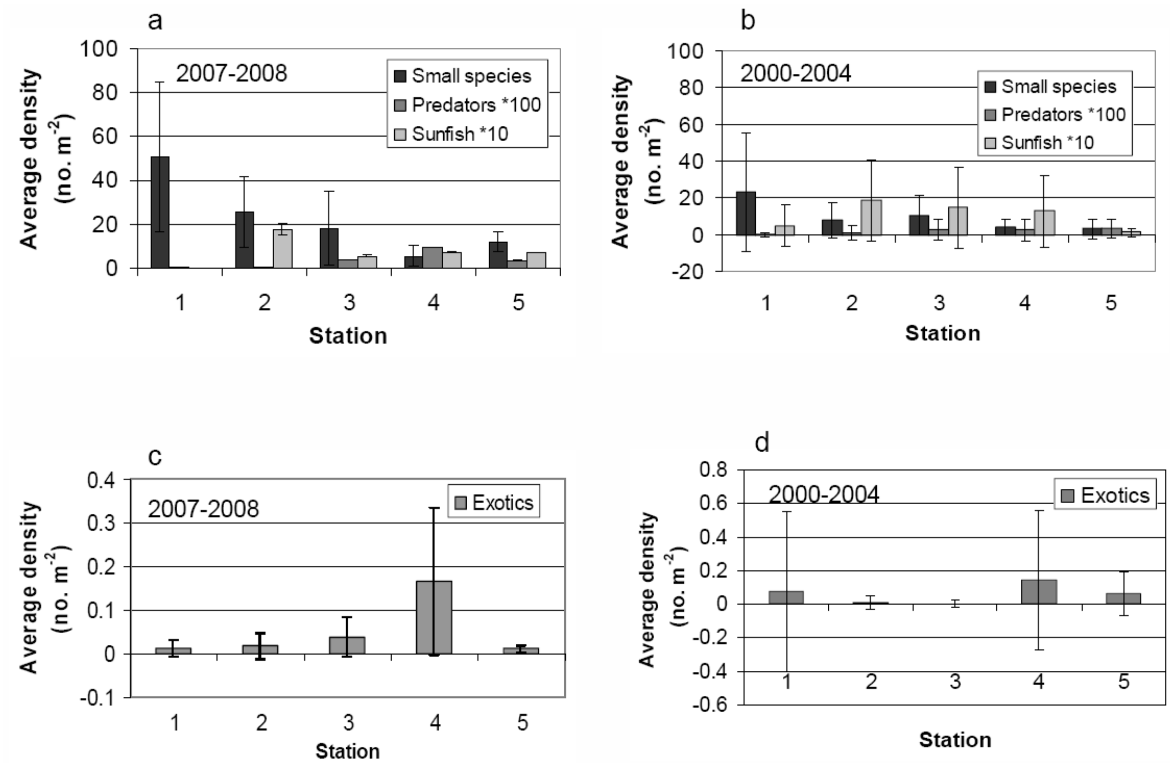
Blue Spring Fish Data (from Stetson University)



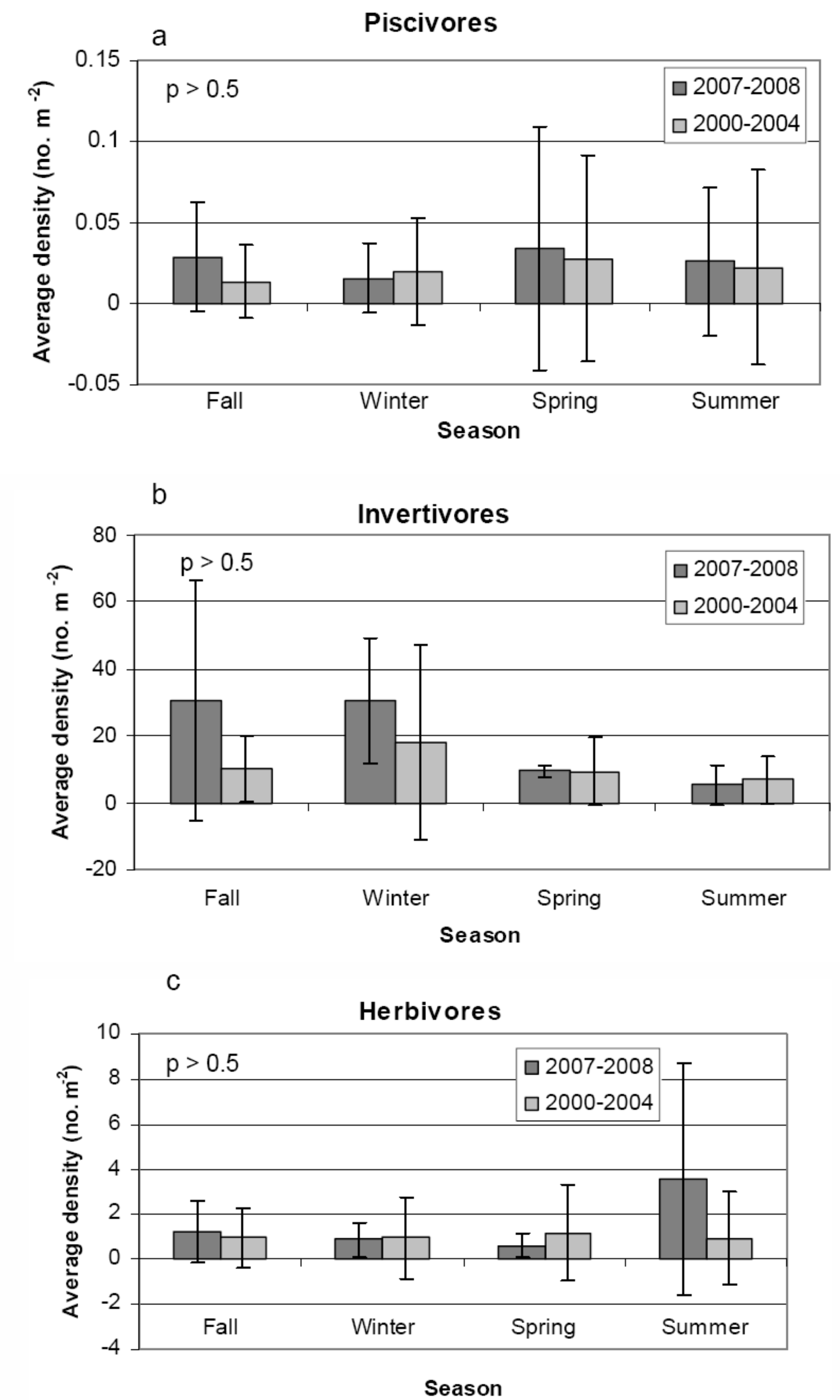
APPENDIX G. Seasonal (a) and spatial (b) patterns in fish diversity of Blue Spring from 2007-2008 and the previous study in 2000-2004. Values represent averages with one standard deviation of all stations and dates for each season (a) or of all dates for each station (b) over the sampling periods (from Work and Gibbs 2008).



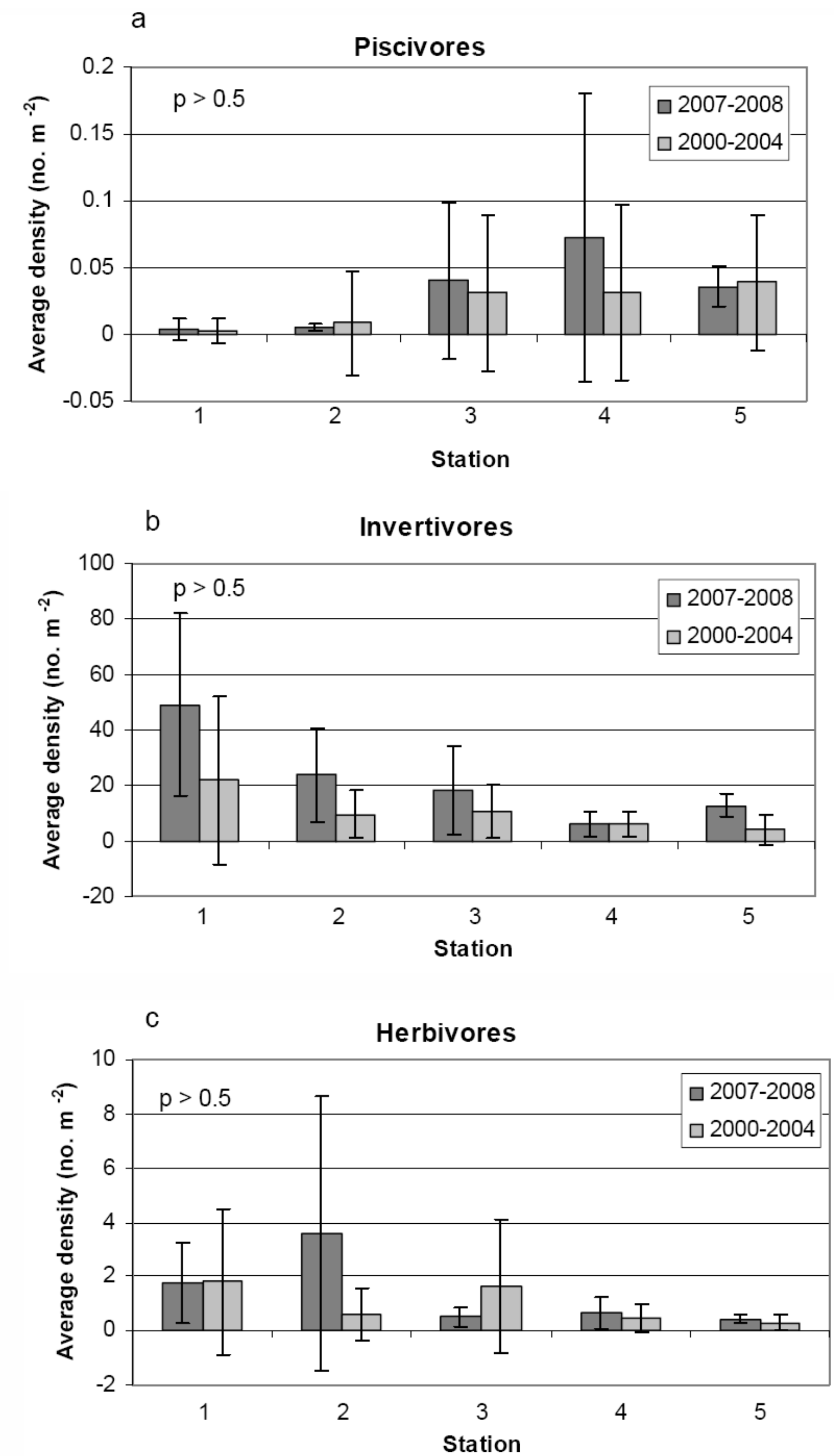
APPENDIX G. Comparisons of the seasonal patterns of native fish between 2007-2008 (a) and the previous study in 2000-2004 (b) and of the seasonal patterns of exotic fish between 2007-2008 (c) and the previous study in 2000-2004 (d) in Blue Spring. Values represent averages with one standard deviation of all stations and dates for each season over the sampling periods (from Work and Gibbs 2008).



APPENDIX G. Comparisons of the spatial patterns of native fish between 2007-2008 (a) and the previous study in 2000-2004 (b) and of the spatial patterns of exotic fish between 2007-2008 (c) and the previous study in 2000-2004 (d) in Blue Spring. Values represent averages with one standard deviation of all dates for each station over the sampling periods (from Work and Gibbs 2008).



APPENDIX G. Seasonal patterns of piscivorous fish (a), invertivorous fish (b), and herbivorous fish (c) in 2007-2008 and in 2000-2004 in Blue Spring. Values represent averages with one standard deviation of all stations and dates for each season over the sampling periods (from Work and Gibbs 2008).



APPENDIX G. Spatial patterns of piscivorous fish (a), invertivorous fish (b), and herbivorous fish (c) in 2007-2008 and in 2000-2004 in Blue Spring. Values represent averages with one standard deviation of all dates for each station over the sampling periods (from Work and Gibbs 2008).

APPENDIX G. Annual and seasonal variation in density (no./m²) of fish species in Blue Spring. Values represent averages of all stations and dates sampled in each season (from Work and Gibbs 2008).

Year	Season	Tarpon	Snook	Bowfin	Gar	Ironcolor shiner	Golden shiner	Channel catfish	Striped mullet	Inland silverside	Seminole killifish	Golden topminnow
2000	Fall	0	0	0	0.0065	0	0.011	0.00038	0.0051	0.18	0.41	0.17
2001	Winter	0	0	0	0	0	0	0	0	0.0083	0.011	0.017
	Spring	0.000031	0	0	0.018	0.025	0.00031	0	0.049	0	0.12	0.038
	Summer	0	0	0	0.004	0.043	0.24	0	0.02	0.27	0.067	0.064
	Fall	0.00051	0	0	0.00087	0.0005	0.12	0.001	0.000032	0.016	0.018	0.037
2002	Winter	0.0049	0	0	0.012	0.0041	0.0067	0.00022	0.0025	0	0.22	0.019
	Spring	0	0	0	0.021	0	0.037	0	0.039	0	0.034	0.065
	Summer	0	0	0	0.013	0.0097	0.25	0	0.011	0.36	0.14	0.0028
	Fall	0.0013	0	0	0.0011	0.0059	0.34	0.0012	0.0049	0.44	0.2	0.0031
2003	Winter	0.0036	0	0	0.0052	0.017	0.06	0.00032	0.0037	0	0.055	0.004
	Spring	0	0	0	0.0084	0.00052	0.2	0.0018	0.032	0	0.01	0.0061
	Summer	0	0	0	0.0087	0.014	0.15	0	0.076	0	0.062	0
	Fall	0	0	0	0.011	0	0.083	0	0.018	0	0.05	0.042
2004	Winter	0.00032	0	0	0.0051	0.0024	0.01	0	0	0	0.0031	0.026
	Spring	0	0	0	0.0082	0.0013	0.0093	0.00013	0.037	0	0.027	0.000021
	Summer	0	0	0	0.00047	0.0063	0.0098	0	0.043	0	0.19	0
2007	Fall	0.0025	0	0.0016	0.022	0	0	0.00012	0.018	0	0.0028	0.062
2008	Winter	0.0012	0.00089	0.0016	0.0097	0	0.00015	0.0022	0.0085	0	0.00034	0.018
	Spring	0	0.000023	0.00043	0.029	0	0	0.0036	0.052	0	0	0
	Summer	0	0	0	0.0041	0.0011	0.93	0	0.01	0.21	0.024	0

APPENDIX G. Annual and seasonal variation in density (no./m²) of fish species in Blue Spring. Values represent averages of all stations and dates sampled in each season (from Work and Gibbs 2008).

Year	Season	Rainwater killifish	Bluefin killifish	Sailfin molly	Mosquitofish	Least killifish	Flagfish	Largemouth bass	Warmouth	White crappie	Bluegill	Spotted sunfish	Redear sunfish
2000	Fall	0.76	0.25	0.63	4.75	0.098	0	0.0061	0	0	0.57	0.0037	0.28
2001	Winter	2.68	0.42	0.58	7.26	0.34	0	0	0	0	0.028	0	0
	Spring	1.9	0.49	0.78	4.71	0.64	0	0.0018	0	0	0.28	0.0037	0.0009
	Summer	0.37	0.32	1.11	6.25	0.62	0	0.00086	0.0012	0	0.08	0.0017	0
	Fall	0.15	0.2	1.5	18.74	0.73	0	0.00019	0.0053	0	0.055	0.0015	0.00058
2002	Winter	0.66	0.37	1.06	31.43	0.64	0.001	0.0027	0.03	0	0.84	0.04	0.000079
	Spring	0.42	0.4	1.51	11.19	0.5	0	0.016	0.21	0	0.84	0.058	0.027
	Summer	0.032	0.089	1.38	5.68	0.065	0	0.024	0.042	0.0033	0.27	0.028	0.04
	Fall	0.2	0.24	0.87	6.68	0.09	0	0.011	0.41	0.0011	0.54	0.024	0.048
2003	Winter	0.084	0.087	0.37	2.56	0.02	0	0.0079	0.42	0.000083	1.13	0.027	0.0038
	Spring	0.13	0.094	1.22	6.58	0.027	0	0.008	0.35	0.0027	1.66	0.1	0.011
	Summer	0.23	0.078	0.053	0.82	0.026	0	0.032	0.4	0.00044	2.21	0.11	0.0031
	Fall	0.2	0.19	0.38	3.81	0.4	0	0.014	0.44	0	1.13	0.11	0.00032
2004	Winter	0.39	0.19	1.43	13.52	0.32	0	0.025	0.95	0.0018	1.72	0.071	0.14
	Spring	0.15	0.16	1.05	5.42	0.41	0	0.034	0.32	0.00013	0.49	0.098	0.39
	Summer	0.33	0.093	0.17	1.3	0.12	0	0.01	0.48	0.00026	0.38	0.03	0.32
2007	Winter	0.39	0.38	0.51	14.88	1.11	0	0.00056	0.0075	0	0.068	0.0011	0.016
2008	Spring	0.61	0.34	0.48	15.21	0.51	0	0.0037	0.07	0	0.2	0.0099	0.052
	Summer	0.55	0.52	0.29	3.65	0.26	0	0.0044	0.1	0	0.27	0.016	0.067
	Fall	0	0	1.98	6.74	0	0	0.022	0.007	0	1.04	0.48	0.046

APPENDIX G. Annual and seasonal variation in density (no./m²) of fish species in Blue Spring. Values represent averages of all stations and dates sampled in each season (from Work and Gibbs 2008).

Year	Season	Redbreast sunfish	Bluespotted sunfish	Blackbanded darter	Blue tilapia	Sailfin suckermouth catfish	Brown hoplo	Pacu
2000	Fall	0.18	0	0	0.013	0.0084	0	0.00013
2001	Winter	0.011	0	0	0	0	0	0
	Spring	0.000016	0	0	0	0	0	0.000047
	Summer	0	0	0	0	0.0045	0	0.000074
	Fall	0	0	0	0	0.0008	0	0.00028
2002	Winter	0.0039	0	0	0	0.0097	0.00011	0.00054
	Spring	0.027	0	0	0	0	0	0
	Summer	0.0038	0	0	0.0029	0.0003	0	0.00059
	Fall	0.0096	0	0	0.0011	0.21	0	0.0011
2003	Winter	0.012	0	0	0.0006	0.23	0	0.00063
	Spring	0.021	0	0	0.00087	0.13	0	0.00028
	Summer	0.02	0	0	0.014	0.0065	0	0
	Fall	0.035	0.0016	0.0067	0	0.12	0	0
2004	Winter	0.057	0	0	0	0.085	0	0
	Spring	0.08	0	0	0.00053	0.027	0	0
	Summer	0.036	0	0	0	0	0	0
2007	Winter	0.0003	0	0	0.012	0.047	0	0.00007
2008	Spring	0.013	0	0	0.0033	0.0029	0	0
	Summer	0.012	0	0	0.01	0.00081	0	0
	Fall	0.0081	0	0	0.0075	0.0014	0	0

APPENDIX G. Annual and spatial variation in density (no./m²) of fish species in Blue Spring. Values represent averages of all stations and dates sampled in each season. (from Work and Gibbs 2008).

Year	Station	Tarpon	Snook	Gar	Bowfin	Ironcolor shiner	Golden shiner	Channel catfish	Striped mullet	Inland silverside	Seminole killifish	Golden topminnow
2000	1	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0.2	0.11
	3	0	0	0	0	0	0.056	0	0	0.89	1.8	0.7
	4	0	0	0.013	0	0	0	0	0	0	0.028	0.042
	5	0	0	0.019	0	0	0	0.0019	0.026	0	0.014	0
2001	1	0	0	0.0000056	0	0	0	0	0	0	0	0.088
	2	0	0	0	0	0.045	0.2	0	0.0033	0	0.029	0.032
	3	0	0	0.000066	0	0.095	0.23	0	0.11	0.036	0.086	0.077
	4	0	0	0.033	0	0.01	0.11	0	0.011	0.67	0.04	0.033
	5	0.0005	0	0.016	0	0.00027	0.0095	0.00087	0.0075	0	0.017	0.02
2002	1	0	0	0.0026	0	0	0.082	0.0015	0	0	0.063	0.0051
	2	0	0	0.0001	0	0.009	0.52	0	0.0038	0.046	0.28	0.027
	3	0	0	0.00044	0	0.00022	0.089	0	0.0096	0.7	0.26	0.044
	4	0.007	0	0.016	0	0.0089	0.0045	0	0.026	0.24	0.13	0.016
	5	0.004	0	0.056	0	0.0093	0.0024	0.00049	0.038	0	0.0095	0
2003	1	0	0	0.0015	0	0	0.022	0.0000087	0	0	0.0074	0.0058
	2	0	0	0.00012	0	0.04	0.47	0	0	0	0.11	0.01
	3	0	0	0.003	0	0.00023	0.064	0	0.046	0	0.078	0.02
	4	0.0041	0	0.0065	0	0	0	0.021	0.066	0	0.0023	0.0033
	5	0.0026	0	0.043	0	0	0	0.0013	0.015	0	0.00027	0.0078
2004	1	0	0	0.0000075	0	0.0052	0.013	0	0	0	0.041	0
	2	0	0	0.00021	0	0.0065	0.18	0	0.0044	0	0.1	0.02
	3	0	0	0.0032	0	0	0.0051	0	0.03	0	0.046	0.015
	4	0	0	0.0043	0	0	0	0	0.077	0	0.0093	0.0093
	5	0.00083	0	0.028	0	0	0	0.00042	0.02	0	0.036	0.00016
2007-2008	1	0.0041	0	0.00019	0	0	0	0	0	0	0	0.12
	2	0	0	0	0	0.02	1.34	0.0005	0	0.25	0.0074	0.042
	3	0	0	0.0061	0.0004	0	0.12	0	0.027	0	0.018	0.014
	4	0	0	0.065	0	0	0.02	0	0.11	0	0.0015	0
	5	0.0016	0.0027	0.013	0.00053	0	0	0	0.028	0	0	0

APPENDIX G. Annual and spatial variation in density (no./m²) of fish species in Blue Spring. Values represent averages of all stations and dates sampled in each season (from Work and Gibbs 2008).

Year	Station	Rainwater killifish	Bluefin killifish	Sailfin molly	Mosquitofish	Least killifish	Flagfish	Largemouth bass	Warmouth	White crappie	Bluegill	Spotted sunfish	Redear sunfish
2000	1	0	0	1.15	8.44	0	0	0	0	0	0	0	0
	2	0.78	0.39	0.74	8.06	0.2	0	0	0	0	0.48	0	0
	3	1.46	0.61	1.15	4.7	0.2	0	0.019	0	0	1.54	0.019	0.083
	4	0.49	0.22	0.042	1.69	0.028	0	0.00012	0	0	0.72	0	1.32
	5	1.06	0.042	0.083	0.85	0.056	0	0.012	0	0	0.092	0	0
2001	1	0.0098	0.051	1.45	12.19	0.3	0	0	0	0	0.0049	0	0
	2	0.42	0.69	1.07	10.47	0.58	0	0	0.0016	0	0.17	0.0026	0.00041
	3	1.84	0.77	2.27	7.54	1.68	0	0.003	0.00042	0	0.39	0.0054	0
	4	1.51	0.29	0.35	4.65	0.55	0	0.0014	0.0042	0	0.12	0.00076	0.0014
	5	2.01	0.17	0.2	3.69	0.46	0	0.00066	0.0013	0	0.057	0.0017	0.00055
2002	1	0.0038	0.073	1.65	38.77	0.098	0	0	0.1	0	0.22	0.017	0.0026
	2	0.26	0.44	0.41	6.76	0.35	0.0013	0.0045	0.38	0.0031	0.92	0.027	0.02
	3	0.83	0.55	2.69	10.82	0.88	0	0.038	0.15	0	0.81	0.079	0.058
	4	0.33	0.16	0.39	4.87	0.14	0	0.012	0.14	0.0016	0.83	0.045	0.054
	5	0.31	0.064	0.22	4.55	0.075	0	0.0056	0.064	0	0.24	0.005	0.0041
2003	1	0.0015	0.0015	1.49	10.03	0.01	0	0.0044	0.22	0	0.93	0.0015	0
	2	0.15	0.23	0.37	1.68	0.056	0	0.0021	0.45	0.00012	2.31	0.13	0.0091
	3	0.34	0.14	0.32	1.74	0.076	0	0.04	0.61	0.0000018	2.04	0.12	0.0031
	4	0.17	0.074	0.052	1.6	0.0098	0	0.016	0.53	0.0039	1.62	0.11	0.0044
	5	0.046	0.05	0.22	0.93	0.026	0	0.0026	0.039	0.00053	0.14	0.014	0.0053
2004	1	0	0.01	2.79	22.29	0.19	0	0.0026	0.28	0	0.22	0.021	0.082
	2	0.26	0.2	0.63	4.62	0.34	0	0.043	1.12	0.00032	1.99	0.16	0.54
	3	0.44	0.32	0.94	4.78	0.73	0	0.038	0.55	0	0.83	0.087	0.083
	4	0.53	0.12	0.17	1.8	0.12	0	0.032	0.75	0	1.22	0.076	0.67
	5	0.14	0.14	0.12	1.33	0.12	0	0.01	0.051	0.00042	0.081	0.0047	0.016
2007-2008	1	0	0.26	1.75	46.9	1.68	0	0	0.00029	0	0.022	0.00019	0
	2	0.82	0.82	3.57	17.64	1	0	0.0055	0.077	0	1.53	0.081	0.082
	3	1.43	0.67	0.44	14.47	1.14	0	0.033	0.093	0	0.38	0.028	0.06
	4	0.67	0.47	0.4	3.94	0.25	0	0.0074	0.058	0	0.49	0.0096	0.072
	5	0.78	0.76	0.24	6.31	0.2	0	0.0064	0.086	0	0.21	0.0053	0.034

APPENDIX G. Annual and spatial variation in density (no./m^2) of fish species in Blue Spring. Values represent averages of all stations and dates sampled in each season (from Work and Gibbs 2008).

Year	Station	Redbreast sunfish	Bluespotted sunfish	Blackbanded darter	Blue tilapia	Sailfin suckermouth catfish	Brown hoplo	Pacu
2000	1	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0
	3	0.46	0	0	0	0	0	0
	4	0.42	0	0	0	0.000123	0	0
	5	0.0056	0	0	0.67	0.042	0	0.00063
2001	1	0	0	0	0	0	0	0
	2	0	0	0	0	0.0044	0	0
	3	0	0	0	0	0.000022	0	0.00014
	4	0	0	0	0	0.0024	0	0
	5	0.004	0	0	0	0.003	0	0.00034
2002	1	0.0013	0	0	0	0.18	0.0000038	0
	2	0.012	0	0	0	0.0001	0	0
	3	0.0057	0	0	0.00011	0.00011	0	0.00056
	4	0.022	0	0	0.00336	0.091	0	0.000038
	5	0.014	0	0	0.0024	0.032	0.00024	0.0037
2003	1	0	0	0	0	0.084	0	0
	2	0.031	0	0.0015	0	0.0045	0	0
	3	0.025	0.0016	0	0.00012	0.014	0	0
	4	0.026	0.00015	0.0016	0.001	0.43	0	0
	5	0.018	0	0	0.0016	0.17	0	0.00038
2004	1	0	0	0	0	0.00014	0	0.0016
	2	0.18	0	0	0	0.031	0	0
	3	0.036	0	0	0	0.0067	0	0
	4	0.07	0	0	0	0.11	0	0
	5	0.0067	0	0	0.0017	0.1	0	0
2007-2008	1	0	0	0	0	0.012	0	0
	2	0.014	0	0	0.0015	0.016	0	0
	3	0.0096	0	0	0.017	0.022	0	0
	4	0.014	0	0	0.018	0.023	0	0
	5	0.033	0	0	0.0016	0.0059	0	0

Appendix H

Blue Spring Turtle Data (from Stetson University)

APPENDIX H. The number of turtles that were captured in Blue Spring Run on October 20-21, 2007 (first sample period) and October 22, 2007 (second sample period) (from Farrell *et al*. 2009).

Common Name	Latin Name	# captured in 1st sample	# captured in 2nd sample	# recaptured in 2nd sample
Florida Snapping Turtle	*Chelydra serpentina*	0	0	0
Florida Softshell Turtle	*Apalone ferox*	0	0	0
Loggerhead Musk Turtle	*Sternotherus minor*	11	5	3
Common Musk Turtle	*Sternotherus odoratus*	1	0	0
Red-eared Slider	*Trachemys scripta*	0	2 (not marked)	0
Florida Red-bellied Turtle	*Pseudemys nelsoni*	16	4	1
Peninsula Cooter	*Pseudemys floridana*	62	5	1
Total Turtles		90	14	5

APPENDIX H. Population estimates and sex ratios for Blue Spring turtles in October 2007 (from Farrell *et al*. 2009).

Common Name	Latin Name	Population Estimate	Lower 95% Confidence Interval	Upper 95% Confidence Interval	% Female
Loggerhead Musk Turtle	*Sternotherus minor*	18.3	5.2	31.5	72.7
Common Musk Turtle	*Sternotherus odoratus*	--	--	--	100
Florida Red-bellied Turtle	*Pseudemys nelsoni*	64	0	172.6	55.6
Peninsula Cooter	*Pseudemys floridana*	310	0	853.5	69.7
Total Turtles		252	429.1	749	--

APPENDIX H. The number of turtles that were captured in the Blue Spring Run on March 18, 2008 (first sample period) and March 20, 2008 (second sample period) (from Farrell *et al*. 2009).

Common Name	Latin Name	# captured in 1st sample	# captured in 2nd sample	# recaptured in 2nd sample
Florida Snapping Turtle	*Chelydra serpentina*	1	0	0
Florida Softshell Turtle	*Apalone ferox*	0	0	0
Loggerhead Musk Turtle	*Sternotherus minor*	2	2	0
Common Musk Turtle	*Sternotherus odoratus*	0	0	0
Red-eared Slider	*Trachemys scripta*	2 (not marked)	0	0
Florida Red-bellied Turtle	*Pseudemys nelsoni*	5	6	1
Peninsula Cooter	*Pseudemys floridana*	9	3	0
Total Turtles		19	11	1

APPENDIX H. Population estimates and sex ratios for Blue Spring turtles in March 2008 (from Farrell *et al*. 2009).

Common Name	Latin Name	Population Estimate	Lower 95% Confidence Interval	Upper 95% Confidence Interval	% Female
Loggerhead Musk Turtle	*Sternotherus minor*	--	--	--	--
Common Musk Turtle	*Sternotherus odoratus*	--	--	--	--
Florida Red-bellied Turtle	*Pseudemys nelsoni*	30	0	83.7	30
Peninsula Cooter	*Pseudemys floridana*	--	--	--	--
Total Turtles		209	0	599.6	--

APPENDIX H. The number of turtles that were captured in the Blue Spring Run on April 11, 2008 (first sample period) and April 12-13, 2008 (second sample period) (from Farrell *et al*. 2009).

Common Name	Latin Name	# captured in 1st sample	# captured in 2nd sample	# recaptured in 2nd sample
Florida Snapping Turtle	*Chelydra serpentina*	1	1	0
Florida Softshell Turtle	*Apalone ferox*	0	1	0
Loggerhead Musk Turtle	*Sternotherus minor*	1	6	0
Common Musk Turtle	*Sternotherus odoratus*	0	0	0
Red-eared Slider	*Trachemys scripta*	0	0	0
Florida Red-bellied Turtle	*Pseudemys nelsoni*	6	15	0
Peninsula Cooter	*Pseudemys floridana*	13	24	2
Total Turtles		21	47	2

APPENDIX H. Population estimates and sex ratios for Blue Spring turtles in April 2008 (from Farrell *et al*. 2009).

Common Name	Latin Name	Population Estimate	Lower 95% Confidence Interval	Upper 95% Confidence Interval	% Female
Loggerhead Musk Turtle	*Sternotherus minor*	--	--	--	14.3
Common Musk Turtle	*Sternotherus odoratus*	--	--	--	--
Florida Red-bellied Turtle	*Pseudemys nelsoni*	--	--	--	38.9
Peninsula Cooter	*Pseudemys floridana*	156	0	363	37.5
Total Turtles		493.5	0	1,163	--

APPENDIX H. The number of turtles that were captured in the Blue Spring Run on October 3-4, 2008 (first sample period) and October 5-6, 2008 (second sample period) (from Farrell *et al*. 2009).

Common Name	Latin Name	# captured in 1st sample	# captured in 2nd sample	# recaptured in 2nd sample
Florida Snapping Turtle	*Chelydra serpentina*	0	1	0
Florida Softshell Turtle	*Apalone ferox*	0	0	0
Loggerhead Musk Turtle	*Sternotherus minor*	10	11	1
Common Musk Turtle	*Sternotherus odoratus*	0	0	0
Red-eared Slider	*Trachemys scripta*	0	0	0
Florida Red-bellied Turtle	*Pseudemys nelsoni*	4	3	1
Peninsula Cooter	*Pseudemys floridana*	8	8	1
Total Turtles		22	23	2

APPENDIX H. Population estimates and sex ratios for Blue Spring turtles in October 2008 (from Farrell *et al*. 2009).

Common Name	Latin Name	Population Estimate	Lower 95% Confidence Interval	Upper 95% Confidence Interval	% Female
Loggerhead Musk Turtle	*Sternotherus minor*	110	20	315	19
Florida Red-bellied Turtle	*Pseudemys nelsoni*	12	7	31	66.7
Peninsula Cooter	*Pseudemys floridana*	64	15	181	15.4
Total Turtles		253	0	588	--

Appendix I

Blue Spring Metabolism Detail and Summaries (from WSI)

METABOLISM WORKSHEET - DAILY DETAIL

VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-570

Date	GPP ($g\ O_2/m^2/d$)	NPP ($g\ O_2/m^2/d$)	CR ($g\ O_2/m^2/d$)	P/R Ratio	PAR (24hr) ($mol/m^2/d$)	PAR Efficiency (%)	PAR Efficiency ($g\ O_2/mol$)
11/13/2007	0.98	-6.28	7.26	0.14	15.73	0.50	0.06
11/14/2007	0.83	-8.12	8.95	0.09	16.14	0.41	0.05
11/15/2007	0.47	-7.21	7.68	0.06	16.07	0.23	0.03
11/16/2007	1.82	-2.98	4.80	0.38	16.79	0.87	0.11
11/17/2007	0.90	-5.40	6.30	0.14	16.63	0.44	0.05
11/18/2007	0.98	-8.48	9.45	0.10	12.60	0.62	0.08
11/19/2007	1.02	-11.04	12.06	0.08	12.86	0.64	0.08
11/20/2007	0.30	-10.36	10.66	0.03	14.94	0.16	0.02
11/21/2007	0.59	-8.68	9.27	0.06	16.11	0.29	0.04
11/22/2007	1.02	-10.18	11.21	0.09	5.70	1.45	0.18
11/23/2007	2.28	-7.71	9.99	0.23	10.66	1.72	0.21
11/24/2007	1.73	-7.07	8.80	0.20	12.17	1.15	0.14
11/25/2007	1.95	-8.90	10.85	0.18	10.90	1.45	0.18
11/26/2007	1.82	-6.54	8.36	0.22	13.88	1.06	0.13
12/7/2007	1.21	-1.39	2.60	0.47	14.18	0.69	0.09
12/8/2007	1.30	-3.70	4.99	0.26	13.99	0.75	0.09
12/9/2007	1.78	-5.19	6.97	0.26	13.77	1.05	0.13
12/10/2007	2.10	-5.11	7.21	0.29	11.74	1.45	0.18
12/11/2007	2.23	-5.51	7.75	0.29	13.29	1.36	0.17
12/12/2007	2.59	-4.79	7.39	0.35	13.65	1.53	0.19
12/13/2007	3.01	-4.58	7.59	0.40	13.45	1.81	0.22
12/14/2007	3.96	-5.93	9.89	0.40	11.06	2.89	0.36
12/15/2007	2.76	-8.13	10.88	0.25	12.65	1.76	0.22
12/16/2007	2.92	-2.12	5.05	0.58	12.21	1.93	0.24
12/17/2007	4.37	3.79	0.58	7.48	14.77	2.39	0.30
12/18/2007	3.66	-0.29	3.95	0.93	11.21	2.64	0.33
12/19/2007	1.95	-2.97	4.92	0.40	13.27	1.18	0.15
12/21/2007	0.16	-7.54	7.70	0.02	14.27	0.09	0.01
12/22/2007	3.69	-4.91	8.60	0.43	5.64	5.28	0.65
12/23/2007	3.06	-7.30	10.37	0.30	12.15	2.03	0.25
12/24/2007	4.62	-5.28	9.91	0.47	13.33	2.80	0.35
12/25/2007	2.91	-7.27	10.18	0.29	7.73	3.04	0.38
12/26/2007	3.14	-5.24	8.38	0.37	9.76	2.60	0.32
12/27/2007	2.09	-5.85	7.94	0.26	12.01	1.40	0.17
12/28/2007	3.42	-6.00	9.42	0.36	12.26	2.25	0.28
12/29/2007	4.15	-7.14	11.29	0.37	10.19	3.29	0.41
12/30/2007	4.78	-7.46	12.24	0.39	10.26	3.77	0.47
12/31/2007	2.82	-8.90	11.72	0.24	5.14	4.43	0.55
1/1/2008	2.21	-5.00	7.21	0.31	10.59	1.69	0.21
1/2/2008	4.07	6.46	-2.39	-1.71	15.01	2.19	0.27
1/3/2008	3.77	5.34	-1.57	-2.40	13.37	2.28	0.28
1/4/2008	2.57	-0.95	3.52	0.73	10.70	1.94	0.24
1/5/2008	2.65	-5.80	8.44	0.31	9.44	2.26	0.28
1/6/2008	2.02	-5.71	7.73	0.26	12.32	1.32	0.16
1/7/2008	2.56	-6.70	9.25	0.28	10.52	1.96	0.24
1/8/2008	1.41	-9.00	10.41	0.14	12.62	0.90	0.11
1/9/2008	1.61	-6.29	7.90	0.20	14.70	0.89	0.11
1/10/2008	3.03	-6.22	9.25	0.33	8.51	2.88	0.36
1/11/2008	5.06	-6.63	11.69	0.43	8.64	4.73	0.59

METABOLISM WORKSHEET - DAILY DETAIL
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-570

Date	GPP ($g\ O_2/m^2/d$)	NPP ($g\ O_2/m^2/d$)	CR ($g\ O_2/m^2/d$)	P/R Ratio	PAR (24hr) ($mol/m^2/d$)	PAR Efficiency (%)	PAR Efficiency ($g\ O_2/mol$)
1/12/2008	5.80	-7.72	13.52	0.43	7.37	6.35	0.79
1/13/2008	2.82	-10.96	13.78	0.20	4.67	4.88	0.60
1/14/2008	5.49	-3.12	8.61	0.64	12.27	3.61	0.45
1/15/2008	5.75	0.07	5.68	1.01	11.10	4.18	0.52
1/16/2008	4.97	-5.21	10.18	0.49	8.44	4.75	0.59
1/17/2008	1.94	-11.91	13.85	0.14	3.68	4.25	0.53
1/18/2008	2.54	-9.86	12.41	0.21	3.50	5.87	0.73
1/19/2008	1.53	-9.63	11.16	0.14	4.80	2.57	0.32
1/20/2008	5.04	1.21	3.83	1.32	13.88	2.93	0.36
1/21/2008	1.49	-5.37	6.86	0.22	12.58	0.96	0.12
1/23/2008	1.54	-5.53	7.07	0.22	8.47	1.46	0.18
1/24/2008	1.52	-5.35	6.87	0.22	8.27	1.48	0.18
1/25/2008	3.88	2.22	1.66	2.34	13.05	2.40	0.30
1/26/2008	1.07	-4.91	5.98	0.18	4.42	1.96	0.24
1/27/2008	2.16	-3.01	5.17	0.42	12.87	1.36	0.17
1/28/2008	0.81	-0.30	1.11	0.73	14.93	0.44	0.05
1/29/2008	1.81	-0.27	2.09	0.87	13.75	1.07	0.13
1/30/2008	3.56	-4.71	8.27	0.43	10.74	2.68	0.33
1/31/2008	2.39	-7.84	10.23	0.23	10.72	1.80	0.22
2/1/2008	1.08	-7.21	8.28	0.13	4.42	1.97	0.24
2/2/2008	3.26	-3.87	7.13	0.46	14.24	1.85	0.23
2/3/2008	3.18	-6.24	9.42	0.34	11.63	2.21	0.27
2/4/2008	3.73	-5.70	9.42	0.40	13.59	2.21	0.27
2/5/2008	4.80	-7.07	11.87	0.40	11.20	3.46	0.43
2/7/2008	6.86	-2.40	9.26	0.74	7.32	7.57	0.94
2/8/2008	7.27	-5.09	12.35	0.59	11.47	5.11	0.63
2/9/2008	5.45	-4.69	10.14	0.54	10.76	4.09	0.51
2/10/2008	4.30	-1.91	6.21	0.69	15.44	2.25	0.28
2/11/2008	5.70	1.31	4.39	1.30	15.64	2.94	0.36
2/12/2008	4.76	-7.48	12.24	0.39	4.87	7.89	0.98
2/13/2008	6.25	-6.71	12.96	0.48	8.32	6.07	0.75
2/14/2008	5.45	-0.83	6.28	0.87	16.08	2.74	0.34
2/15/2008	5.45	-2.75	8.20	0.66	12.82	3.43	0.43
2/16/2008	4.93	-4.38	9.31	0.53	15.38	2.59	0.32
2/17/2008	6.53	-4.70	11.23	0.58	14.83	3.56	0.44
2/18/2008	7.06	-8.17	15.22	0.46	10.59	5.38	0.67
2/19/2008	6.49	-3.49	9.98	0.65	17.32	3.02	0.37
2/20/2008	7.32	1.45	5.86	1.25	11.29	5.23	0.65
2/21/2008	6.53	-4.81	11.33	0.58	6.59	8.00	0.99
2/22/2008	9.49	-4.61	14.10	0.67	11.65	6.58	0.81
2/23/2008	5.30	-7.82	13.12	0.40	8.07	5.30	0.66
2/24/2008	8.75	-2.87	11.62	0.75	12.66	5.58	0.69
2/25/2008	8.54	-3.35	11.89	0.72	17.98	3.84	0.48
2/26/2008	9.00	-2.06	11.06	0.81	12.46	5.83	0.72
2/27/2008	10.18	1.57	8.60	1.18	10.40	7.90	0.98
2/28/2008	7.47	5.43	2.04	3.66	18.86	3.20	0.40
2/29/2008	5.24	-0.33	5.57	0.94	16.06	2.63	0.33
3/1/2008	5.79	-4.19	9.98	0.58	17.28	2.70	0.33
3/2/2008	4.52	-2.88	7.40	0.61	18.02	2.03	0.25

METABOLISM WORKSHEET - DAILY DETAIL
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-570

Date	GPP ($g\ O_2/m^2/d$)	NPP ($g\ O_2/m^2/d$)	CR ($g\ O_2/m^2/d$)	P/R Ratio	PAR (24hr) ($mol/m^2/d$)	PAR Efficiency (%)	PAR Efficiency ($g\ O_2/mol$)
3/3/2008	7.03	-6.01	13.04	0.54	18.98	2.99	0.37
3/4/2008	7.14	-7.63	14.77	0.48	10.36	5.56	0.69
3/5/2008	8.18	-5.89	14.07	0.58	19.31	3.42	0.42
3/6/2008	5.65	-6.31	11.96	0.47	15.71	2.90	0.36
3/7/2008	4.63	-6.19	10.81	0.43	9.27	4.03	0.50
3/8/2008	15.03	4.75	10.28	1.46	20.69	5.87	0.73
3/9/2008	6.72	-0.58	7.30	0.92	21.77	2.49	0.31
3/10/2008	6.88	-2.23	9.11	0.75	17.29	3.21	0.40
3/11/2008	6.39	-7.27	13.66	0.47	10.88	4.74	0.59
3/12/2008	7.90	-5.81	13.71	0.58	13.03	4.89	0.61
3/13/2008	7.11	-5.75	12.86	0.55	20.73	2.77	0.34
3/14/2008	4.97	-7.83	12.80	0.39	6.17	6.50	0.81
3/15/2008	11.10	-2.56	13.66	0.81	18.61	4.81	0.60
3/16/2008	7.27	-6.74	14.01	0.52	21.75	2.70	0.33
3/17/2008	7.61	-4.33	11.94	0.64	20.53	2.99	0.37
3/19/2008	6.97	-4.65	11.62	0.60	20.49	2.75	0.34
3/20/2008	7.55	-2.73	10.28	0.73	17.73	3.44	0.43
3/21/2008	5.78	-0.91	6.69	0.86	19.12	2.44	0.30
3/22/2008	6.29	-3.62	9.92	0.63	7.98	6.36	0.79
3/23/2008	6.63	-6.51	13.14	0.50	13.30	4.02	0.50
3/24/2008	10.25	1.54	8.71	1.18	12.93	6.40	0.79
3/25/2008	6.31	1.01	5.30	1.19	16.86	3.02	0.37
3/26/2008	4.83	-2.25	7.08	0.68	10.92	3.57	0.44
3/27/2008	6.00	-1.90	7.90	0.76	14.16	3.42	0.42
3/28/2008	6.07	-4.91	10.98	0.55	14.74	3.32	0.41
3/29/2008	6.20	-6.73	12.93	0.48	11.63	4.30	0.53
3/30/2008	7.67	-5.60	13.26	0.58	9.04	6.85	0.85
3/31/2008	7.19	-6.20	13.39	0.54	7.73	7.51	0.93
4/2/2008	6.05	-2.01	8.06	0.75	9.26	5.27	0.65
4/3/2008	8.44	-7.77	16.21	0.52	9.54	7.14	0.88
4/4/2008	8.19	-9.70	17.89	0.46	10.51	6.29	0.78
4/5/2008	6.58	-10.61	17.19	0.38	7.13	7.45	0.92
4/6/2008	7.01	-11.96	18.97	0.37	4.79	11.82	1.46
4/7/2008	7.99	-11.45	19.44	0.41	7.70	8.38	1.04
4/8/2008	8.80	-8.52	17.32	0.51	6.29	11.30	1.40
4/9/2008	6.98	-11.02	18.00	0.39	11.10	5.08	0.63
4/10/2008	6.51	-9.98	16.50	0.39	12.43	4.23	0.52
4/11/2008	6.85	-8.62	15.47	0.44	14.75	3.75	0.46
4/12/2008	5.75	-11.25	17.00	0.34	13.10	3.54	0.44
4/13/2008	4.82	-11.71	16.53	0.29	5.47	7.11	0.88
4/14/2008	8.97	-2.67	11.64	0.77	12.51	5.79	0.72
4/15/2008	9.89	-3.91	13.80	0.72	12.88	6.20	0.77
4/16/2008	8.45	-4.08	12.53	0.67	17.27	3.95	0.49
4/17/2008	5.90	-5.02	10.92	0.54	17.59	2.71	0.34
4/18/2008	5.95	-7.68	13.64	0.44	17.91	2.68	0.33
4/19/2008	7.15	-9.95	17.10	0.42	15.05	3.84	0.48
4/20/2008	9.19	-9.08	18.27	0.50	18.39	4.04	0.50
4/21/2008	6.97	-10.52	17.49	0.40	18.69	3.01	0.37
4/22/2008	7.90	-7.48	15.38	0.51	20.34	3.14	0.39

METABOLISM WORKSHEET - DAILY DETAIL
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-570

Date	GPP ($g O_2/m^2/d$)	NPP ($g O_2/m^2/d$)	CR ($g O_2/m^2/d$)	P/R Ratio	PAR (24hr) ($mol/m^2/d$)	PAR Efficiency (%)	PAR Efficiency ($g O_2/mol$)
4/23/2008	9.76	-5.87	15.63	0.62	16.35	4.82	0.60
4/24/2008	7.53	-10.18	17.72	0.43	19.95	3.05	0.38
4/25/2008	8.10	-9.87	17.98	0.45	18.97	3.45	0.43
4/26/2008	9.18	-8.65	17.83	0.51	20.62	3.59	0.45
4/27/2008	9.11	-11.00	20.11	0.45	21.75	3.38	0.42
4/28/2008	9.67	-11.77	21.44	0.45	15.49	5.04	0.62
4/29/2008	9.63	-11.48	21.11	0.46	21.00	3.70	0.46
4/30/2008	9.38	-6.28	15.66	0.60	26.75	2.83	0.35
5/1/2008	9.32	-6.39	15.71	0.59	27.64	2.72	0.34
5/2/2008	9.47	-8.69	18.16	0.52	23.20	3.30	0.41
5/3/2008	10.07	-9.01	19.08	0.53	25.87	3.14	0.39
5/4/2008	11.60	-9.20	20.80	0.56	27.19	3.45	0.43
5/5/2008	10.90	-9.24	20.14	0.54	25.81	3.41	0.42
5/6/2008	13.14	-6.05	19.19	0.68	31.99	3.32	0.41
5/7/2008	9.94	-10.51	20.44	0.49	29.18	2.75	0.34
5/9/2008	15.75	5.31	10.44	1.51	27.58	4.61	0.57
5/10/2008	13.16	-0.23	13.39	0.98	26.82	3.96	0.49
5/11/2008	18.04	5.18	12.86	1.40	24.59	5.92	0.73
5/12/2008	13.10	1.64	11.46	1.14	31.18	3.39	0.42
5/13/2008	10.26	-1.29	11.55	0.89	31.00	2.67	0.33
5/14/2008	10.53	-1.33	11.87	0.89	31.51	2.70	0.33
5/15/2008	11.63	-1.33	12.96	0.90	28.71	3.27	0.41
5/16/2008	14.26	0.48	13.78	1.04	24.92	4.62	0.57
5/17/2008	12.67	-3.01	15.68	0.81	23.55	4.34	0.54
5/18/2008	13.72	-1.32	15.04	0.91	22.53	4.92	0.61
5/19/2008	12.54	-3.30	15.83	0.79	23.22	4.36	0.54
5/20/2008	15.98	-0.48	16.45	0.97	27.20	4.74	0.59
5/21/2008	14.04	-2.05	16.10	0.87	33.65	3.37	0.42
5/22/2008	6.24	-10.02	16.26	0.38	8.09	6.23	0.77
5/24/2008	12.89	-3.52	16.41	0.79	7.82	13.31	1.65
5/25/2008	11.76	-4.72	16.48	0.71	11.57	8.21	1.02
5/26/2008	11.66	-3.54	15.20	0.77	11.94	7.89	0.98
5/27/2008	11.70	-3.39	15.09	0.78	11.80	8.01	0.99
5/28/2008	10.42	-4.99	15.41	0.68	12.19	6.90	0.86
5/29/2008	11.57	-4.50	16.08	0.72	12.94	7.22	0.89
5/30/2008	12.37	-4.64	17.00	0.73	13.02	7.67	0.95
5/31/2008	10.58	-6.57	17.15	0.62	12.73	6.72	0.83
6/1/2008	9.75	-8.13	17.87	0.55	10.95	7.19	0.89
6/2/2008	9.58	-7.98	17.56	0.55	12.56	6.16	0.76
6/3/2008	12.67	-4.87	17.54	0.72	12.08	8.47	1.05
6/4/2008	13.29	-4.70	18.00	0.74	12.50	8.58	1.06
6/5/2008	9.92	-8.76	18.68	0.53	11.52	6.95	0.86
6/6/2008	10.21	-8.28	18.49	0.55	12.77	6.45	0.80
6/7/2008	10.68	-7.46	18.14	0.59	13.98	6.17	0.76
6/8/2008	10.93	-7.09	18.02	0.61	11.96	7.37	0.91
6/9/2008	9.06	-9.14	18.20	0.50	9.88	7.41	0.92
6/10/2008	7.17	-11.80	18.97	0.38	14.73	3.93	0.49
6/11/2008	12.41	-5.87	18.28	0.68	14.45	6.93	0.86
6/12/2008	9.26	-9.26	18.52	0.50	14.05	5.32	0.66

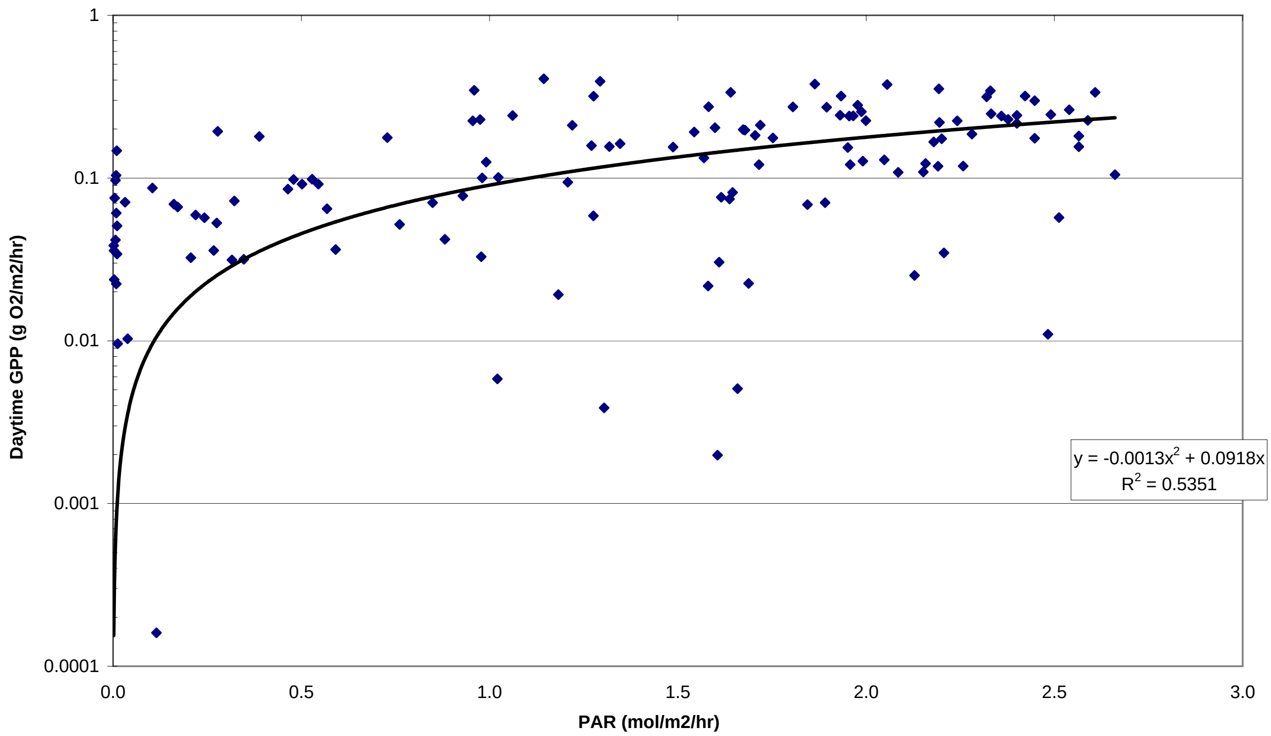
METABOLISM WORKSHEET - DAILY DETAIL
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-570

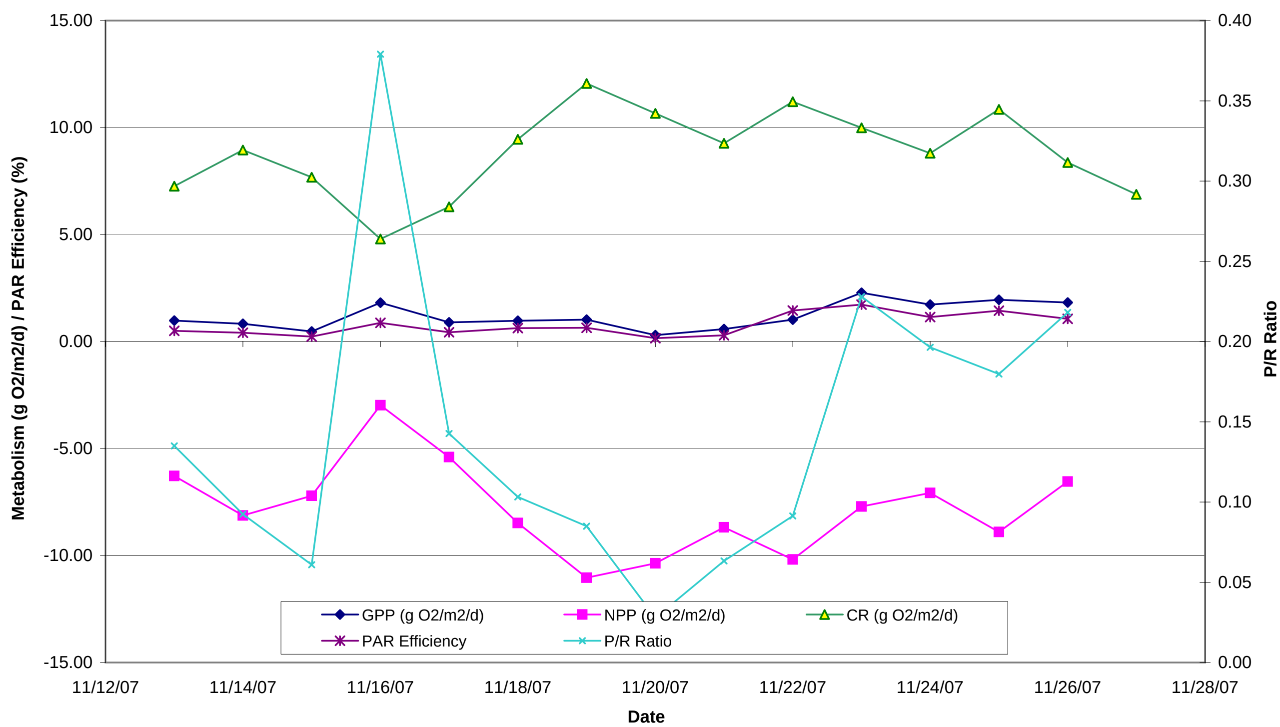
Date	GPP ($g O_2/m^2/d$)	NPP ($g O_2/m^2/d$)	CR ($g O_2/m^2/d$)	P/R Ratio	PAR (24hr) ($mol/m^2/d$)	PAR Efficiency (%)	PAR Efficiency ($g O_2/mol$)
6/13/2008	9.48	-8.95	18.43	0.51	17.19	4.45	0.55
6/14/2008	8.32	-9.55	17.87	0.47	18.90	3.55	0.44
6/15/2008	7.76	-10.63	18.39	0.42	12.74	4.91	0.61
6/16/2008	9.72	-8.80	18.53	0.52	16.57	4.74	0.59
6/17/2008	11.68	-7.76	19.44	0.60	21.09	4.47	0.55
6/18/2008	10.17	-10.50	20.67	0.49	16.39	5.01	0.62
6/19/2008	10.38	-9.10	19.48	0.53	18.28	4.59	0.57
6/21/2008	5.83	-13.26	19.09	0.31	8.70	5.41	0.67
6/22/2008	9.94	-8.74	18.68	0.53	14.27	5.62	0.70
6/23/2008	9.72	-10.41	20.13	0.48	19.04	4.12	0.51
6/25/2008	7.36	-4.45	11.81	0.62	11.48	5.18	0.64
6/26/2008	8.81	-4.11	12.92	0.68	11.26	6.32	0.78
6/27/2008	11.76	-1.72	13.48	0.87	16.19	5.86	0.73
6/28/2008	8.97	-4.88	13.85	0.65	17.58	4.12	0.51
6/29/2008	10.50	-3.85	14.35	0.73	19.38	4.37	0.54
6/30/2008	9.17	-6.10	15.27	0.60	17.94	4.13	0.51
7/1/2008	10.10	-4.57	14.67	0.69	14.49	5.63	0.70
7/2/2008	8.87	-5.72	14.60	0.61	16.67	4.30	0.53
7/3/2008	12.08	-2.96	15.04	0.80	17.38	5.61	0.70
7/4/2008	9.78	-5.52	15.31	0.64	21.65	3.65	0.45
7/5/2008	9.26	-6.64	15.90	0.58	24.36	3.07	0.38
7/6/2008	8.81	-7.95	16.77	0.53	21.22	3.35	0.42
7/7/2008	7.66	-8.58	16.24	0.47	16.79	3.68	0.46
7/9/2008	13.56	-1.17	14.72	0.92	19.70	5.56	0.69
7/10/2008	12.15	-5.45	17.60	0.69	25.95	3.78	0.47
7/11/2008	8.38	-10.37	18.75	0.45	21.42	3.16	0.39
7/12/2008	10.28	-8.40	18.68	0.55	11.60	7.16	0.89
7/13/2008	9.53	-9.65	19.17	0.50	23.39	3.29	0.41
7/14/2008	10.95	-4.16	15.10	0.72	22.87	3.86	0.48
7/15/2008	14.15	-3.92	18.07	0.78	12.57	9.09	1.13
7/16/2008	6.91	-10.45	17.36	0.40	13.16	4.24	0.53
7/17/2008	9.10	-5.33	14.43	0.63	14.01	5.24	0.65
7/18/2008	10.03	-5.65	15.68	0.64	18.89	4.29	0.53
7/19/2008	7.47	-10.09	17.57	0.43	22.70	2.66	0.33
7/20/2008	7.46	-9.77	17.23	0.43	26.65	2.26	0.28
7/21/2008	8.31	-7.28	15.58	0.53	27.07	2.48	0.31
7/22/2008	6.37	-9.10	15.48	0.41	22.53	2.28	0.28
7/23/2008	8.19	-9.42	17.62	0.47	17.92	3.69	0.46
7/24/2008	6.77	-11.32	18.09	0.37	22.47	2.43	0.30
7/25/2008	6.58	-11.94	18.52	0.36	22.83	2.33	0.29
7/26/2008	6.20	-14.16	20.36	0.30	21.20	2.36	0.29
7/27/2008	10.37	-8.02	18.39	0.56	21.78	3.84	0.48
7/28/2008	2.60	-18.70	21.30	0.12	17.89	1.17	0.15
7/29/2008	2.88	-19.08	21.96	0.13	13.53	1.72	0.21
7/30/2008	1.96	-19.76	21.72	0.09	16.12	0.98	0.12
7/31/2008	4.08	-17.97	22.05	0.19	17.49	1.88	0.23
8/1/2008	4.23	-18.05	22.28	0.19	17.84	1.91	0.24
8/2/2008	5.19	-16.44	21.63	0.24	17.13	2.45	0.30
8/3/2008	4.45	-16.84	21.29	0.21	28.08	1.28	0.16

METABOLISM WORKSHEET - DAILY DETAIL
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-570

Date	GPP (g O_2/m^2/d)	NPP (g O_2/m^2/d)	CR (g O_2/m^2/d)	P/R Ratio	PAR (24hr) (mol/m^2/d)	PAR Efficiency (%)	PAR Efficiency (g O_2/mol)
8/4/2008	5.47	-16.41	21.88	0.25	22.92	1.93	0.24
8/15/2008	8.23	-3.00	11.22	0.73	9.09	7.30	0.90
8/16/2008	7.13	-5.29	12.42	0.57	11.57	4.97	0.62
8/17/2008	0.88	-10.31	11.19	0.08	15.19	0.47	0.06
8/28/2008	0.44	-1.63	2.07	0.21	12.85	0.28	0.03

Average	6.77	-6.06	12.82	0.56	15.12	3.87	0.48
Median	6.86	-5.96	12.96	0.51	13.93	3.45	0.43
Maximum	18.04	6.46	22.28	7.48	33.65	13.31	1.65
Minimum	0.16	-19.76	-2.39	-2.40	3.50	0.09	0.01
Std Dev	3.70	4.32	5.08	0.61	5.97	2.22	0.27
N	250	250	250	250	250	250	250

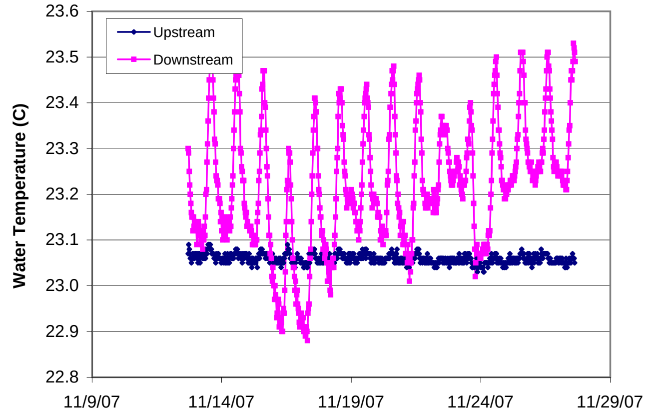


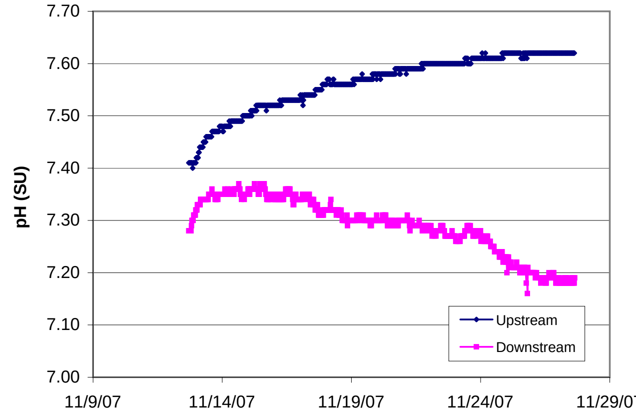


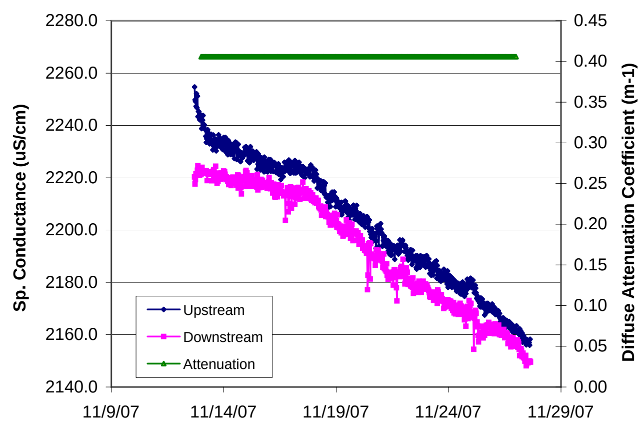
Stats	GPP	NPP	CR	P/R ratio	PAR Eff. (%)
	$(g\ O_2/m^2/d)$				
Avg	1.19	-7.78	8.83	0.14	0.79
Max	2.28	-2.98	12.06	0.38	1.72
Min	0.30	-11.04	4.80	0.03	0.16

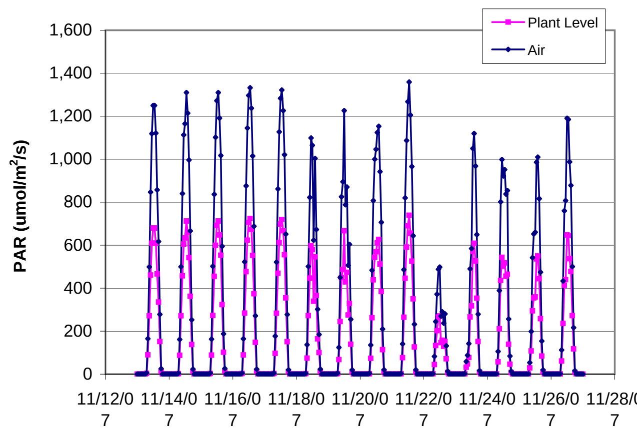
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-570 METABOLISM ESTIMATES

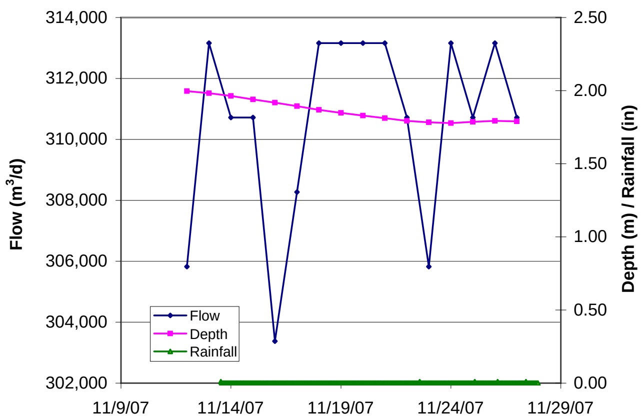
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-570 METABOLISM SUMMARY



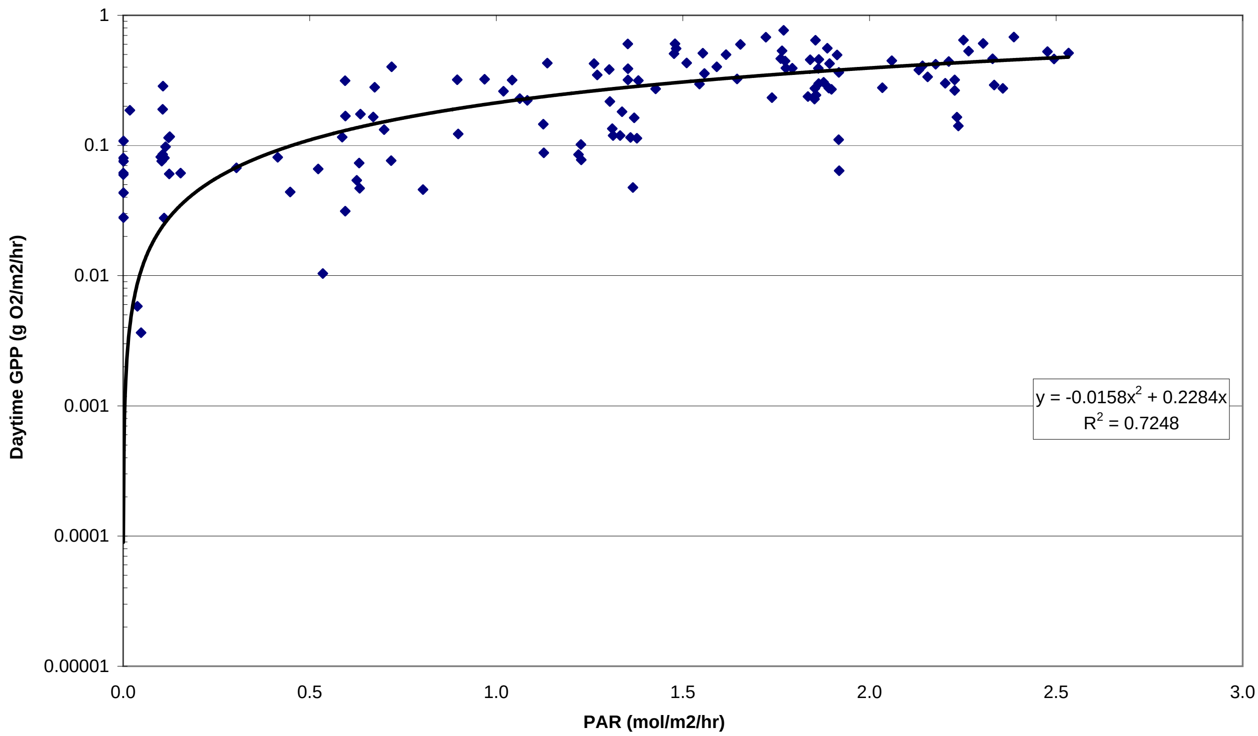


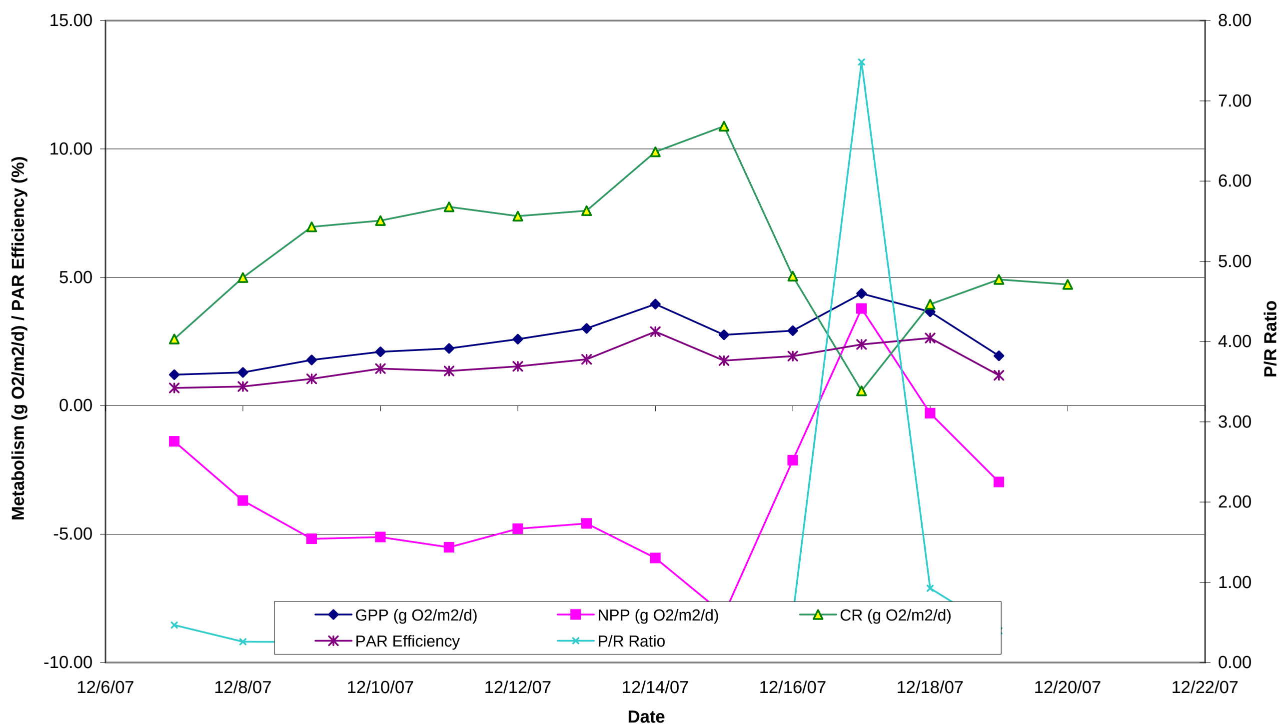






Parameter	Units	Avg	Min	Max	N
DO - up	mg/L	0.02	0.02	0.02	718
down		0.46	0.12	1.03	718
Wtr Temp - up	C	23.1	23.0	23.1	717
down		23.2	22.9	23.5	718
pH - up	SU	7.56	7.40	7.62	717
down		7.29	7.16	7.37	718
SpCond - up	uS/cm	2202	2156	2255	717
down		2193	2148	2225	718
Flow - up	m^3/d	310,562	303,375	313,162	16
Depth	m	1.86	1.78	2.00	16
Rainfall Total	in		0.05		
PAR - air	$umol/m^2/s$	290	0.0	1,359	337
plant		158	0.0	739	337
DO rate chng	$g/m^2/hr$				
corr		-0.324	-0.644	0.074	337
uncorr		0.401	0.109	0.774	337

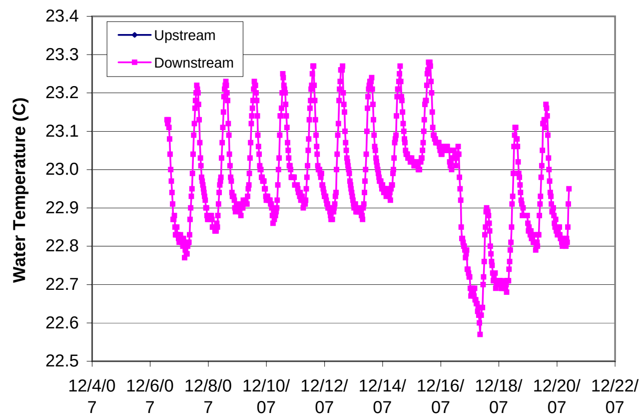


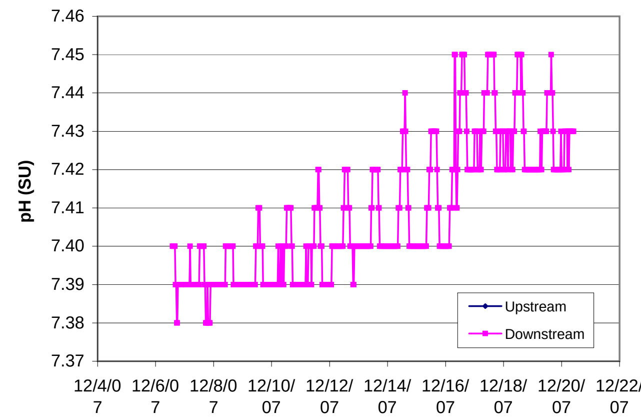


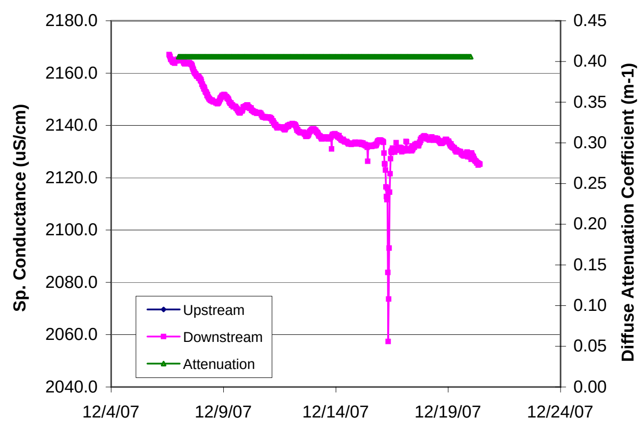
Stats	GPP	NPP	CR	P/R ratio	PAR Eff. (%)
	$(g\ O_2/m^2/d)$				
Avg	2.60	-3.53	6.04	0.95	1.65
Max	4.37	3.79	10.88	7.48	2.89
Min	1.21	-8.13	0.58	0.25	0.69

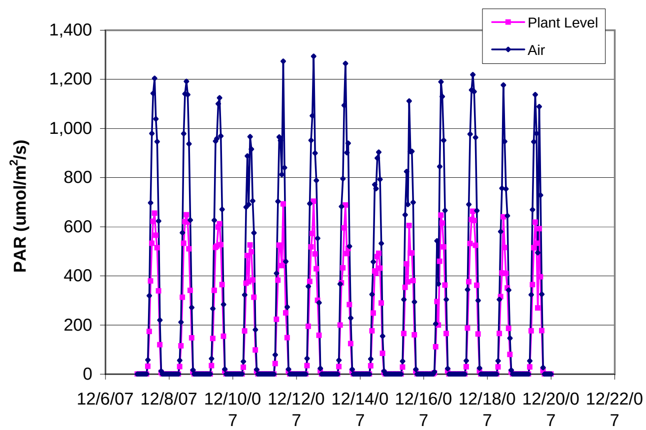
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-570 METABOLISM ESTIMATES

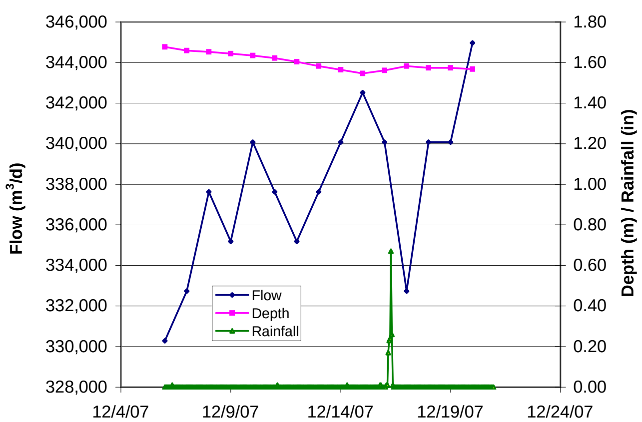
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-570 METABOLISM SUMMARY



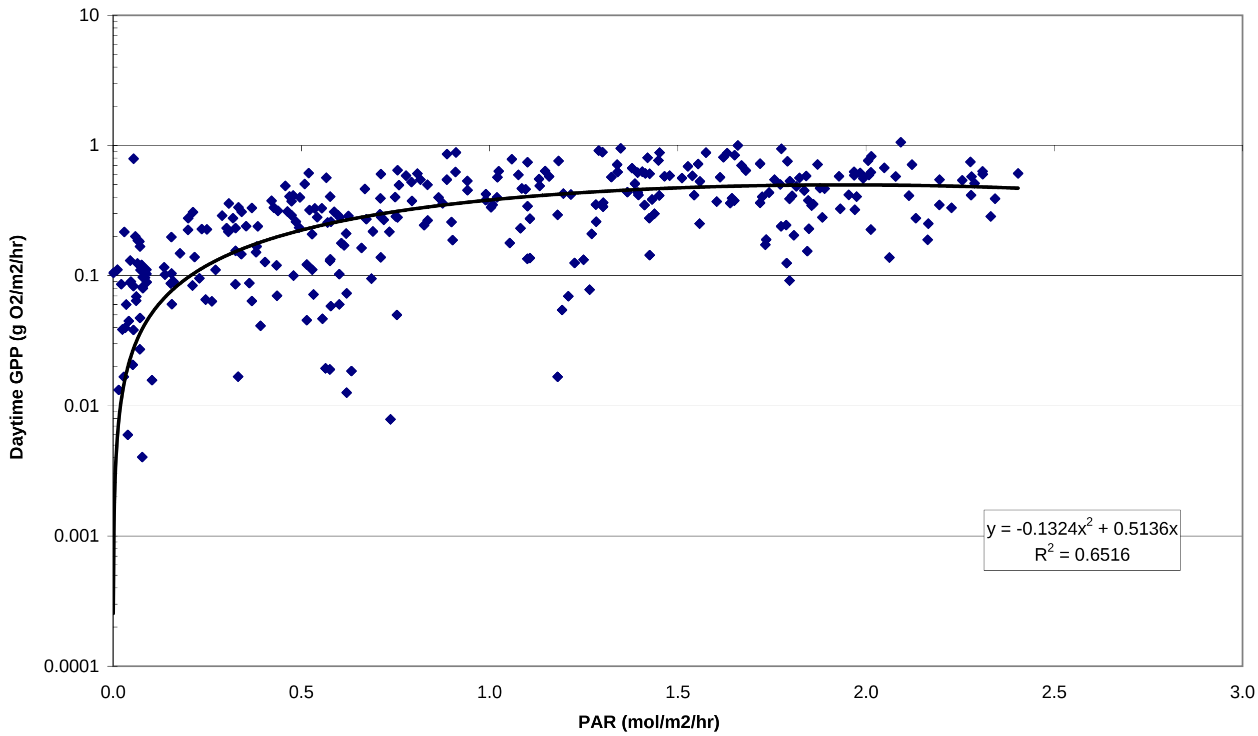


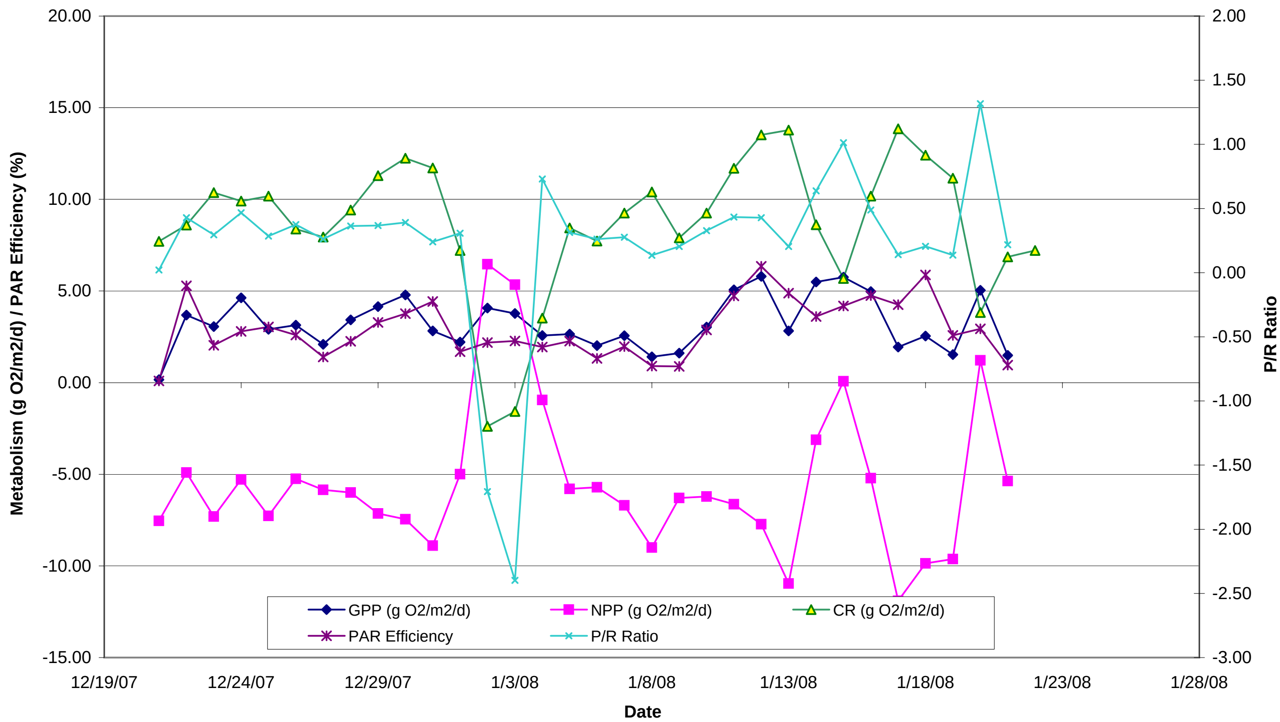






Parameter	Units	Avg	Min	Max	N
DO - up	mg/L	0.02	0.02	0.02	665
down		0.78	0.49	1.39	665
Wtr Temp - up	C				
down		23.0	22.6	23.3	665
pH - up	SU				
down		7.41	7.38	7.45	665
SpCond - up	uS/cm				
down		2140	2057	2167	665
Flow - up	m^3/d	337,791	330,288	344,967	15
Depth	m	1.60	1.55	1.68	15
Rainfall Total	in		1.65		
PAR - air	$umol/m^2/s$	276	0.0	1,294	360
plant		150	0.0	704	313
DO rate chng	$g/m^2/hr$				
corr		-0.149	-0.500	0.517	313
uncorr		0.809	0.515	1.450	313

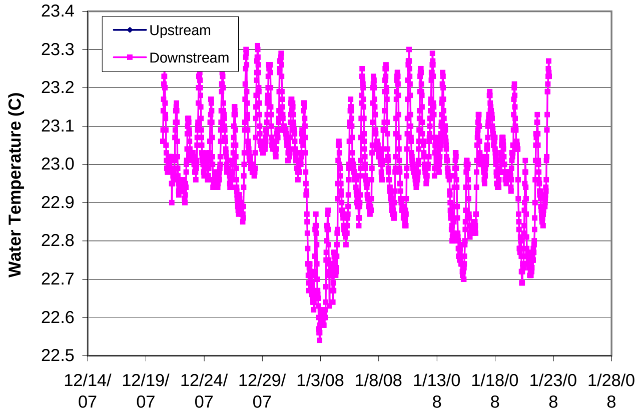


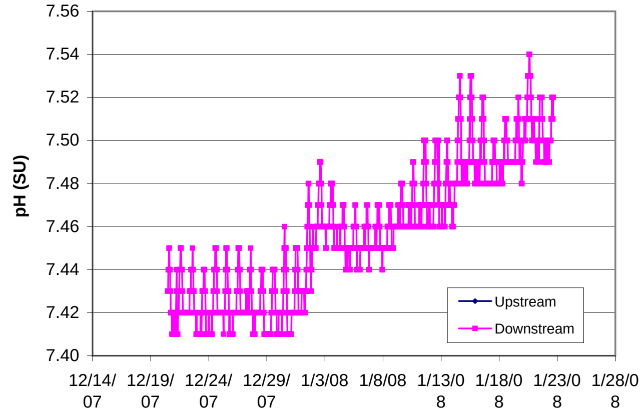


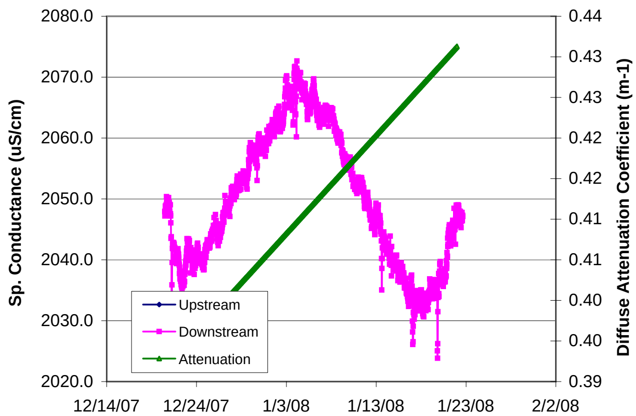
Stats	GPP	NPP	CR	P/R ratio	PAR Eff. (%)
	($g\ O_2/m^2/d$)				
Avg	3.22	-5.50	8.68	0.22	2.95
Max	5.80	6.46	13.85	1.32	6.35
Min	0.16	-11.91	-2.39	-2.40	0.09

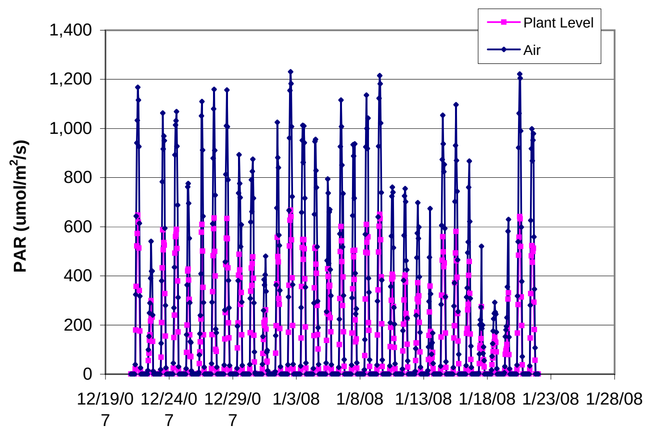
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-570 METABOLISM ESTIMATES

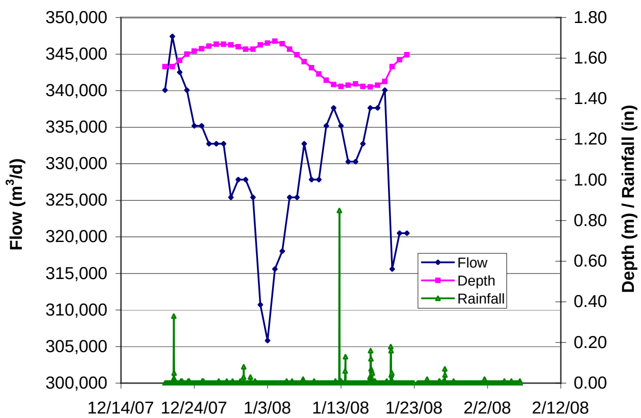
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-570 METABOLISM SUMMARY



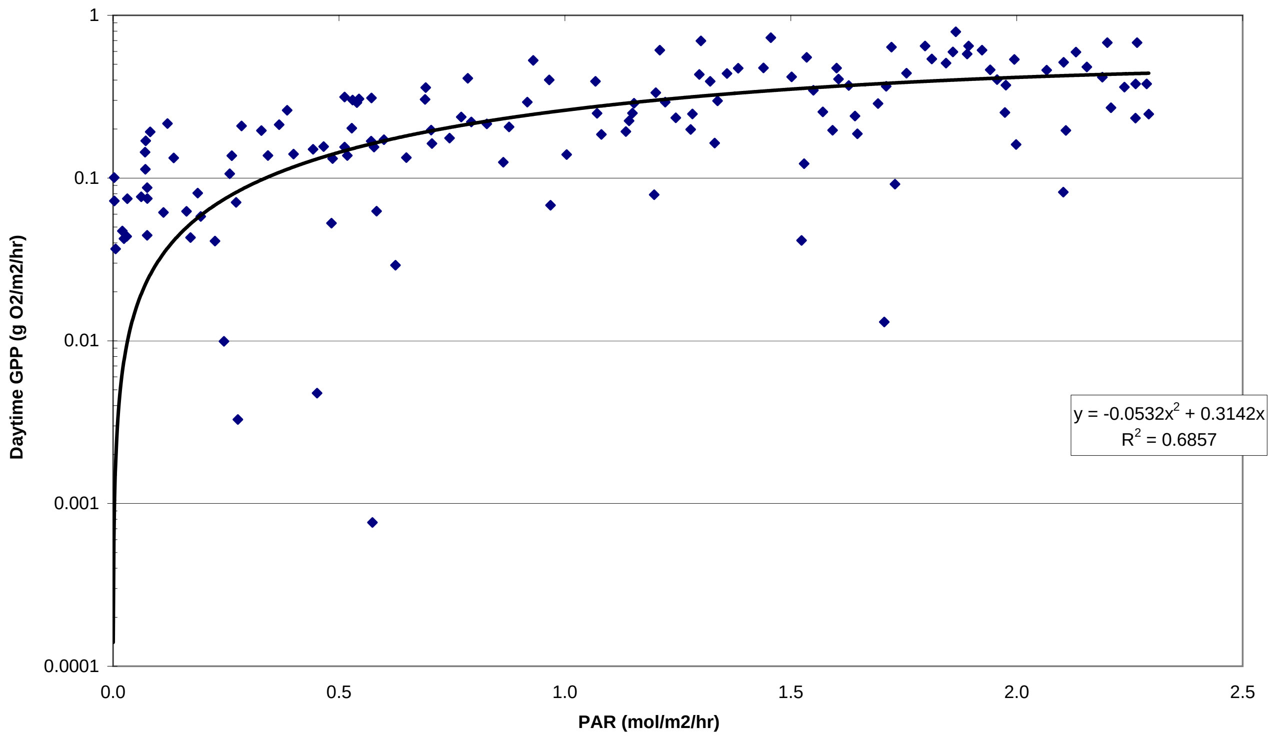


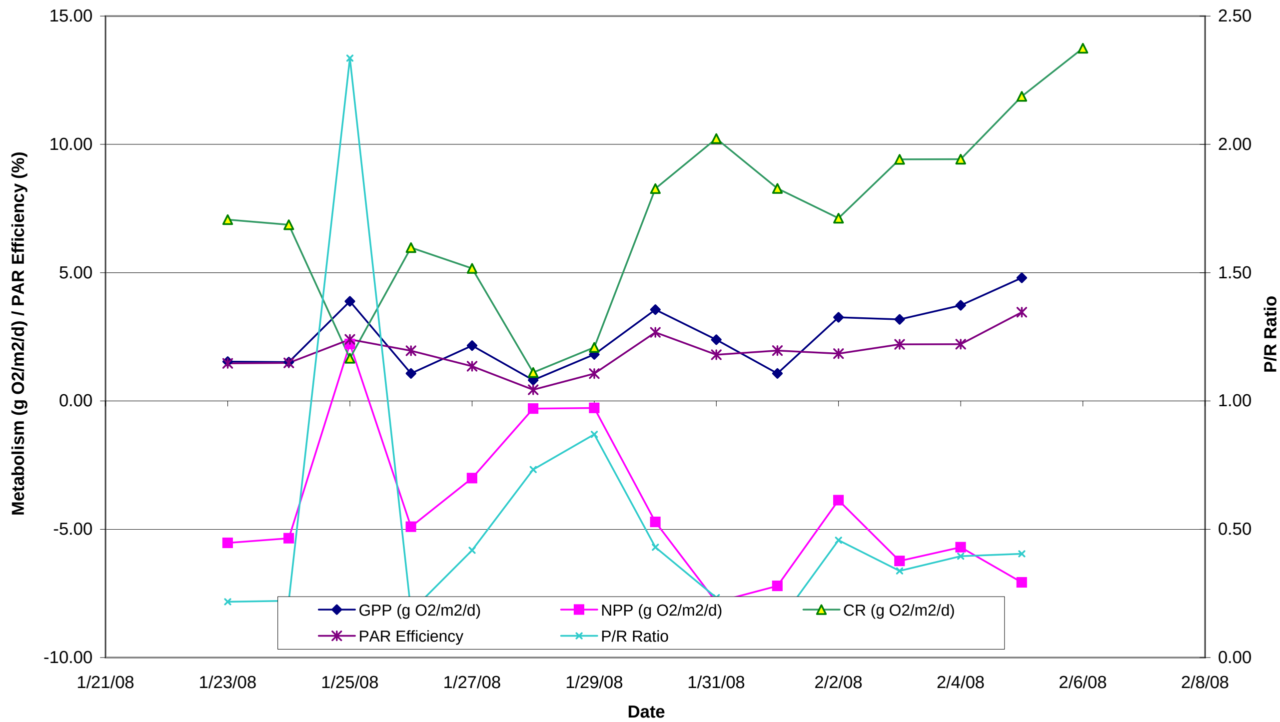






Parameter	Units	Avg	Min	Max	N
DO - up	mg/L	0.01	0.01	0.01	1594
down		0.71	0.29	1.68	1594
Wtr Temp - up	C				
down		23.0	22.5	23.3	1594
pH - up	SU				
down		7.46	7.41	7.54	1594
SpCond - up	uS/cm				
down		2050	2024	2073	1594
Flow - up	m^3/d	329,640	305,822	347,414	34
Depth	m	1.58	1.46	1.68	34
Rainfall Total	in		3.08		
PAR - air	umol/m^2/s	231	0.0	1,453	1153
plant		116	0.0	668	769
DO rate chng	g/m^2/hr				
corr		-0.229	-0.702	0.705	769
uncorr		0.725	0.322	1.718	769

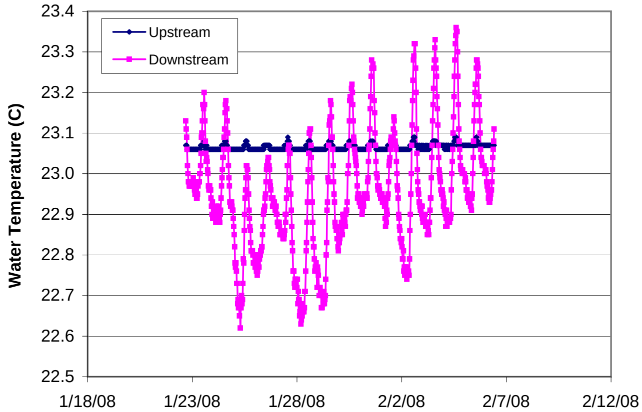


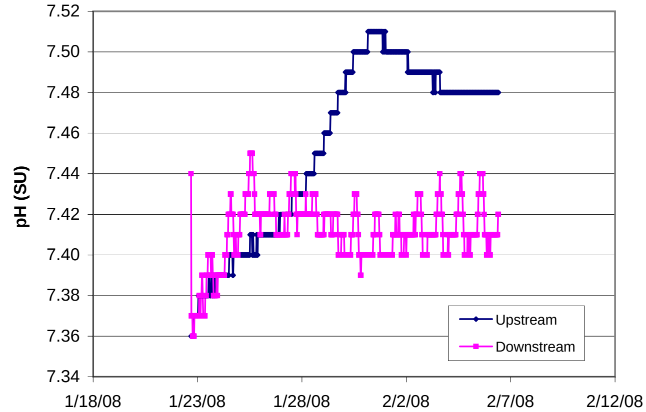


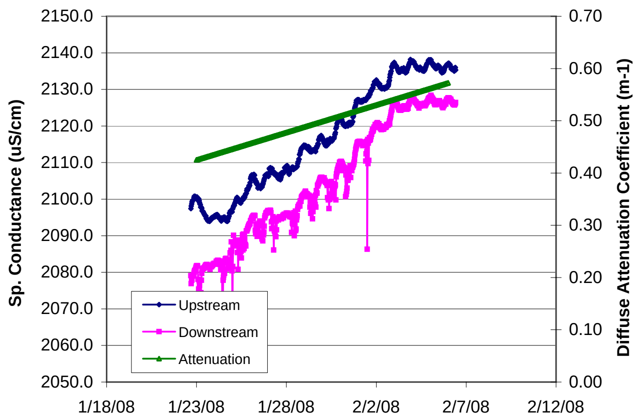
Stats	GPP	NPP	CR	P/R	PAR Eff.
	(g O_2/m^2/d)			ratio	(%)
Avg	2.48	-4.27	7.22	0.53	1.88
Max	4.80	2.22	13.75	2.34	3.46
Min	0.81	-7.84	1.11	0.13	0.44

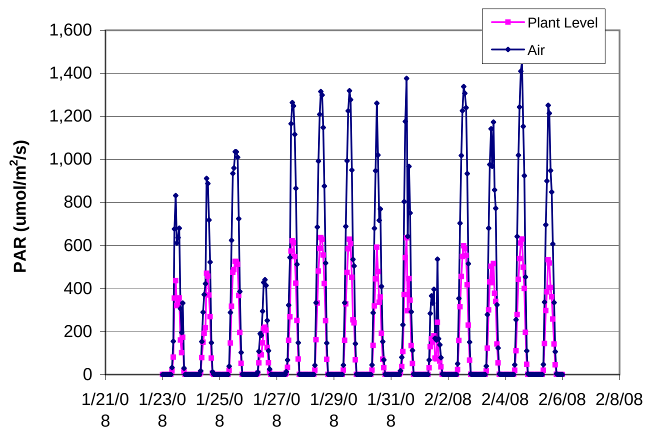
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-570 METABOLISM ESTIMATES

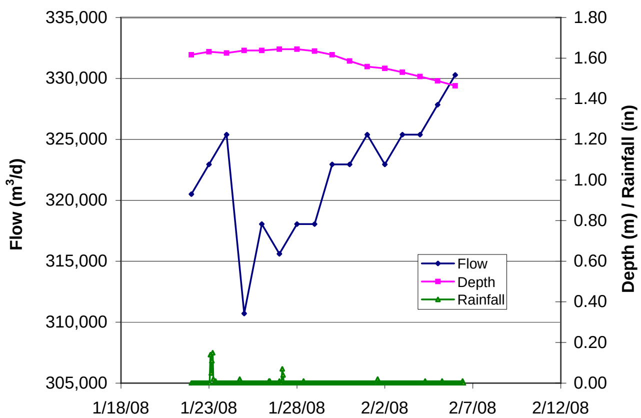
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-570 METABOLISM SUMMARY



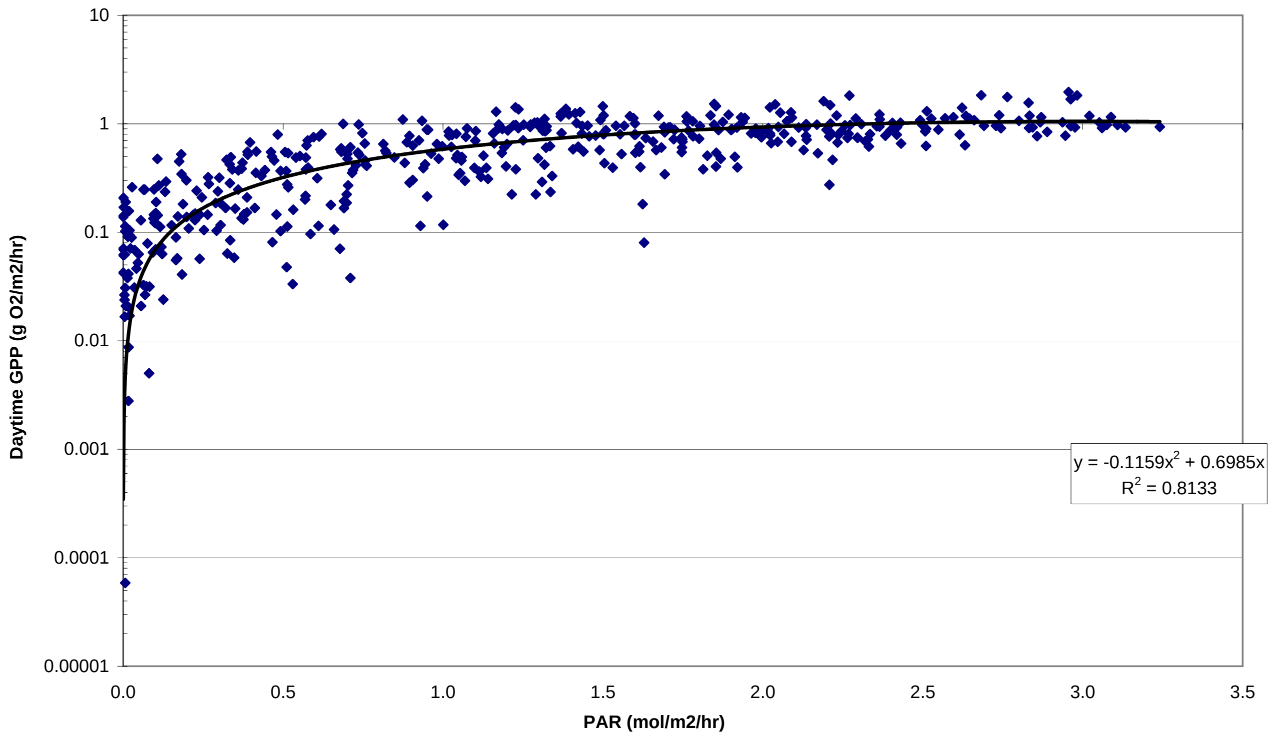


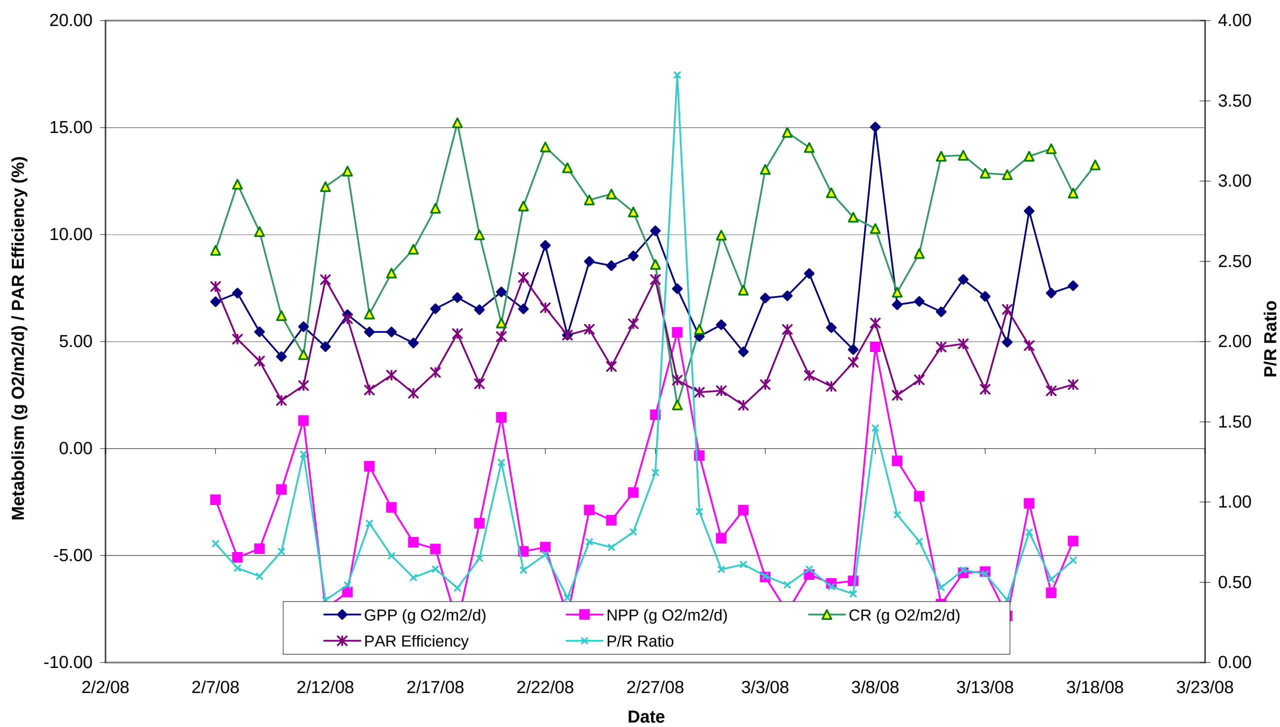






Parameter	Units	Avg	Min	Max	N
DO - up	mg/L	0.02	0.00	0.22	708
down		0.75	0.43	1.94	708
Wtr Temp - up	C	23.1	23.1	23.1	708
down		23.0	22.6	23.4	708
pH - up	SU	7.45	7.36	7.51	708
down		7.41	7.36	7.45	708
SpCond - up	uS/cm	2117	2094	2138	708
down		2105	2062	2128	708
Flow - up	m^3/d	322,031	310,715	330,288	16
Depth	m	1.59	1.46	1.64	16
Rainfall Total	in		0.71		
PAR - air	$umol/m^2/s$	259	0.0	1,453	371
plant		126	0.0	637	337
DO rate chng	$g/m^2/hr$				
corr		-0.185	-0.594	0.398	337
uncorr		0.740	0.449	1.238	337

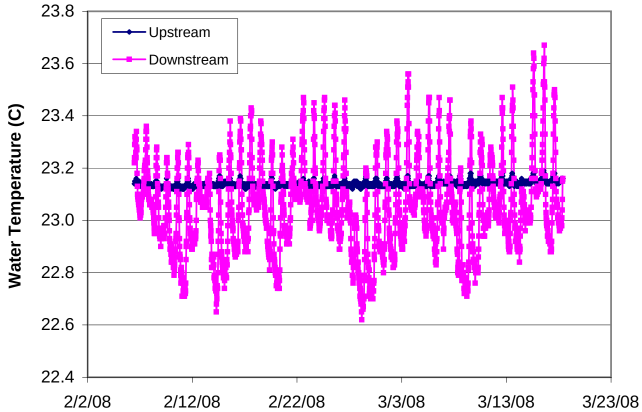


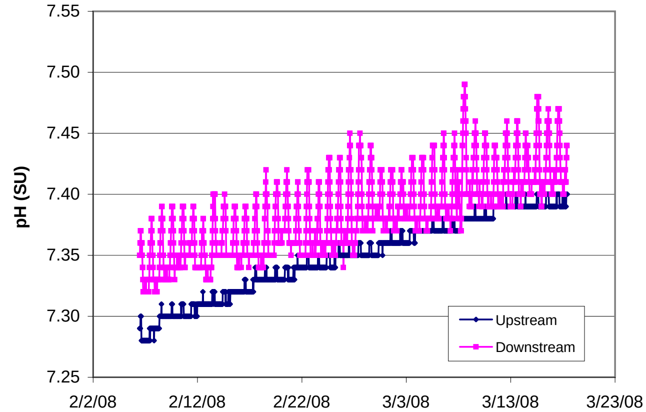


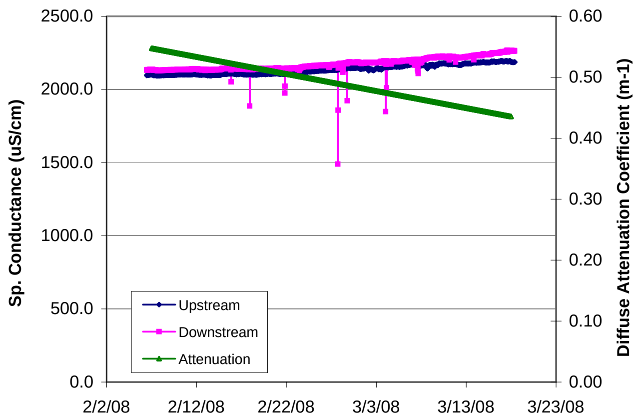
Stats	GPP	NPP	CR	P/R ratio	PAR Eff. (%)
	(g $O_2/m^2/d$)				
Avg	6.96	-3.65	10.67	0.76	4.38
Max	15.03	5.43	15.22	3.66	8.00
Min	4.30	-8.17	2.04	0.39	2.03

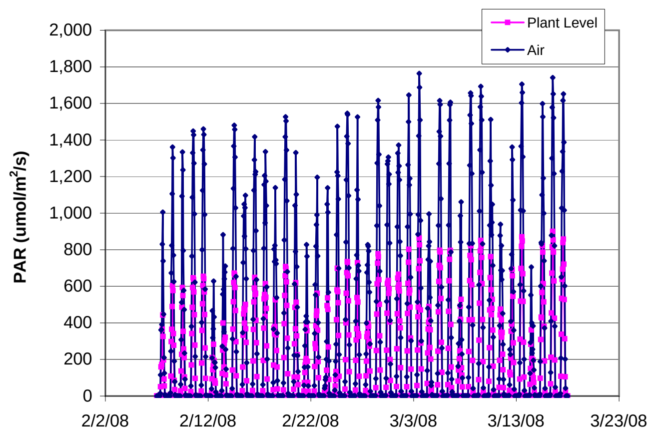
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-570 METABOLISM ESTIMATES

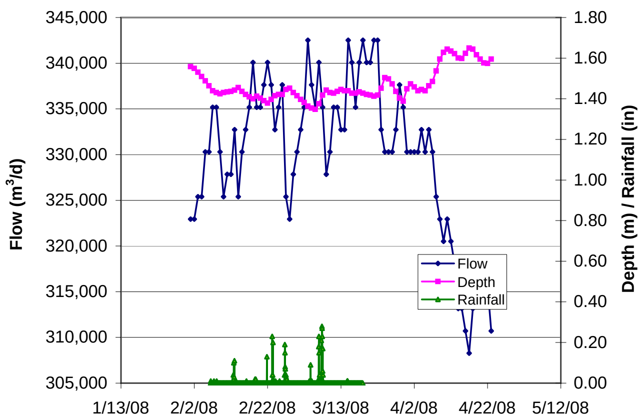
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-570 METABOLISM SUMMARY



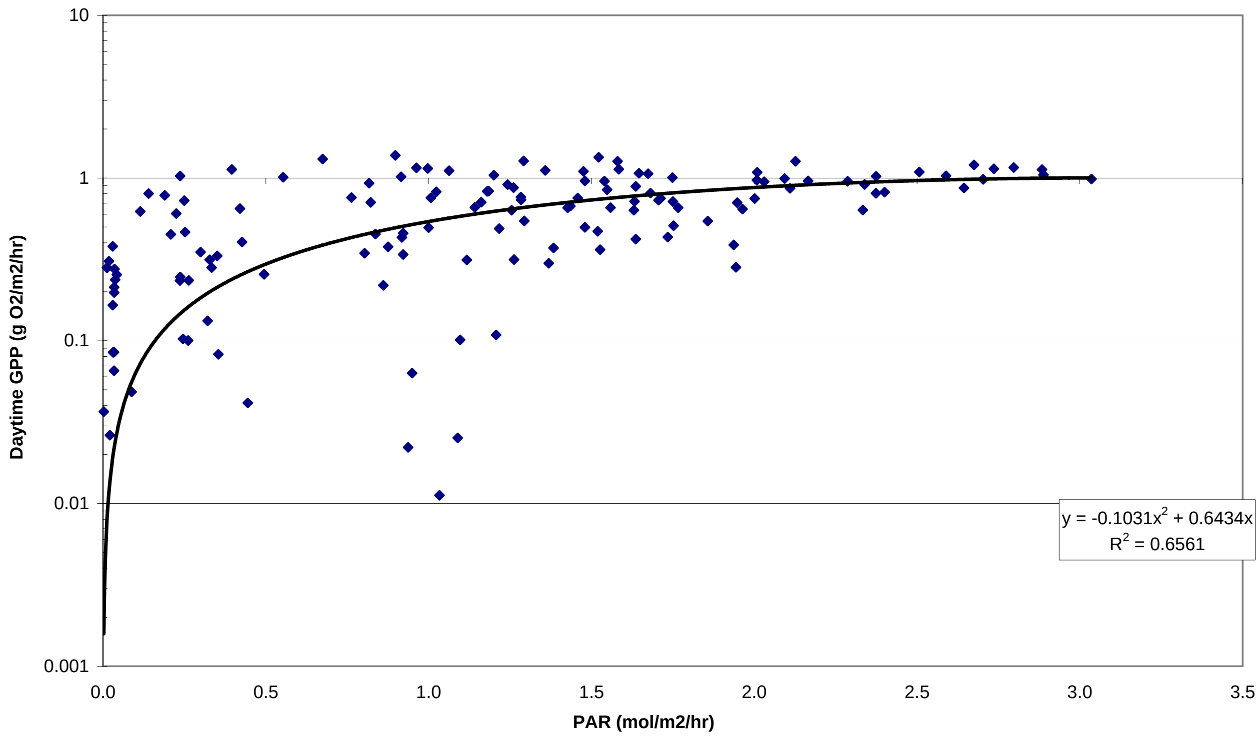


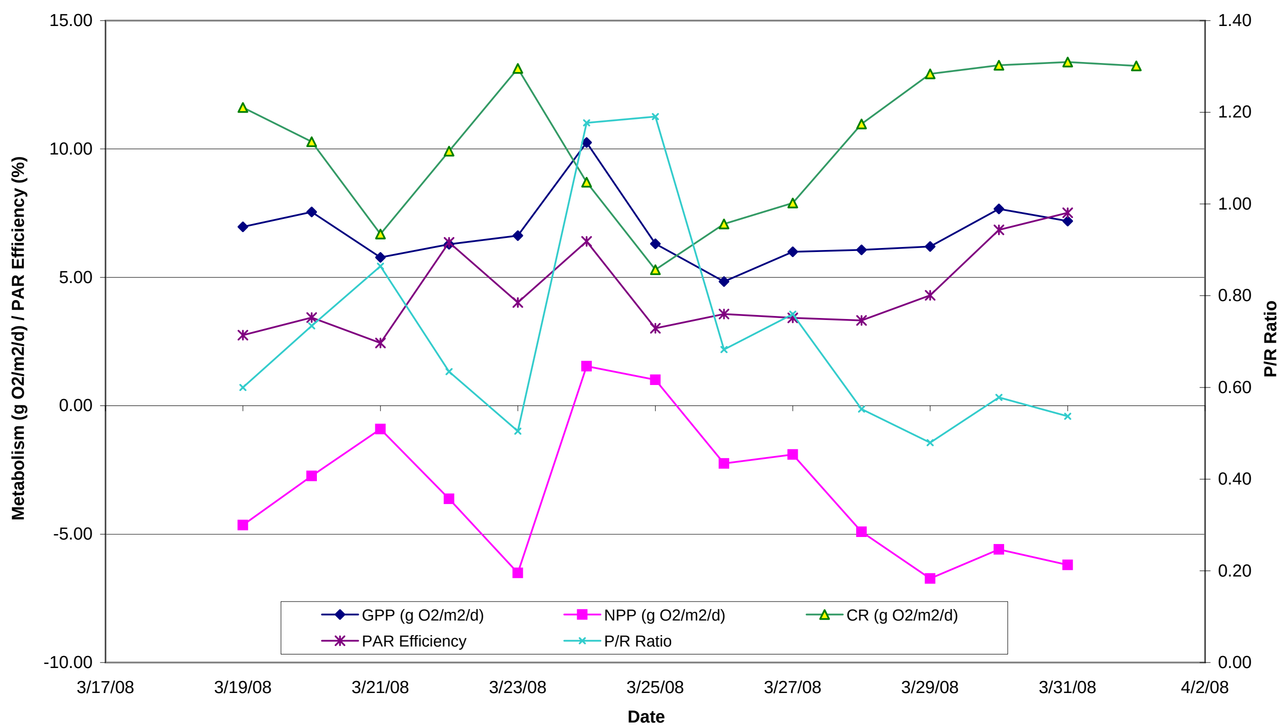






Parameter	Units	Avg	Min	Max	N
DO - up	mg/L	0.07	-0.01	0.14	1967
down		0.97	0.38	2.62	1966
Wtr Temp - up	C	23.1	23.1	23.2	1967
down		23.0	22.6	23.7	1966
pH - up	SU	7.35	7.28	7.40	1967
down		7.38	7.32	7.49	1966
SpCond - up	uS/cm	2135	2093	2196	1967
down		2174	1489	2268	1966
Flow - up	m^3/d	330,022	308,269	342,521	83
Depth	m	1.47	1.35	1.65	83
Rainfall Total	in		3.95		
PAR - air	$umol/m^2/s$	339	0.0	1,764	1000
plant		164	0.0	900	961
DO rate chng	$g/m^2/hr$				
corr		-0.154	-0.711	1.658	961
uncorr		0.985	0.418	2.671	961

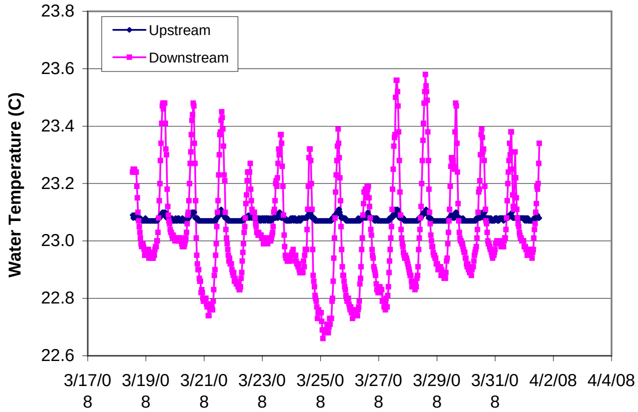


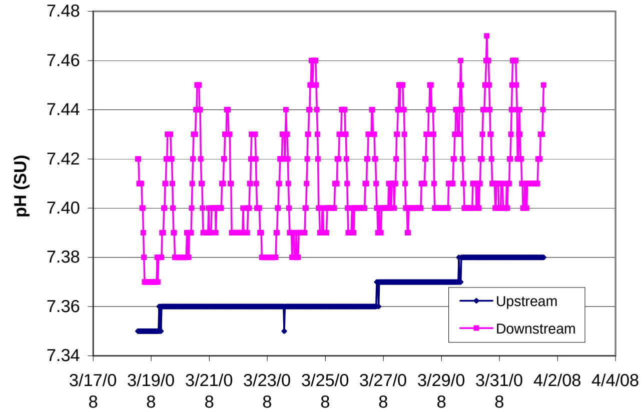


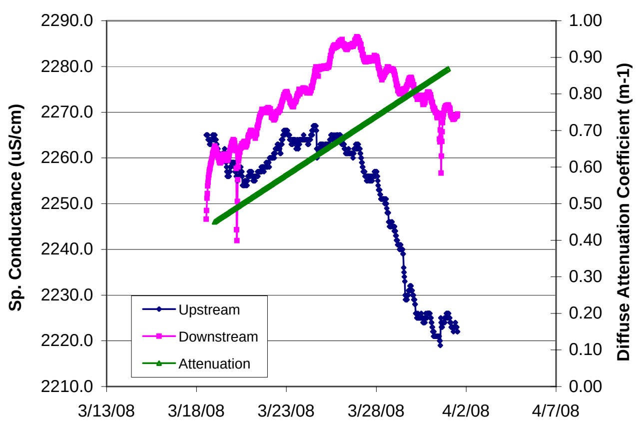
Stats	GPP	NPP	CR	P/R ratio	PAR Eff. (%)
	($g\ O_2/m^2/d$)				
Avg	6.75	-3.34	10.32	0.71	4.42
Max	10.25	1.54	13.39	1.19	7.51
Min	4.83	-6.73	5.30	0.48	2.44

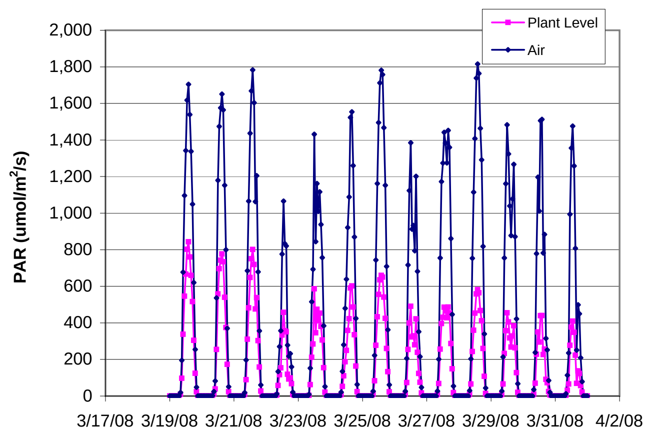
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-570 METABOLISM ESTIMATES

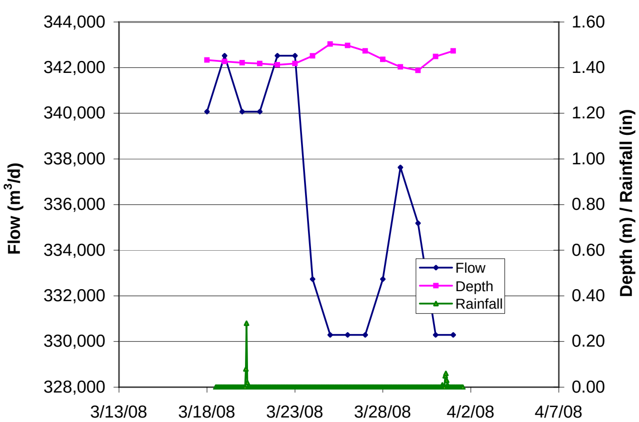
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-570 METABOLISM SUMMARY



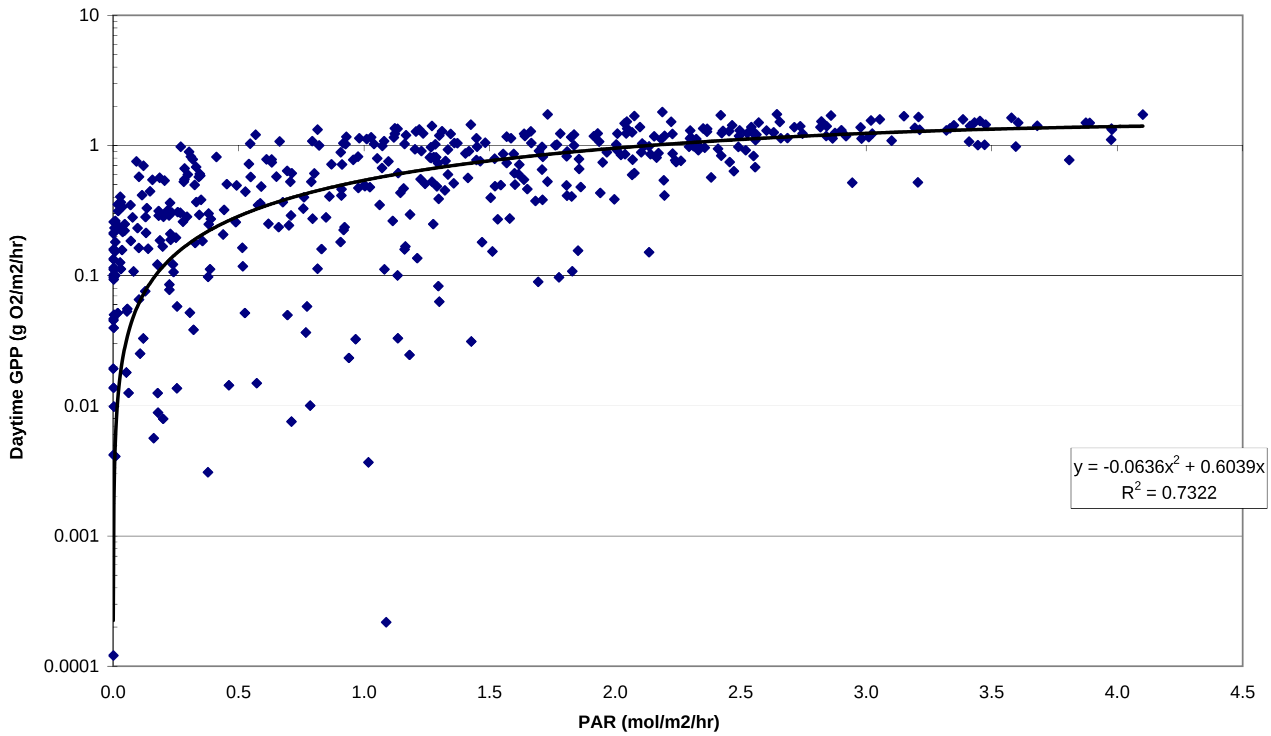


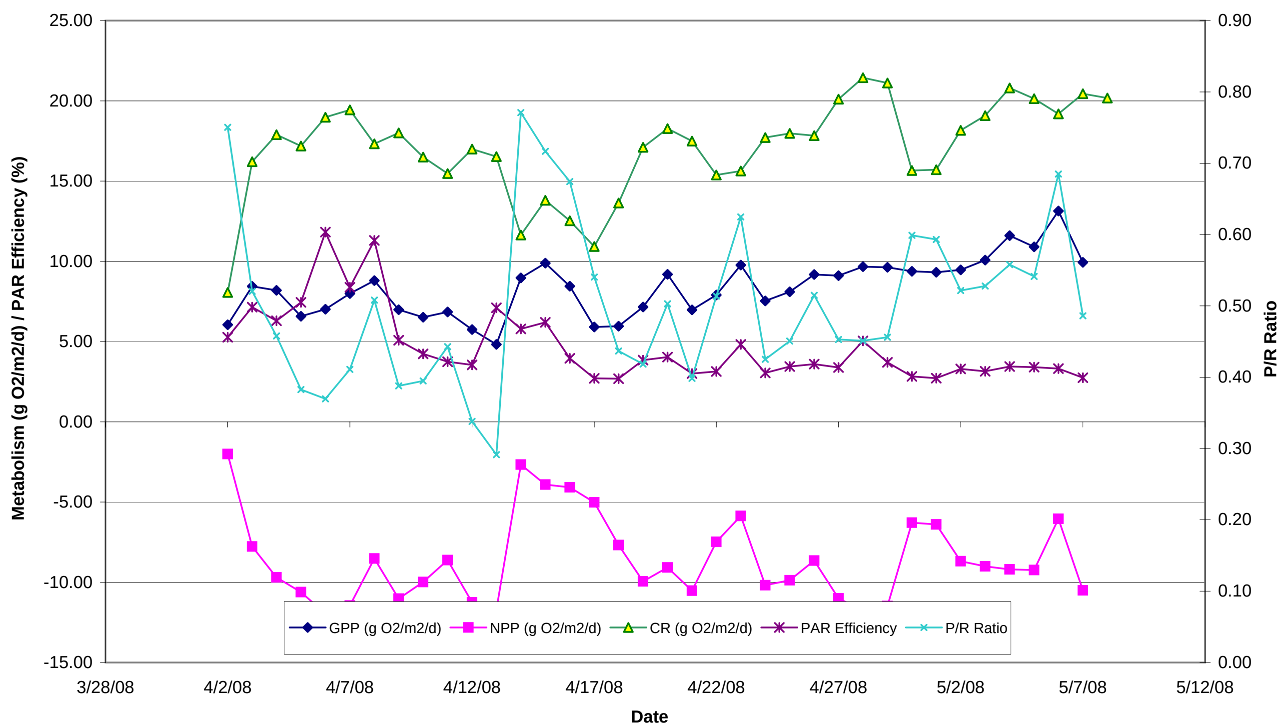






Parameter	Units	Avg	Min	Max	N
DO - up	mg/L	0.01	-0.02	0.14	662
down		0.88	0.43	2.05	672
Wtr Temp - up	C	23.1	23.1	23.1	672
down		23.0	22.7	23.6	672
pH - up	SU	7.37	7.35	7.38	672
down		7.41	7.37	7.47	672
SpCond - up	uS/cm	2252	2219	2267	672
down		2273	2242	2287	672
Flow - up	m^3/d	335,833	330,288	342,521	15
Depth	m	1.44	1.39	1.50	15
Rainfall Total	in		0.54		
PAR - air	$umol/m^2/s$	412	0.0	1,815	343
plant		157	0.0	843	313
DO rate chng	$g/m^2/hr$				
corr		-0.142	-0.650	1.121	313
uncorr		0.959	0.472	2.088	313

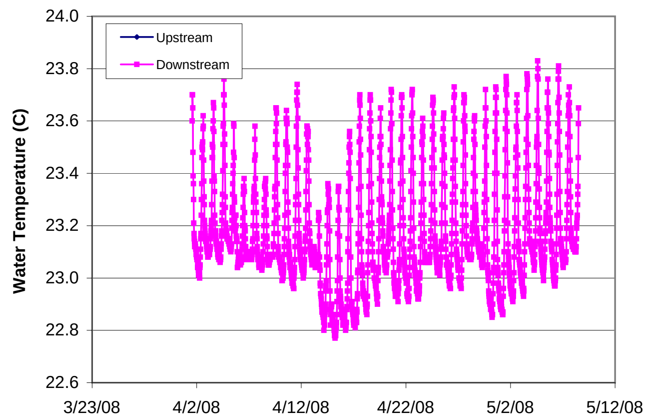


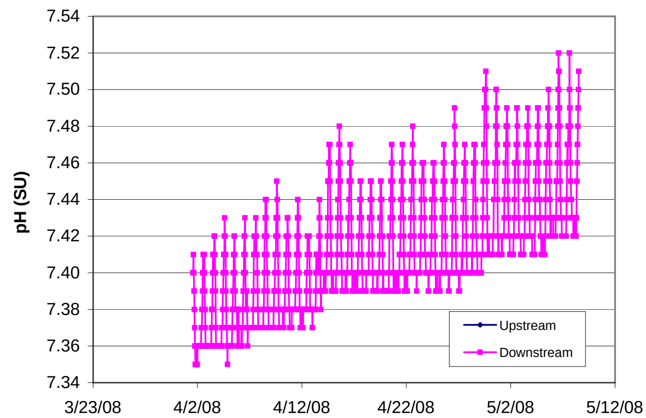


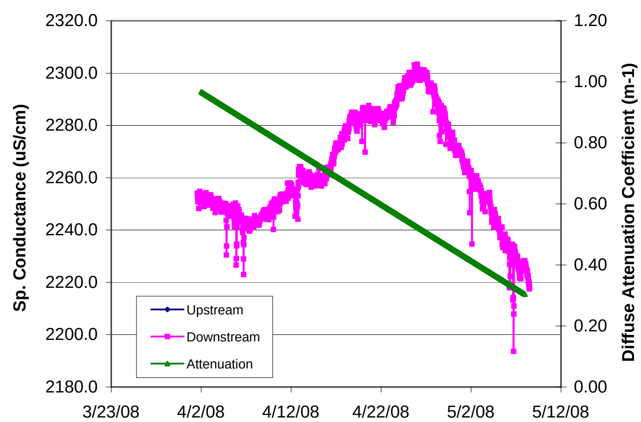
Stats	GPP	NPP	CR	P/R	PAR Eff.
	(g $O_2/m^2/d$)			ratio	(%)
Avg	8.37	-8.59	17.04	0.50	4.68
Max	13.14	-2.01	21.44	0.77	11.82
Min	4.82	-11.96	8.06	0.29	2.68

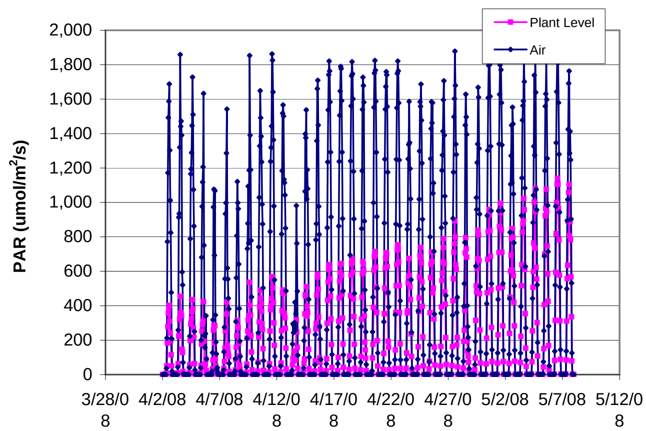
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-570 METABOLISM ESTIMATES

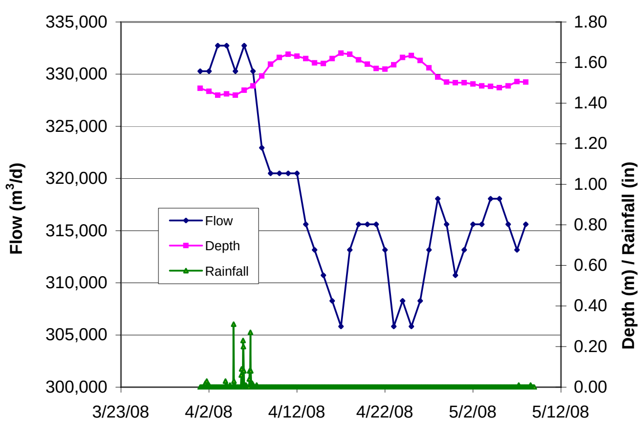
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-570 METABOLISM SUMMARY



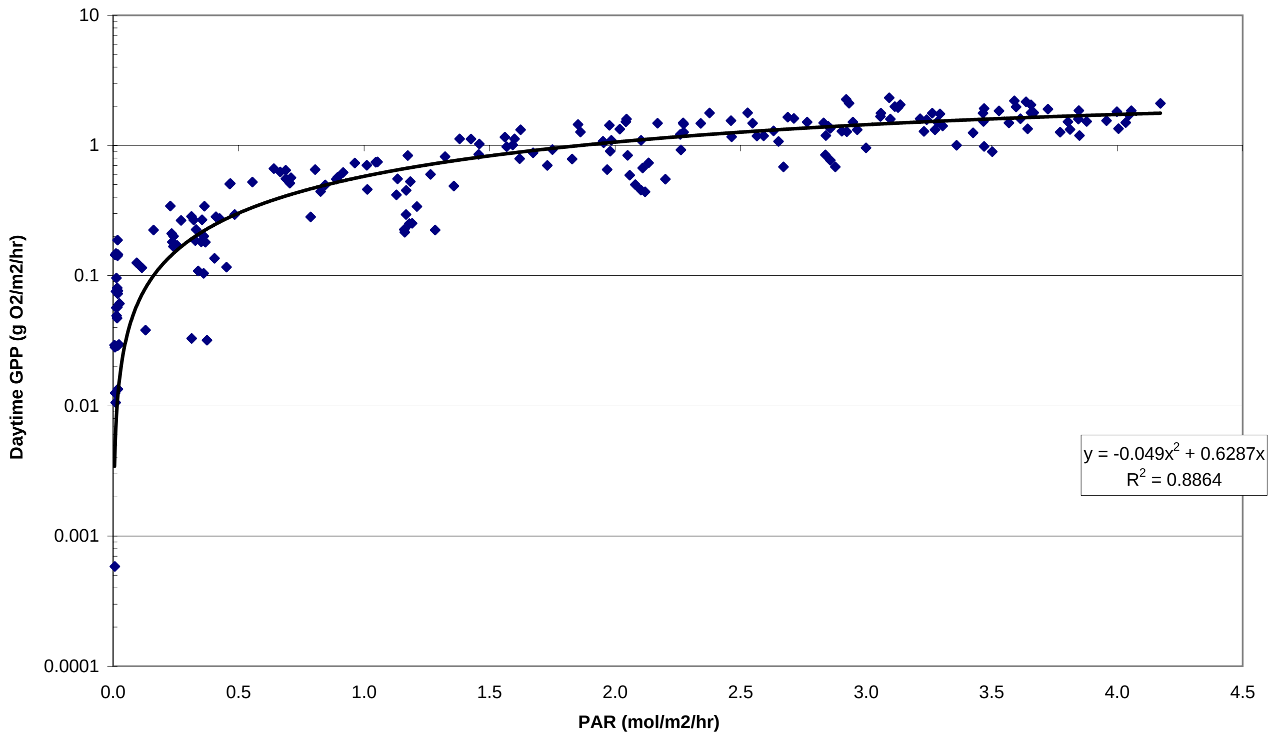


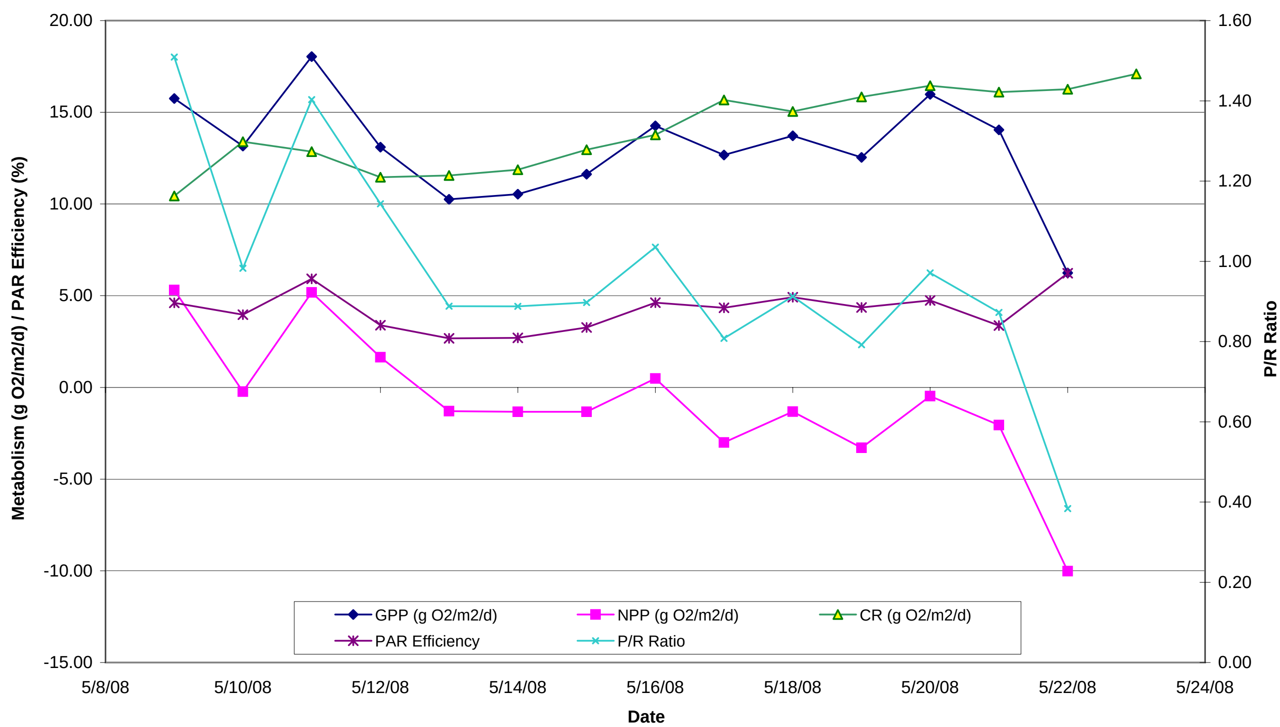






Parameter	Units	Avg	Min	Max	N
DO - up	mg/L	0.01	0.01	0.01	1775
down		0.59	0.00	2.32	1775
Wtr Temp - up	C				
down		23.2	22.8	23.8	1775
pH - up	SU				
down		7.41	7.35	7.52	1775
SpCond - up	uS/cm				
down		2263	2194	2303	1775
Flow - up	m^3/d	317,411	305,822	332,734	38
Depth	m	1.55	1.44	1.65	38
Rainfall Total	in		1.80		
PAR - air	$umol/m^2/s$	473	0.0	1,878	889
plant		197	0.0	1140	865
DO rate chng	$g/m^2/hr$				
corr		-0.363	-1.025	1.056	865
uncorr		0.589	-0.006	1.958	865

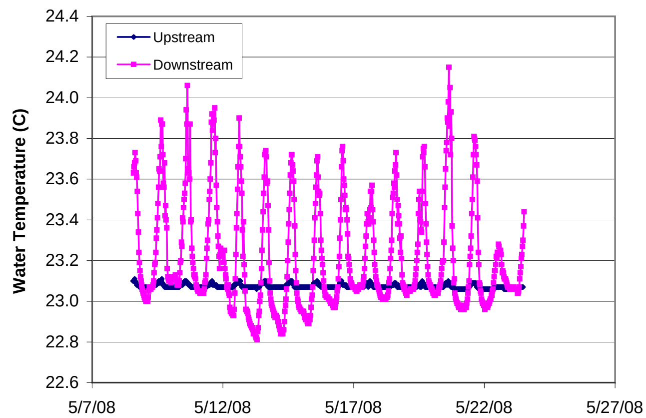


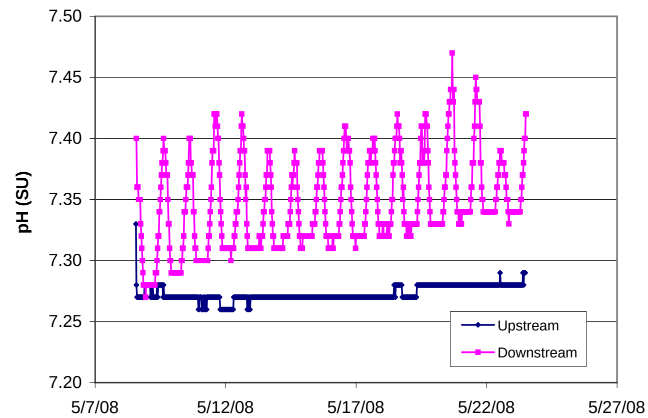


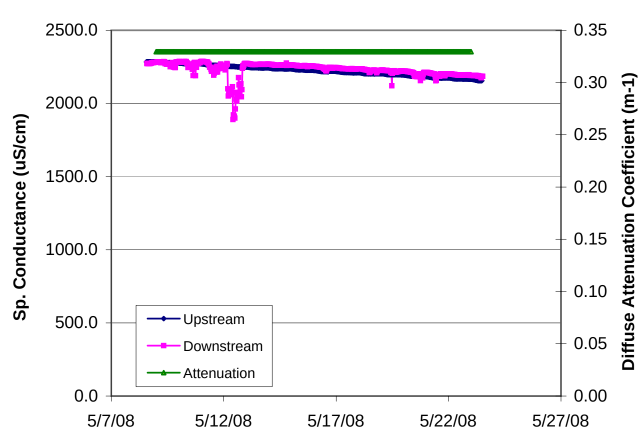
Stats	GPP	NPP	CR	P/R ratio	PAR Eff. (%)
	($g\ O_2/m^2/d$)				
Avg	12.99	-0.84	14.05	0.96	4.22
Max	18.04	5.31	17.10	1.51	6.23
Min	6.24	-10.02	10.44	0.38	2.67

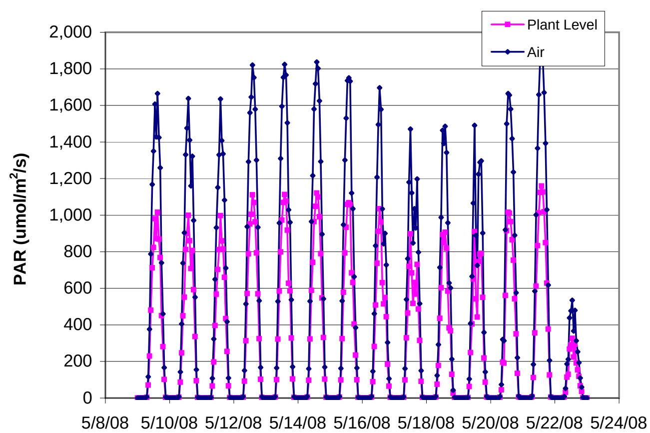
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-570 METABOLISM ESTIMATES

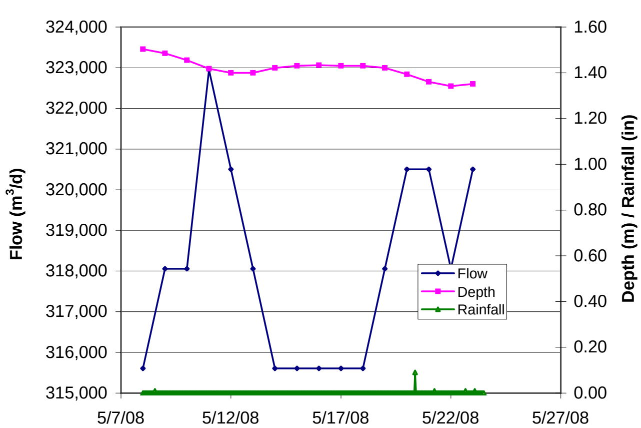
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-570 METABOLISM SUMMARY



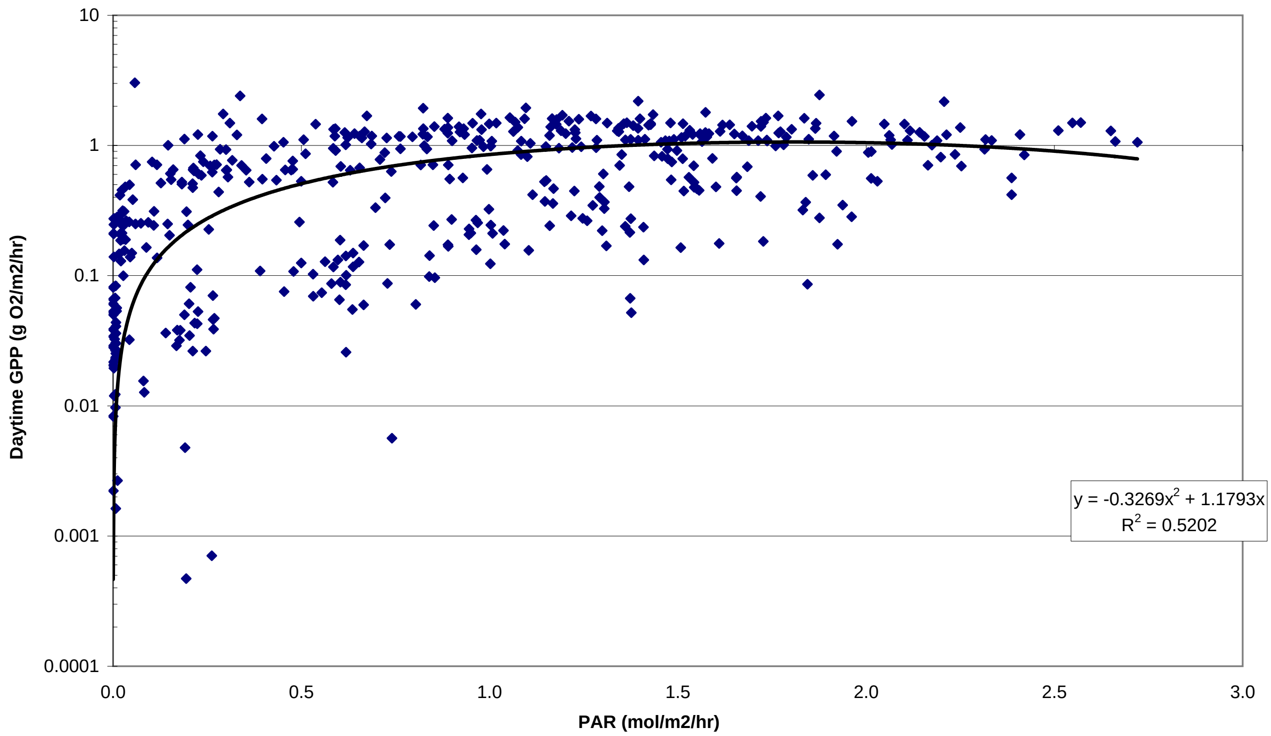


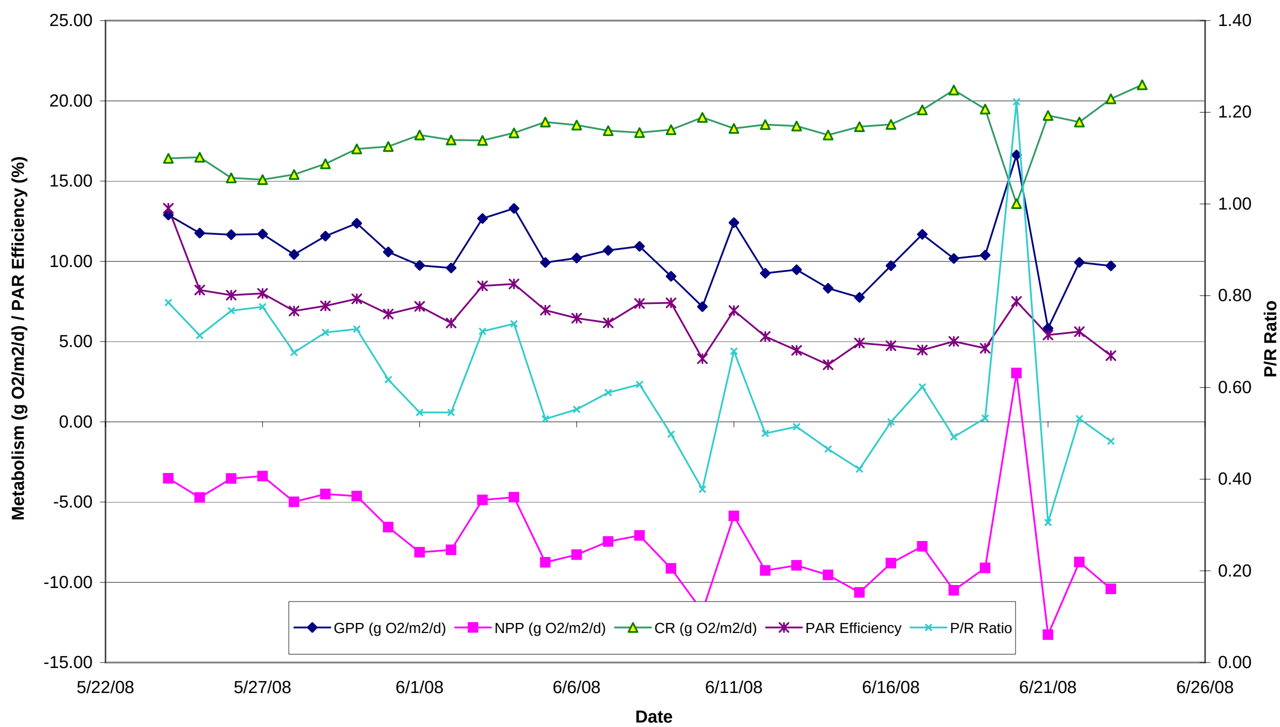






Parameter	Units	Avg	Min	Max	N
DO - up	mg/L	0.03	0.00	0.62	717
down		1.02	0.36	3.09	718
Wtr Temp - up	C	23.1	23.1	23.1	717
down		23.2	22.8	24.2	718
pH - up	SU	7.27	7.26	7.33	717
down		7.34	7.27	7.47	718
SpCond - up	uS/cm	2224	2155	2285	717
down		2231	1890	2287	718
Flow - up	m^3/d	318,055	315,608	322,948	16
Depth	m	1.42	1.34	1.50	16
Rainfall Total	in		0.13		
PAR - air	$umol/m^2/s$	490	0.0	1,900	373
plant		300	0.0	1159	337
DO rate chng	$g/m^2/hr$				
corr		-0.044	-0.748	1.844	337
uncorr		1.022	0.385	2.804	337



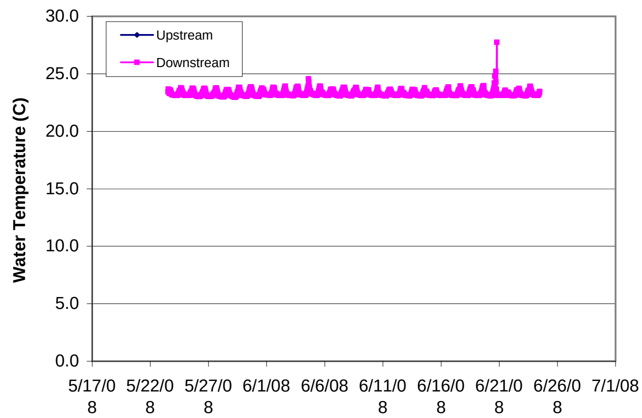


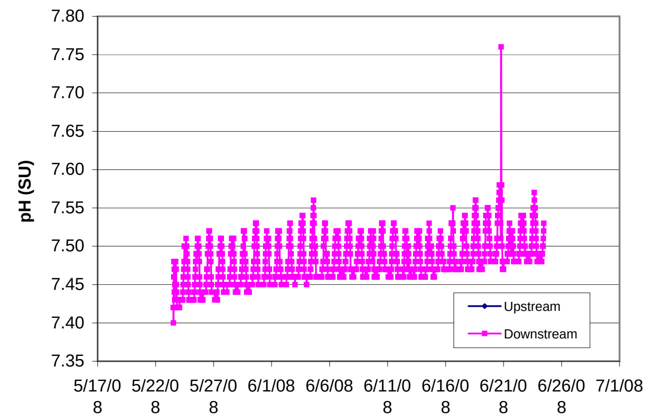
Stats	GPP	NPP	CR	P/R ratio	PAR Eff. (%)
	($g\ O_2/m^2/d$)				
Avg	10.56	-7.22	17.89	0.61	6.49
Max	16.63	3.03	21.00	1.22	13.31
Min	5.83	-13.26	13.60	0.31	3.55

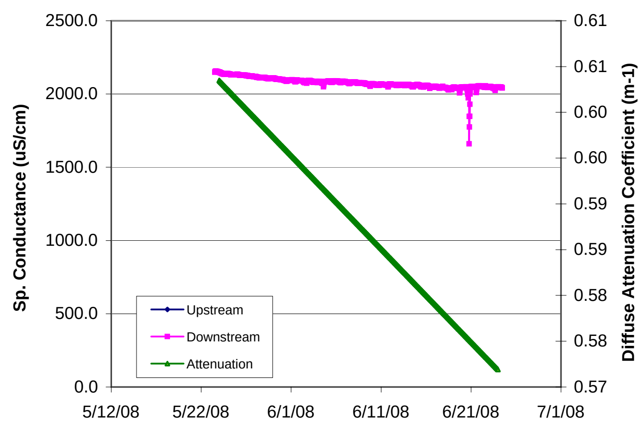
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-570 METABOLISM ESTIMATES

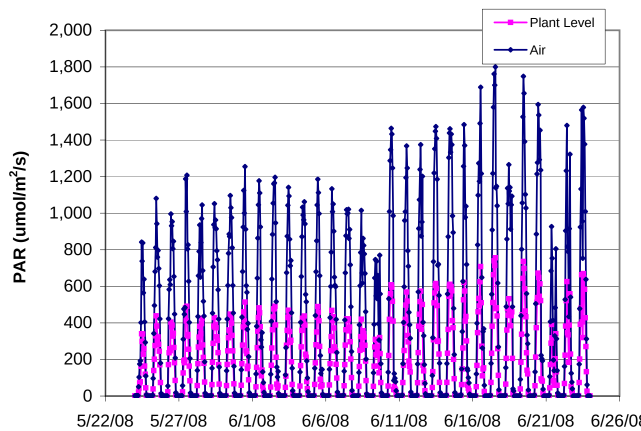
APPENDIX X

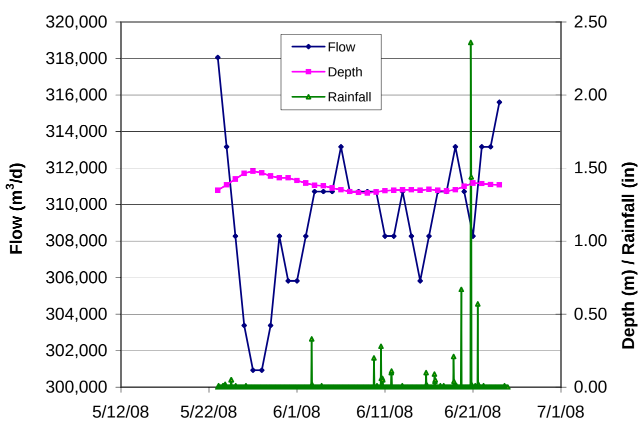
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-570 METABOLISM SUMMARY



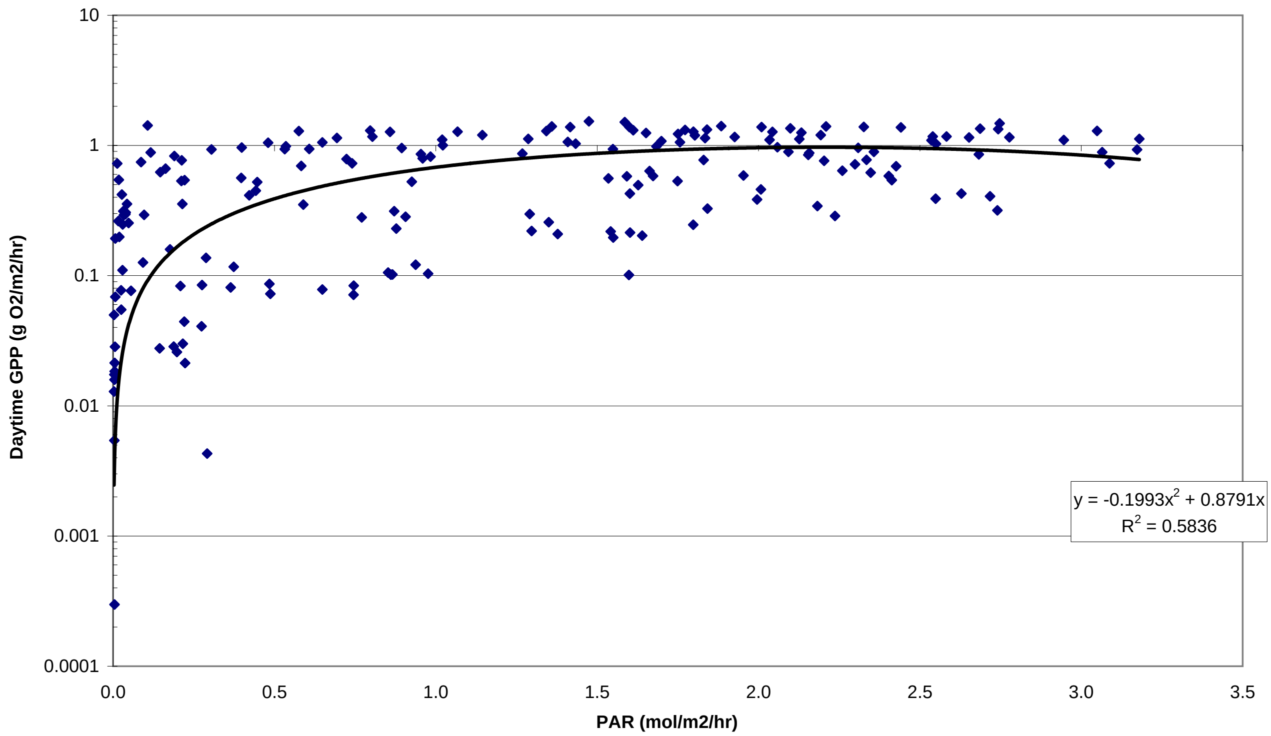


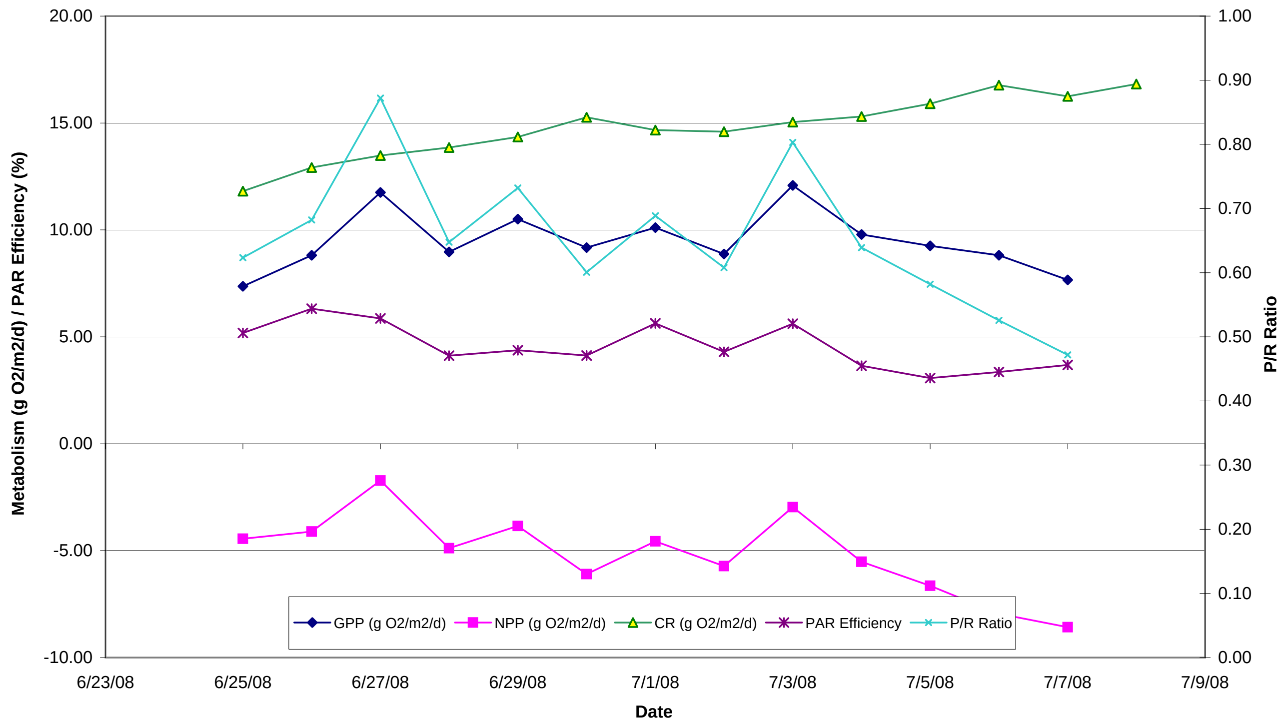






Parameter	Units	Avg	Min	Max	N
DO - up	mg/L				
down		0.78	0.17	5.60	1535
Wtr Temp - up	C				
down		23.3	23.0	27.7	1535
pH - up	SU				
down		7.48	7.40	7.76	1535
SpCond - up	uS/cm				
down		2078	1660	2157	1535
Flow - up	m^3/d	309,381	300,929	318,055	33
Depth	m	1.38	1.33	1.48	33
Rainfall Total	in		7.17		
PAR - air	$umol/m^2/s$	381	0.0	1,799	791
plant		159	0.0	756	745
DO rate chng	$g/m^2/hr$				
corr		-0.303	-1.000	2.237	745
uncorr		0.782	0.179	3.152	745

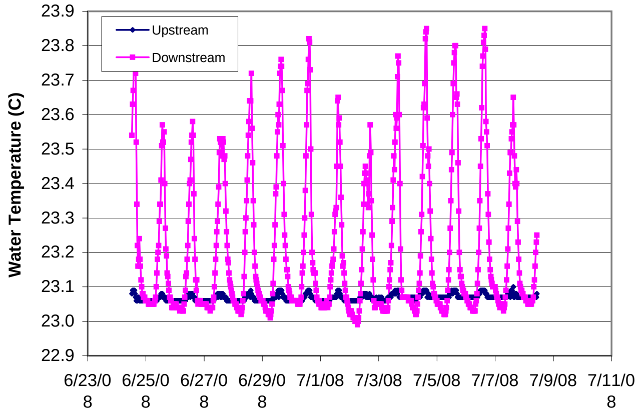


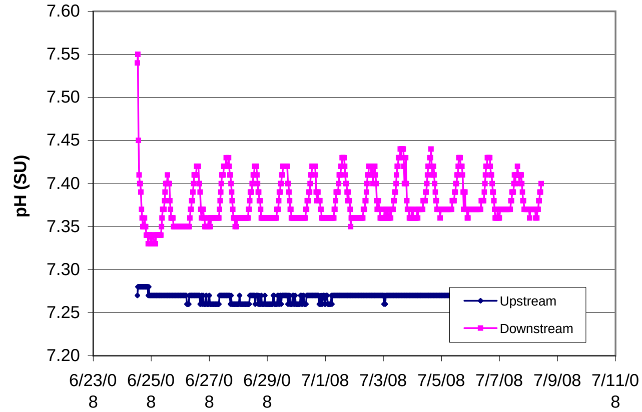


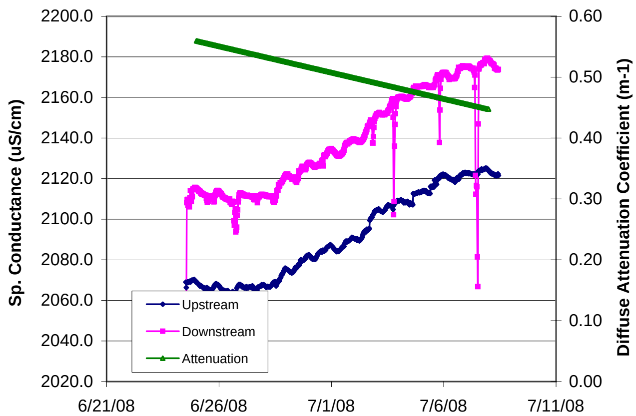
Stats	GPP	NPP	CR	P/R ratio	PAR Eff. (%)
	($g\ O_2/m^2/d$)				
Avg	9.47	-5.16	14.79	0.65	4.56
Max	12.08	-1.72	16.82	0.87	6.32
Min	7.36	-8.58	11.81	0.47	3.07

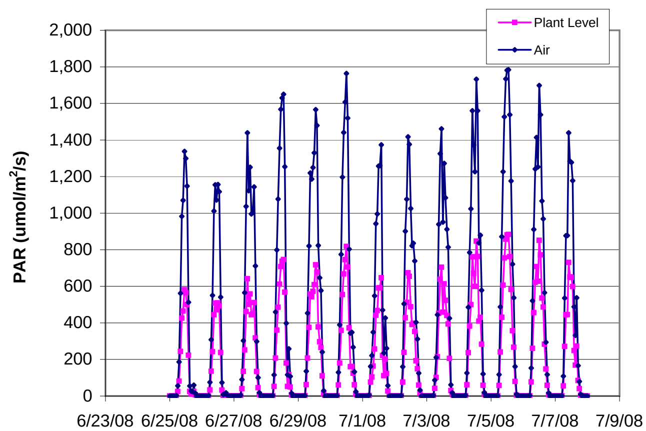
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-570 METABOLISM ESTIMATES

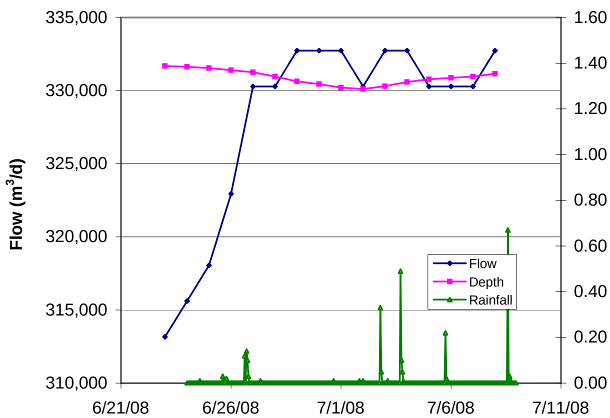
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-570 METABOLISM SUMMARY



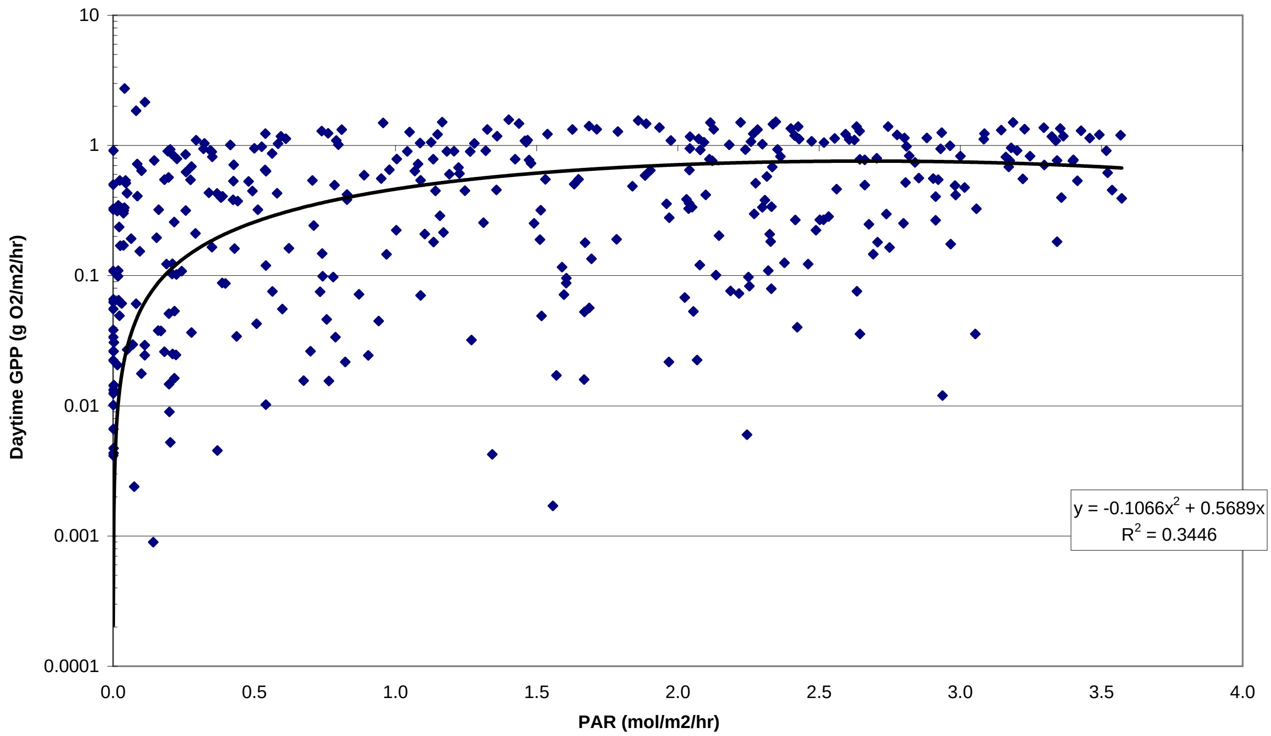


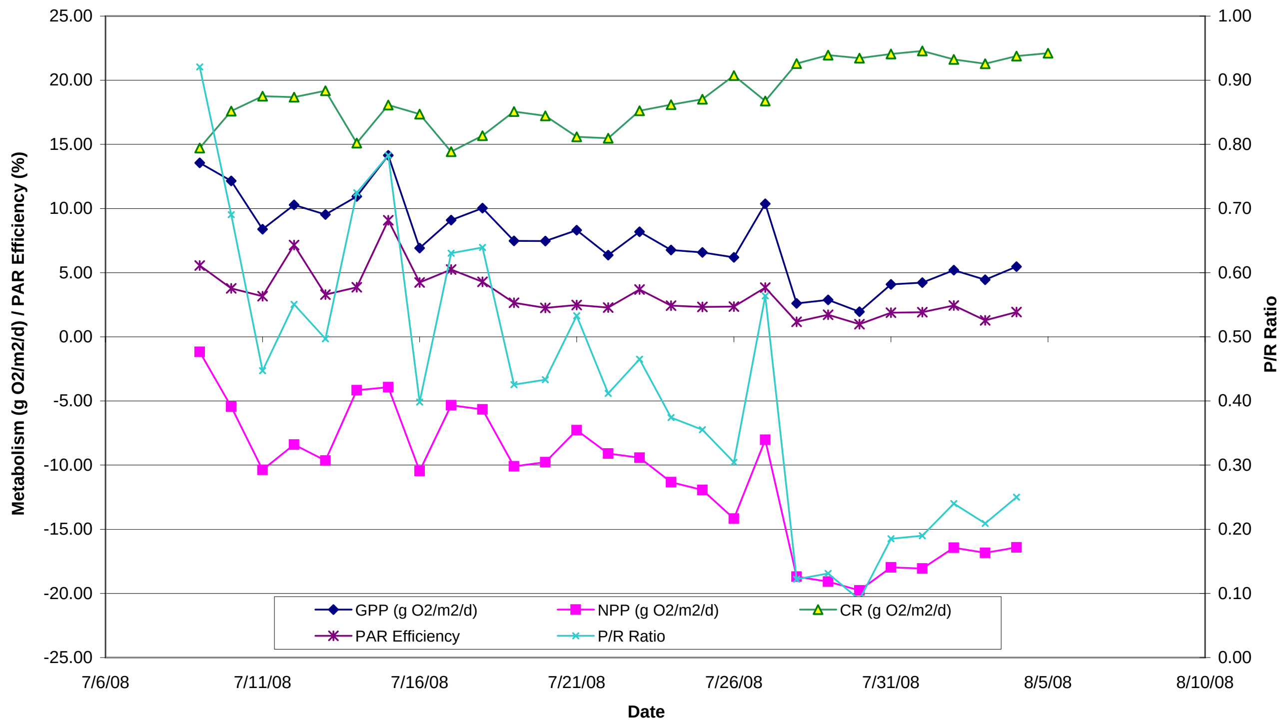






Parameter	Units	Avg	Min	Max	N
DO - up	mg/L	0.04	0.00	0.25	669
down		0.96	0.42	2.91	669
Wtr Temp - up	C	23.1	23.1	23.1	669
down		23.2	23.0	23.9	669
pH - up	SU	7.27	7.26	7.28	669
down		7.38	7.33	7.55	669
SpCond - up	uS/cm	2092	2063	2125	669
down		2138	2040	2179	669
Flow - up	m^3/d	327,994	313,162	332,734	16
Depth	m	1.34	1.29	1.39	16
Rainfall Total	in		2.51		
PAR - air	$umol/m^2/s$	419	0.0	1,784	360
plant		201	0.0	883	313
DO rate chng	$g/m^2/hr$				
corr		-0.221	-0.783	0.876	313
uncorr		0.991	0.453	2.036	313

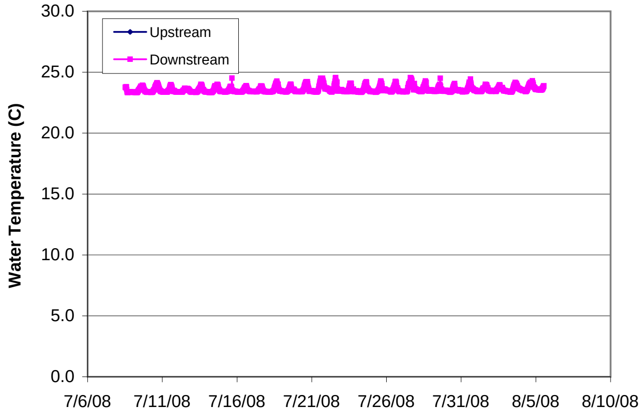


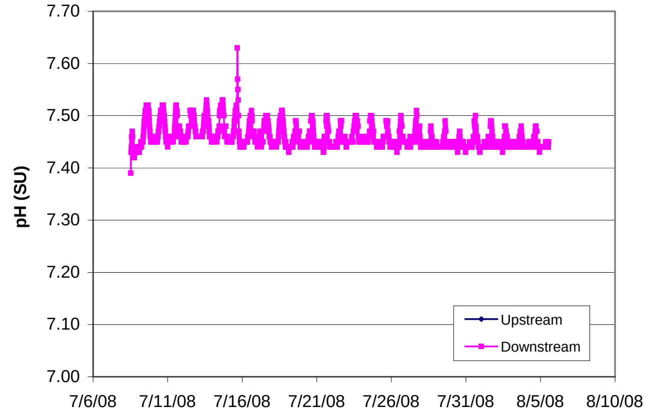


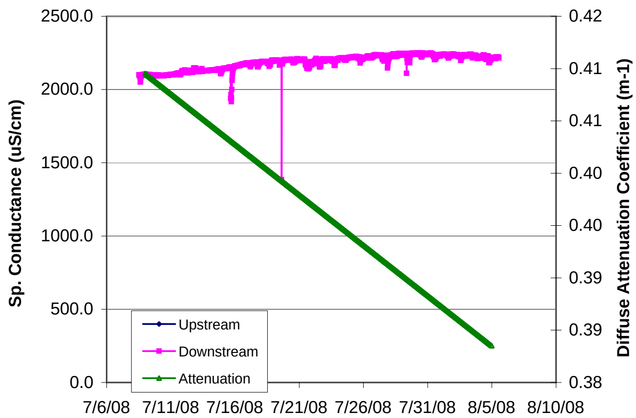
	GPP	NPP	CR	P/R	PAR Eff.
Stats	(g $O_2/m^2/d$)			ratio	(%)
Avg	7.54	-11.07	18.74	0.43	3.23
Max	14.15	-1.17	22.28	0.92	9.09
Min	1.96	-19.76	14.43	0.09	0.98

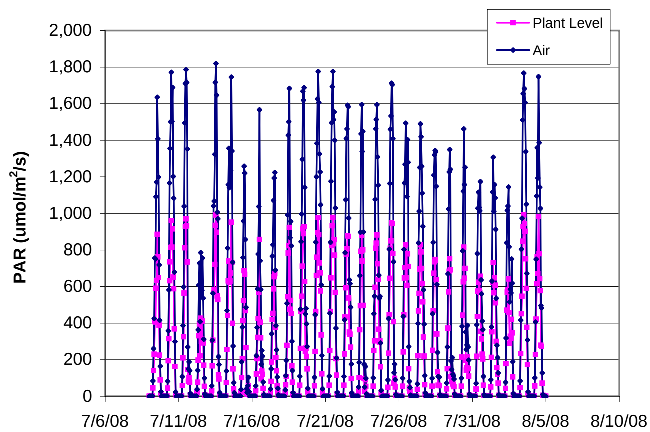
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-570 METABOLISM ESTIMATES

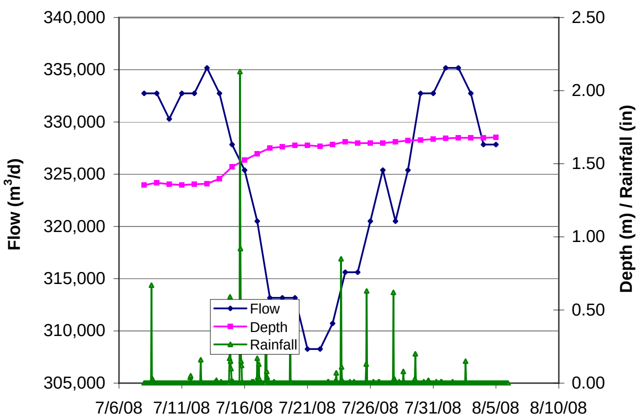
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-570 METABOLISM SUMMARY



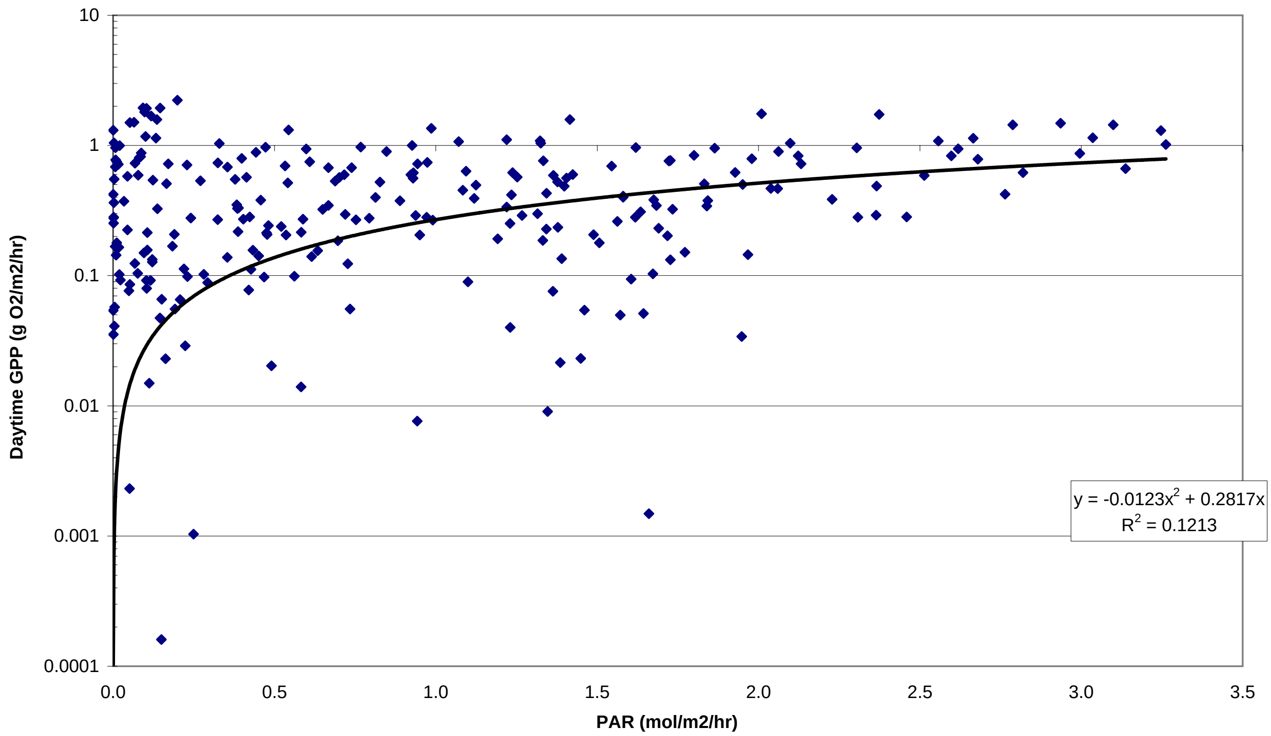


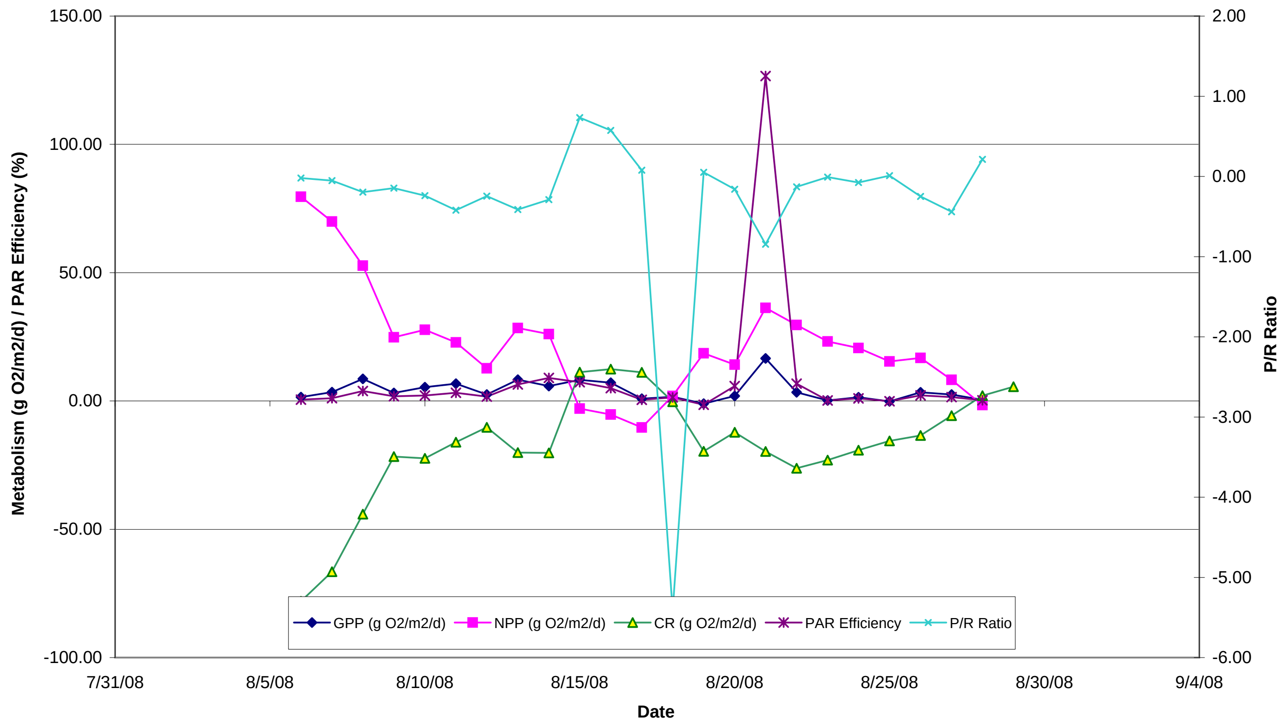






Parameter	Units	Avg	Min	Max	N
DO - up	mg/L	0.02	0.02	0.02	1353
down		0.50	0.00	3.72	1353
Wtr Temp - up	C				
down		23.6	23.3	24.6	1353
pH - up	SU				
down		7.46	7.39	7.63	1353
SpCond - up	uS/cm				
down		2186	1384	2250	1353
Flow - up	m^3/d	324,720	308,269	335,181	29
Depth	m	1.57	1.35	1.68	29
Rainfall Total	in		10.29		
PAR - air	$umol/m^2/s$	419	0.0	1,820	696
plant		231	0.0	992	649
DO rate chng	$g/m^2/hr$				
corr		-0.465	-0.946	2.015	649
uncorr		0.494	-0.021	2.894	649

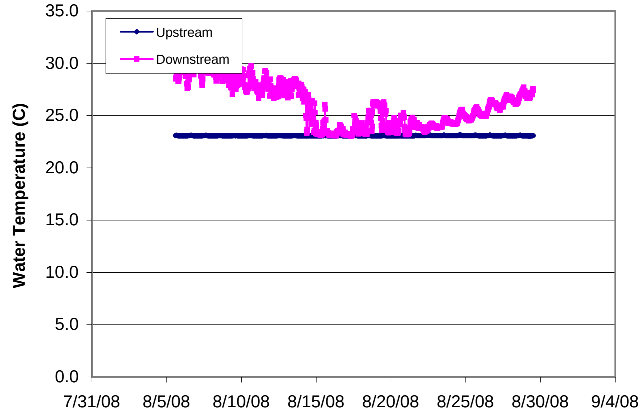


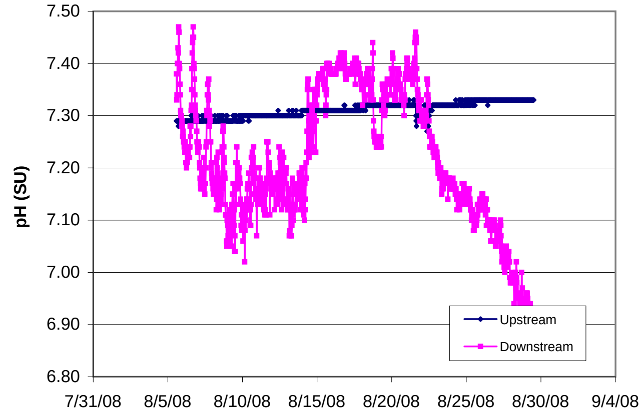


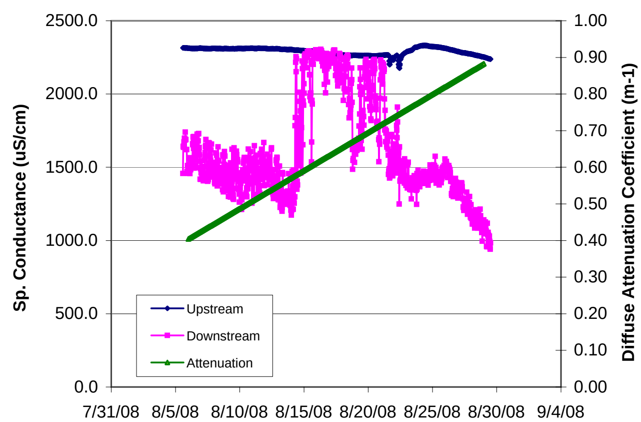
Stats	GPP	NPP	CR	P/R ratio	PAR Eff. (%)
	(g $O_2/m^2/d$)				
Avg	4.00	22.15	-17.16	-0.33	8.10
Max	16.61	79.58	12.42	0.73	126.61
Min	-1.02	-10.31	-78.06	-5.42	-1.50

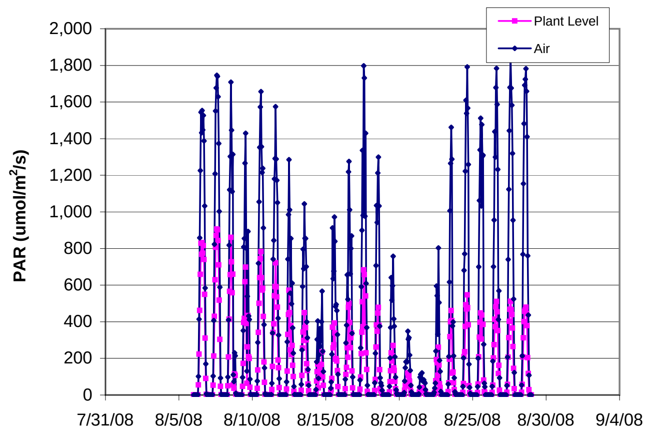
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-570 METABOLISM ESTIMATES

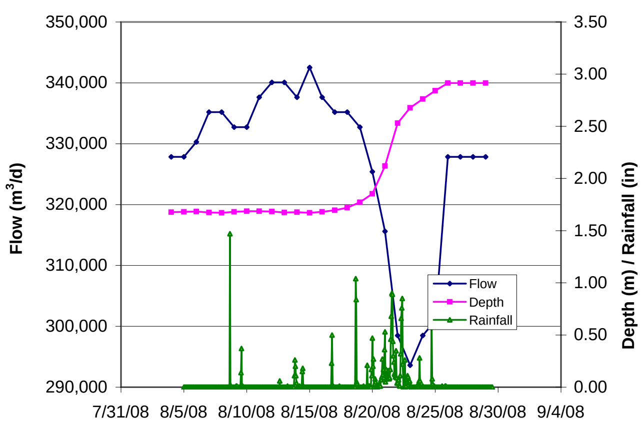
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-570 METABOLISM SUMMARY











Parameter	Units	Avg	Min	Max	N
DO - up	mg/L	0.03	0.00	0.34	1150
down		1.65	0.20	5.17	1150
Wtr Temp - up	C	23.1	23.1	23.1	1150
down		26.1	23.1	31.4	1150
pH - up	SU	7.31	7.27	7.33	1150
down		7.22	6.89	7.47	1150
SpCond - up	uS/cm	2291	2177	2331	1150
down		1603	941	2305	1150
Flow - up	m^3/d	327,088	293,589	342,521	26
Depth	m	2.06	1.67	2.91	26
Rainfall Total	in		20.40		
PAR - air	umol/m^2/s	357	0.0	1,841	569
plant		139	0.0	906	553
DO rate chng	g/m^2/hr				
corr		0.865	-0.552	4.252	553
uncorr		1.522	0.182	4.874	553

METABOLISM WORKSHEET - DAILY DETAIL
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-355

Date	GPP ($g\ O_2/m^2/d$)	NPP ($g\ O_2/m^2/d$)	CR ($g\ O_2/m^2/d$)	P/R Ratio	PAR (24hr) ($mol/m^2/d$)	PAR Efficiency (%)	PAR Efficiency ($g\ O_2/mol$)
11/13/2007	1.11	-3.93	5.04	0.22	15.57	0.58	0.07
11/14/2007	2.11	-3.44	5.55	0.38	15.98	1.07	0.13
11/15/2007	1.09	-3.71	4.80	0.23	15.90	0.55	0.07
11/16/2007	2.42	-0.54	2.96	0.82	16.62	1.18	0.15
11/17/2007	1.65	-1.77	3.43	0.48	16.46	0.81	0.10
11/18/2007	1.90	-4.08	5.98	0.32	12.47	1.23	0.15
11/19/2007	1.85	-5.86	7.71	0.24	12.73	1.17	0.15
11/20/2007	1.71	-6.06	7.77	0.22	14.78	0.93	0.12
11/21/2007	1.94	-5.49	7.42	0.26	15.95	0.98	0.12
11/22/2007	1.59	-7.24	8.83	0.18	5.64	2.27	0.28
11/23/2007	1.92	-6.26	8.18	0.23	10.55	1.47	0.18
11/24/2007	1.90	-4.81	6.71	0.28	12.04	1.27	0.16
11/25/2007	2.92	-4.90	7.82	0.37	10.79	2.19	0.27
11/26/2007	2.70	-4.94	7.63	0.35	13.73	1.59	0.20
12/7/2007	2.32	-7.35	9.67	0.24	14.03	1.33	0.17
12/8/2007	2.55	-9.56	12.11	0.21	13.85	1.49	0.18
12/9/2007	2.67	-10.78	13.45	0.20	13.63	1.58	0.20
12/10/2007	3.04	-11.40	14.44	0.21	11.62	2.11	0.26
12/11/2007	3.44	-11.45	14.89	0.23	13.15	2.11	0.26
12/12/2007	3.40	-11.54	14.94	0.23	13.50	2.03	0.25
12/13/2007	3.88	-11.37	15.25	0.25	13.31	2.35	0.29
12/14/2007	4.32	-12.75	17.07	0.25	10.94	3.19	0.39
12/15/2007	3.00	-14.78	17.78	0.17	12.52	1.93	0.24
12/16/2007	1.94	-10.62	12.56	0.15	12.08	1.30	0.16
12/17/2007	4.51	-4.09	8.60	0.52	14.62	2.49	0.31
12/18/2007	4.50	-5.89	10.39	0.43	11.09	3.27	0.41
12/19/2007	2.55	-9.51	12.07	0.21	13.13	1.57	0.19
12/22/2007	2.24	-20.89	23.13	0.10	5.64	3.21	0.40
12/23/2007	3.55	-16.30	19.84	0.18	12.15	2.36	0.29
12/24/2007	4.89	-15.91	20.80	0.23	13.33	2.96	0.37
12/25/2007	2.67	-19.07	21.74	0.12	7.73	2.79	0.35
12/26/2007	2.91	-19.18	22.09	0.13	9.76	2.41	0.30
12/27/2007	3.08	-18.40	21.48	0.14	12.01	2.07	0.26
12/28/2007	3.59	-19.77	23.36	0.15	12.26	2.37	0.29
12/29/2007	3.55	-19.66	23.21	0.15	10.19	2.81	0.35
12/30/2007	4.22	-19.63	23.86	0.18	10.26	3.32	0.41
12/31/2007	2.48	-21.39	23.87	0.10	5.14	3.89	0.48
1/1/2008	2.52	-17.93	20.45	0.12	10.59	1.92	0.24
1/2/2008	3.96	-8.22	12.19	0.33	15.01	2.13	0.26
1/3/2008	4.29	-7.46	11.75	0.37	13.37	2.59	0.32
1/4/2008	3.11	-13.29	16.40	0.19	10.70	2.35	0.29
1/5/2008	2.33	-17.63	19.96	0.12	9.44	2.00	0.25
1/6/2008	2.77	-19.19	21.95	0.13	12.32	1.81	0.22
1/7/2008	3.21	-20.76	23.97	0.13	10.52	2.46	0.30
1/8/2008	3.78	-22.63	26.42	0.14	12.62	2.42	0.30
1/9/2008	3.08	-23.30	26.38	0.12	14.70	1.69	0.21
1/10/2008	4.32	-23.69	28.02	0.15	8.51	4.10	0.51
1/11/2008	4.97	-25.69	30.65	0.16	8.64	4.64	0.57

METABOLISM WORKSHEET - DAILY DETAIL
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-355

Date	GPP ($g\ O_2/m^2/d$)	NPP ($g\ O_2/m^2/d$)	CR ($g\ O_2/m^2/d$)	P/R Ratio	PAR (24hr) ($mol/m^2/d$)	PAR Efficiency (%)	PAR Efficiency ($g\ O_2/mol$)
1/12/2008	5.11	-25.34	30.44	0.17	7.37	5.59	0.69
1/13/2008	2.16	-29.13	31.29	0.07	4.67	3.73	0.46
1/14/2008	6.10	-21.37	27.46	0.22	12.27	4.01	0.50
1/15/2008	5.88	-19.88	25.77	0.23	11.10	4.28	0.53
1/16/2008	6.21	-22.64	28.85	0.22	8.44	5.94	0.74
1/17/2008	0.79	-30.89	31.68	0.02	3.68	1.73	0.21
1/18/2008	2.09	-29.44	31.53	0.07	3.50	4.81	0.60
1/19/2008	1.27	-28.48	29.75	0.04	4.80	2.13	0.26
1/20/2008	7.44	-15.92	23.37	0.32	13.88	4.33	0.54
1/21/2008	5.64	-18.18	23.82	0.24	12.58	3.62	0.45
1/23/2008	1.96	-10.39	12.34	0.16	8.47	1.87	0.23
1/24/2008	1.37	-11.53	12.90	0.11	8.27	1.34	0.17
1/25/2008	3.43	-4.30	7.72	0.44	13.05	2.12	0.26
1/26/2008	0.85	-9.45	10.30	0.08	4.42	1.55	0.19
1/27/2008	1.12	-8.72	9.84	0.11	12.87	0.70	0.09
1/28/2008	1.16	-4.86	6.03	0.19	14.93	0.63	0.08
1/29/2008	2.06	-6.12	8.18	0.25	13.75	1.21	0.15
1/30/2008	2.89	-10.83	13.72	0.21	10.74	2.17	0.27
1/31/2008	3.16	-12.57	15.72	0.20	10.72	2.38	0.29
2/1/2008	0.80	-14.42	15.22	0.05	4.42	1.46	0.18
2/2/2008	3.31	-9.82	13.13	0.25	14.24	1.88	0.23
2/3/2008	4.02	-11.78	15.79	0.25	11.63	2.79	0.35
2/4/2008	4.79	-12.14	16.93	0.28	13.59	2.84	0.35
2/5/2008	5.21	-13.23	18.44	0.28	11.20	3.75	0.46
2/8/2008	8.00	-12.35	20.35	0.39	12.09	5.34	0.66
2/9/2008	6.88	-12.88	19.77	0.35	11.32	4.91	0.61
2/10/2008	5.71	-12.54	18.25	0.31	16.19	2.85	0.35
2/11/2008	6.76	-10.72	17.48	0.39	16.35	3.34	0.41
2/12/2008	4.56	-16.90	21.46	0.21	5.08	7.25	0.90
2/13/2008	4.36	-17.48	21.84	0.20	8.65	4.07	0.50
2/14/2008	6.31	-9.25	15.56	0.41	16.68	3.06	0.38
2/15/2008	5.81	-12.32	18.14	0.32	13.26	3.54	0.44
2/16/2008	5.78	-14.48	20.26	0.29	15.86	2.94	0.36
2/17/2008	6.23	-16.10	22.33	0.28	15.25	3.30	0.41
2/18/2008	6.90	-16.06	22.96	0.30	10.87	5.13	0.64
2/19/2008	7.06	-12.57	19.63	0.36	17.72	3.22	0.40
2/20/2008	8.59	-10.50	19.08	0.45	11.51	6.02	0.75
2/21/2008	6.94	-15.94	22.88	0.30	6.70	8.36	1.04
2/22/2008	8.40	-15.46	23.86	0.35	11.82	5.74	0.71
2/23/2008	4.57	-18.26	22.83	0.20	8.17	4.51	0.56
2/24/2008	6.51	-15.18	21.68	0.30	12.77	4.11	0.51
2/25/2008	7.70	-12.94	20.64	0.37	18.08	3.44	0.43
2/26/2008	7.03	-13.09	20.11	0.35	12.50	4.54	0.56
2/27/2008	8.99	-8.48	17.47	0.51	10.40	6.98	0.86
2/28/2008	7.52	-5.96	13.47	0.56	18.82	3.22	0.40
2/29/2008	5.37	-10.02	15.39	0.35	15.98	2.71	0.34
3/1/2008	5.51	-12.01	17.52	0.31	17.15	2.59	0.32
3/2/2008	6.34	-13.19	19.54	0.32	17.83	2.87	0.36
3/3/2008	5.54	-16.86	22.40	0.25	18.73	2.39	0.30
3/4/2008	5.64	-18.49	24.13	0.23	10.20	4.47	0.55
3/5/2008	5.38	-18.01	23.39	0.23	18.95	2.29	0.28
3/6/2008	5.16	-17.37	22.53	0.23	15.37	2.71	0.34
3/7/2008	4.20	-14.96	19.17	0.22	9.05	3.75	0.46
3/8/2008	5.34	-13.05	18.39	0.29	20.13	2.14	0.26

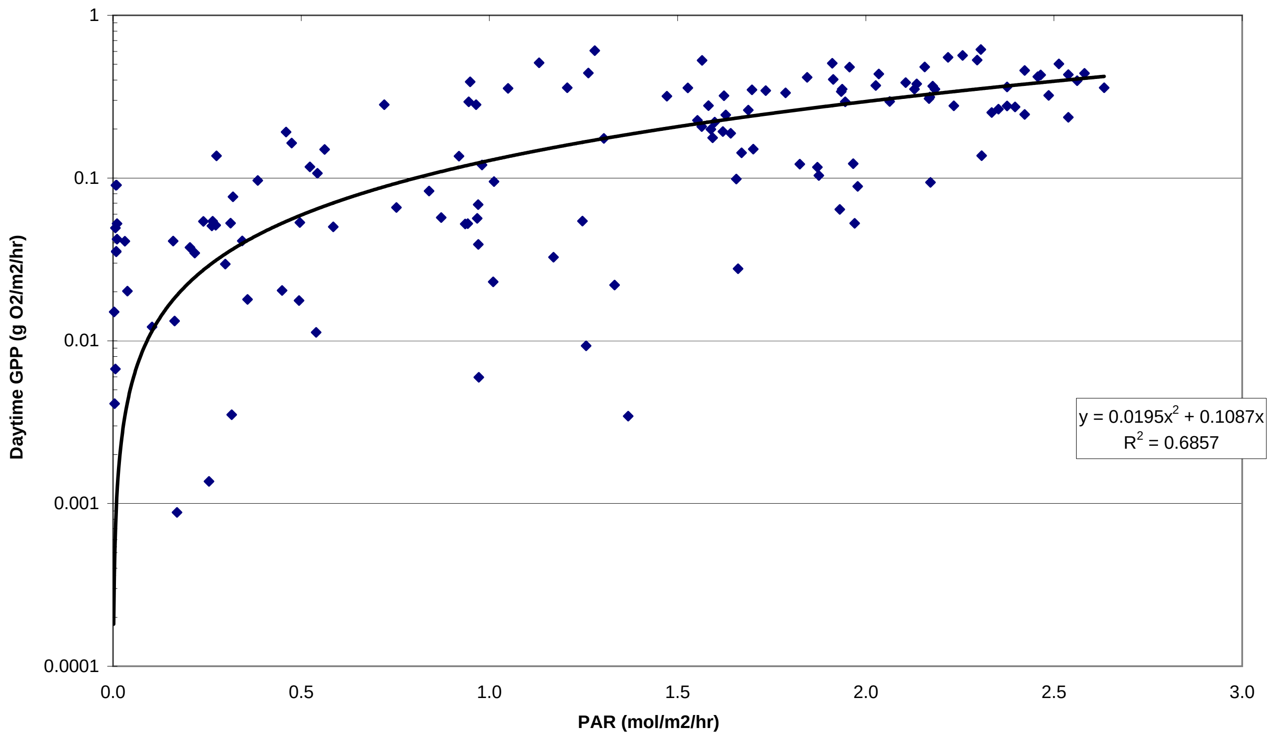
METABOLISM WORKSHEET - DAILY DETAIL
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-355

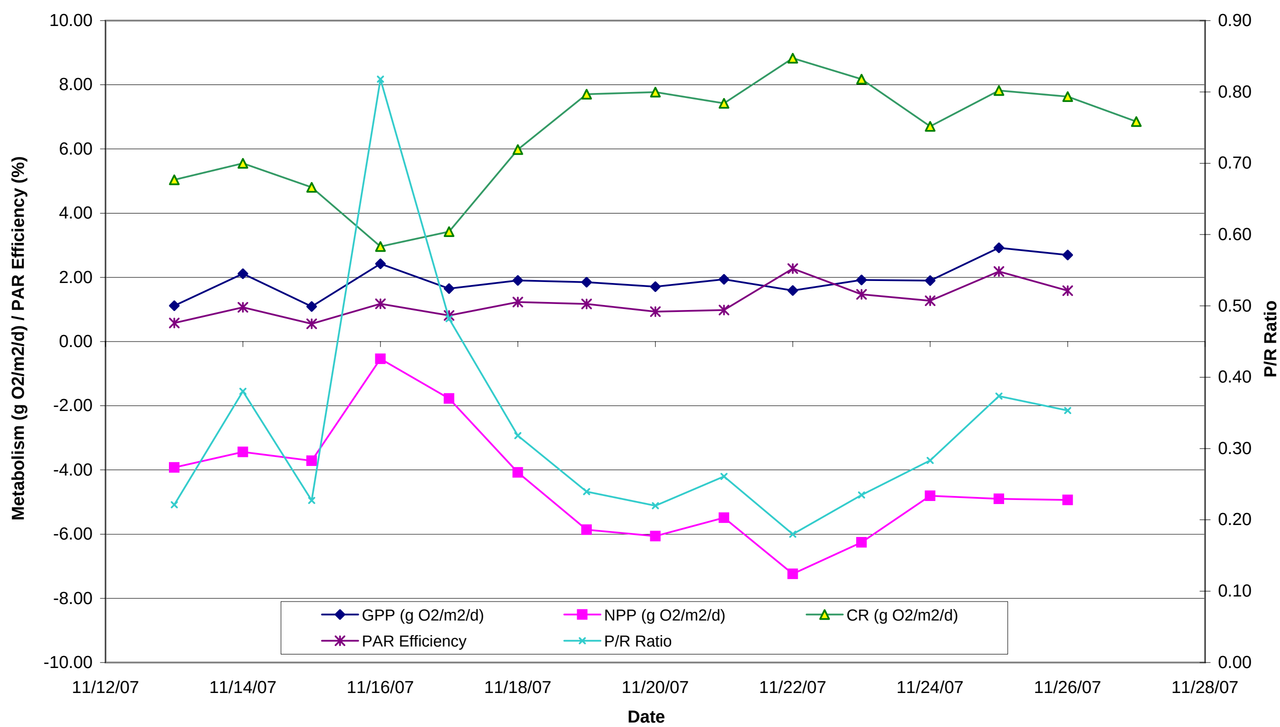
Date	GPP ($g\ O_2/m^2/d$)	NPP ($g\ O_2/m^2/d$)	CR ($g\ O_2/m^2/d$)	P/R Ratio	PAR (24hr) ($mol/m^2/d$)	PAR Efficiency (%)	PAR Efficiency ($g\ O_2/mol$)
3/9/2008	3.77	-12.62	16.39	0.23	21.13	1.44	0.18
3/10/2008	4.56	-11.14	15.70	0.29	16.73	2.20	0.27
3/11/2008	3.88	-12.80	16.68	0.23	10.50	2.99	0.37
3/12/2008	3.91	-12.20	16.11	0.24	12.54	2.52	0.31
3/13/2008	4.53	-10.33	14.86	0.30	19.90	1.84	0.23
3/14/2008	2.23	-12.63	14.86	0.15	5.91	3.05	0.38
3/15/2008	2.36	-12.86	15.23	0.16	17.77	1.07	0.13
3/16/2008	3.22	-11.69	14.91	0.22	20.71	1.25	0.16
3/17/2008	4.14	-9.86	14.00	0.30	19.50	1.71	0.21
3/19/2008	6.47	-16.31	22.78	0.28	19.07	2.74	0.34
3/20/2008	5.98	-15.96	21.93	0.27	16.25	2.97	0.37
3/21/2008	6.95	-12.88	19.83	0.35	17.27	3.25	0.40
3/22/2008	5.46	-16.97	22.43	0.24	7.10	6.21	0.77
3/23/2008	5.69	-17.64	23.33	0.24	11.65	3.94	0.49
3/24/2008	5.98	-13.03	19.01	0.31	11.15	4.33	0.54
3/25/2008	6.28	-8.74	15.03	0.42	14.33	3.54	0.44
3/26/2008	5.20	-11.44	16.64	0.31	9.15	4.59	0.57
3/27/2008	5.92	-13.72	19.64	0.30	11.67	4.10	0.51
3/28/2008	5.81	-17.44	23.25	0.25	11.96	3.92	0.49
3/29/2008	5.29	-19.36	24.64	0.21	9.30	4.59	0.57
3/30/2008	5.83	-17.81	23.65	0.25	7.12	6.62	0.82
3/31/2008	6.31	-15.78	22.09	0.29	5.99	8.50	1.05
5/9/2008	9.52	-10.27	19.80	0.48	24.83	3.10	0.38
5/10/2008	7.37	-14.88	22.25	0.33	24.15	2.46	0.31
5/11/2008	7.68	-15.57	23.24	0.33	22.14	2.80	0.35
5/12/2008	7.53	-15.38	22.90	0.33	28.07	2.16	0.27
5/13/2008	8.56	-11.54	20.11	0.43	27.91	2.48	0.31
5/14/2008	9.79	-10.18	19.97	0.49	28.37	2.79	0.35
5/15/2008	10.46	-10.07	20.53	0.51	25.85	3.27	0.40
5/16/2008	10.34	-11.59	21.92	0.47	22.43	3.72	0.46
5/17/2008	7.97	-14.68	22.65	0.35	21.20	3.04	0.38
5/18/2008	8.83	-13.67	22.49	0.39	20.28	3.51	0.44
5/19/2008	8.12	-15.69	23.81	0.34	20.90	3.14	0.39
5/20/2008	8.66	-16.14	24.79	0.35	24.49	2.85	0.35
5/21/2008	8.05	-16.91	24.96	0.32	30.30	2.14	0.27
5/22/2008	4.84	-20.41	25.24	0.19	7.29	5.36	0.66
6/25/2008	8.00	-14.37	22.36	0.36	10.43	6.19	0.77
6/26/2008	9.07	-15.05	24.12	0.38	10.29	7.11	0.88
6/27/2008	10.82	-14.78	25.60	0.42	14.90	5.86	0.73
6/28/2008	7.72	-18.83	26.55	0.29	16.28	3.83	0.47
6/29/2008	7.61	-19.38	26.99	0.28	18.07	3.40	0.42
6/30/2008	8.51	-18.44	26.96	0.32	16.83	4.08	0.51
7/1/2008	7.55	-19.56	27.11	0.28	13.68	4.45	0.55
7/2/2008	7.29	-18.66	25.95	0.28	15.85	3.71	0.46
7/3/2008	9.39	-16.97	26.37	0.36	16.63	4.56	0.57
7/4/2008	7.30	-18.22	25.52	0.29	20.85	2.83	0.35
7/5/2008	7.69	-17.99	25.68	0.30	23.61	2.63	0.33
7/6/2008	6.58	-19.37	25.96	0.25	20.70	2.57	0.32
7/7/2008	7.09	-18.58	25.67	0.28	16.49	3.47	0.43
8/6/2008	5.36	-13.45	18.80	0.28	27.26	1.59	0.20
8/7/2008	5.55	-14.77	20.33	0.27	28.54	1.57	0.19
8/8/2008	6.86	-14.03	20.89	0.33	20.34	2.72	0.34
8/9/2008	5.68	-15.59	21.27	0.27	16.49	2.78	0.34
8/10/2008	5.24	-15.26	20.50	0.26	24.31	1.74	0.22

METABOLISM WORKSHEET - DAILY DETAIL
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-355

Date	GPP (g $O_2/m^2/d$)	NPP (g $O_2/m^2/d$)	CR (g $O_2/m^2/d$)	P/R Ratio	PAR (24hr) (mol/m^2/d)	PAR Efficiency (%)	PAR Efficiency (g O_2/mol)
8/11/2008	5.95	-14.09	20.03	0.30	21.01	2.29	0.28
8/12/2008	5.00	-16.58	21.59	0.23	15.23	2.65	0.33
8/13/2008	5.58	-14.45	20.03	0.28	13.56	3.32	0.41
8/14/2008	3.69	-18.90	22.59	0.16	6.99	4.27	0.53
8/15/2008	5.47	-16.33	21.80	0.25	12.50	3.53	0.44
8/16/2008	6.67	-14.27	20.94	0.32	16.36	3.29	0.41
8/17/2008	5.99	-14.43	20.42	0.29	22.10	2.19	0.27
8/18/2008	6.49	-13.24	19.73	0.33	14.15	3.70	0.46
8/19/2008	1.06	-15.55	16.62	0.06	8.43	1.02	0.13
8/23/2008	2.48	-7.26	9.74	0.25	13.71	1.46	0.18
8/24/2008	2.70	-7.47	10.16	0.27	21.25	1.02	0.13
8/25/2008	2.62	-7.73	10.36	0.25	20.15	1.05	0.13
8/26/2008	2.57	-8.27	10.84	0.24	23.22	0.89	0.11
8/27/2008	2.54	-8.41	10.95	0.23	25.63	0.80	0.10
8/28/2008	2.55	-8.42	10.97	0.23	25.52	0.81	0.10

Average	4.86	-13.85	18.70	0.27	14.30	2.96	0.37
Median	4.89	-13.72	20.03	0.25	13.50	2.78	0.34
Maximum	10.82	-0.54	31.68	0.82	30.30	8.50	1.05
Minimum	0.79	-30.89	2.96	0.02	3.50	0.55	0.07
Std Dev	2.35	5.50	6.38	0.11	5.63	1.54	0.19
N	171	171	171	171	171	171	171

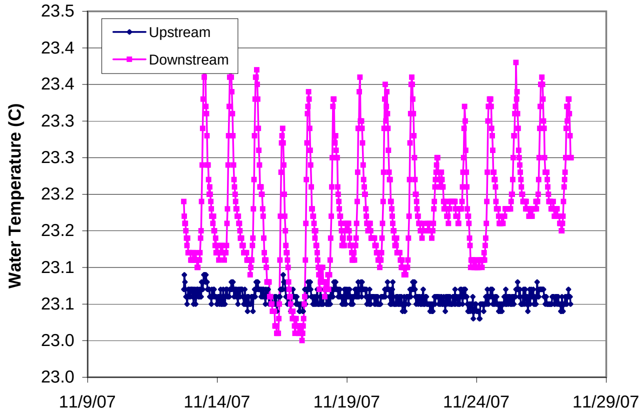


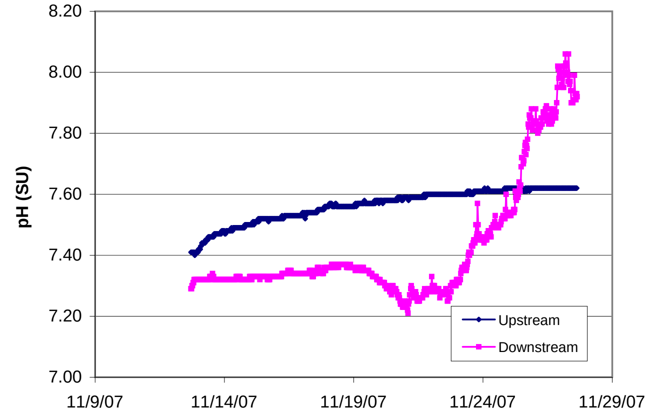


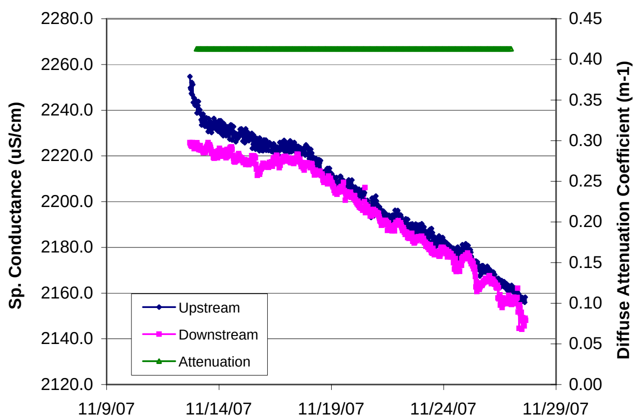
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-355 METABOLISM ESTIMATES

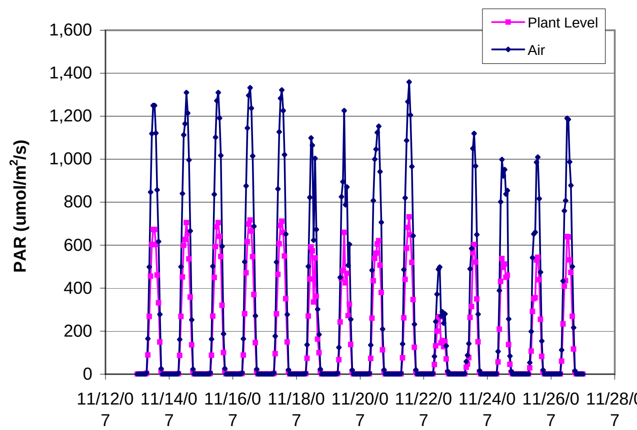
Stats	GPP	NPP	CR	P/R	PAR Eff.
	($g\ O_2/m^2/d$)			ratio	(%)
Avg	1.92	-4.50	6.45	0.33	1.24
Max	2.92	-0.54	8.83	0.82	2.27
Min	1.09	-7.24	2.96	0.18	0.55

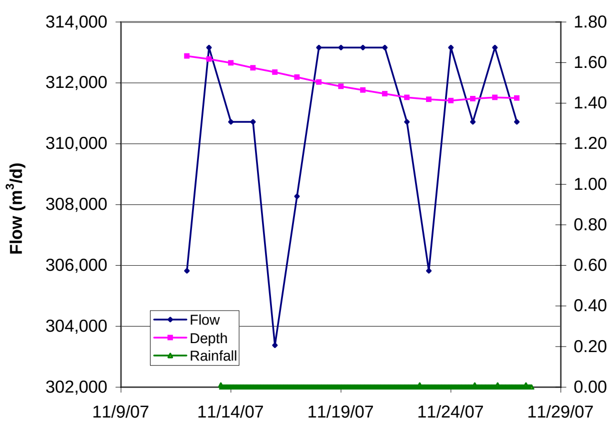
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-355 METABOLISM SUMMARY



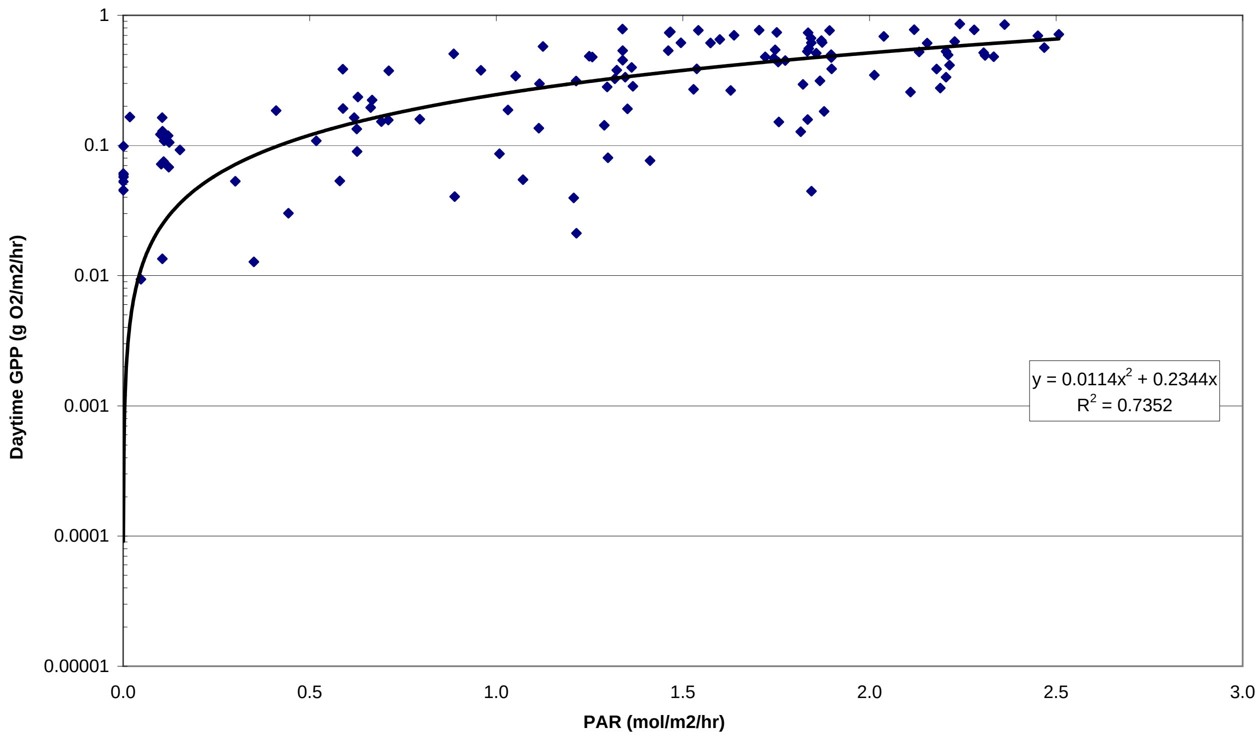


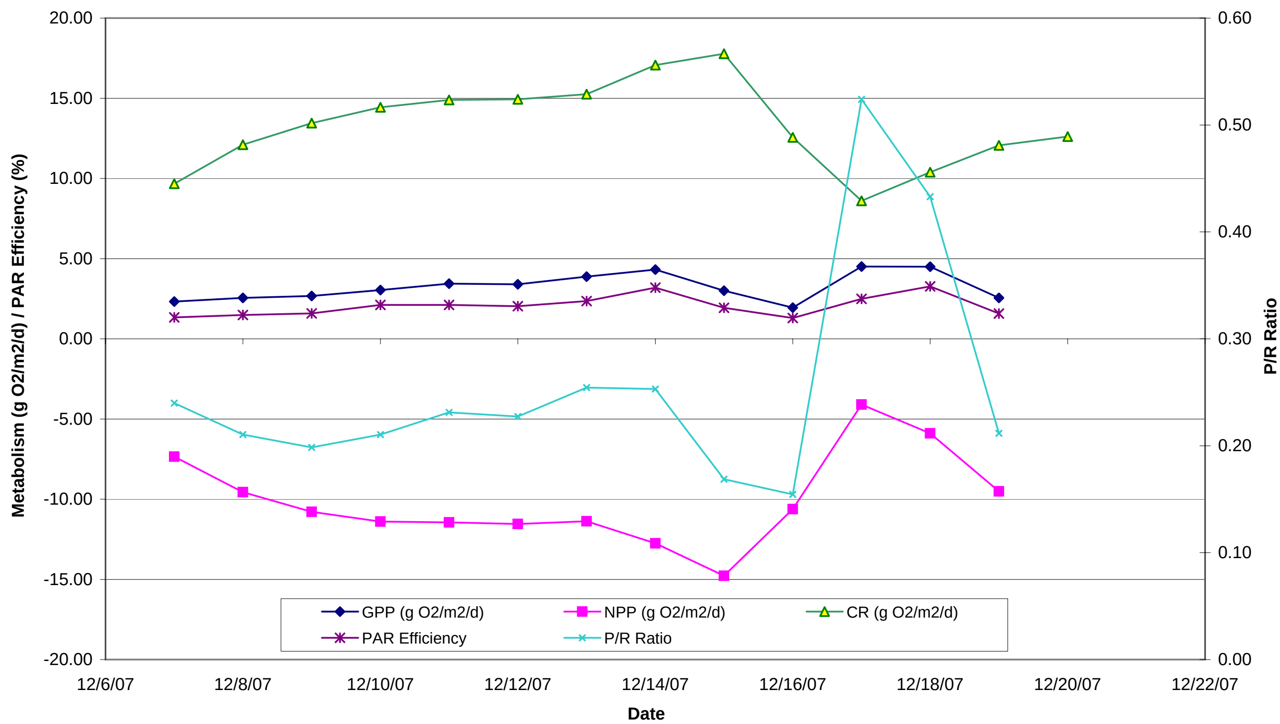






Parameter	Units	Avg	Min	Max	N
DO - up	mg/L	0.02	0.02	0.02	718
down		0.45	0.33	0.79	718
Wtr Temp - up	C	23.1	23.0	23.1	717
down		23.2	23.0	23.4	718
pH - up	SU	7.56	7.40	7.62	717
down		7.43	7.21	8.06	718
SpCond - up	uS/cm	2202	2156	2255	717
down		2196	2144	2226	718
Flow - up	m^3/d	310,562	303,375	313,162	16
Depth	m	1.50	1.41	1.63	16
Rainfall Total	in		0.05		
PAR - air	$umol/m^2/s$	290	0.0	1,359	337
plant		156	0.0	731	337
DO rate chng	$g/m^2/hr$				
corr		-0.189	-0.415	0.428	337
uncorr		0.719	0.526	1.255	337

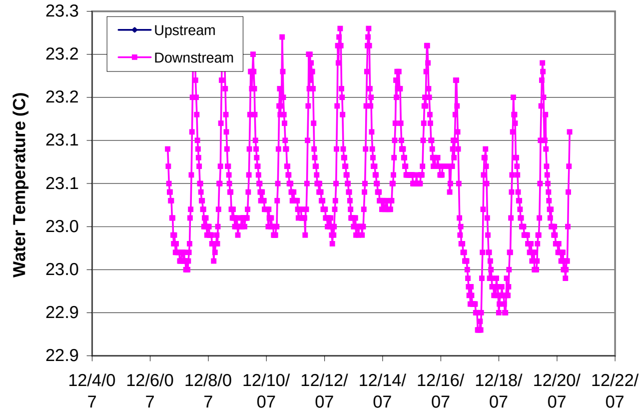


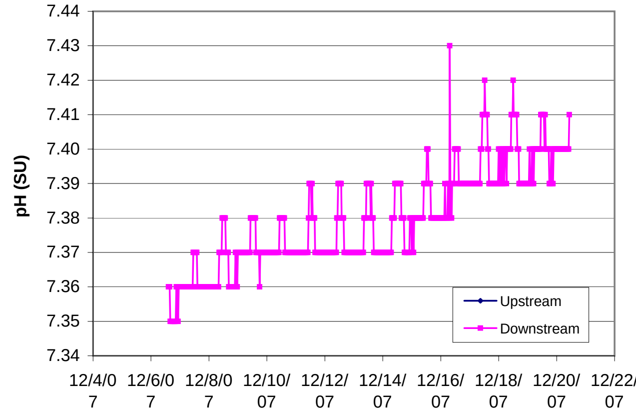


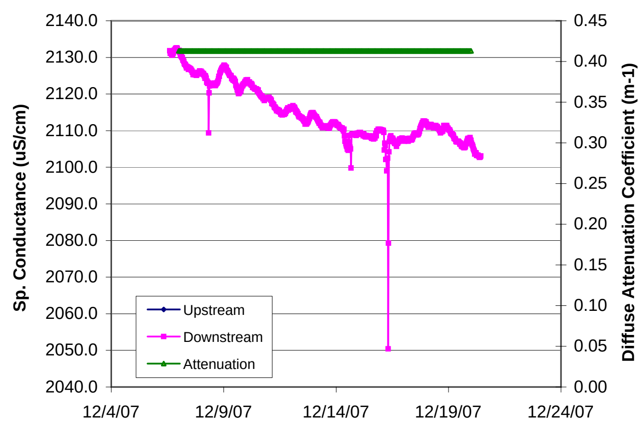
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-355 METABOLISM ESTIMATES

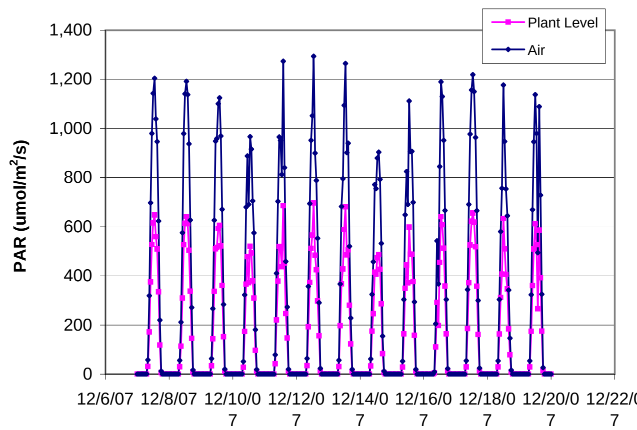
	GPP	NPP	CR	P/R	PAR Eff.
Stats	($g\ O_2/m^2/d$)			ratio	(%)
Avg	3.24	-10.08	13.27	0.26	2.06
Max	4.51	-4.09	17.78	0.52	3.27
Min	1.94	-14.78	8.60	0.15	1.30

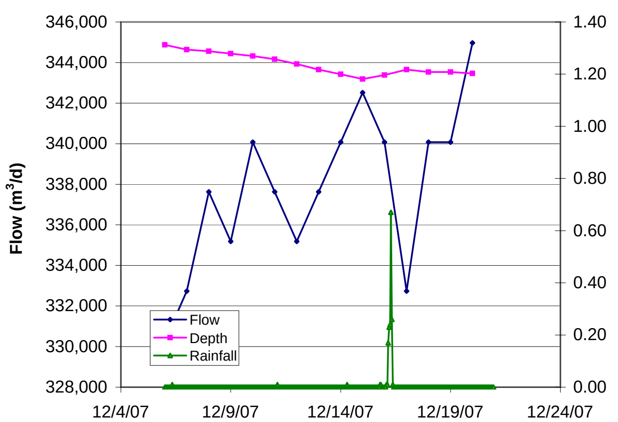
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-355 METABOLISM SUMMARY



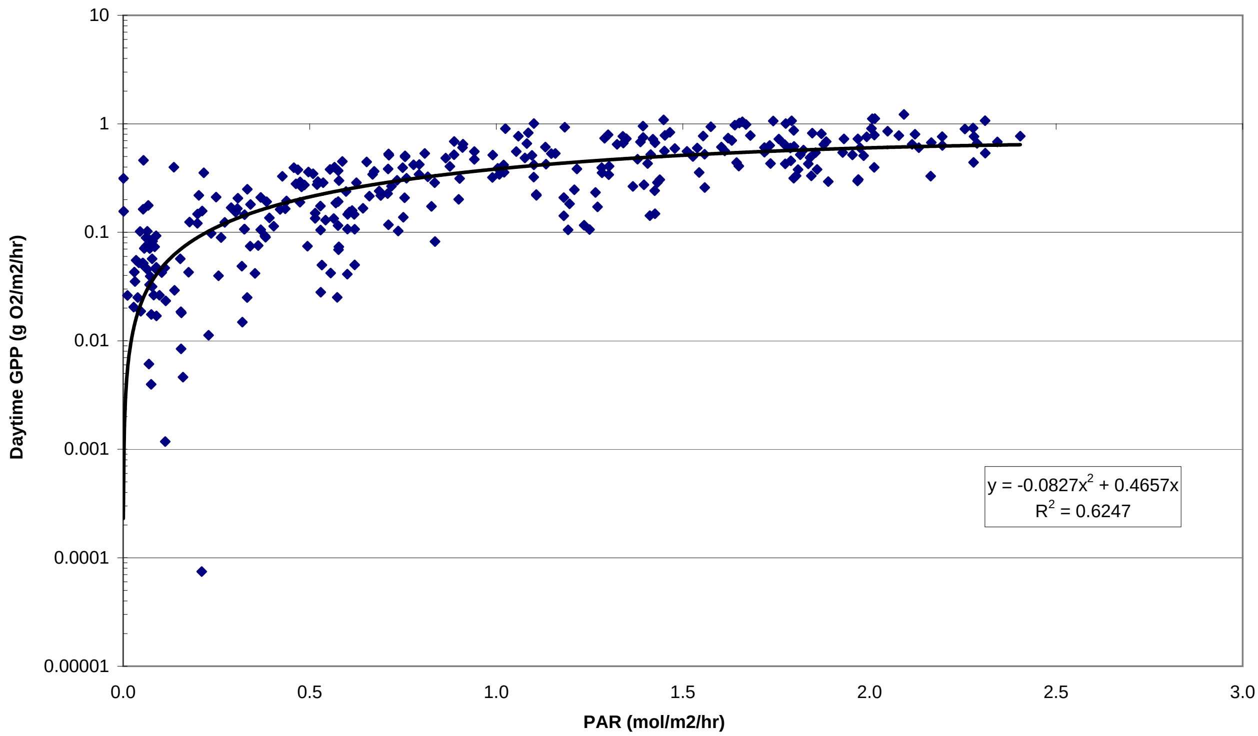


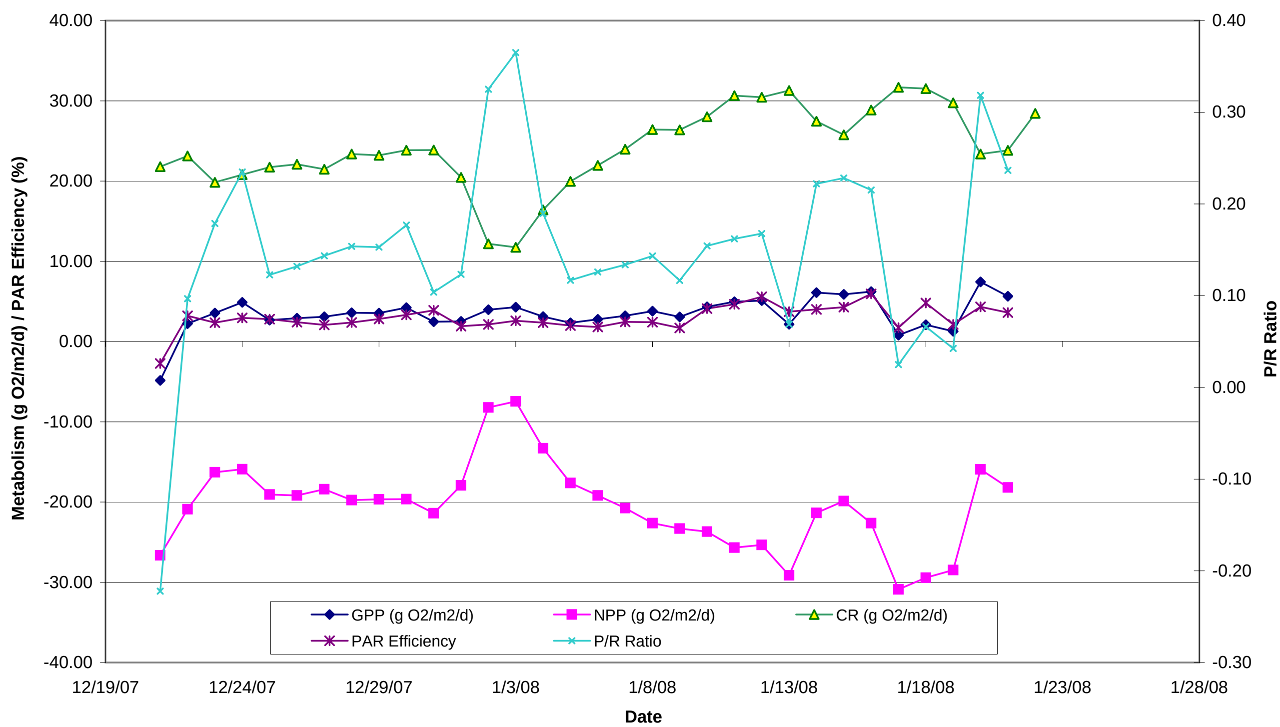






Parameter	Units	Avg	Min	Max	N
DO - up	mg/L	0.02	0.02	0.02	665
down		0.46	0.31	0.94	665
Wtr Temp - up	C				
down		23.0	22.9	23.2	665
pH - up	SU				
down		7.38	7.35	7.43	665
SpCond - up	uS/cm				
down		2115	2050	2133	665
Flow - up	m^3/d	337,791	330,288	344,967	15
Depth	m	1.24	1.18	1.31	15
Rainfall Total	in		1.65		
PAR - air	umol/m^2/s	276	0.0	1,294	360
plant		149	0.0	696	313
DO rate chng	g/m^2/hr				
corr		-0.423	-0.776	0.501	313
uncorr		0.863	0.575	1.769	313

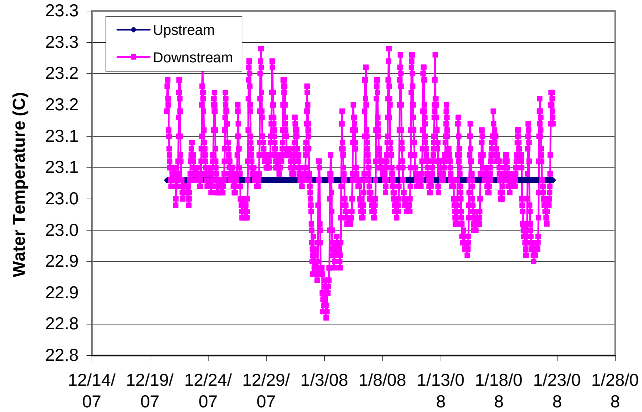


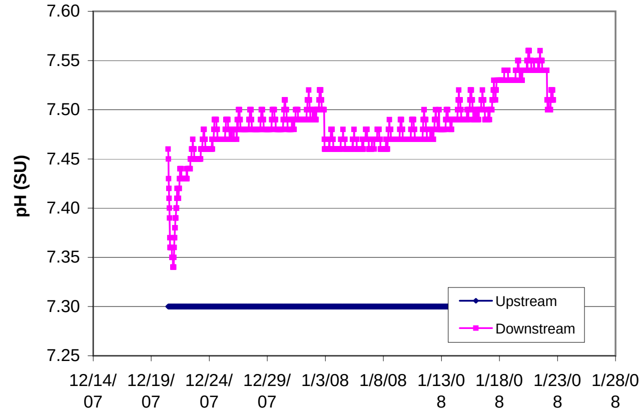


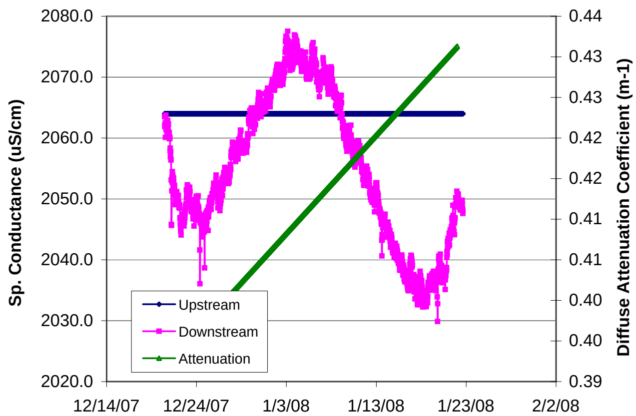
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-355 METABOLISM ESTIMATES

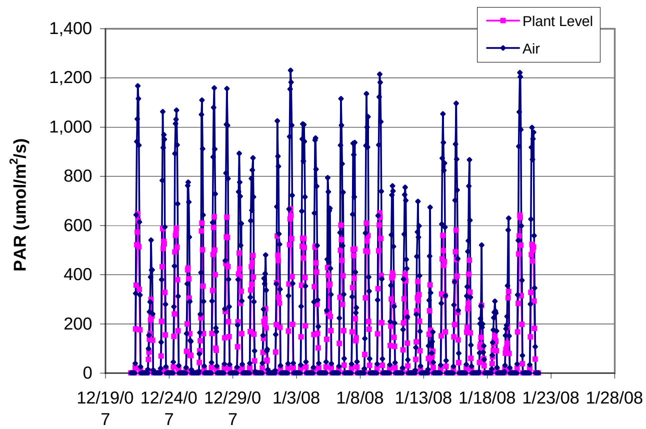
Stats	GPP	NPP	CR	P/R ratio	PAR Eff. (%)
	($g O_2/m^2/d$)				
Avg	3.42	-20.56	24.11	0.15	2.93
Max	7.44	-7.46	31.68	0.37	5.94
Min	-4.84	-30.89	11.75	-0.22	-2.74

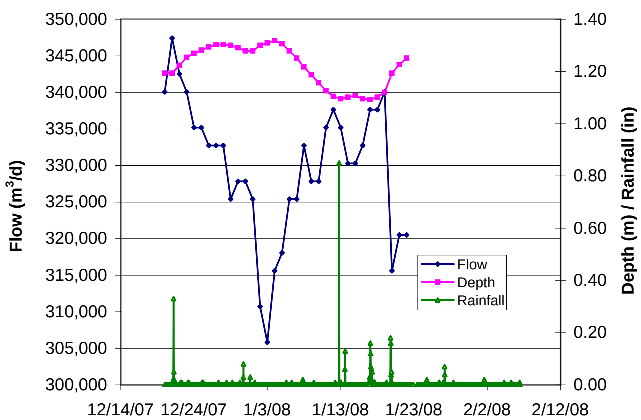
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-355 METABOLISM SUMMARY



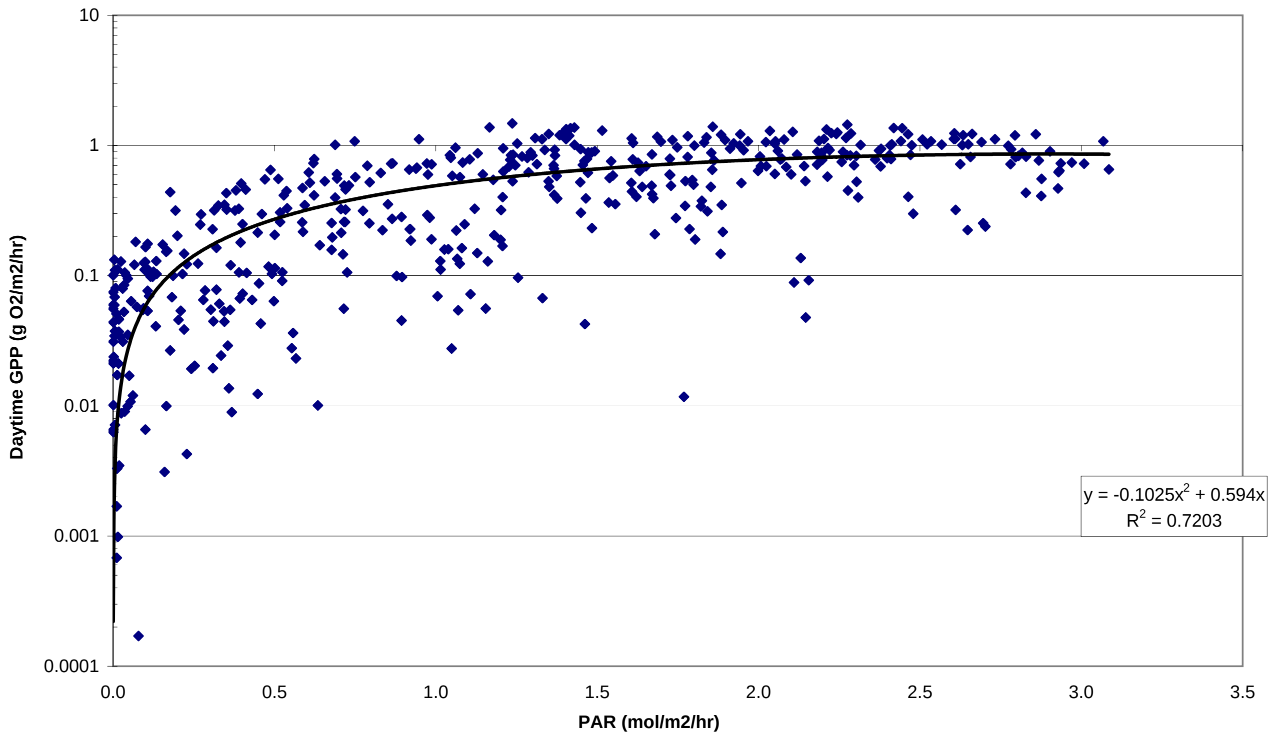


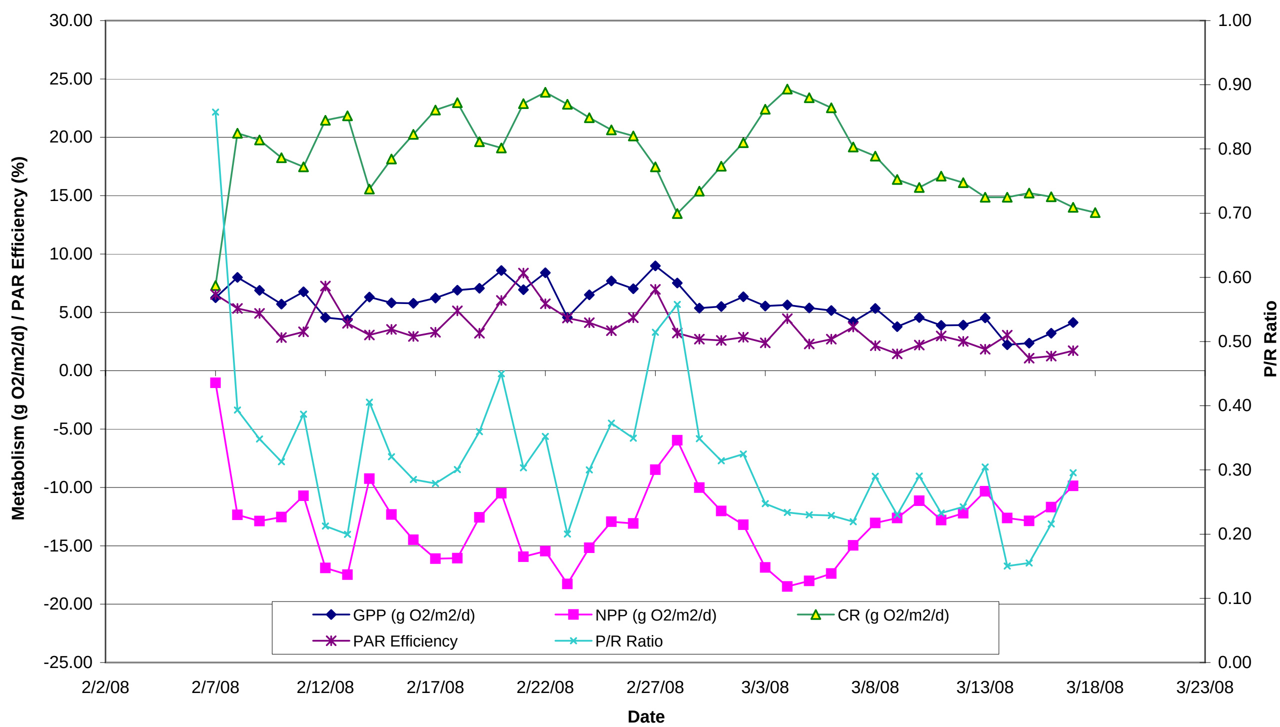






Parameter	Units	Avg	Min	Max	N
DO - up	mg/L	0.01	0.01	0.01	1594
down		0.25	0.00	1.02	1594
Wtr Temp - up	C	23.0	23.0	23.0	1594
down		23.0	22.8	23.2	1594
pH - up	SU	7.30	7.30	7.30	1594
down		7.48	7.34	7.56	1594
SpCond - up	uS/cm	2064	2064	2064	1594
down		2055	2030	2078	1594
Flow - up	m^3/d	329,640	305,822	347,414	34
Depth	m	1.22	1.09	1.32	34
Rainfall Total	in		3.08		
PAR - air	$umol/m^2/s$	231	0.0	1,453	1153
plant		116	0.0	668	769
DO rate chng	$g/m^2/hr$				
corr		-0.860	-1.407	0.387	769
uncorr		0.441	-0.020	1.476	769

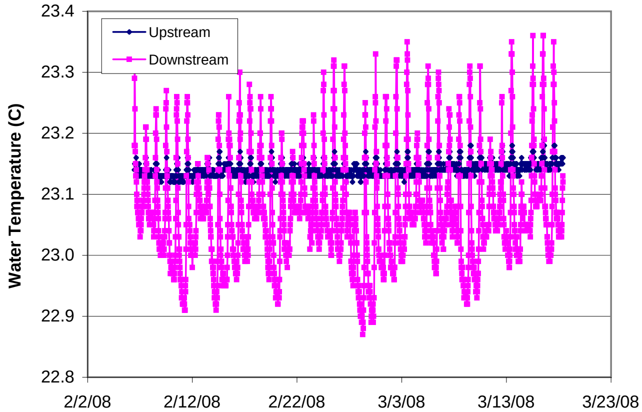


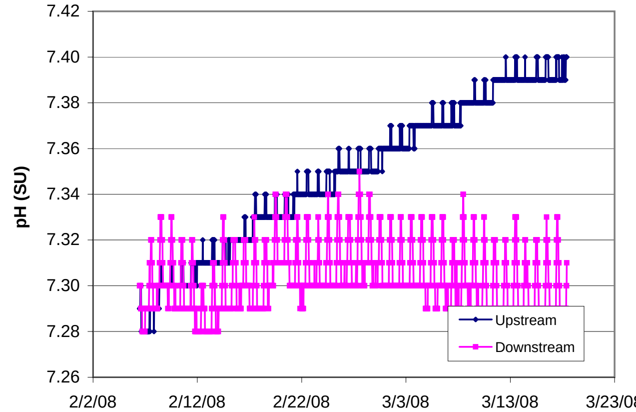


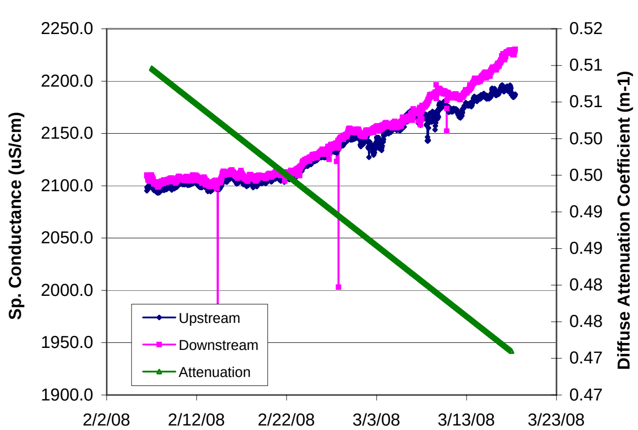
Stats	GPP	NPP	CR	P/R ratio	PAR Eff. (%)
	(g $O_2/m^2/d$)				
Avg	5.70	-13.01	18.59	0.32	3.66
Max	8.99	-1.04	24.13	0.86	8.36
Min	2.23	-18.49	7.29	0.15	1.07

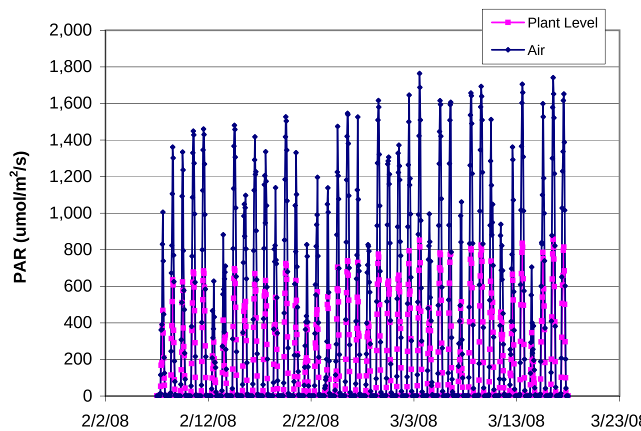
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-355 METABOLISM ESTIMATES

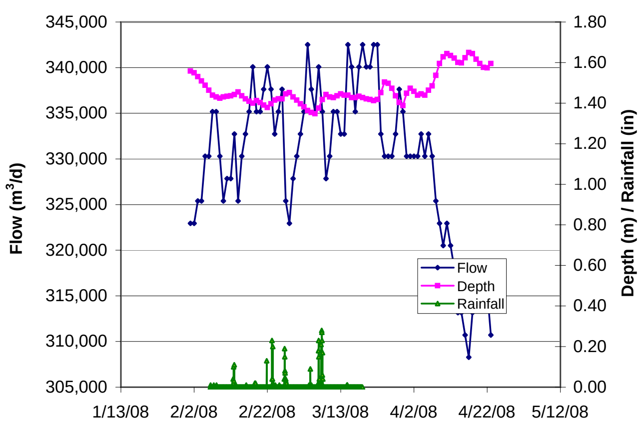
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-355 METABOLISM SUMMARY



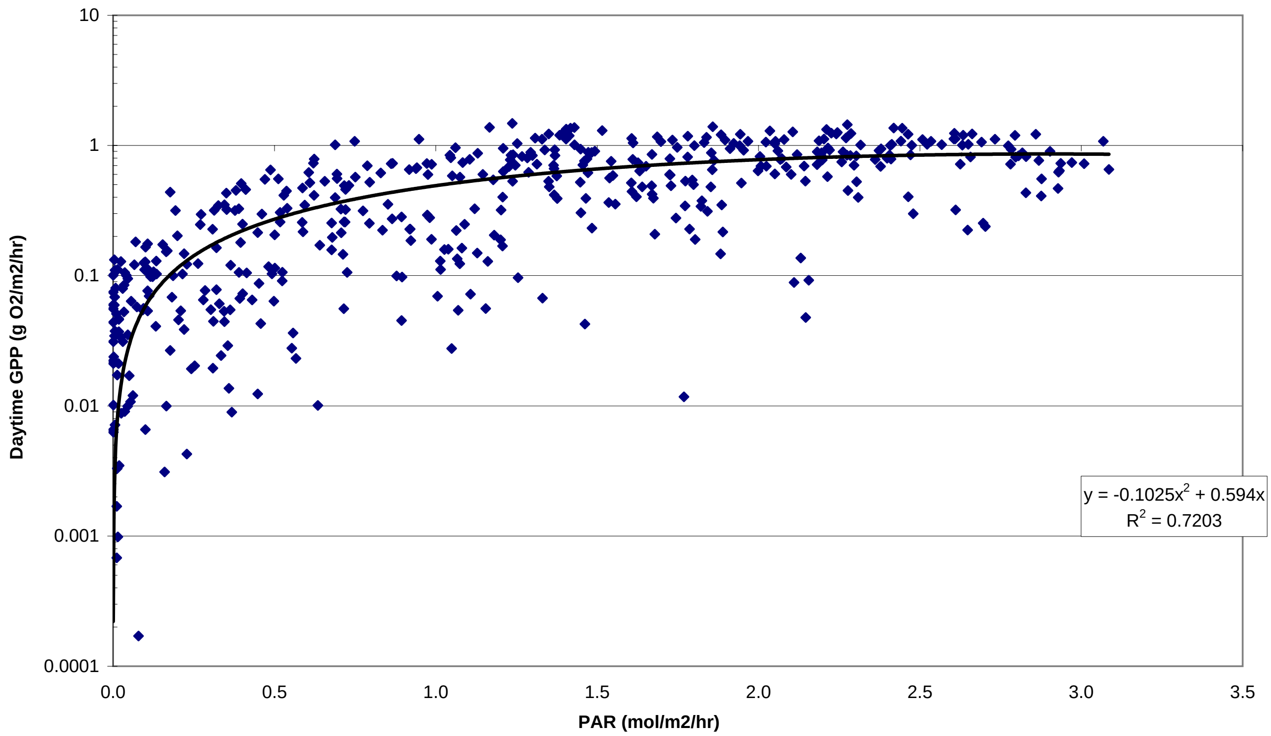


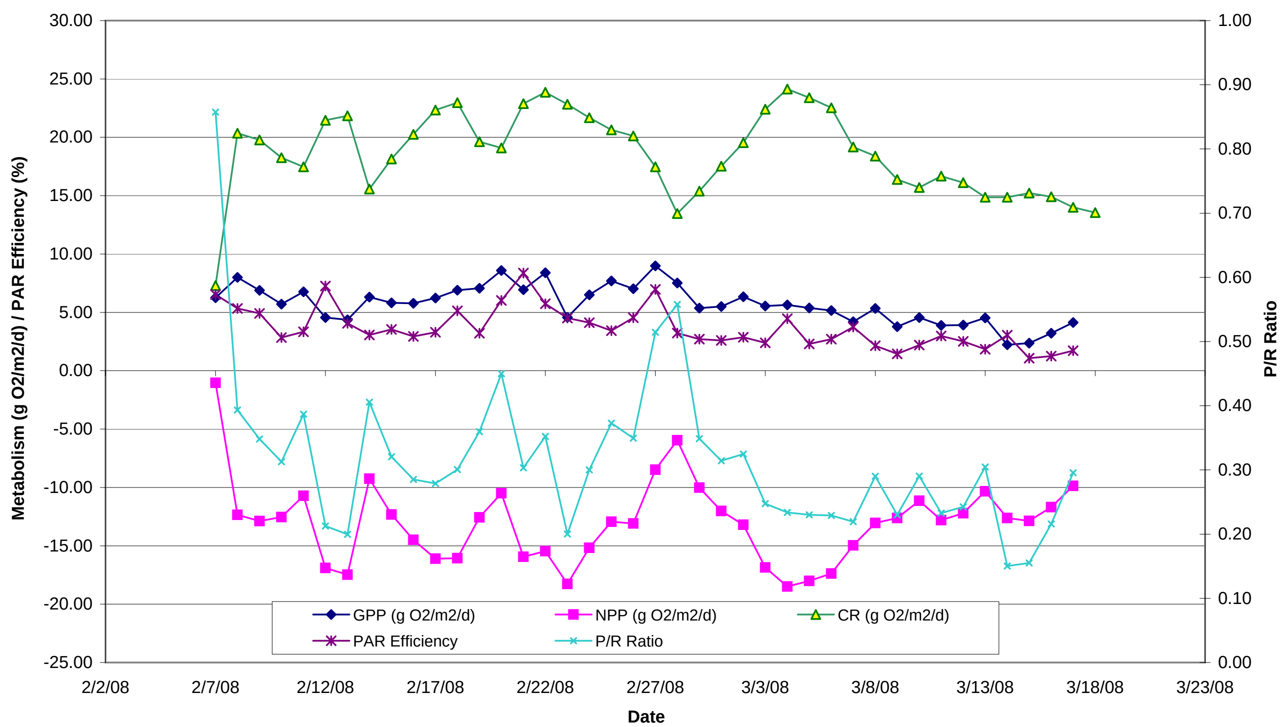






Parameter	Units	Avg	Min	Max	N
DO - up	mg/L	0.07	-0.01	0.14	1967
down		0.60	0.28	1.76	1967
Wtr Temp - up	C	23.1	23.1	23.2	1967
down		23.1	22.9	23.4	1967
pH - up	SU	7.35	7.28	7.40	1967
down		7.30	7.28	7.35	1967
SpCond - up	uS/cm	2135	2093	2196	1967
down		2144	1933	2230	1967
Flow - up	m^3/d	330,022	308,269	342,521	83
Depth	m	1.47	1.35	1.65	83
Rainfall Total	in		3.95		
PAR - air	$umol/m^2/s$	339	0.0	1,764	1000
plant		164	0.0	857	961
DO rate chng	$g/m^2/hr$				
corr		-0.544	-1.038	0.813	961
uncorr		1.069	0.551	2.260	961

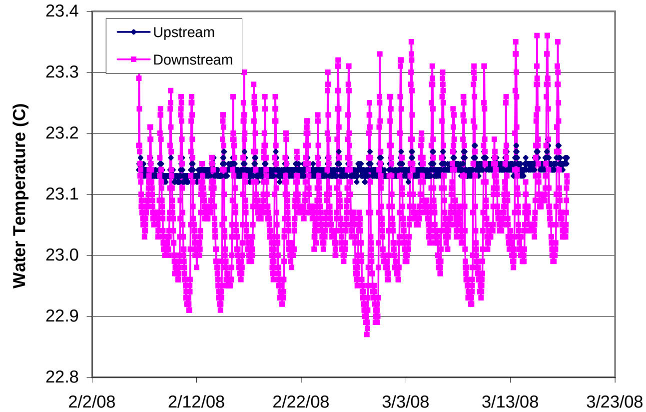


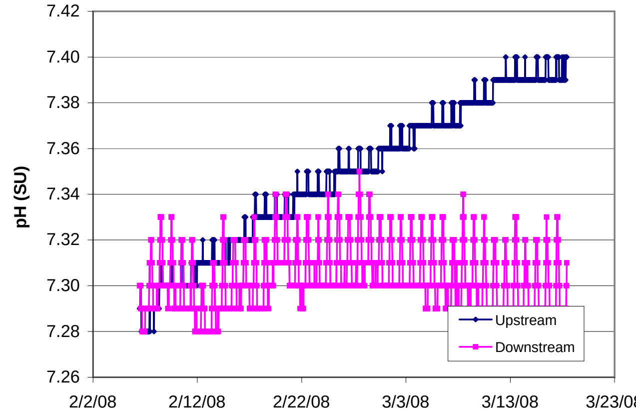


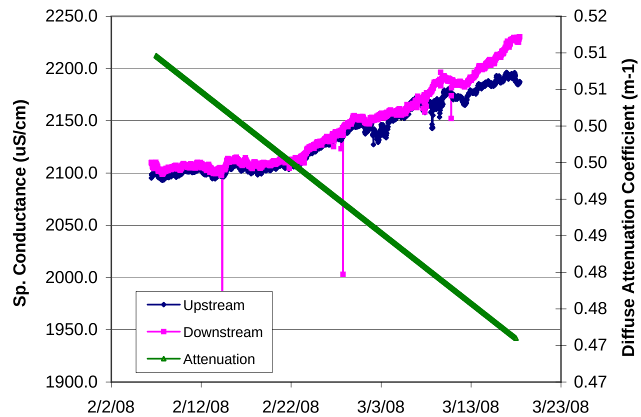
Stats	GPP	NPP	CR	P/R ratio	PAR Eff. (%)
	(g O_2/m^2/d)				
Avg	5.70	-13.01	18.59	0.32	3.66
Max	8.99	-1.04	24.13	0.86	8.36
Min	2.23	-18.49	7.29	0.15	1.07

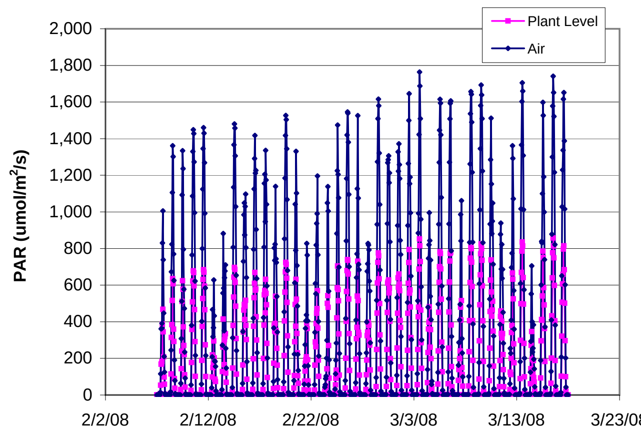
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-355 METABOLISM ESTIMATES

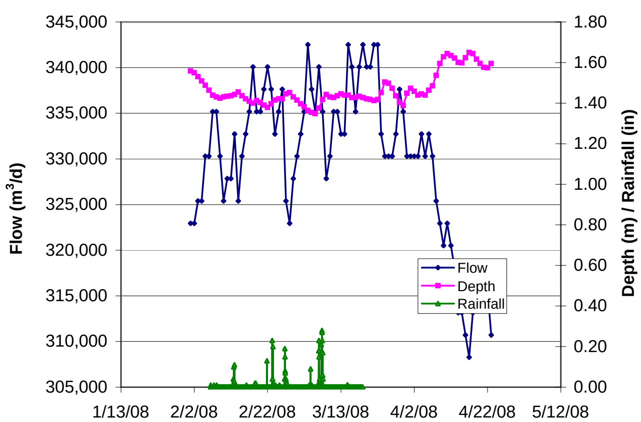
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-355 METABOLISM SUMMARY



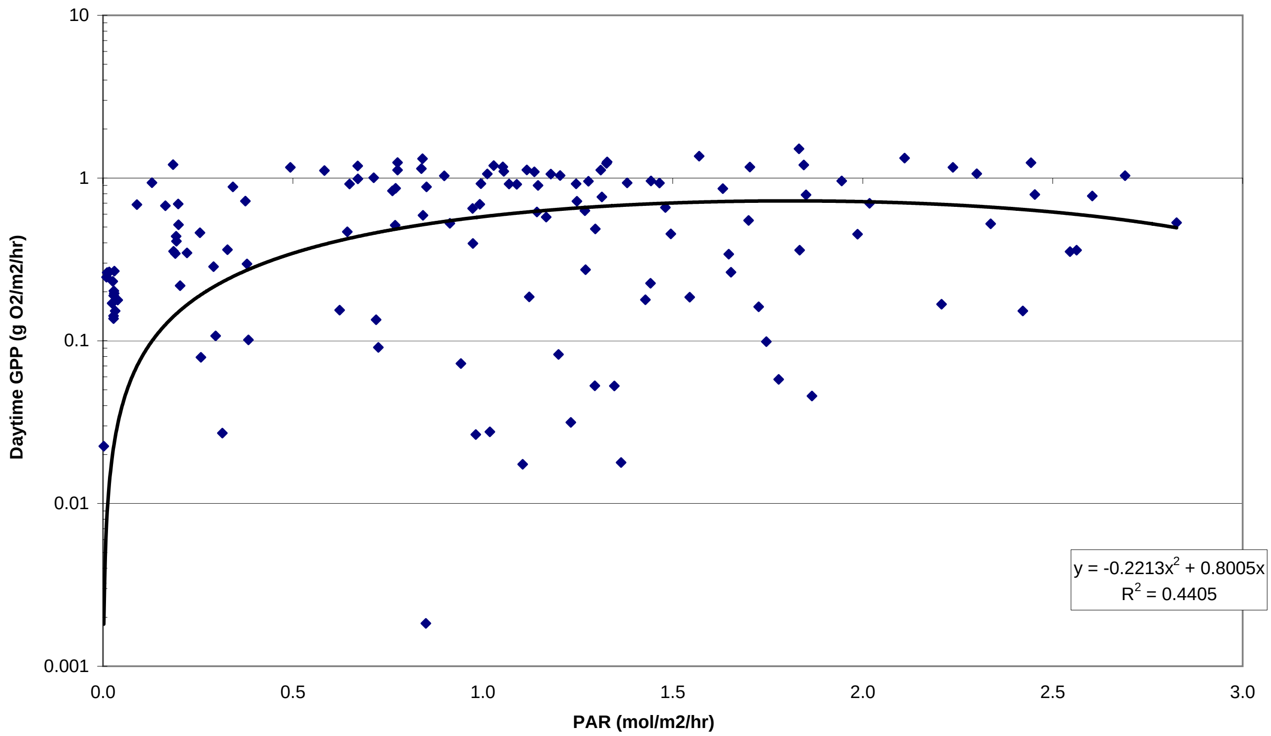


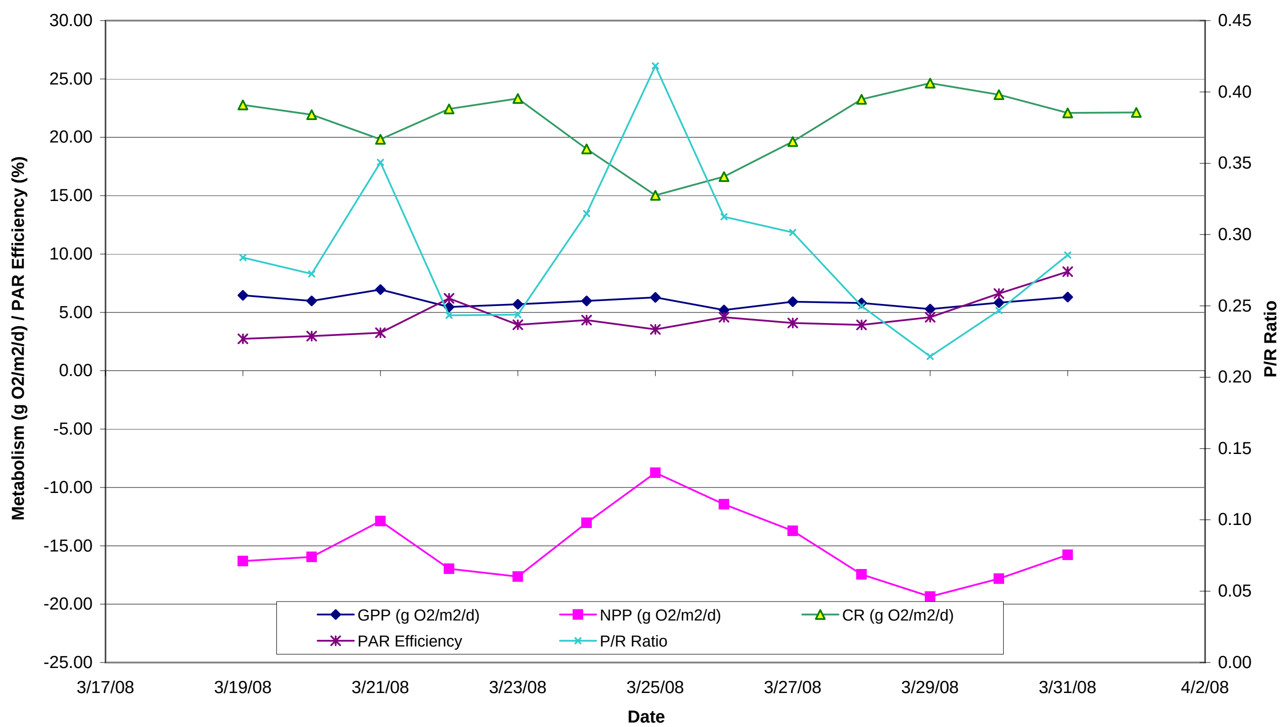






Parameter	Units	Avg	Min	Max	N
DO - up	mg/L	0.07	-0.01	0.14	1967
down		0.60	0.28	1.76	1967
Wtr Temp - up	C	23.1	23.1	23.2	1967
down		23.1	22.9	23.4	1967
pH - up	SU	7.35	7.28	7.40	1967
down		7.30	7.28	7.35	1967
SpCond - up	uS/cm	2135	2093	2196	1967
down		2144	1933	2230	1967
Flow - up	m^3/d	330,022	308,269	342,521	83
Depth	m	1.47	1.35	1.65	83
Rainfall Total	in		3.95		
PAR - air	$umol/m^2/s$	339	0.0	1,764	1000
plant		164	0.0	857	961
DO rate chng	$g/m^2/hr$				
corr		-0.544	-1.038	0.813	961
uncorr		1.069	0.551	2.260	961

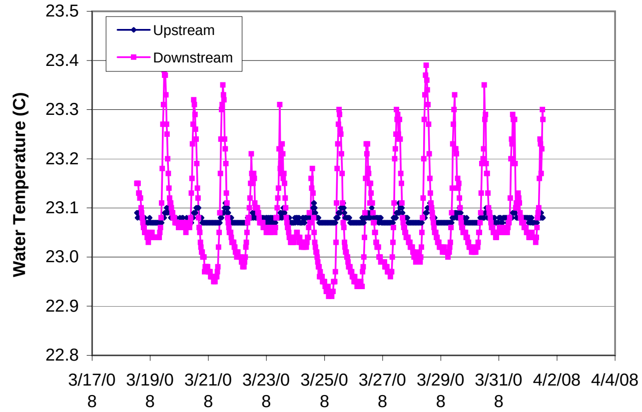


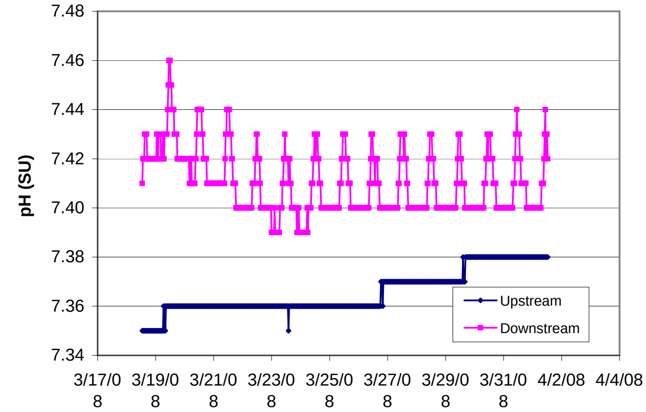


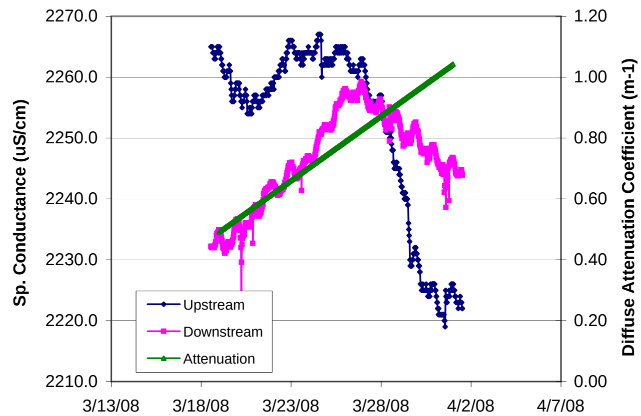
Stats	GPP	NPP	CR	P/R ratio	PAR Eff. (%)
	(g O_2/m^2/d)				
Avg	5.94	-15.16	21.17	0.29	4.56
Max	6.95	-8.74	24.64	0.42	8.50
Min	5.20	-19.36	15.03	0.21	2.74

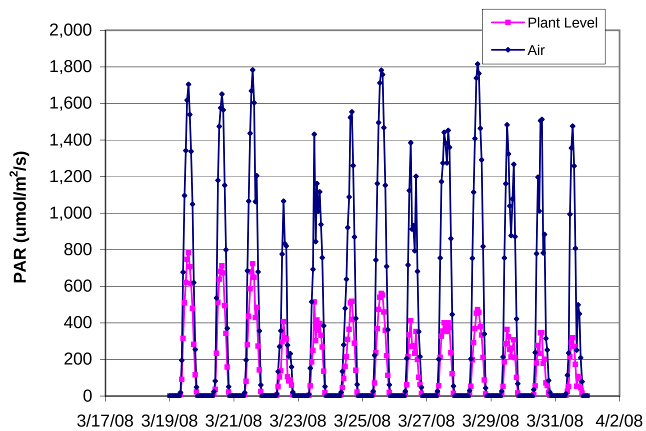
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-355 METABOLISM ESTIMATES

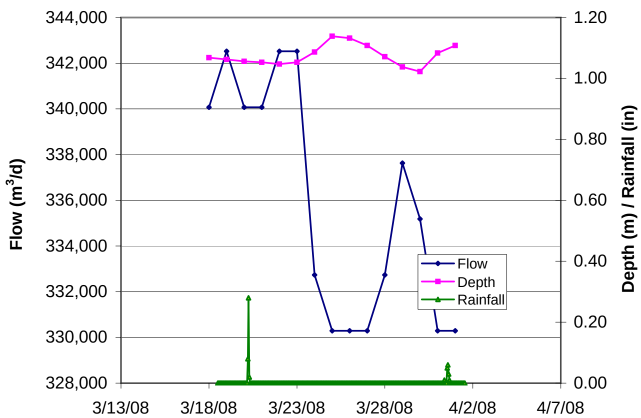
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-355 METABOLISM SUMMARY



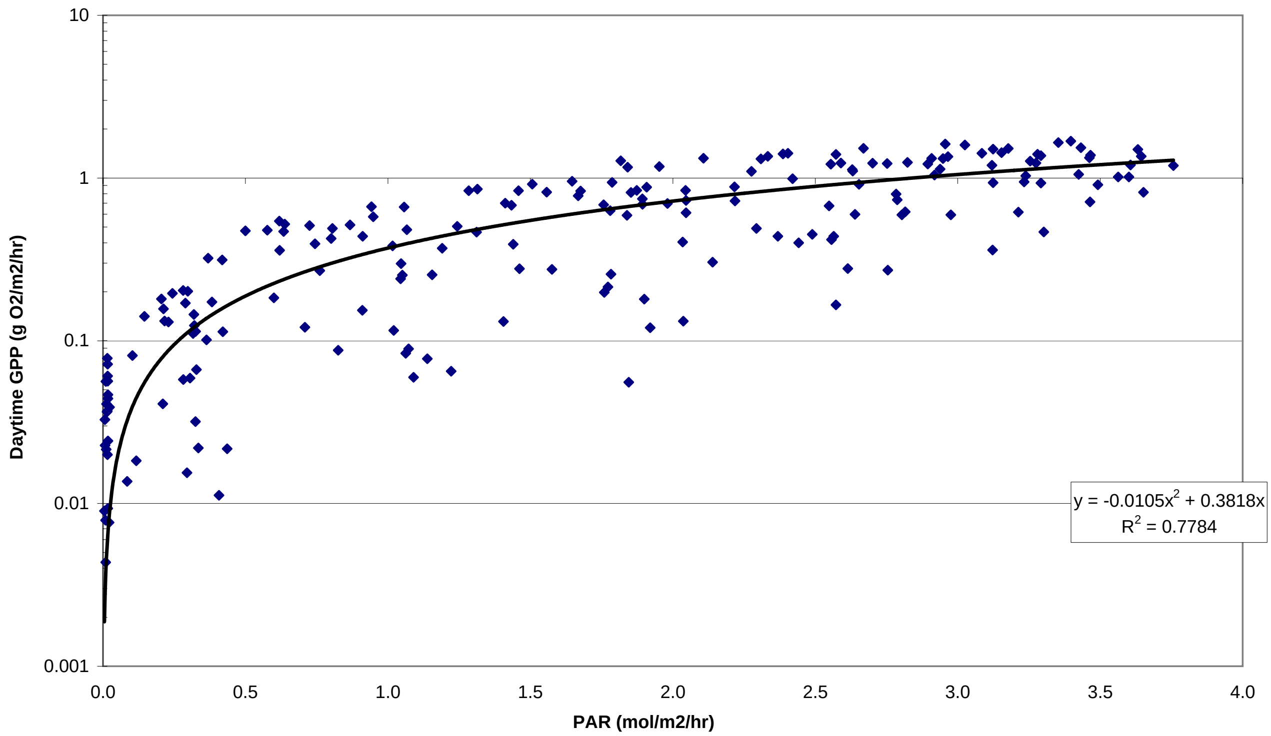


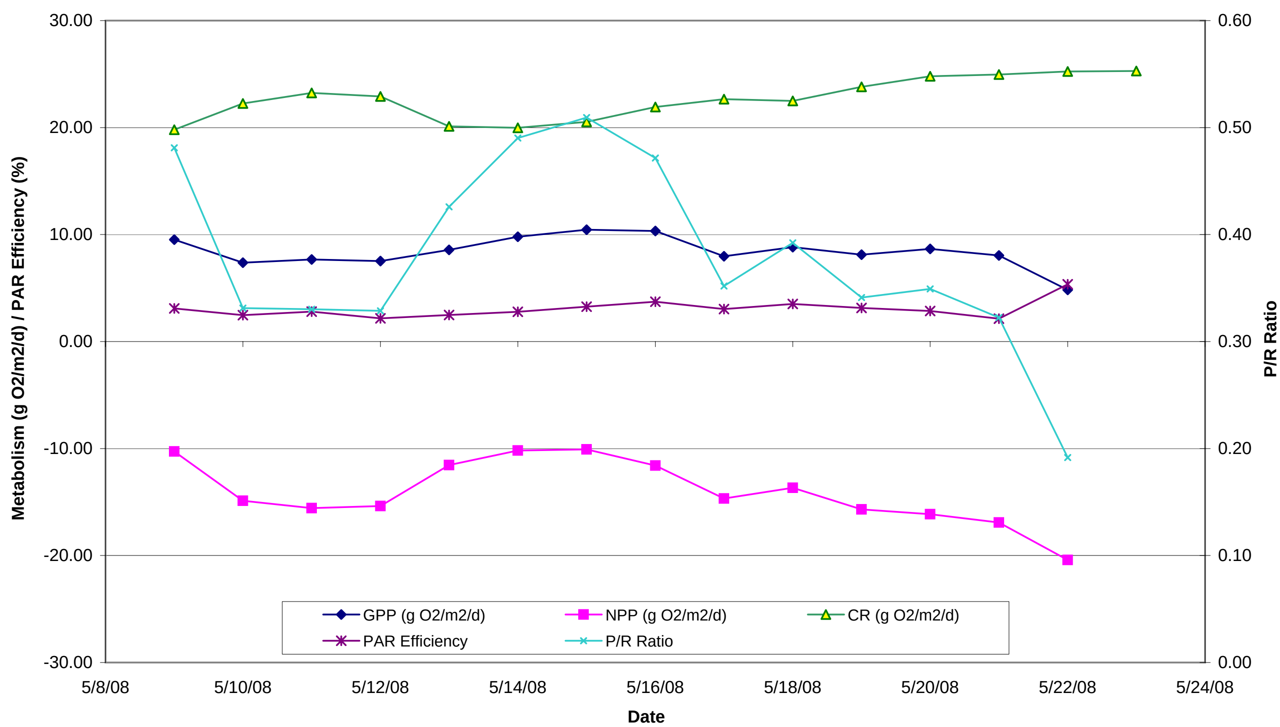






Parameter	Units	Avg	Min	Max	N
DO - up	mg/L	0.01	-0.02	0.14	662
down		0.46	0.24	1.10	662
Wtr Temp - up	C	23.1	23.1	23.1	672
down		23.1	22.9	23.4	672
pH - up	SU	7.37	7.35	7.38	672
down		7.41	7.39	7.46	672
SpCond - up	uS/cm	2252	2219	2267	672
down		2246	2222	2259	672
Flow - up	m^3/d	335,833	330,288	342,521	15
Depth	m	1.08	1.02	1.14	15
Rainfall Total	in		0.54		
PAR - air	$umol/m^2/s$	412	0.0	1,815	343
plant		135	0.0	785	313
DO rate chng	$g/m^2/hr$				
corr		-0.632	-1.087	0.630	313
uncorr		0.923	0.512	2.117	313

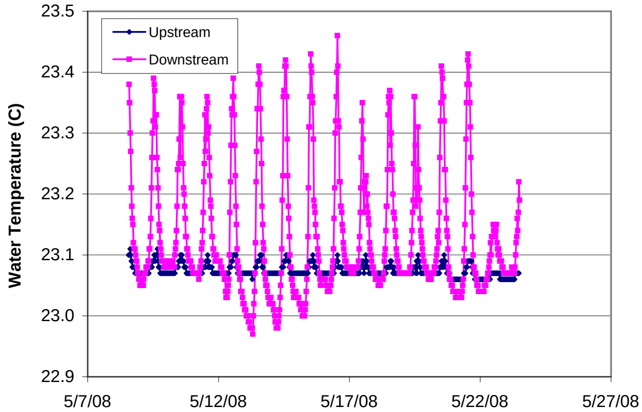


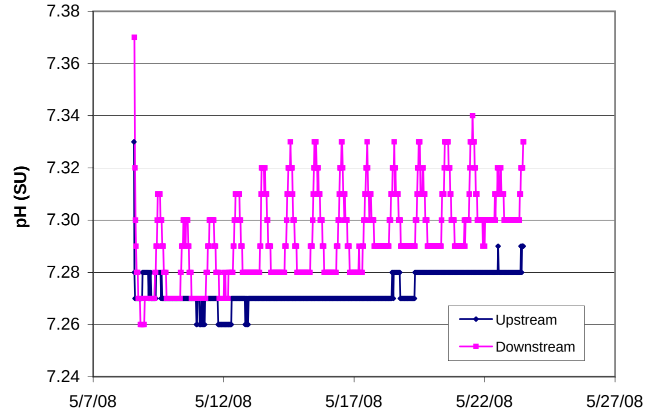


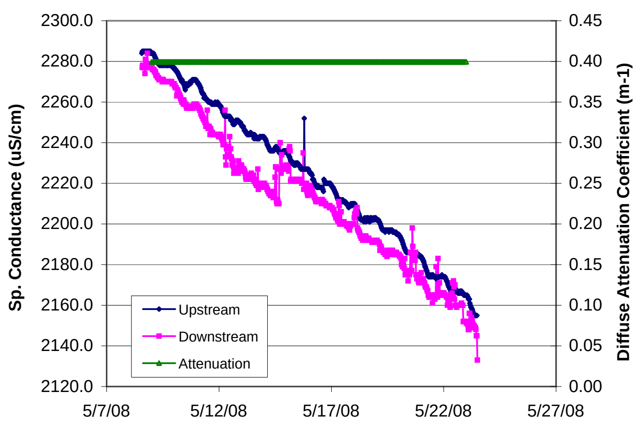
Stats	GPP	NPP	CR	P/R	PAR Eff.
	($g\ O_2/m^2/d$)			ratio	(%)
Avg	8.41	-14.07	22.66	0.38	3.06
Max	10.46	-10.07	25.29	0.51	5.36
Min	4.84	-20.41	19.80	0.19	2.14

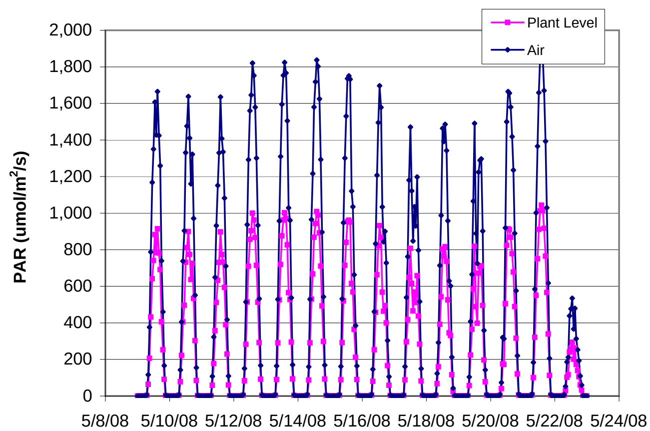
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-355 METABOLISM ESTIMATES

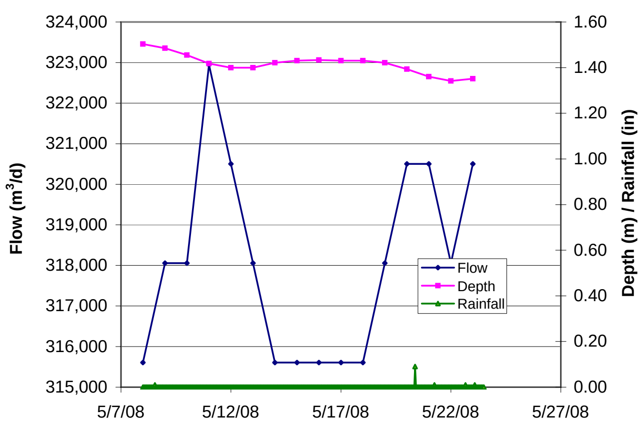
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-355 METABOLISM SUMMARY



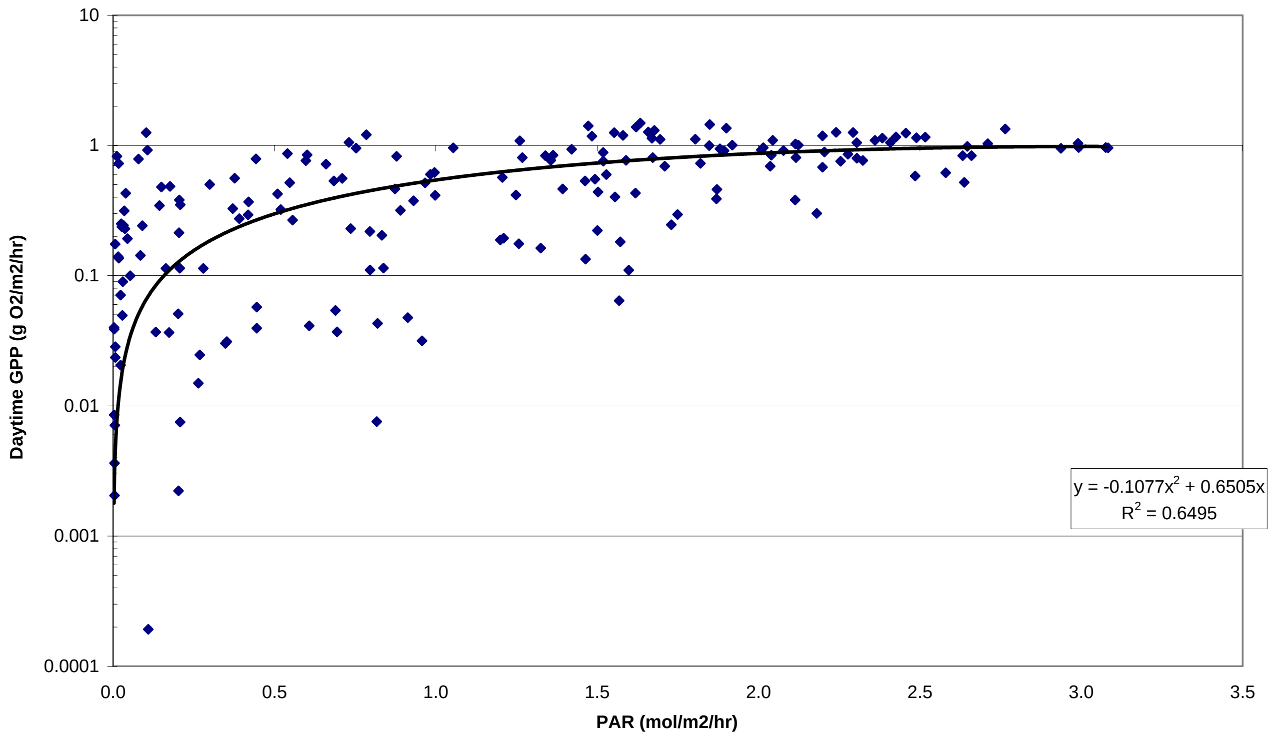


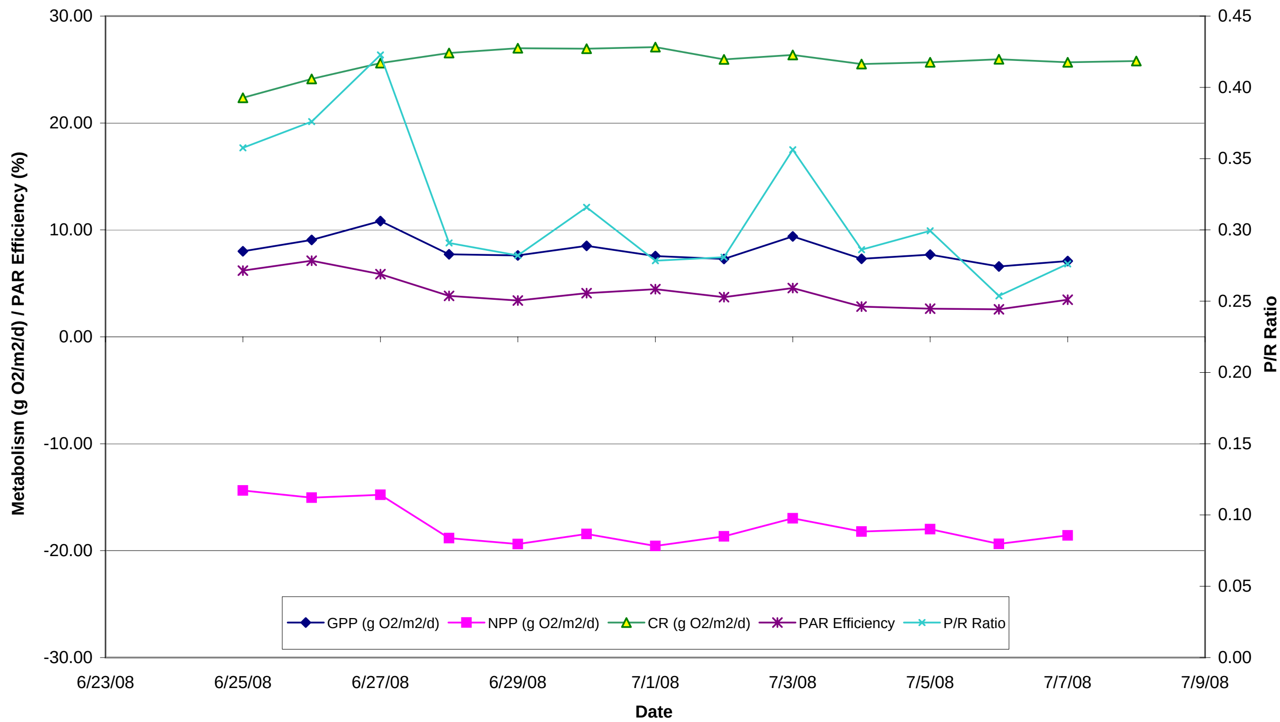






Parameter	Units	Avg	Min	Max	N
DO - up	mg/L	0.03	0.00	0.62	717
down		0.51	0.27	1.61	717
Wtr Temp - up	C	23.1	23.1	23.1	717
down		23.1	23.0	23.5	717
pH - up	SU	7.27	7.26	7.33	717
down		7.29	7.26	7.37	717
SpCond - up	uS/cm	2224	2155	2285	717
down		2213	2133	2284	717
Flow - up	m^3/d	318,055	315,608	322,948	16
Depth	m	1.42	1.34	1.50	16
Rainfall Total	in		0.13		
PAR - air	umol/m^2/s	490	0.0	1,900	373
plant		271	0.0	1044	337
DO rate chng	g/m^2/hr				
corr		-0.594	-1.067	0.831	337
uncorr		0.932	0.525	2.241	337

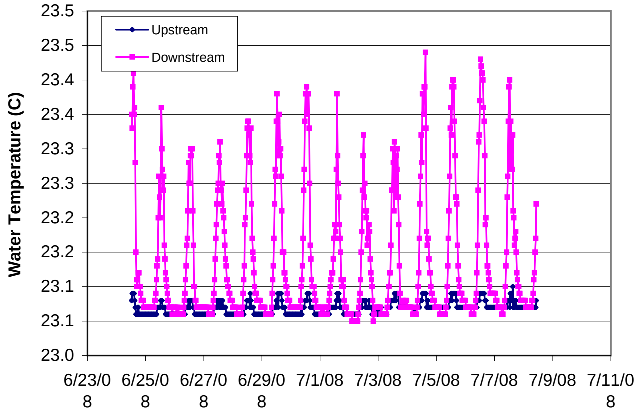


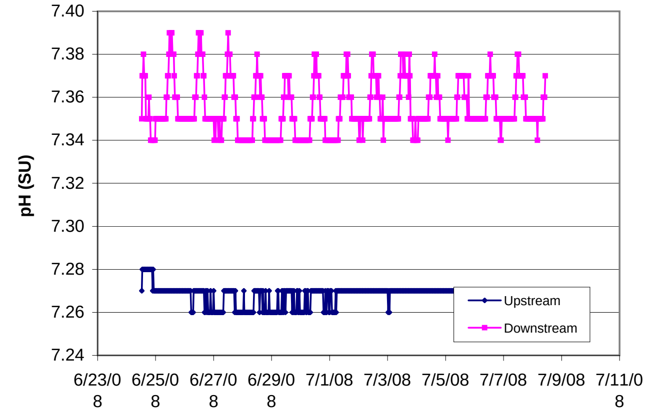


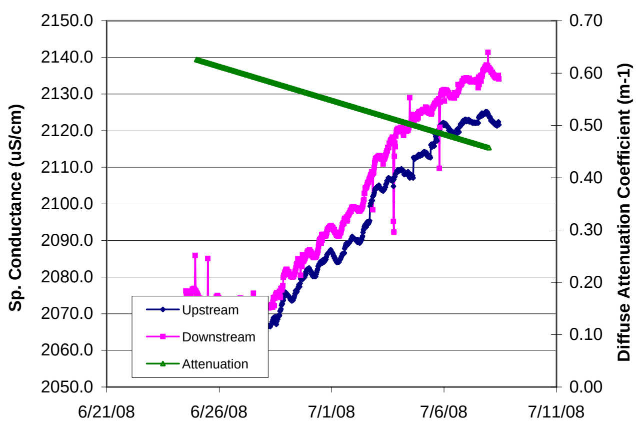
	GPP	NPP	CR	P/R	PAR Eff.
Stats	($g\ O_2/m^2/d$)			ratio	(%)
Avg	8.05	-17.71	25.76	0.31	4.21
Max	10.82	-14.37	27.11	0.42	7.11
Min	6.58	-19.56	22.36	0.25	2.57

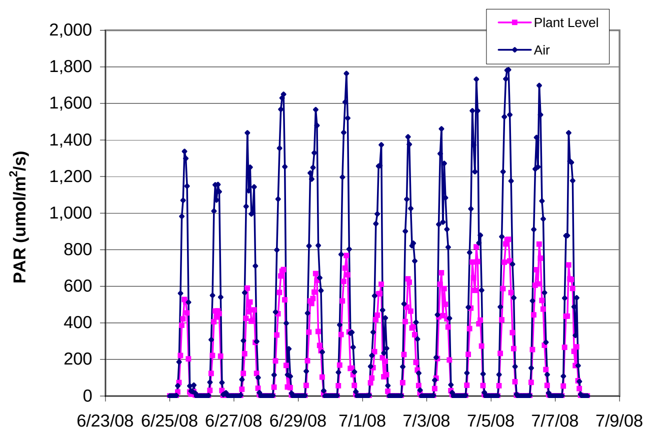
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-355 METABOLISM ESTIMATES

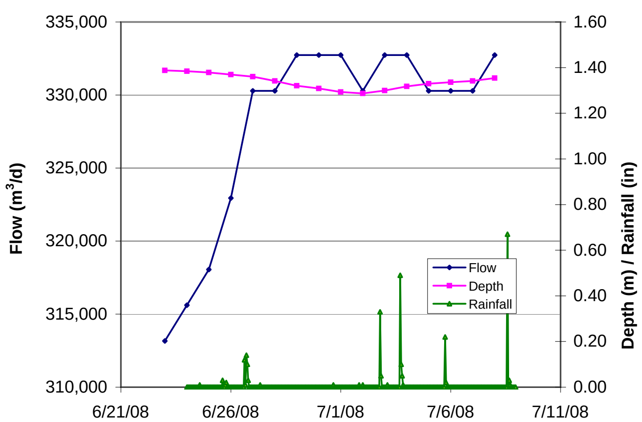
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-355 METABOLISM SUMMARY



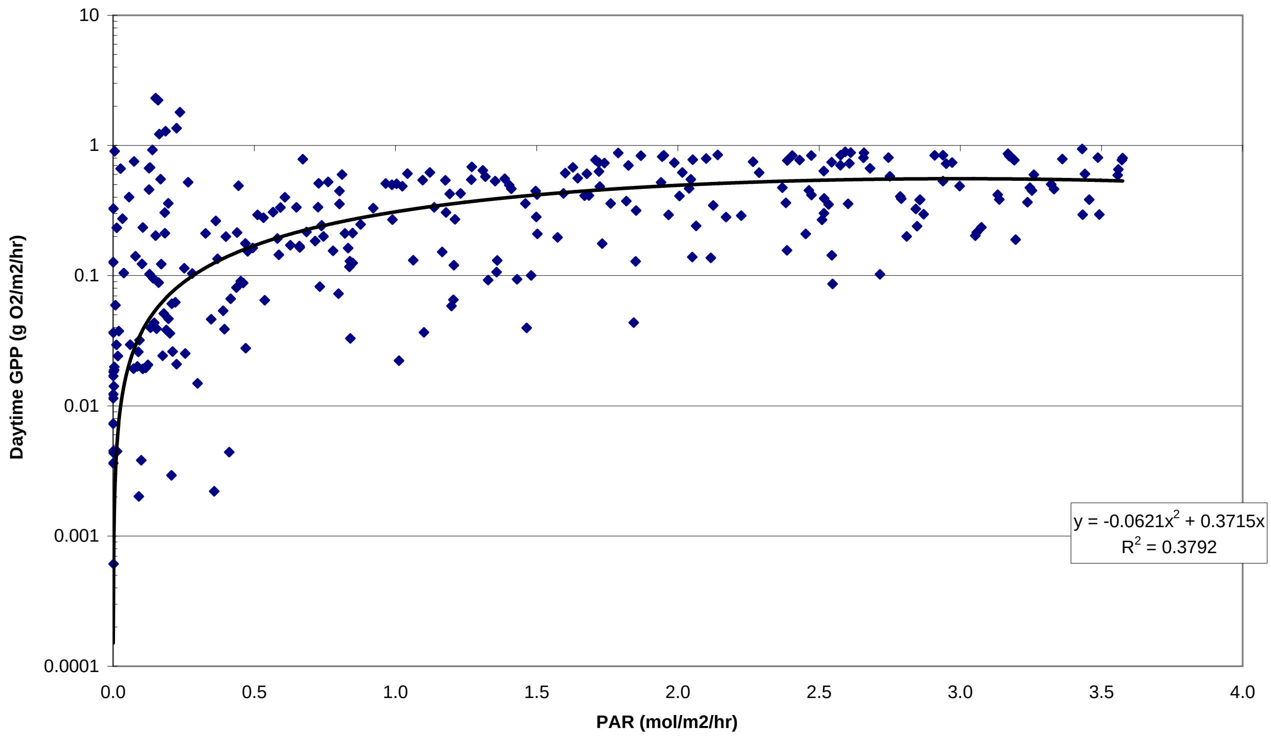


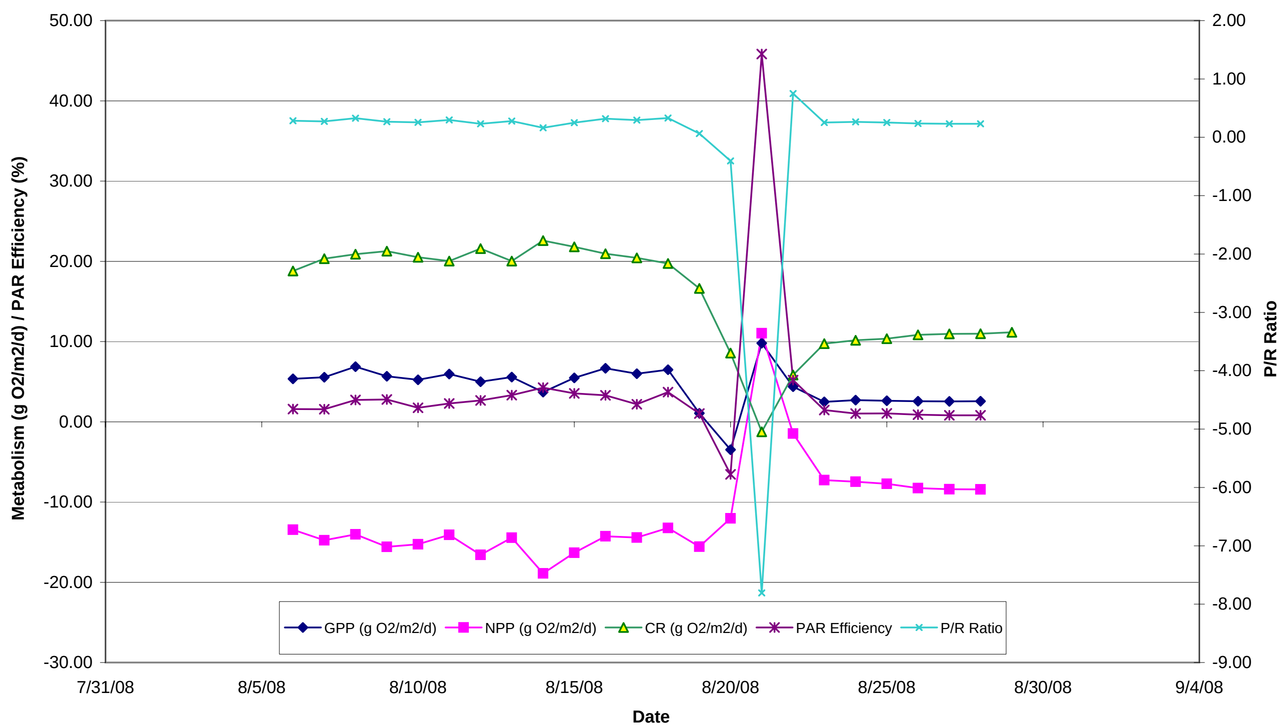






Parameter	Units	Avg	Min	Max	N
DO - up	mg/L	0.04	0.00	0.25	669
down		0.55	0.31	1.55	669
Wtr Temp - up	C	23.1	23.1	23.1	669
down		23.1	23.1	23.4	669
pH - up	SU	7.27	7.26	7.28	669
down		7.35	7.34	7.39	669
SpCond - up	uS/cm	2092	2063	2125	669
down		2100	2059	2141	669
Flow - up	m^3/d	327,994	313,162	332,734	16
Depth	m	1.34	1.29	1.39	16
Rainfall Total	in		2.51		
PAR - air	$umol/m^2/s$	419	0.0	1,784	360
plant		190	0.0	856	313
DO rate chng	$g/m^2/hr$				
corr		-0.742	-1.178	0.484	313
uncorr		1.030	0.651	2.025	313

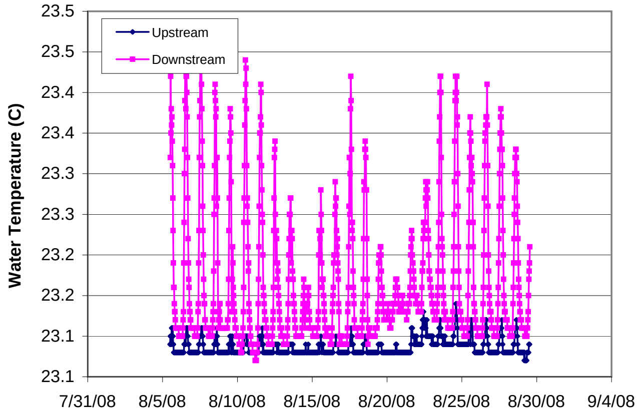


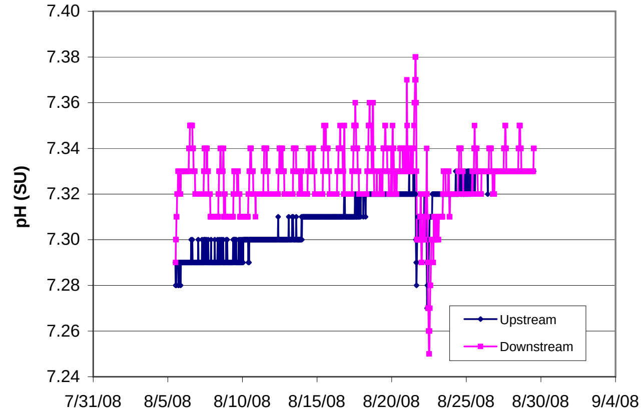


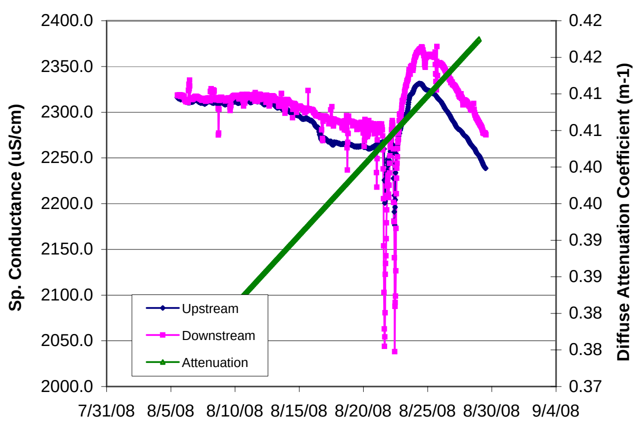
Stats	GPP	NPP	CR	P/R ratio	PAR Eff. (%)
	(g $O_2/m^2/d$)				
Avg	4.38	-11.35	15.54	-0.10	3.79
Max	9.79	11.05	22.59	0.75	45.84
Min	-3.47	-18.90	-1.25	-7.81	-6.55

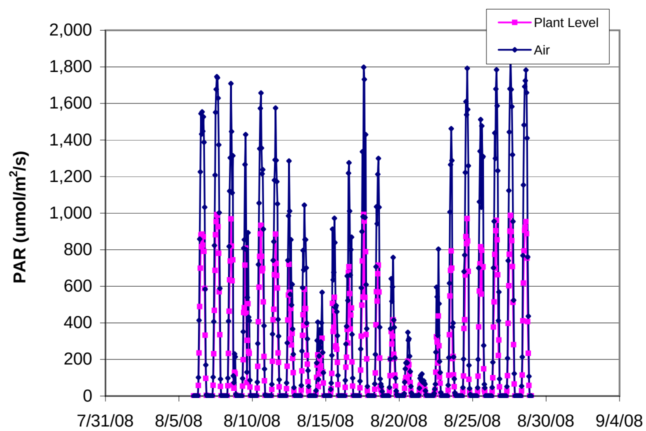
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-355 METABOLISM ESTIMATES

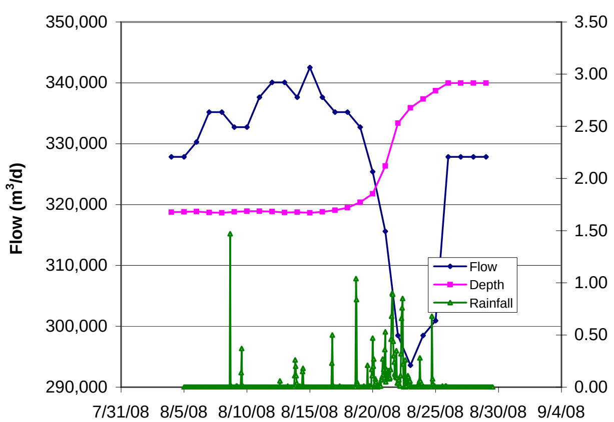
VOLUSIA BLUE SPRING - MAIN BOIL TO VBS-355 METABOLISM SUMMARY











Parameter	Units	Avg	Min	Max	N
DO - up	mg/L	0.03	0.00	0.34	1154
down		0.28	0.01	1.94	1154
Wtr Temp - up	C	23.1	23.1	23.1	1154
down		23.2	23.1	23.5	1154
pH - up	SU	7.31	7.27	7.33	1154
down		7.33	7.25	7.38	1154
SpCond - up	uS/cm	2291	2177	2331	1154
down		2307	2038	2372	1154
Flow - up	m^3/d	327,088	293,589	342,521	26
Depth	m	2.06	1.67	2.91	26
Rainfall Total	in		20.40		
PAR - air	$umol/m^2/s$	357	0.0	1,841	569
plant		196	0.0	993	553
DO rate chng	$g/m^2/hr$				
corr		-0.468	-0.975	2.070	553
uncorr		0.441	0.003	2.615	553

METABOLISM WORKSHEET - DAILY DETAIL
VOLUSIA BLUE SPRING - VBS-355 TO VBS-570

Date	GPP ($g\ O_2/m^2/d$)	NPP ($g\ O_2/m^2/d$)	CR ($g\ O_2/m^2/d$)	P/R Ratio	PAR (24hr) ($mol/m^2/d$)	PAR Efficiency (%)	PAR Efficiency ($g\ O_2/mol$)
11/13/2007	1.30	-11.06	12.36	0.10	15.65	0.67	0.08
11/16/2007	1.36	-8.74	10.10	0.13	16.71	0.66	0.08
11/17/2007	0.18	-12.07	12.25	0.01	16.54	0.09	0.01
11/18/2007	0.24	-15.46	15.70	0.02	12.54	0.15	0.02
11/19/2007	0.30	-19.50	19.80	0.02	12.79	0.19	0.02
11/22/2007	0.44	-16.29	16.73	0.03	5.67	0.63	0.08
11/23/2007	2.72	-11.98	14.70	0.19	10.61	2.07	0.26
11/24/2007	1.67	-12.05	13.72	0.12	12.11	1.11	0.14
11/25/2007	0.63	-16.07	16.69	0.04	10.84	0.47	0.06
11/26/2007	0.68	-10.73	11.41	0.06	13.80	0.40	0.05
12/9/2007	0.76	-2.50	3.27	0.23	13.70	0.45	0.06
12/10/2007	1.13	-1.73	2.86	0.40	11.68	0.78	0.10
12/11/2007	0.98	-2.64	3.62	0.27	13.22	0.60	0.07
12/12/2007	1.75	-1.18	2.93	0.60	13.57	1.04	0.13
12/13/2007	2.08	-1.11	3.19	0.65	13.38	1.25	0.16
12/14/2007	3.54	-2.67	6.21	0.57	11.00	2.60	0.32
12/15/2007	1.89	-5.75	7.64	0.25	12.58	1.21	0.15
12/18/2007	2.70	1.90	0.80	3.38	11.15	1.96	0.24
12/19/2007	1.66	0.25	1.41	1.18	13.20	1.02	0.13
12/21/2007	5.11	-0.31	5.42	0.94	14.28	2.89	0.36
12/22/2007	5.40	0.20	5.20	1.04	5.64	7.73	0.96
12/23/2007	2.55	-9.83	12.38	0.21	12.16	1.69	0.21
12/24/2007	4.49	-5.43	9.92	0.45	13.36	2.72	0.34
12/25/2007	3.39	-6.27	9.67	0.35	7.75	3.54	0.44
12/26/2007	3.74	-1.26	5.00	0.75	9.79	3.09	0.38
12/27/2007	0.93	-3.64	4.57	0.20	12.06	0.62	0.08
12/28/2007	3.41	-1.91	5.32	0.64	12.31	2.23	0.28
12/29/2007	5.04	-4.86	9.90	0.51	10.24	3.97	0.49
12/30/2007	5.75	-5.42	11.17	0.51	10.31	4.50	0.56
12/31/2007	3.49	-6.81	10.30	0.34	5.17	5.44	0.67
1/1/2008	2.11	-2.52	4.62	0.46	10.66	1.60	0.20
1/2/2008	4.21				15.11	2.25	0.28
1/3/2008	3.19				13.46	1.92	0.24
1/4/2008	2.06	2.39	-0.32	-6.38	10.78	1.54	0.19
1/5/2008	3.31	-3.36	6.67	0.50	9.51	2.81	0.35
1/6/2008	1.80	-2.60	4.40	0.41	12.43	1.17	0.14
1/7/2008	2.19	-3.25	5.44	0.40	10.62	1.67	0.21
1/10/2008	2.14	-0.91	3.05	0.70	8.60	2.01	0.25
1/11/2008	5.44	-0.65	6.08	0.89	8.74	5.02	0.62
1/12/2008	6.17	-3.43	9.61	0.64	7.46	6.68	0.83
1/13/2008	3.86	-6.22	10.09	0.38	4.72	6.61	0.82
1/14/2008	5.18	2.05	3.13	1.66	12.43	3.37	0.42
1/15/2008	5.98				11.25	4.29	0.53
1/16/2008	3.76	-1.14	4.91	0.77	8.55	3.55	0.44
1/17/2008	3.12	-6.31	9.42	0.33	3.74	6.73	0.83
1/18/2008	2.90	-3.84	6.74	0.43	3.55	6.61	0.82
1/19/2008	1.70	-3.00	4.71	0.36	4.87	2.82	0.35
1/20/2008	2.92				14.10	1.67	0.21
1/23/2008	1.07	-3.47	4.54	0.24	8.47	1.02	0.13
1/24/2008	1.47	-2.10	3.57	0.41	8.27	1.43	0.18
1/25/2008	4.34						
1/26/2008	1.12	-3.50	4.63	0.24	4.42	2.05	0.25
1/27/2008	3.14	0.06	3.08	1.02	12.87	1.97	0.24
1/28/2008	0.54						
1/29/2008	1.73						
1/30/2008	4.37	-1.38	5.75	0.76	10.74	3.28	0.41
1/31/2008	1.66	-6.62	8.28	0.20	10.72	1.25	0.15

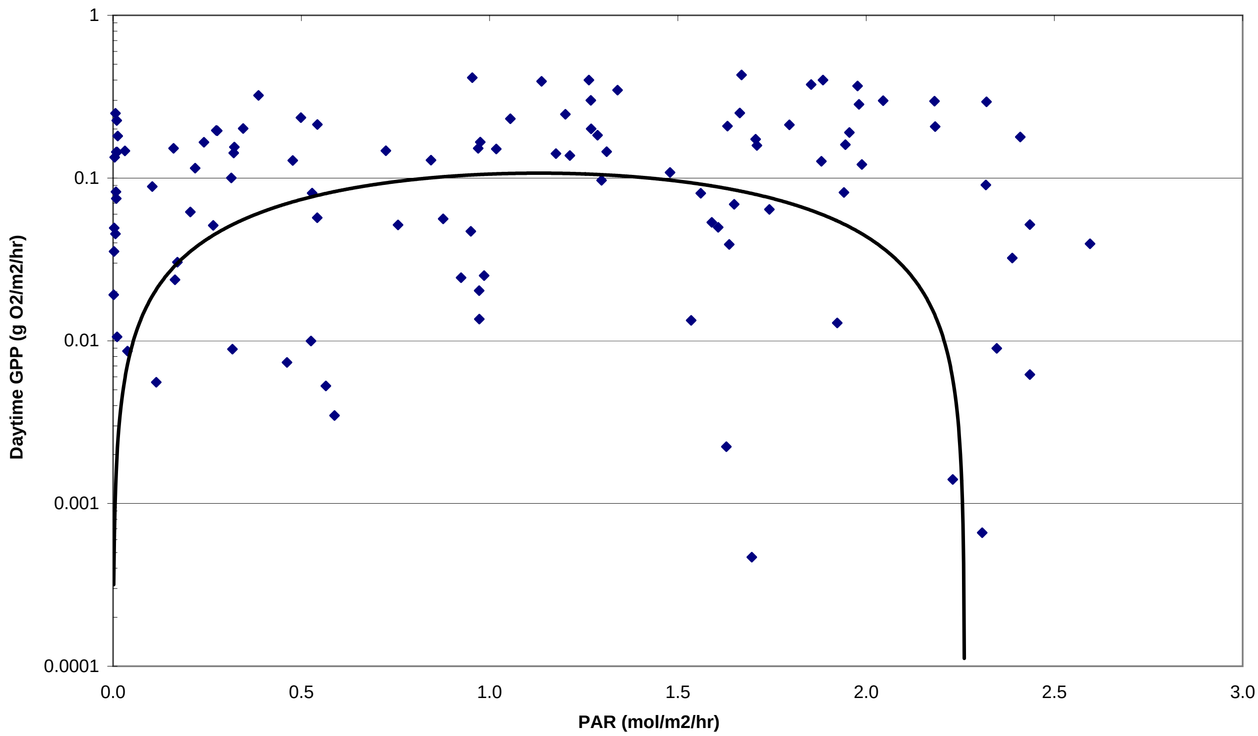
METABOLISM WORKSHEET - DAILY DETAIL
VOLUSIA BLUE SPRING - VBS-355 TO VBS-570

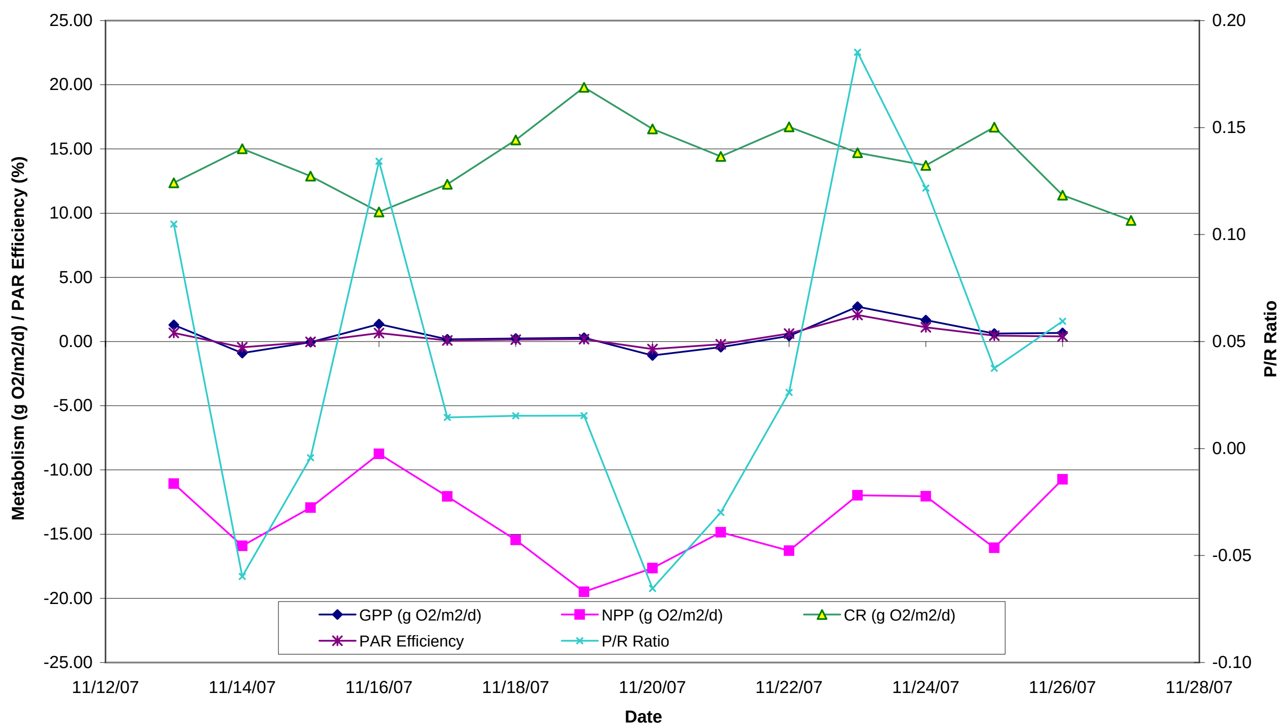
Date	GPP ($g\ O_2/m^2/d$)	NPP ($g\ O_2/m^2/d$)	CR ($g\ O_2/m^2/d$)	P/R Ratio	PAR (24hr) ($mol/m^2/d$)	PAR Efficiency (%)	PAR Efficiency ($g\ O_2/mol$)
2/1/2008	1.44	-3.35	4.79	0.30	4.42	2.63	0.33
2/2/2008	3.31	-1.48	4.79	0.69	14.24	1.88	0.23
2/3/2008	2.44	-4.40	6.84	0.36	11.63	1.70	0.21
2/4/2008	2.74	-3.26	6.00	0.46	13.59	1.63	0.20
2/5/2008	4.58	-5.16	9.74	0.47	11.20	3.30	0.41
2/7/2008	7.14	-9.57	16.71	0.43	8.77	6.57	0.81
2/8/2008	6.57	-2.96	9.53	0.69	13.65	3.88	0.48
2/9/2008	4.02	-1.61	5.62	0.71	12.71	2.55	0.32
2/10/2008	2.76						
2/11/2008	4.78						
2/12/2008	4.76	-2.66	7.42	0.64	5.61	6.85	0.85
2/13/2008	8.30	-0.54	8.83	0.94	9.50	7.05	0.87
2/14/2008	4.68	2.79	1.89	2.47	18.23	2.07	0.26
2/15/2008	5.20	2.01	3.19	1.63	14.42	2.91	0.36
2/16/2008	4.15	0.47	3.68	1.13	17.16	1.95	0.24
2/17/2008	6.81	1.32	5.49	1.24	16.41	3.35	0.41
2/18/2008	7.16	-5.58	12.73	0.56	11.63	4.97	0.62
2/19/2008	5.79	-0.27	6.06	0.95	18.86	2.48	0.31
2/20/2008	6.17						
2/21/2008	6.35	0.62	5.73	1.11	7.06	7.27	0.90
2/22/2008	10.02	-0.30	10.33	0.97	12.38	6.54	0.81
2/23/2008	6.21	-2.63	8.84	0.70	8.51	5.89	0.73
2/24/2008	11.31	3.96	7.36	1.54	13.24	6.90	0.85
2/25/2008	9.60	0.67	8.93	1.07	18.65	4.16	0.51
2/26/2008	11.11	4.04	7.07	1.57	12.83	6.99	0.87
2/27/2008	11.86	6.74	5.13	2.31	10.61	9.03	1.12
2/28/2008	7.39						
2/29/2008	5.13	4.26	0.87	5.87	16.14	2.57	0.32
3/1/2008	5.97	-2.03	8.00	0.75	17.22	2.80	0.35
3/2/2008	2.80	1.91	0.89	3.15	17.81	1.27	0.16
3/3/2008	8.58	-1.46	10.04	0.85	18.61	3.72	0.46
3/4/2008	8.81	-2.85	11.66	0.76	10.08	7.06	0.87
3/5/2008	11.18	-0.40	11.58	0.97	18.63	4.85	0.60
3/6/2008	6.34	-1.89	8.23	0.77	15.04	3.40	0.42
3/7/2008	4.76	-4.14	8.90	0.54	8.80	4.37	0.54
3/9/2008	10.03	6.44	3.59	2.79	20.34	3.98	0.49
3/10/2008	9.54	1.10	8.44	1.13	16.02	4.81	0.60
3/11/2008	9.15	-7.56	16.71	0.55	10.00	7.39	0.92
3/12/2008	11.96	-5.18	17.14	0.70	11.88	8.13	1.01
3/13/2008	10.00	-6.59	16.59	0.60	18.75	4.31	0.53
3/14/2008	7.67	-9.28	16.96	0.45	5.54	11.19	1.39
3/19/2008	7.83	2.45	5.38	1.46	18.65	3.39	0.42
3/20/2008	9.29	5.49	3.79	2.45	16.87	4.44	0.55
3/21/2008	4.52						
3/22/2008	7.09						
3/23/2008	7.64	-0.26	7.90	0.97	14.38	4.29	0.53
3/24/2008	14.92	12.13	2.79	5.35	14.61	8.24	1.02
3/25/2008	6.46						
3/26/2008	4.43						
3/27/2008	6.37						
3/28/2008	6.50	2.96	3.54	1.83	19.75	2.66	0.33
3/29/2008	7.17	0.88	6.29	1.14	16.27	3.56	0.44
3/30/2008	9.43	1.42	8.01	1.18	13.17	5.78	0.72
3/31/2008	8.31	-0.70	9.00	0.92	11.77	5.70	0.71
5/9/2008	22.48	17.51	4.96	4.53	22.97	7.90	0.98

METABOLISM WORKSHEET - DAILY DETAIL
VOLUSIA BLUE SPRING - VBS-355 TO VBS-570

Date	GPP ($g\ O_2/m^2/d$)	NPP ($g\ O_2/m^2/d$)	CR ($g\ O_2/m^2/d$)	P/R Ratio	PAR (24hr) ($mol/m^2/d$)	PAR Efficiency (%)	PAR Efficiency ($g\ O_2/mol$)
5/10/2008	19.49	10.77	8.72	2.23	22.34	7.04	0.87
5/11/2008	28.29	20.98	7.30	3.87	20.48	11.15	1.38
5/12/2008	18.93	14.94	3.99	4.74	25.97	5.89	0.73
5/13/2008	12.25	4.15	8.10	1.51	25.81	3.83	0.47
5/14/2008	11.36	2.77	8.59	1.32	26.24	3.49	0.43
5/15/2008	12.93	2.85	10.09	1.28	23.91	4.37	0.54
5/16/2008	18.35	8.11	10.23	1.79	20.75	7.14	0.88
5/17/2008	17.68	4.38	13.30	1.33	19.61	7.28	0.90
5/18/2008	19.10	6.79	12.31	1.55	18.76	8.22	1.02
5/19/2008	17.09	4.20	12.88	1.33	19.33	7.14	0.88
5/20/2008	24.03	10.77	13.26	1.81	22.65	8.57	1.06
5/21/2008	20.56	7.61	12.94	1.59	28.02	5.92	0.73
5/22/2008	8.11	-5.30	13.41	0.61	6.74	9.72	1.20
6/25/2008	6.60	0.11	6.49	1.02	12.35	4.32	0.53
6/26/2008	8.87	1.90	6.97	1.27	12.14	5.90	0.73
6/27/2008	12.89	5.81	7.08	1.82	17.51	5.94	0.74
6/28/2008	10.21	3.09	7.12	1.43	19.06	4.33	0.54
6/29/2008	13.57	5.21	8.36	1.62	21.08	5.20	0.64
6/30/2008	9.83	-0.30	10.13	0.97	19.56	4.06	0.50
7/1/2008	12.64	3.41	9.22	1.37	15.84	6.44	0.80
7/2/2008	10.38	0.61	9.76	1.06	18.28	4.58	0.57
7/3/2008	14.26	3.83	10.44	1.37	19.11	6.03	0.75
7/4/2008	11.91	0.47	11.44	1.04	23.87	4.03	0.50
7/5/2008	10.99	-1.55	12.53	0.88	26.94	3.29	0.41
7/6/2008	11.15	-2.79	13.94	0.80	23.53	3.83	0.47
7/7/2008	8.02	-4.59	12.60	0.64	18.67	3.47	0.43

Average	6.68	-1.18	8.13	1.00	13.86	3.96	0.49
Median	5.30	-1.32	7.95	0.76	13.19	3.54	0.44
Maximum	28.29	20.98	19.80	5.87	28.02	11.19	1.39
Minimum	0.18	-19.50	-0.32	-6.38	3.55	0.09	0.01
Std Dev	5.35	6.25	4.19	1.23	5.38	2.51	0.31
N	138	122	122	122	126	126	126

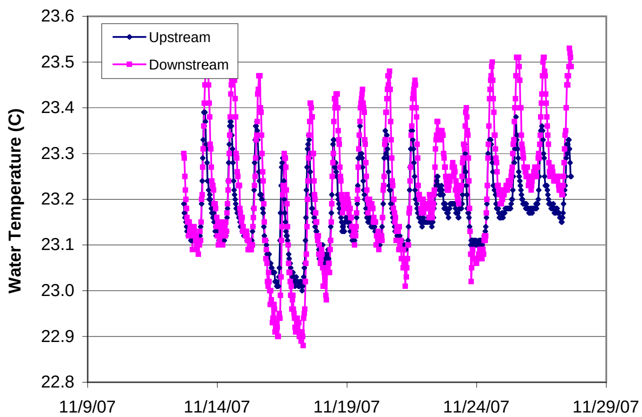


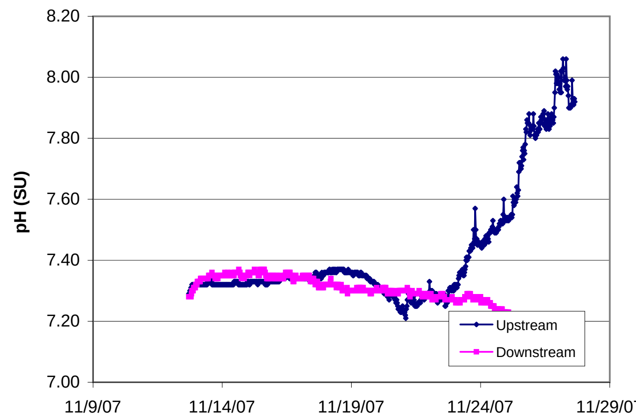


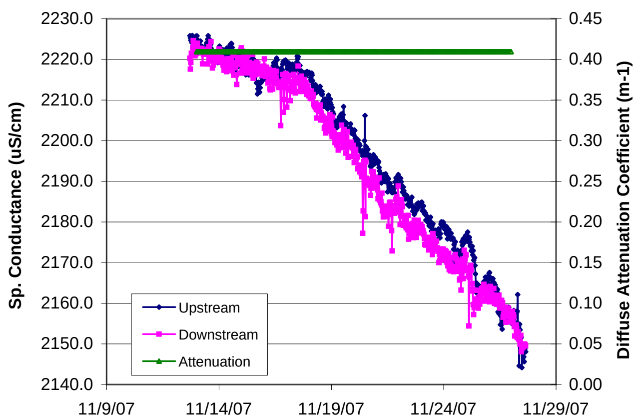
Stats	GPP	NPP	CR	P/R	PAR Eff.
	($g\ O_2/m^2/d$)			ratio	(%)
Avg	0.50	-13.95	14.12	0.04	0.37
Max	2.72	-8.74	19.80	0.19	2.07
Min	-1.08	-19.50	9.44	-0.07	-0.59

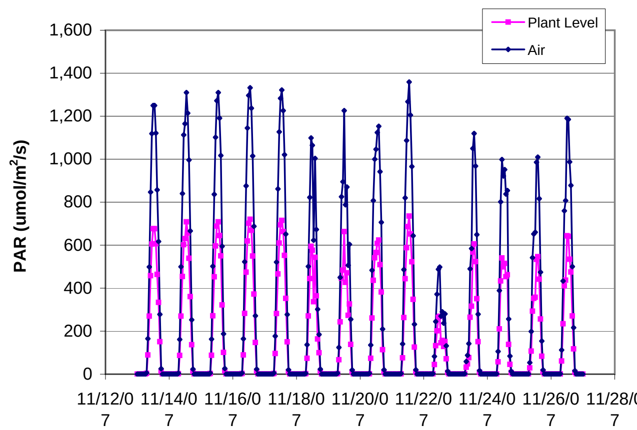
VOLUSIA BLUE SPRING - VBS-355 TO VBS-570 METABOLISM ESTIMATES

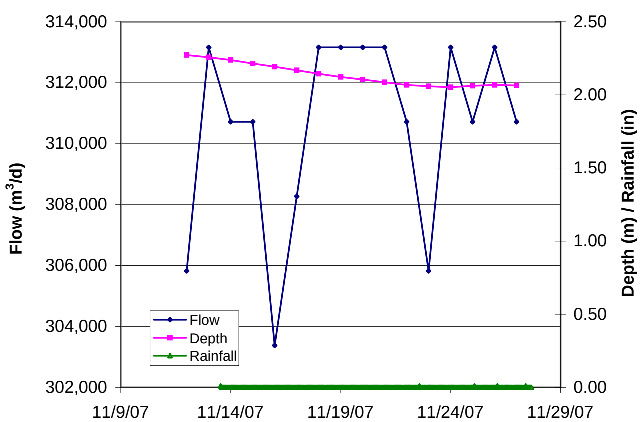
VOLUSIA BLUE SPRING - VBS-355 TO VBS-570 METABOLISM SUMMARY



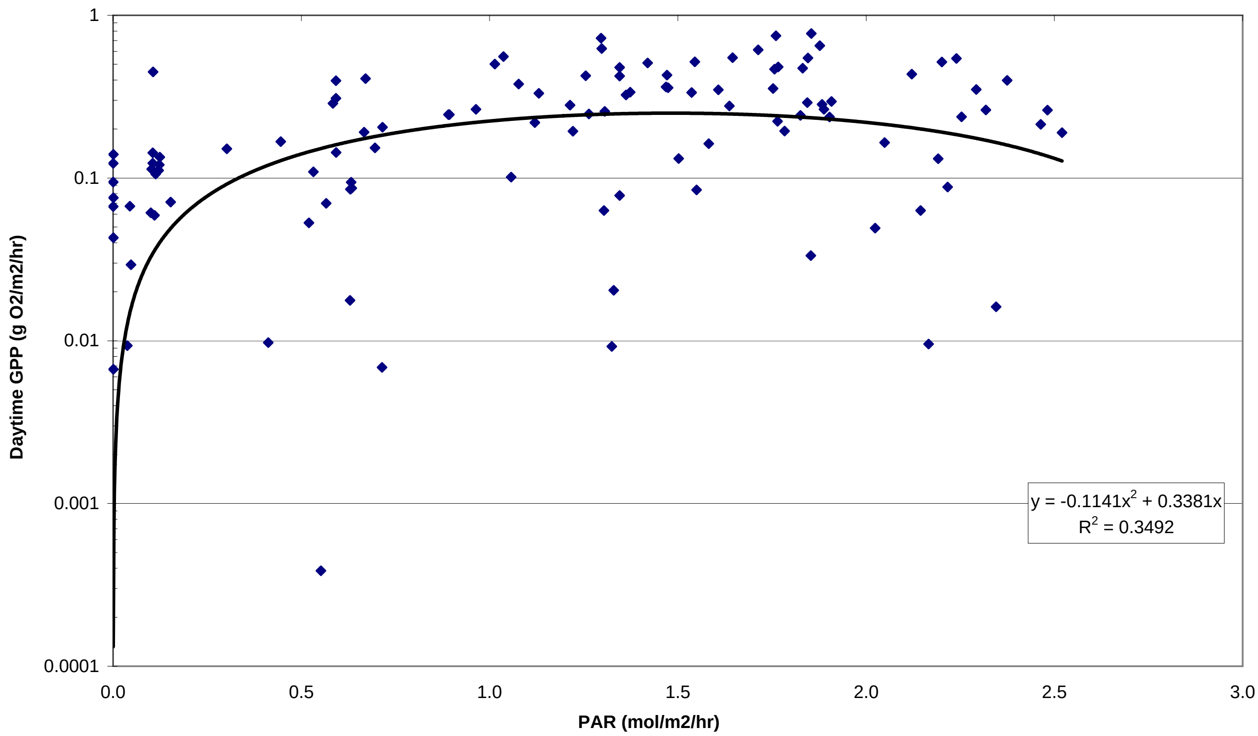


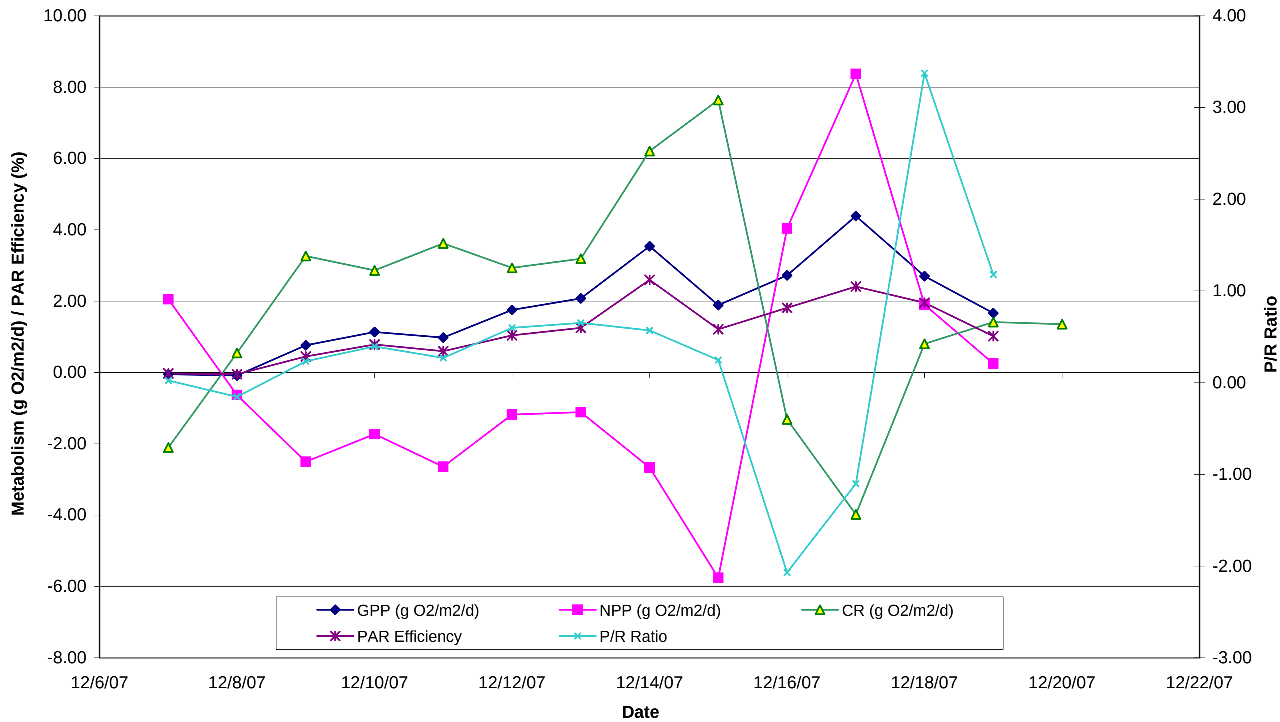






Parameter	Units	Avg	Min	Max	N
DO - up	mg/L	0.45	0.33	0.79	718
down		0.46	0.12	1.03	718
Wtr Temp - up	C	23.2	23.0	23.4	718
down		23.2	22.9	23.5	718
pH - up	SU	7.43	7.21	8.06	718
down		7.29	7.16	7.37	718
SpCond - up	uS/cm	2196	2144	2226	718
down		2193	2148	2225	718
Flow - up	m^3/d	310,562	303,375	313,162	16
Depth	m	2.14	2.05	2.27	16
Rainfall Total	in		0.05		
PAR - air	$umol/m^2/s$	290	0.0	1,359	337
plant		157	0.0	735	337
DO rate chng	$g/m^2/hr$				
corr		-0.579	-0.976	-0.127	337
uncorr		0.013	-0.375	0.438	337

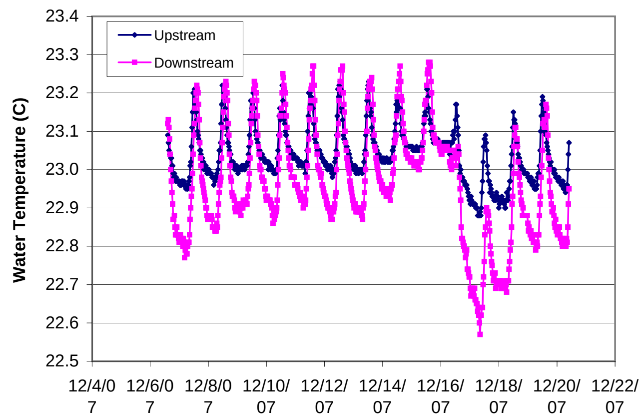


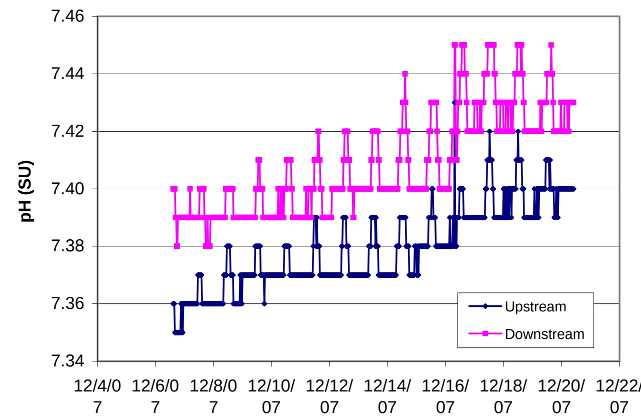


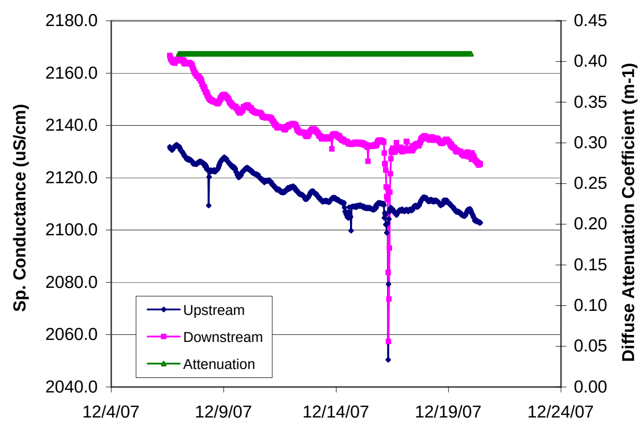
Stats	GPP	NPP	CR	P/R ratio	PAR Eff. (%)
	($g\ O_2/m^2/d$)				
Avg	1.81	-0.12	1.89	0.32	1.16
Max	4.39	8.37	7.64	3.38	2.60
Min	-0.08	-5.75	-3.98	-2.07	-0.05

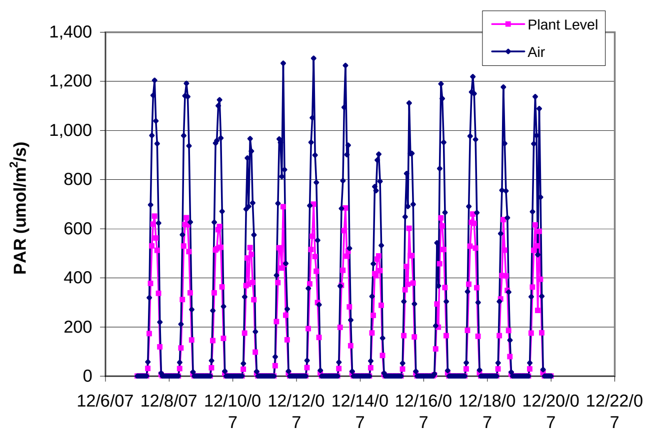
VOLUSIA BLUE SPRING - VBS-355 TO VBS-570 METABOLISM ESTIMATES

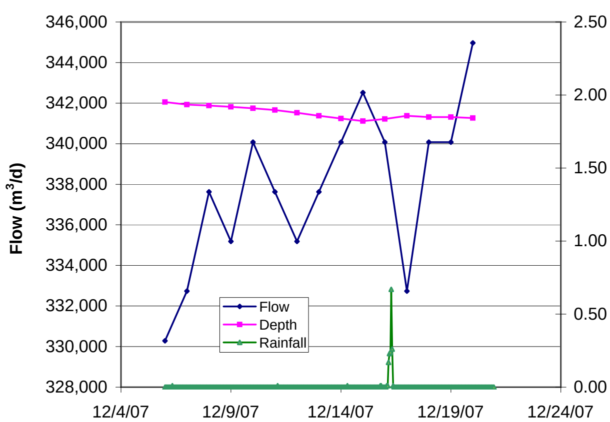
VOLUSIA BLUE SPRING - VBS-355 TO VBS-570 METABOLISM SUMMARY



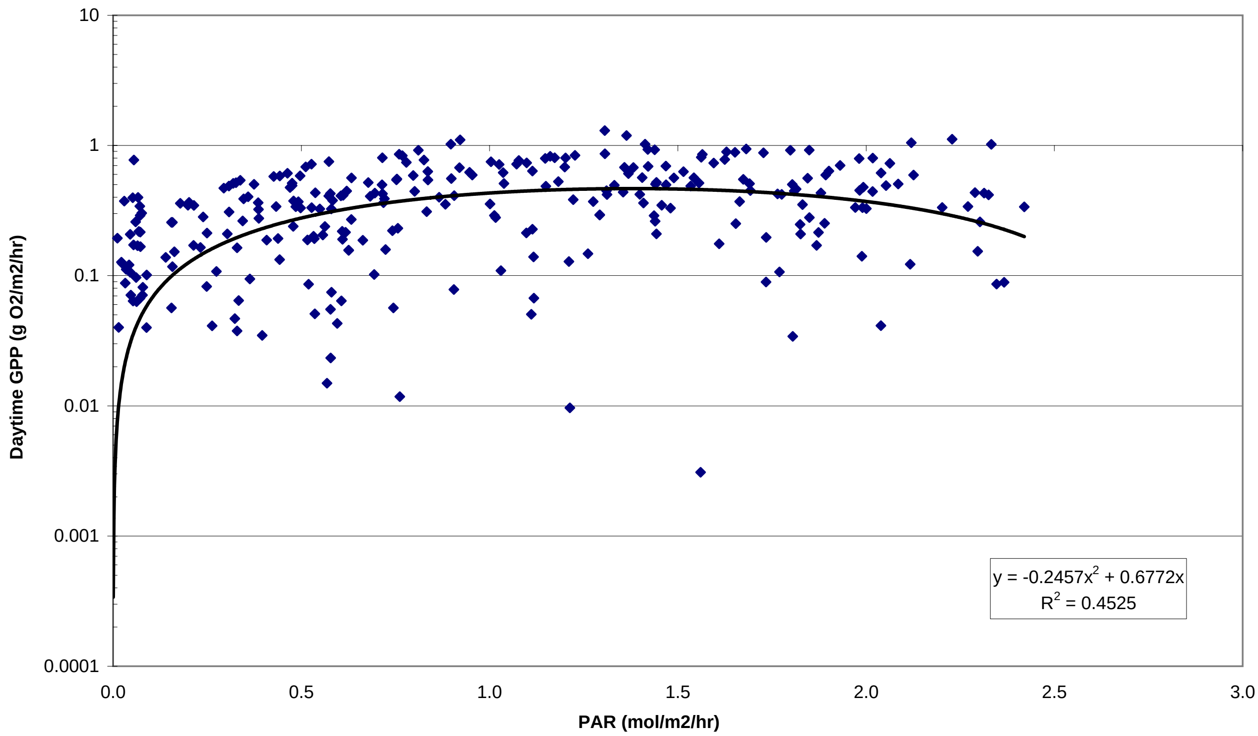


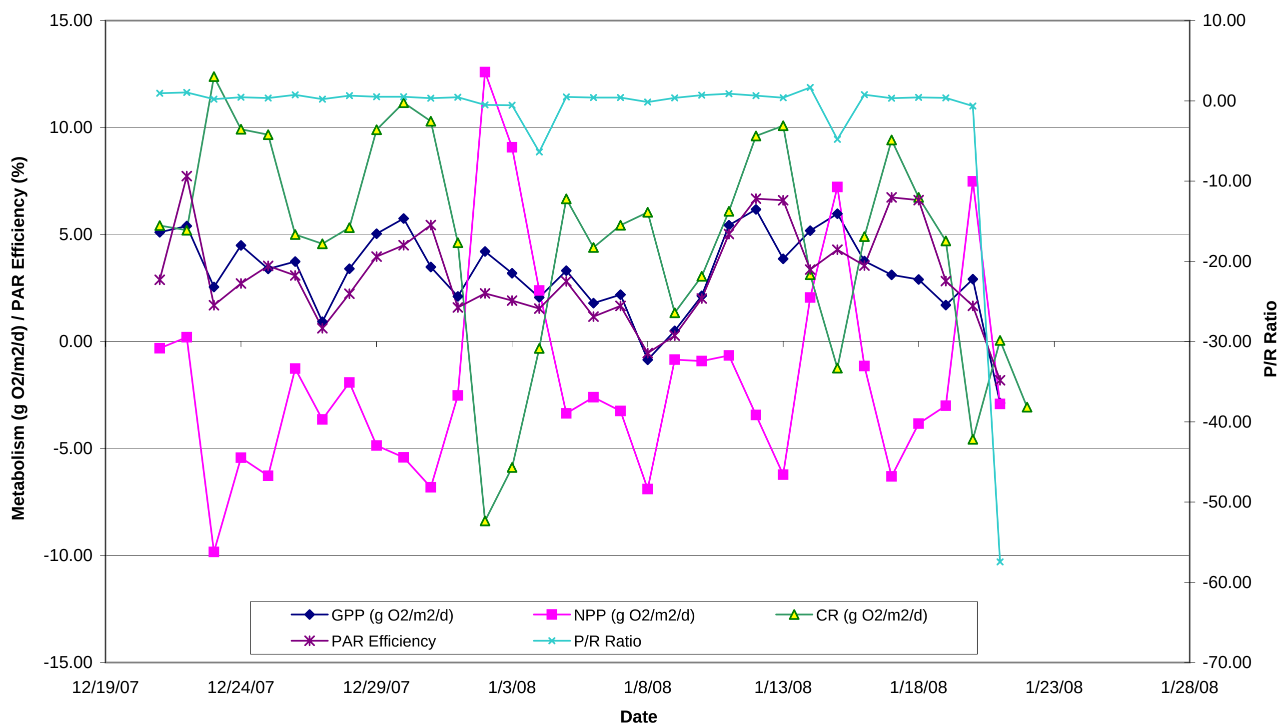






Parameter	Units	Avg	Min	Max	N
DO - up	mg/L	0.46	0.31	1.49	664
down		0.78	0.49	1.63	664
Wtr Temp - up	C	23.0	22.9	23.2	664
down		23.0	22.6	23.3	664
pH - up	SU	7.38	7.35	7.43	664
down		7.41	7.38	7.45	664
SpCond - up	uS/cm	2115	2050	2133	664
down		2139	2057	2167	664
Flow - up	m^3/d	337,791	330,288	344,967	15
Depth	m	1.88	1.82	1.95	15
Rainfall Total	in		1.65		
PAR - air	$umol/m^2/s$	276	0.0	1,294	360
plant		149	0.0	700	313
DO rate chng	$g/m^2/hr$				
corr		-0.008	-0.709	1.245	313
uncorr		0.747	0.005	1.990	313

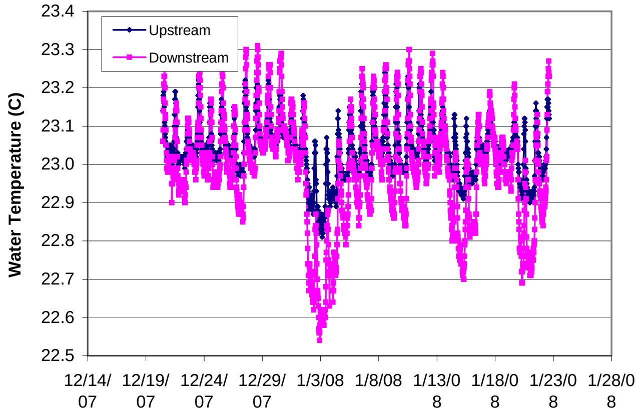


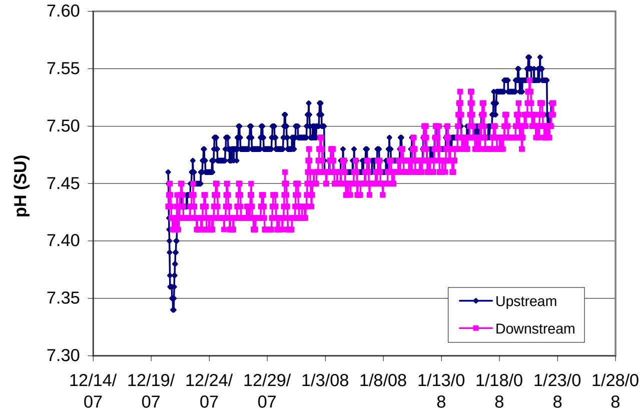


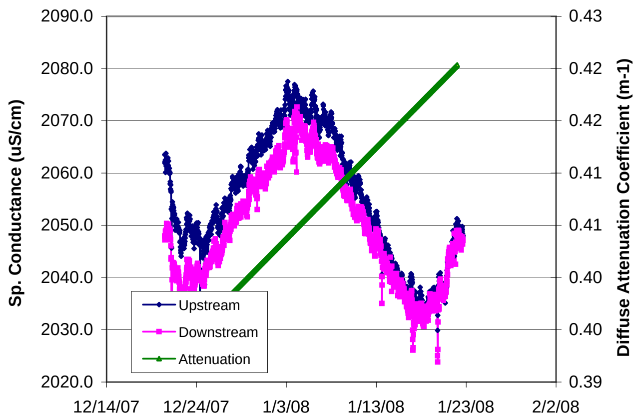
Stats	GPP	NPP	CR	P/R ratio	PAR Eff. (%)
	($g\ O_2/m^2/d$)				
Avg	3.19	-1.64	4.60	-1.76	3.08
Max	6.17	12.59	12.38	1.66	7.73
Min	-2.87	-9.83	-8.38	-57.46	-1.81

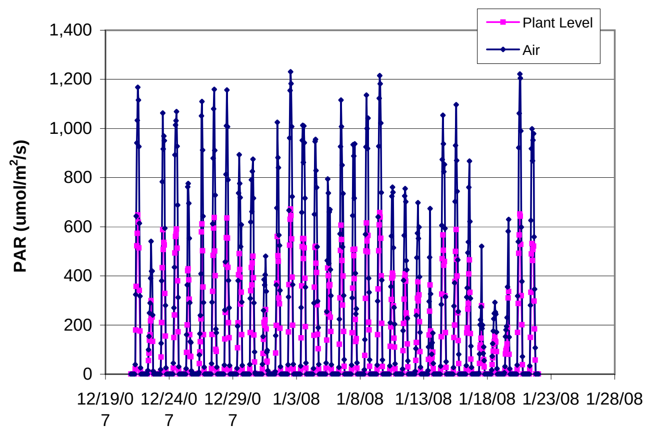
VOLUSIA BLUE SPRING - VBS-355 TO VBS-570 METABOLISM ESTIMATES

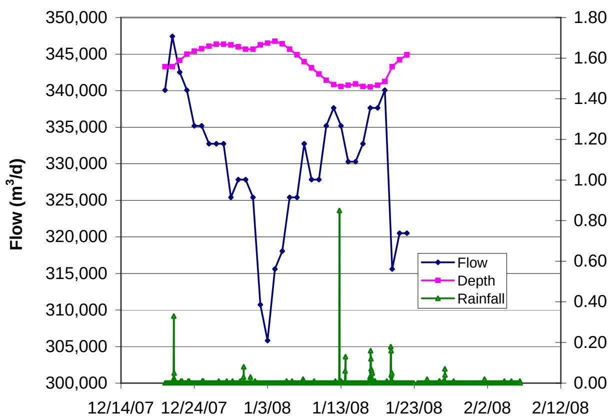
VOLUSIA BLUE SPRING - VBS-355 TO VBS-570 METABOLISM SUMMARY



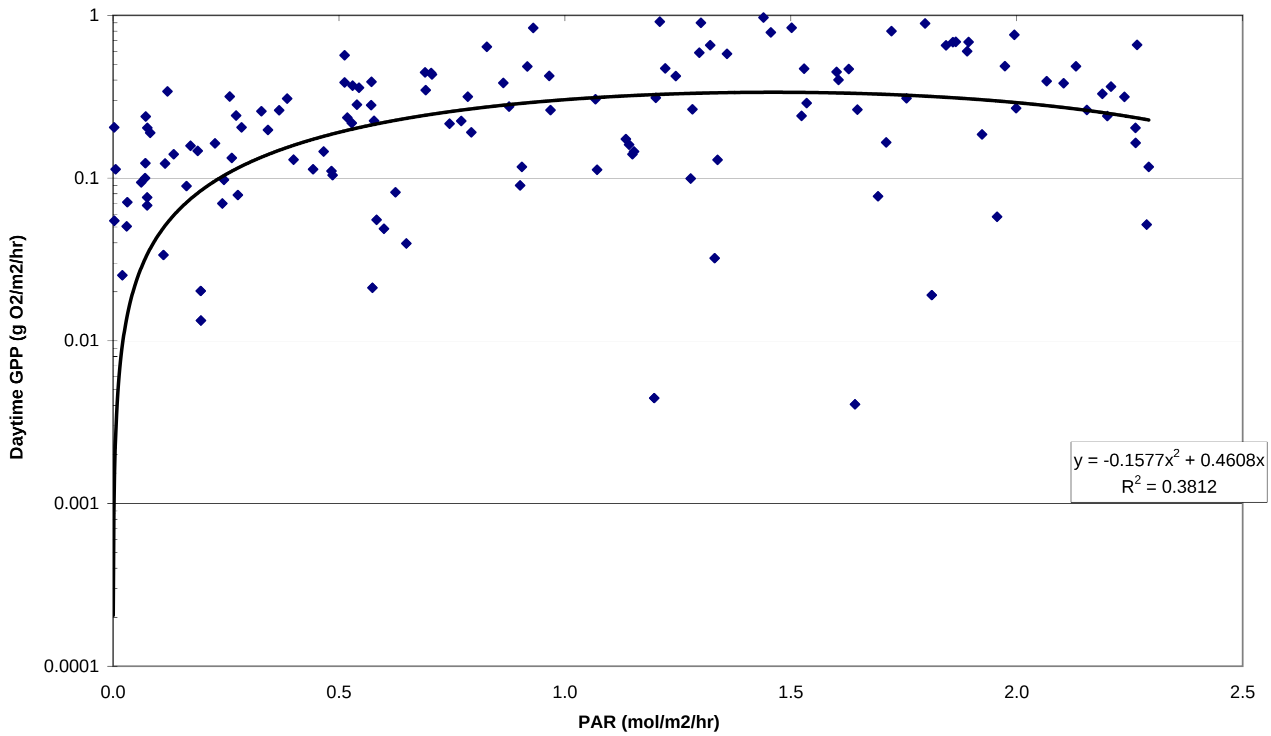


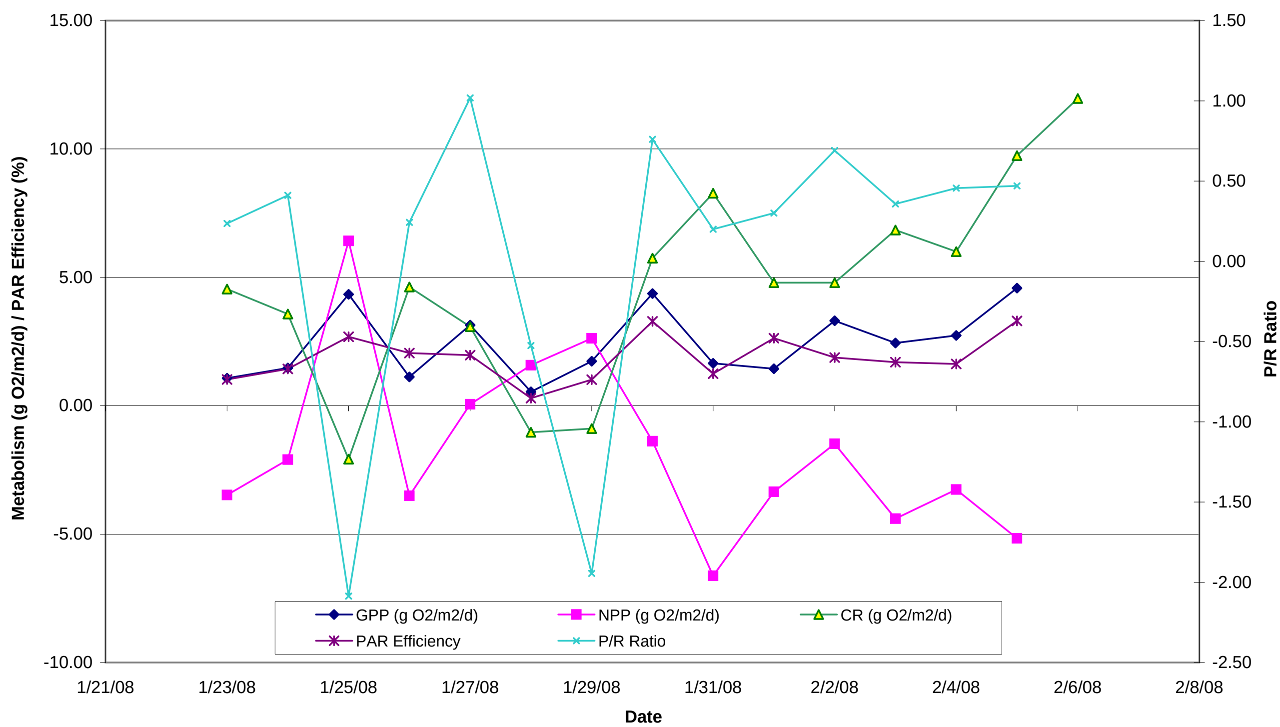






Parameter	Units	Avg	Min	Max	N
DO - up	mg/L	0.25	0.00	1.02	1594
down		0.71	0.29	1.68	1594
Wtr Temp - up	C	23.0	22.8	23.2	1594
down		23.0	22.5	23.3	1594
pH - up	SU	7.48	7.34	7.56	1594
down		7.46	7.41	7.54	1594
SpCond - up	uS/cm	2055	2030	2078	1594
down		2050	2024	2073	1594
Flow - up	m^3/d	329,640	305,822	347,414	34
Depth	m	1.58	1.46	1.68	34
Rainfall Total	in		3.08		
PAR - air	$umol/m^2/s$	231	0.0	1,453	1153
plant		117	0.0	672	769
DO rate chng	$g/m^2/hr$				
corr		-0.065	-0.714	1.040	769
uncorr		1.058	0.469	2.120	769

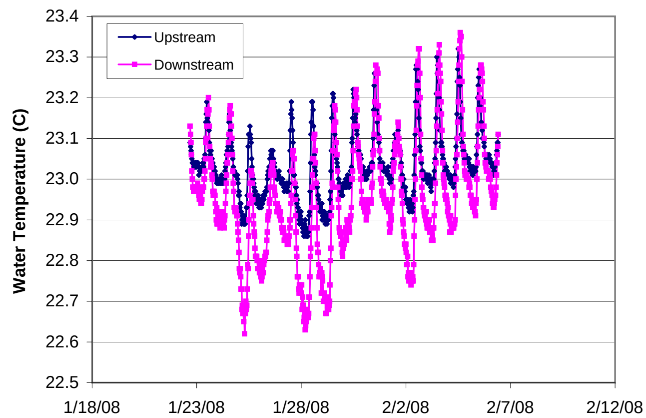


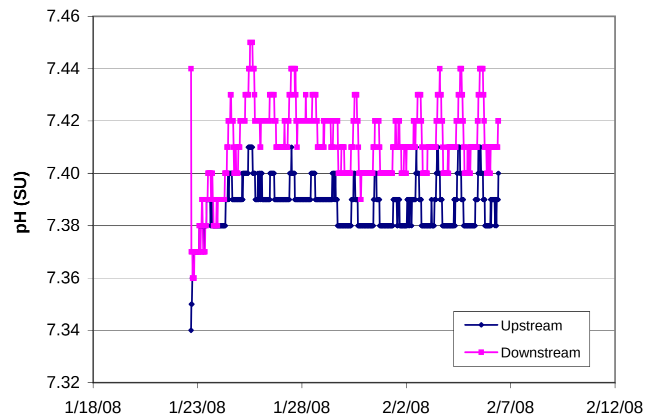


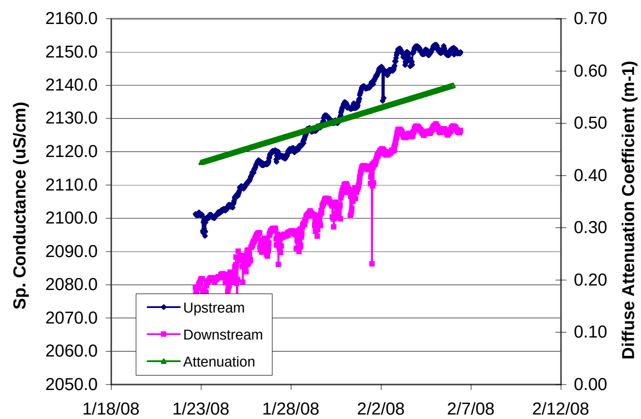
VOLUSIA BLUE SPRING - VBS-355 TO VBS-570 METABOLISM ESTIMATES

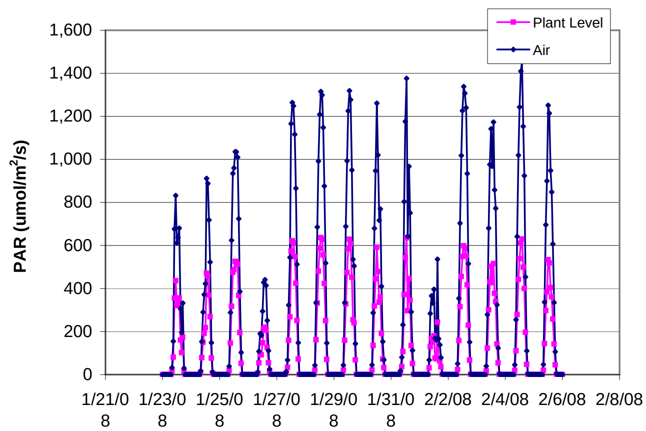
Stats	GPP	NPP	CR	P/R ratio	PAR Eff. (%)
	($g\ O_2/m^2/d$)				
Avg	2.42	-1.72	4.66	0.04	1.87
Max	4.58	6.42	11.97	1.02	3.30
Min	0.54	-6.62	-2.08	-2.09	0.29

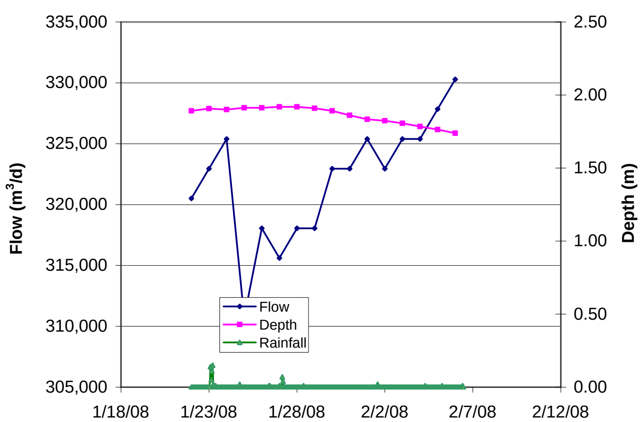
VOLUSIA BLUE SPRING - VBS-355 TO VBS-570 METABOLISM SUMMARY



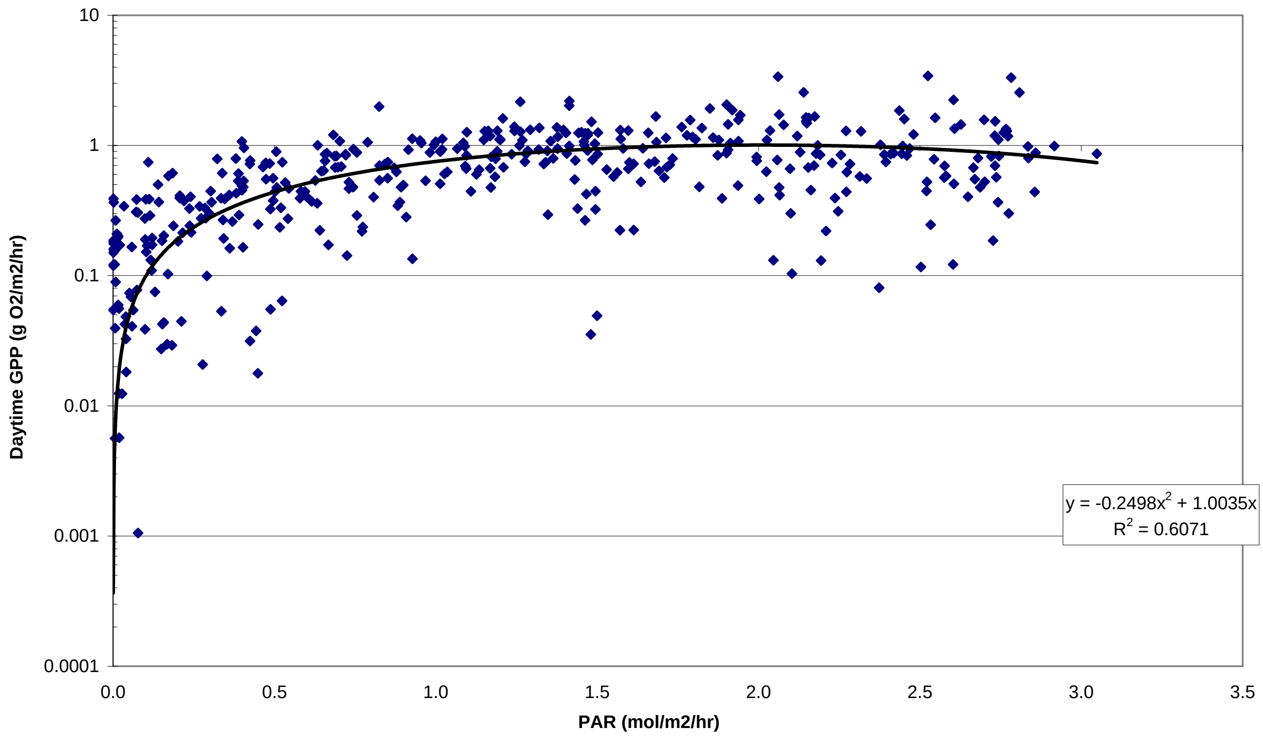


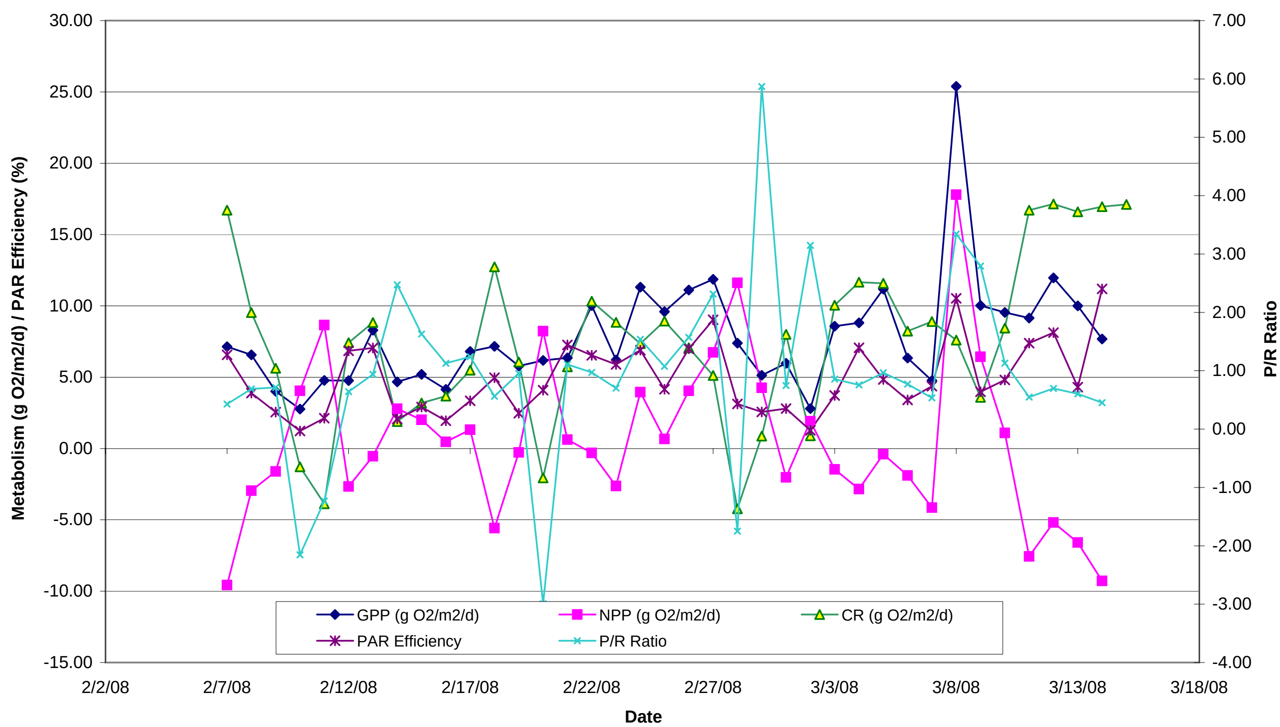






Parameter	Units	Avg	Min	Max	N
DO - up	mg/L	0.45	0.27	0.92	708
down		0.75	0.43	1.94	708
Wtr Temp - up	C	23.0	22.9	23.3	708
down		23.0	22.6	23.4	708
pH - up	SU	7.39	7.34	7.41	708
down		7.41	7.36	7.45	708
SpCond - up	uS/cm	2129	2095	2152	708
down		2105	2062	2128	708
Flow - up	m^3/d	322,031	310,715	330,288	16
Depth	m	1.86	1.74	1.92	16
Rainfall Total	in		0.71		
PAR - air	$umol/m^2/s$	259	0.0	1,453	371
plant		126	0.0	637	337
DO rate chng	$g/m^2/hr$				
corr		-0.079	-0.670	0.568	337
uncorr		0.648	0.105	1.335	337

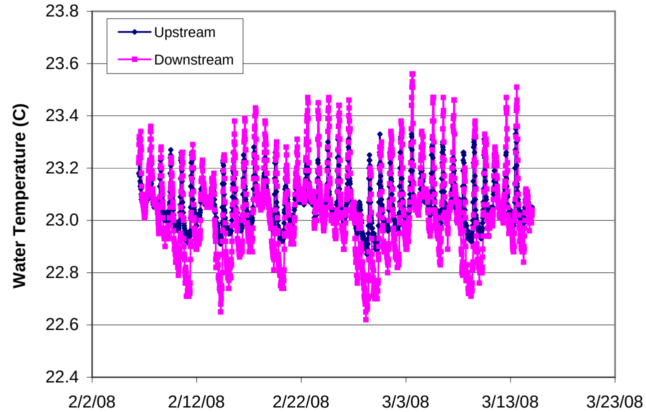


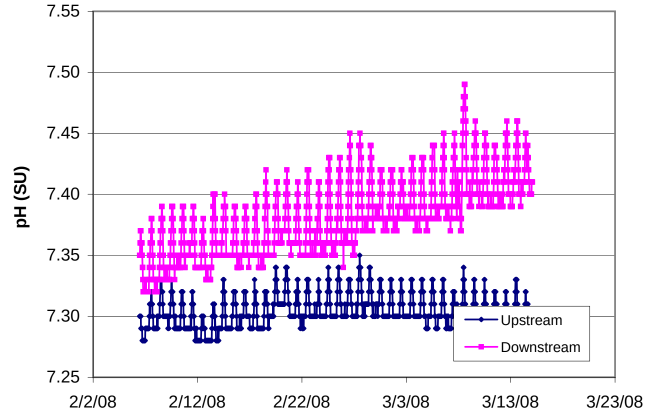


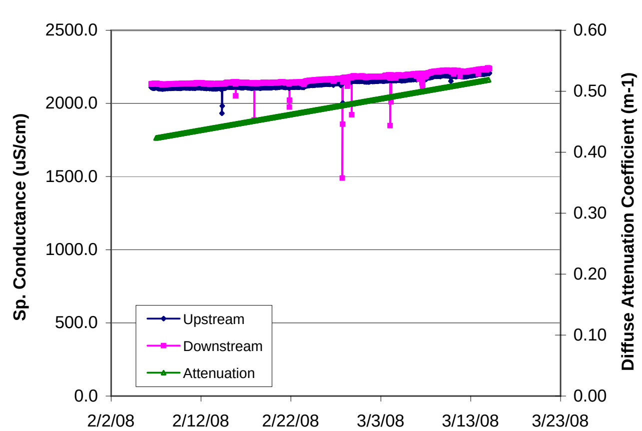
VOLUSIA BLUE SPRING - VBS-355 TO VBS-570 METABOLISM ESTIMATES

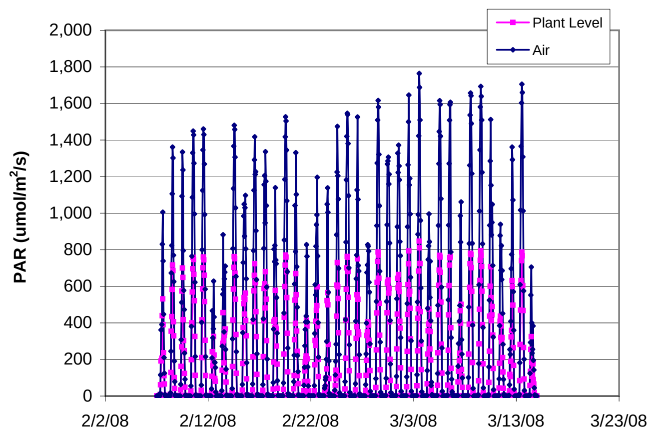
Stats	GPP	NPP	CR	P/R ratio	PAR Eff. (%)
	($g\ O_2/m^2/d$)				
Avg	7.82	0.52	7.56	0.97	4.93
Max	25.39	17.79	17.14	5.87	11.19
Min	2.76	-9.57	-4.22	-2.99	1.23

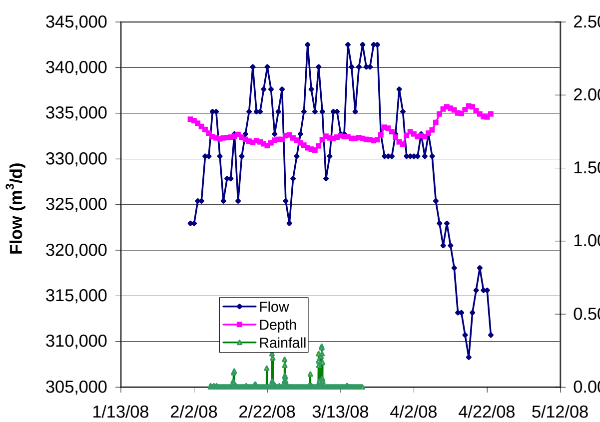
VOLUSIA BLUE SPRING - VBS-355 TO VBS-570 METABOLISM SUMMARY



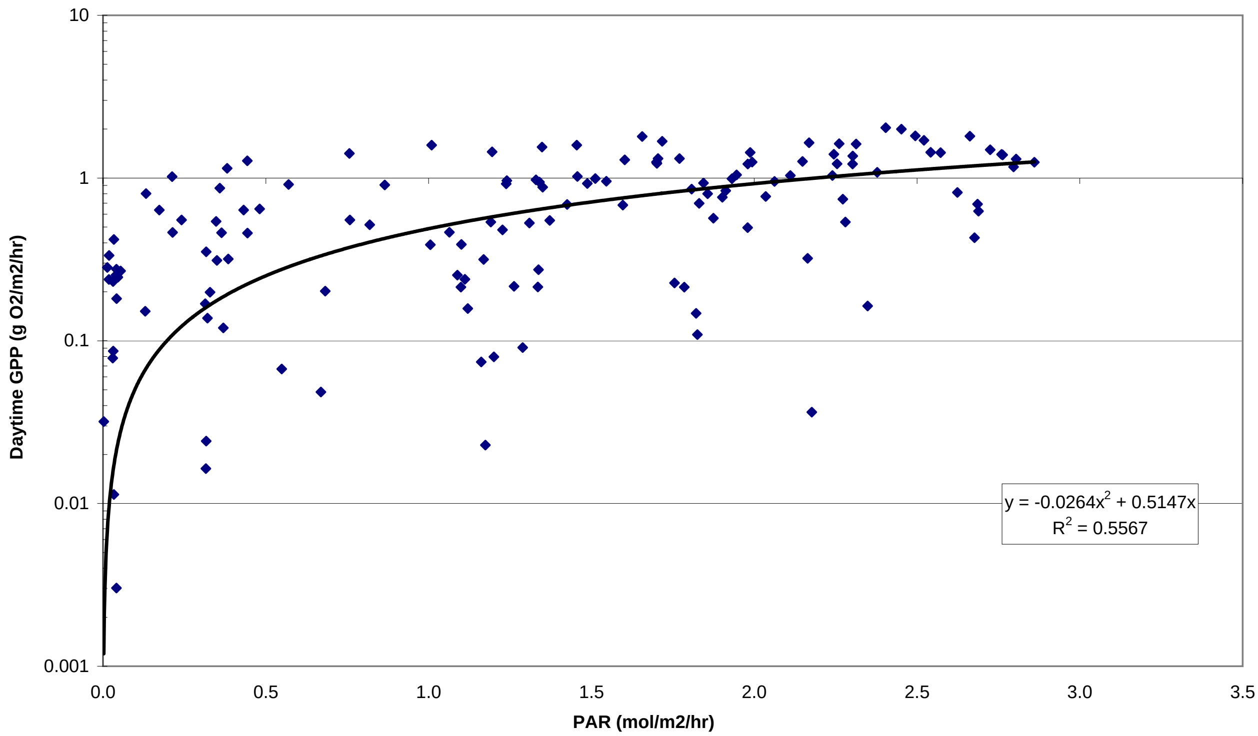


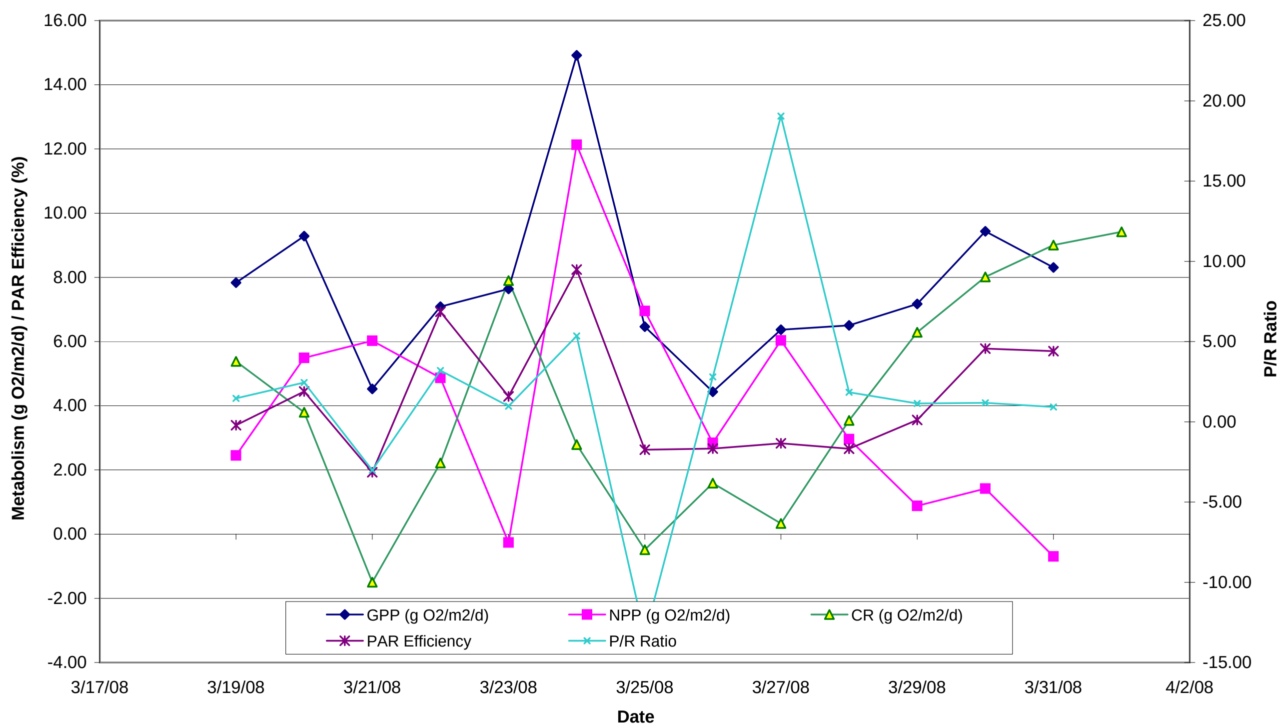






Parameter	Units	Avg	Min	Max	N
DO - up	mg/L	0.59	0.28	1.76	1807
down		0.97	0.38	2.62	1807
Wtr Temp - up	C	23.1	22.9	23.4	1807
down		23.0	22.6	23.6	1807
pH - up	SU	7.30	7.28	7.35	1807
down		7.38	7.32	7.49	1807
SpCond - up	uS/cm	2137	1933	2208	1807
down		2167	1489	2243	1807
Flow - up	m^3/d	330,022	308,269	342,521	83
Depth	m	1.74	1.62	1.92	83
Rainfall Total	in		3.95		
PAR - air	$umol/m^2/s$	339	0.0	1,764	1000
plant		163	0.0	847	889
DO rate chng	$g/m^2/hr$				
corr		0.021	-1.038	3.271	889
uncorr		0.898	-0.211	4.058	889

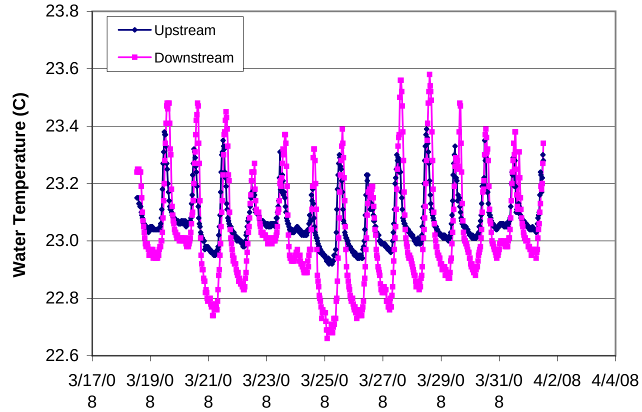


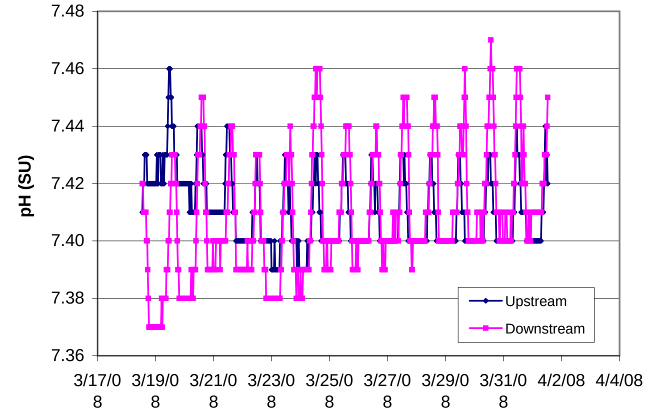


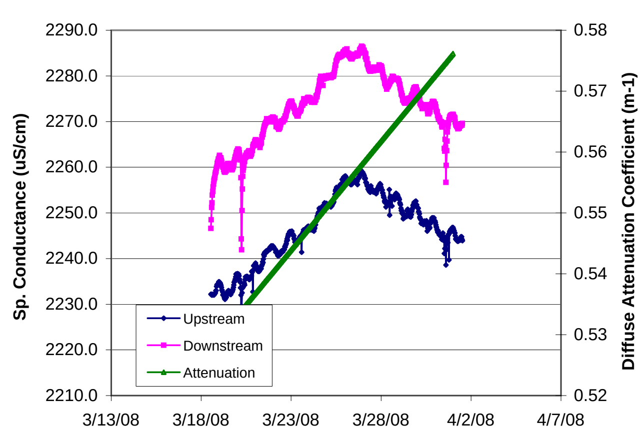
Stats	GPP	NPP	CR	P/R	PAR Eff.
	(g $O_2/m^2/d$)			ratio	(%)
Avg	7.69	3.93	4.16	1.85	4.23
Max	14.92	12.13	9.42	19.05	8.24
Min	4.43	-0.70	-1.50	-13.32	1.93

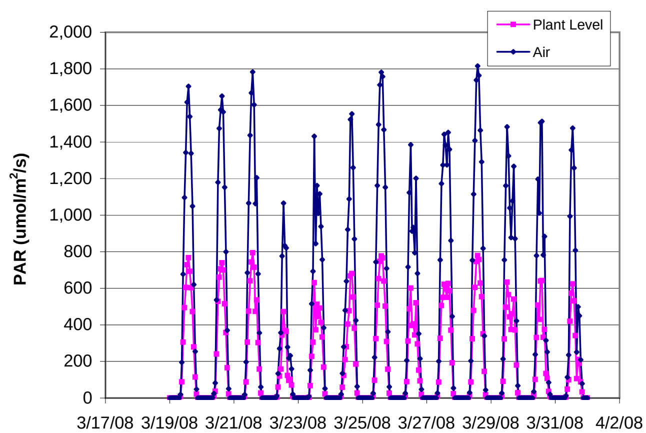
VOLUSIA BLUE SPRING - VBS-355 TO VBS-570 METABOLISM ESTIMATES

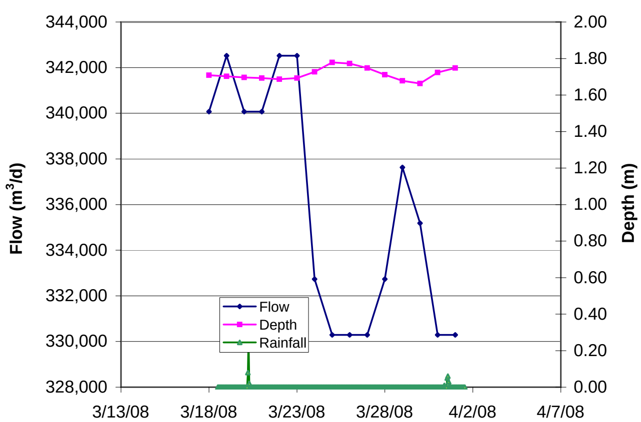
VOLUSIA BLUE SPRING - VBS-355 TO VBS-570 METABOLISM SUMMARY



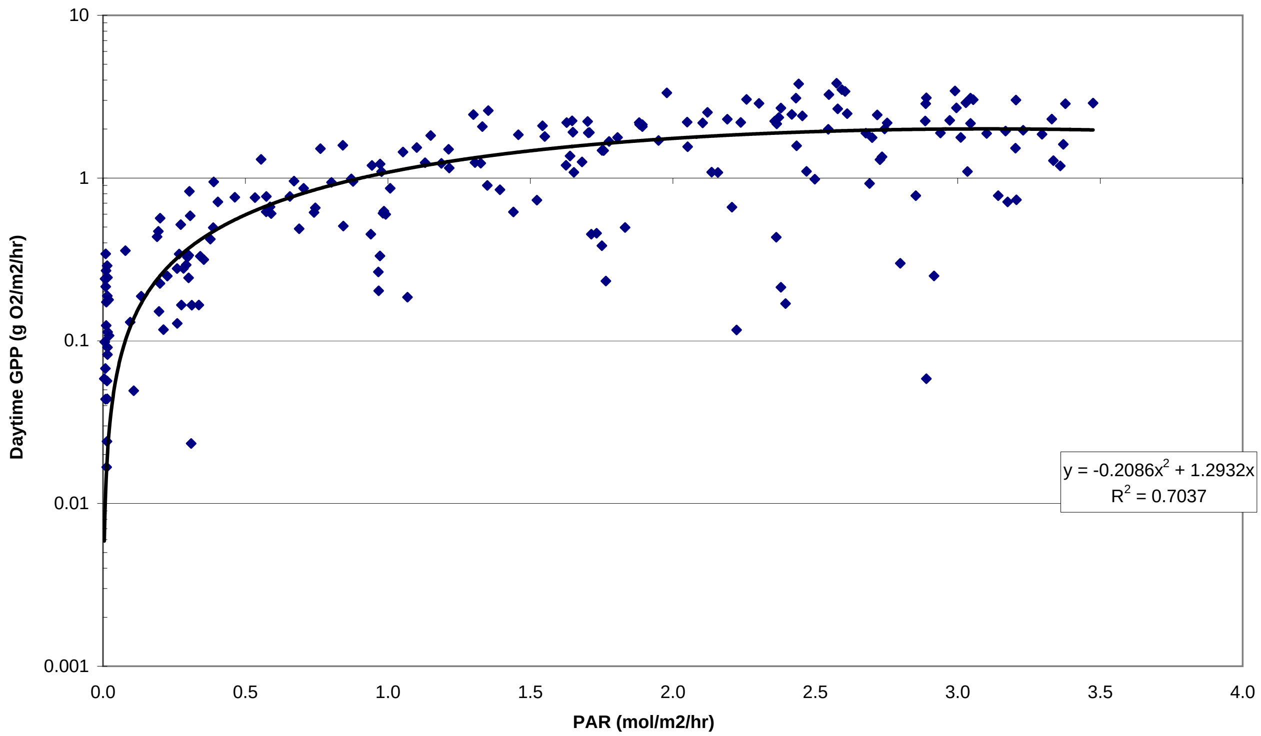


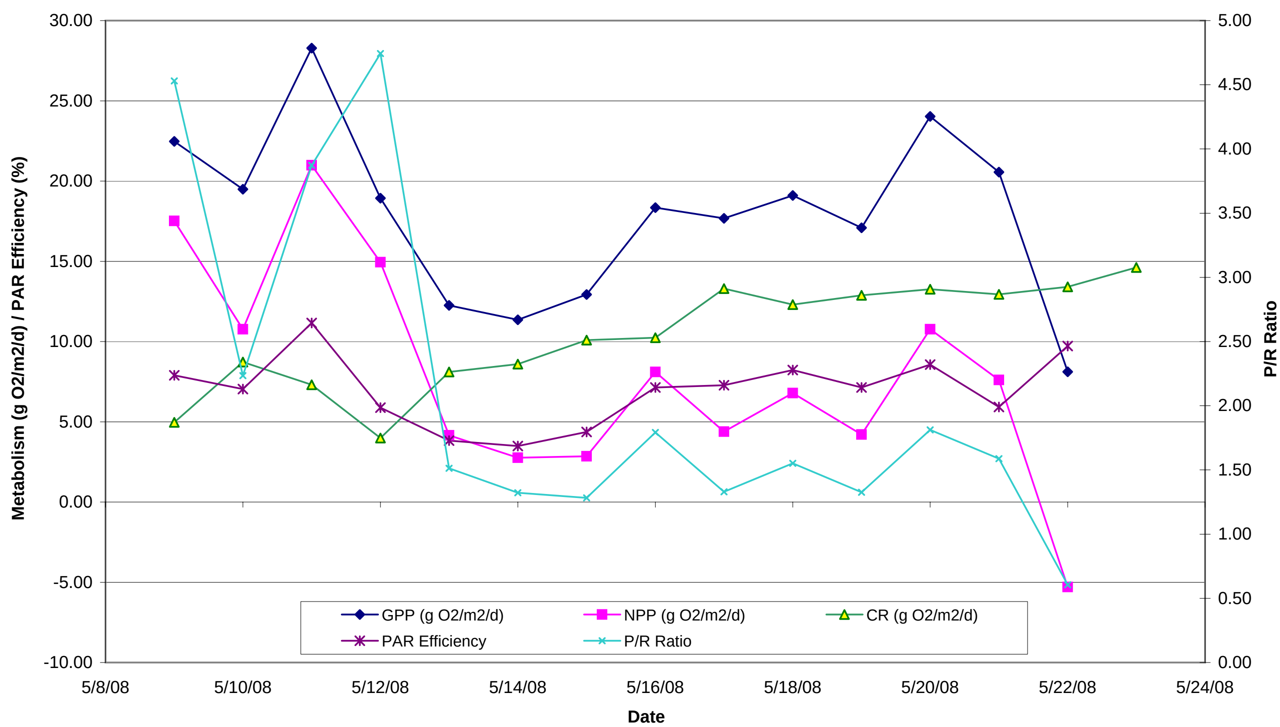






Parameter	Units	Avg	Min	Max	N
DO - up	mg/L	0.46	0.24	1.10	662
down		0.88	0.43	2.05	672
Wtr Temp - up	C	23.1	22.9	23.4	672
down		23.0	22.7	23.6	672
pH - up	SU	7.41	7.39	7.46	672
down		7.41	7.37	7.47	672
SpCond - up	uS/cm	2246	2222	2259	672
down		2273	2242	2287	672
Flow - up	m^3/d	335,833	330,288	342,521	15
Depth	m	1.72	1.66	1.78	15
Rainfall Total	in		0.54		
PAR - air	$umol/m^2/s$	412	0.0	1,815	343
plant		181	0.0	794	313
DO rate chng	$g/m^2/hr$				
corr		0.158	-0.474	2.058	313
uncorr		1.002	0.359	2.790	313

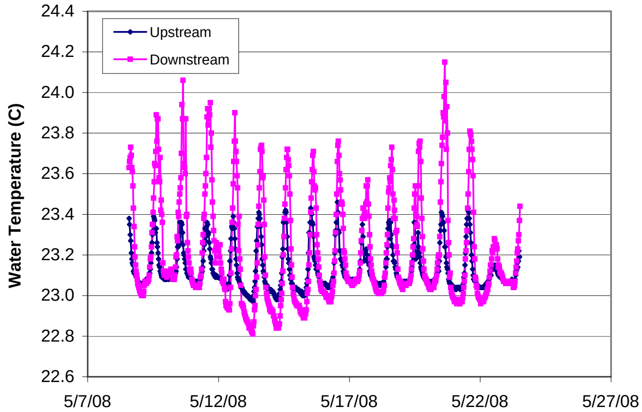


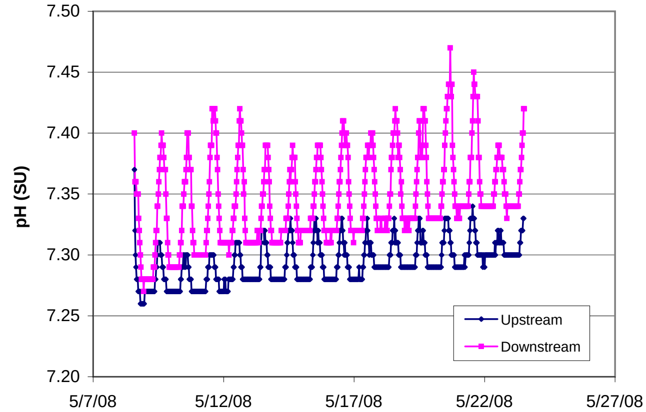


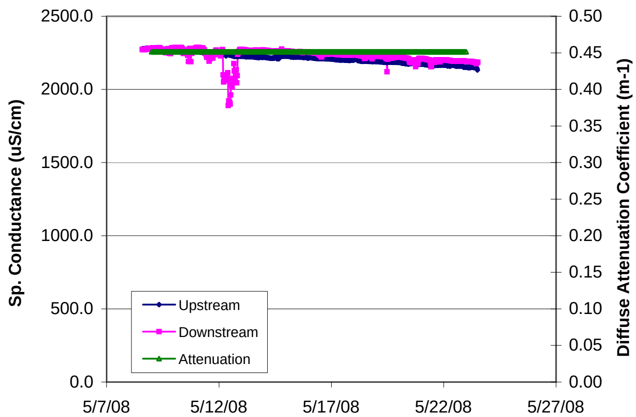
Stats	GPP	NPP	CR	P/R	PAR Eff.
	$(g\ O_2/m^2/d)$			ratio	(%)
Avg	17.90	7.90	10.31	2.11	6.98
Max	28.29	20.98	14.61	4.74	11.15
Min	8.11	-5.30	3.99	0.61	3.49

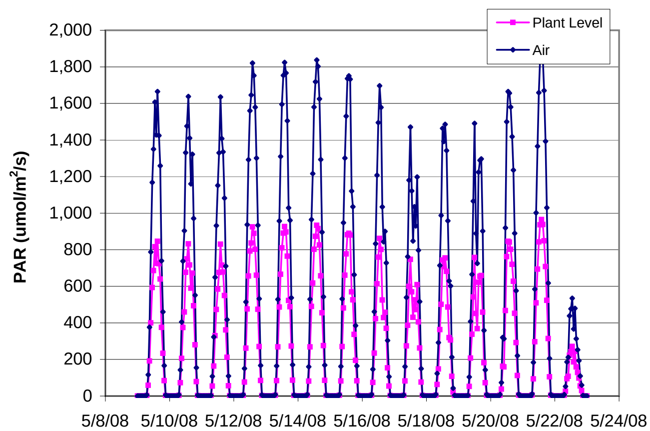
VOLUSIA BLUE SPRING - VBS-355 TO VBS-570 METABOLISM ESTIMATES

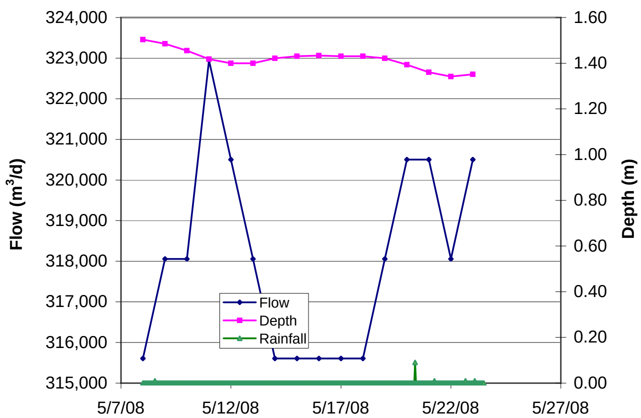
VOLUSIA BLUE SPRING - VBS-355 TO VBS-570 METABOLISM SUMMARY



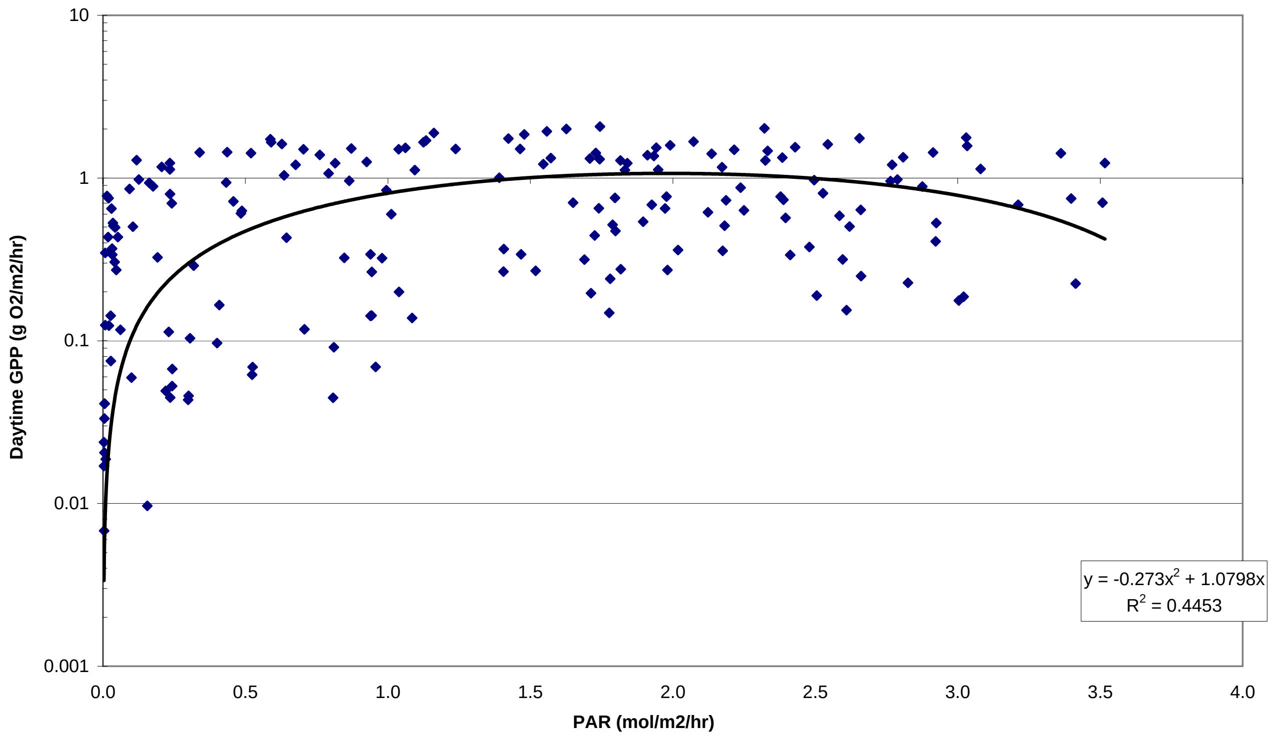


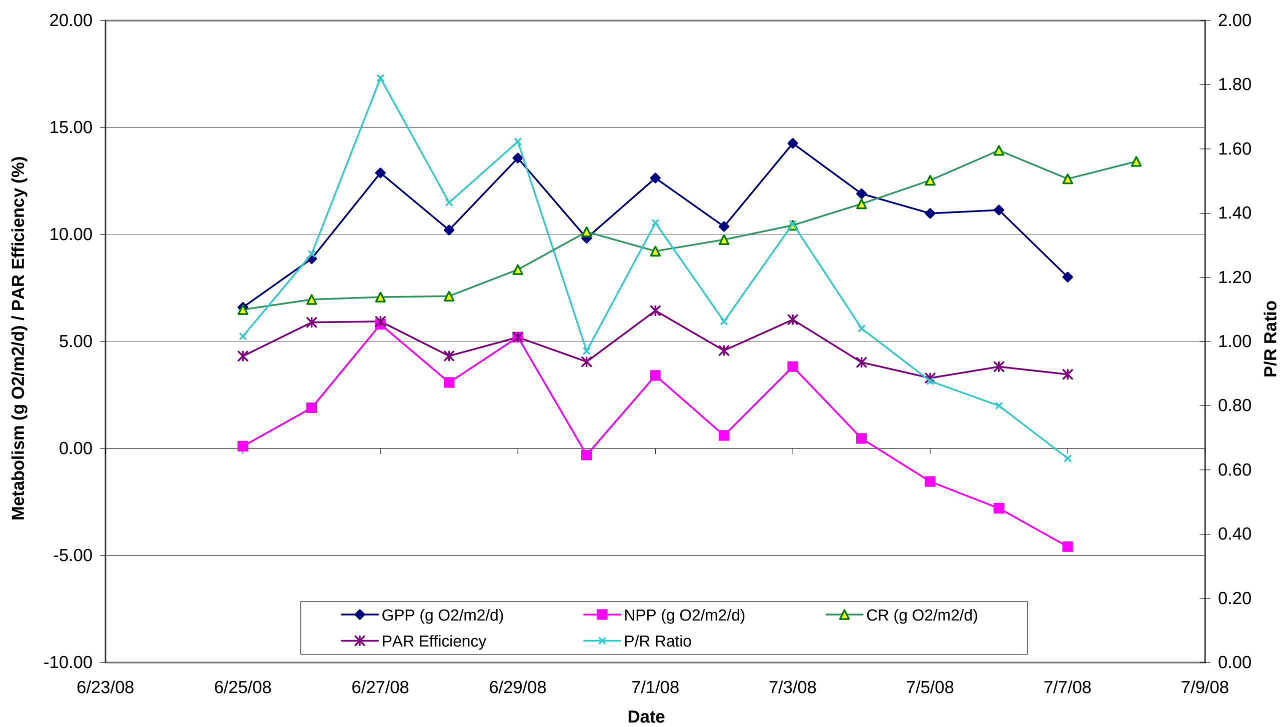






Parameter	Units	Avg	Min	Max	N
DO - up	mg/L	0.51	0.27	1.61	717
down		1.02	0.36	3.09	718
Wtr Temp - up	C	23.1	23.0	23.5	717
down		23.2	22.8	24.2	718
pH - up	SU	7.29	7.26	7.37	717
down		7.34	7.27	7.47	718
SpCond - up	uS/cm	2213	2133	2284	717
down		2231	1890	2287	718
Flow - up	m^3/d	318,055	315,608	322,948	16
Depth	m	1.42	1.34	1.50	16
Rainfall Total	in		0.13		
PAR - air	$umol/m^2/s$	490	0.0	1,900	373
plant		250	0.0	965	337
DO rate chng	$g/m^2/hr$				
corr		0.315	-0.720	3.660	337
uncorr		1.127	0.151	4.373	337

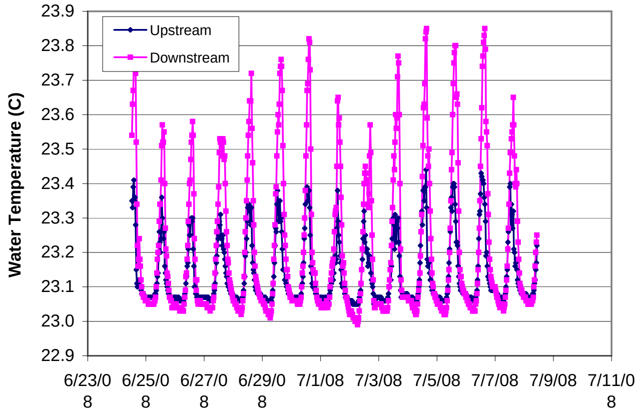


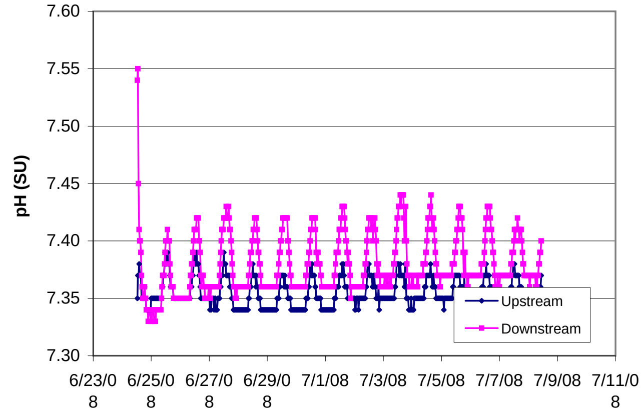


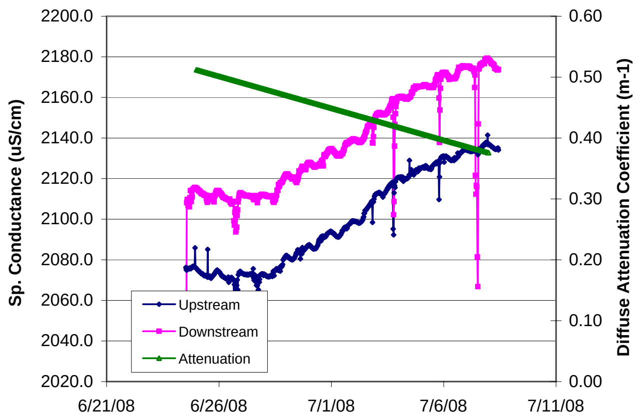
Stats	GPP	NPP	CR	P/R ratio	PAR Eff. (%)
	(g O_2/m^2/d)				
Avg	10.87	1.17	9.97	1.18	4.72
Max	14.26	5.81	13.94	1.82	6.44
Min	6.60	-4.59	6.49	0.64	3.29

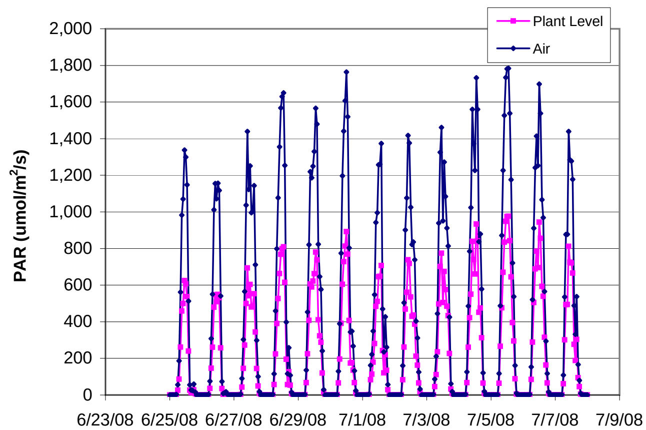
VOLUSIA BLUE SPRING - VBS-355 TO VBS-570 METABOLISM ESTIMATES

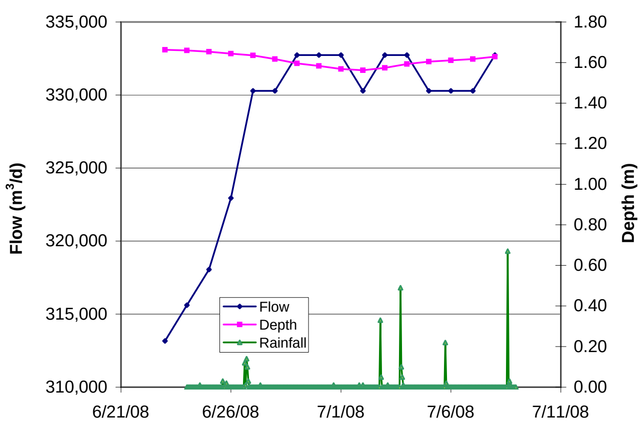
VOLUSIA BLUE SPRING - VBS-355 TO VBS-570 METABOLISM SUMMARY



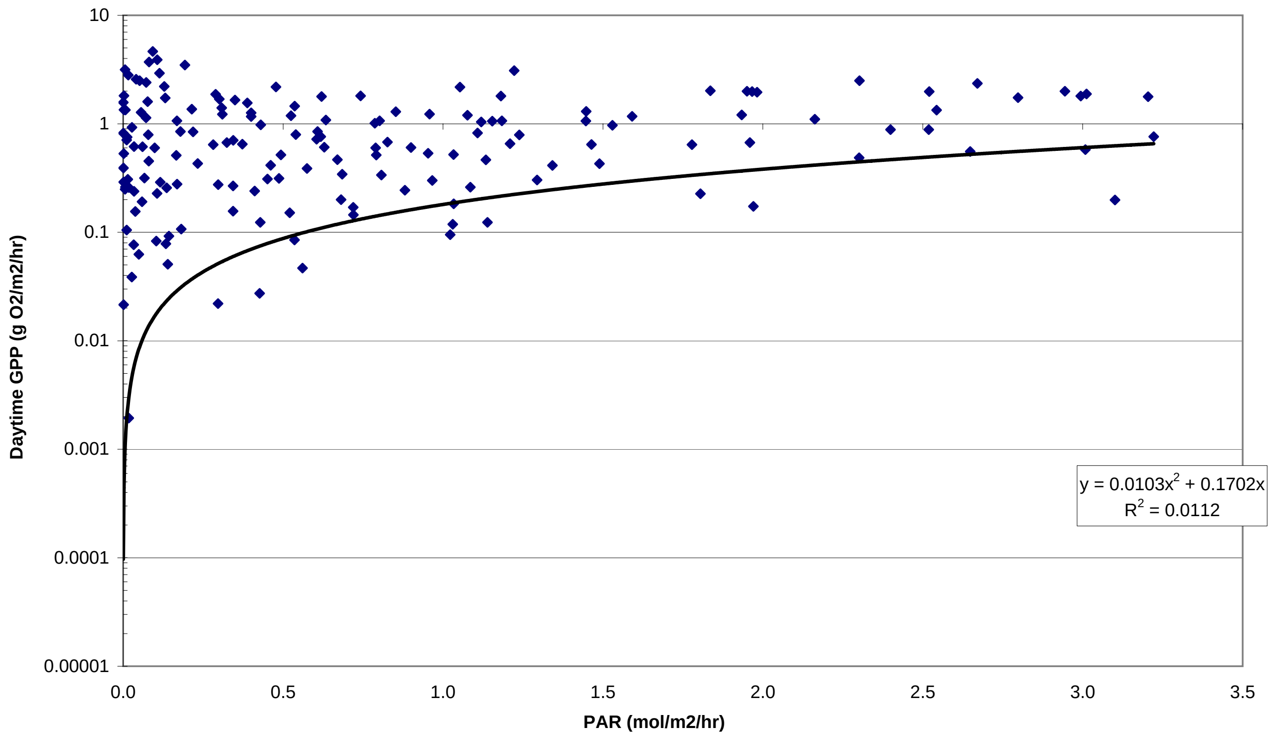


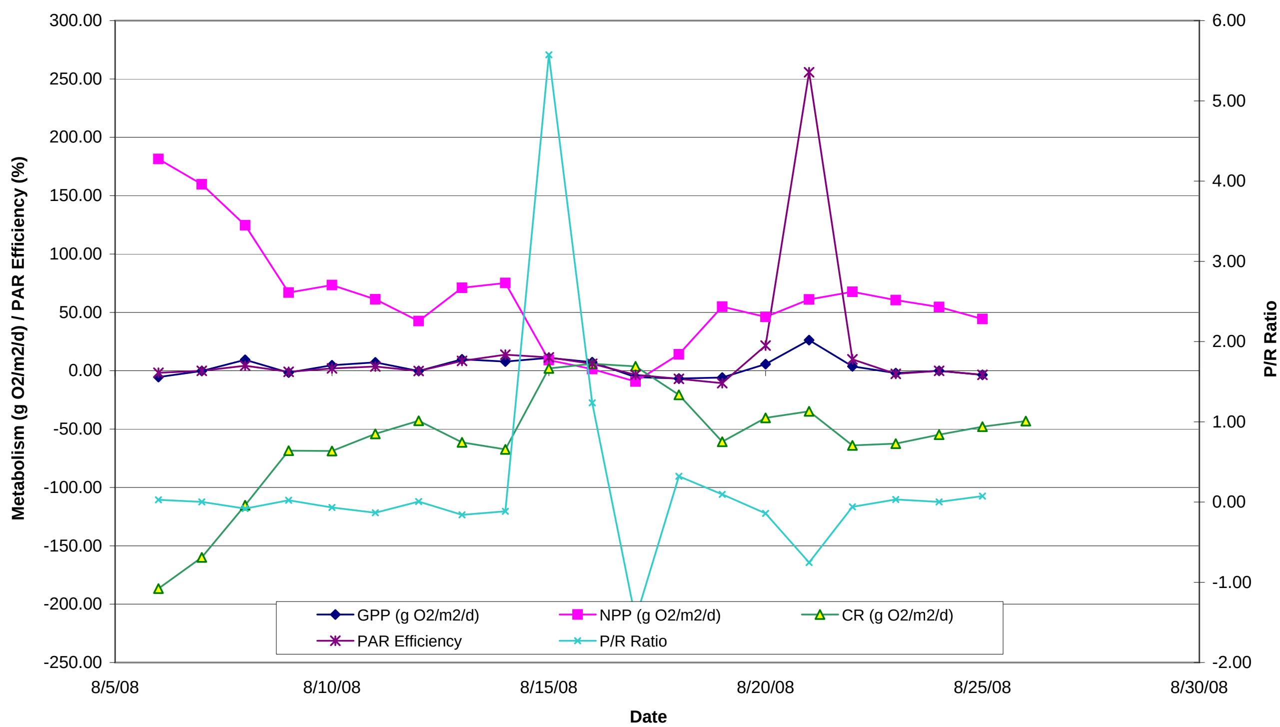






Parameter	Units	Avg	Min	Max	N
DO - up	mg/L	0.55	0.31	1.55	669
down		0.96	0.42	2.91	669
Wtr Temp - up	C	23.1	23.1	23.4	669
down		23.2	23.0	23.9	669
pH - up	SU	7.35	7.34	7.39	669
down		7.38	7.33	7.55	669
SpCond - up	uS/cm	2100	2059	2141	669
down		2138	2040	2179	669
Flow - up	m^3/d	327,994	313,162	332,734	16
Depth	m	1.61	1.56	1.66	16
Rainfall Total	in		2.51		
PAR - air	$umol/m^2/s$	419	0.0	1,784	360
plant		220	0.0	977	313
DO rate chng	$g/m^2/hr$				
corr		0.040	-0.739	1.594	313
uncorr		0.947	0.199	2.439	313

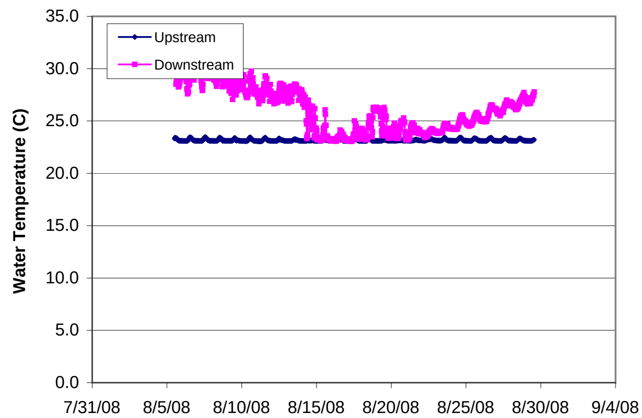


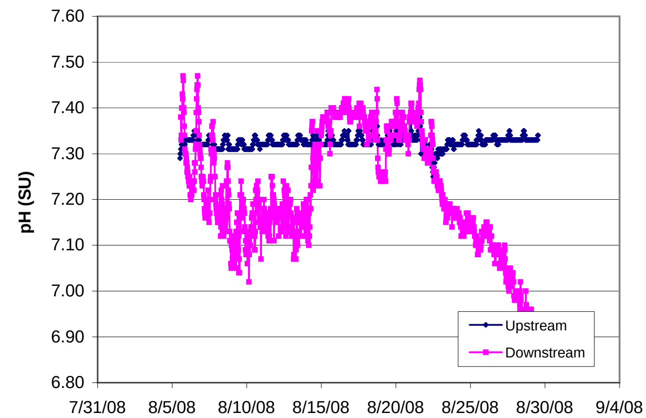


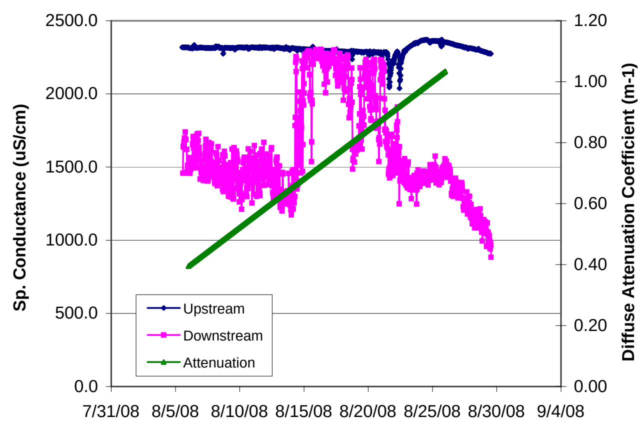
Stats	GPP	NPP	CR	P/R ratio	PAR Eff. (%)
	($g\ O_2/m^2/d$)				
Avg	3.10	63.04	-59.13	0.22	15.32
Max	26.22	181.35	5.90	5.57	255.68
Min	-6.64	-9.21	-186.73	-1.46	-10.66

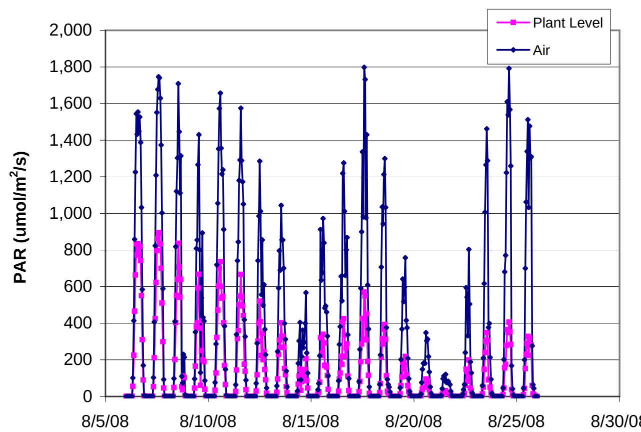
VOLUSIA BLUE SPRING - VBS-355 TO VBS-570 METABOLISM ESTIMATES

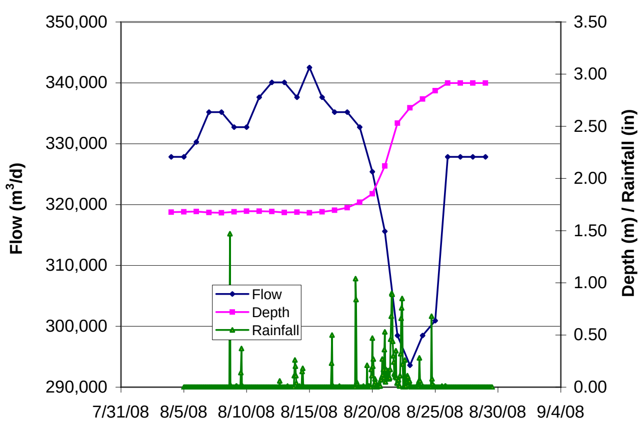
VOLUSIA BLUE SPRING - VBS-355 TO VBS-570 METABOLISM SUMMARY











Parameter	Units	Avg	Min	Max	N
DO - up	mg/L	0.28	0.01	1.94	1154
down		1.65	0.20	5.17	1152
Wtr Temp - up	C	23.2	23.1	23.5	1154
down		26.1	23.1	31.4	1152
pH - up	SU	7.33	7.25	7.38	1154
down		7.22	6.86	7.47	1152
SpCond - up	uS/cm	2307	2038	2372	1154
down		1602	884	2305	1152
Flow - up	m^3/d	327,088	293,589	342,521	26
Depth	m	2.06	1.67	2.91	26
Rainfall Total	in		20.40		
PAR - air	$umol/m^2/s$	357	0.0	1,841	569
plant		124	0.0	895	481
DO rate chng	$g/m^2/hr$				
corr		2.514	-0.489	9.228	481
uncorr		3.080	0.000	9.747	481

Appendix J

Blue Spring Particulate Export Detail and Summaries (from WSI)

APPENDIX J. Blue Spring particulate export detail and summary by sampling location and date.

Particulate Export Measurements from Volusia Blue Spring - 11/13/07 & 11/27/07

											Laboratory Analysis					Total Sample							
Segment	Date	Start Time	Sample #	Upsteam Area (m^2)	Time of Tow (s)	Flow Rate (m^3/s)	Net Area (m^2)	Water Velocity (m/s)	Volume Filtered (m^3)	Total Sample Volume (mL)	Vol. Dried (mL)	Dry Wt. (g)	Ash Wt. (g)	% Ash	Ash-Free Dry Wt. (g)	Dry Wt. (g)	Ash-Free Dry Wt. (g)	Dry Matter (g/m^3)	Organic Matter (g/m^3)	Dry Matter (g/d)	Organic Matter (g/d)	Dry Matter ($g/m^2/d$)	Organic Matter ($g/m^2/d$)
VBS35	11/13/07	11:02	1	718	604	3.61	0.1886	0.152	17.36	38	38	0.12	0.10	83.33	0.0200	0.120	0.0200	0.00691	0.00115	2,158	360	3.007	0.501
		11:15	2	718	598	3.61	0.1886	0.122	13.75	45	45	0.11	0.09	81.82	0.0200	0.110	0.0200	0.00800	0.00145	2,497	454	3.480	0.633
		11:30	3	718	610	3.61	0.1886	0.125	14.38	46	46	0.12	0.09	75.00	0.0300	0.120	0.0300	0.00835	0.00209	2,605	651	3.631	0.908
VBS355	11/13/07	10:22	1	7,972	424	3.61	0.1886	0.116	9.26	27	27	0.12	0.11	91.67	0.0100	0.120	0.0100	0.01296	0.00108	4,044	337	0.507	0.042
		10:31	2	7,972	498	3.61	0.1886	0.116	10.88	40	40	0.14	0.07	50.00	0.0700	0.140	0.0700	0.01287	0.00644	4,017	2,009	0.504	0.252
		10:43	3	7,972	455	3.61	0.1886	0.116	9.94	35	35	0.07	0.05	71.43	0.0200	0.070	0.0200	0.00704	0.00201	2,198	628	0.276	0.079
VBS570	11/13/07	8:48	1	14,447	627	3.61	0.1886	0.043	5.05	48	48	0.14	0.07	50.00	0.0700	0.140	0.0700	0.02775	0.01387	8,660	4,330	0.599	0.300
		9:04	2	14,447	601	3.61	0.1886	0.049	5.53	60	60	0.15	0.11	73.33	0.0400	0.150	0.0400	0.02714	0.00724	8,470	2,259	0.586	0.156
		9:18	3	14,447	607	3.61	0.1886	0.049	5.58	38	38	0.08	0.05	62.50	0.0300	0.080	0.0300	0.01433	0.00537	4,473	1,677	0.310	0.116
VBS35	11/27/07	14:20	1	718	576	3.60	0.1886	0.174	18.87	45	45	0.50	0.46	92.00	0.0400	0.500	0.0400	0.02650	0.00212	8,252	660	11.500	0.920
		14:35	2	718	646	3.60	0.1886	0.183	22.28	53	53	0.20	0.15	75.00	0.0500	0.200	0.0500	0.00898	0.00224	2,796	699	3.897	0.974
		14:50	3	718	540	3.60	0.1886	0.177	18.00	63	63	0.19	0.14	73.68	0.0500	0.190	0.0500	0.01055	0.00278	3,287	865	4.581	1.206
VBS355	11/27/07	12:49	1	7,608	662	3.60	0.1886	0.055	6.85	38	38	0.07	0.06	85.71	0.0100	0.070	0.0100	0.01022	0.00146	3,183	455	0.418	0.060
		13:04	2	7,608	881	3.60	0.1886	0.049	8.10	39	39	0.10	0.08	80.00	0.0200	0.100	0.0200	0.01234	0.00247	3,844	769	0.505	0.101
		13:20	3	7,608	944	3.60	0.1886	0.052	9.22	37	37	0.09	0.06	66.67	0.0300	0.090	0.0300	0.00976	0.00325	3,039	1,013	0.399	0.133
VBS570	11/27/07	10:55	1	13,921	572	3.60	0.1886	0.043	4.60	40	40	0.09	0.07	77.78	0.0200	0.090	0.0200	0.01955	0.00435	6,089	1,353	0.437	0.097
		11:10	2	13,921	840	3.60	0.1886	0.070	11.10	53	53	0.12	0.09	75.00	0.0300	0.120	0.0300	0.01081	0.00270	3,365	841	0.242	0.060
		11:25	3	13,921	708	3.60	0.1886	0.076	10.17	49	49	0.10	0.07	70.00	0.0300	0.100	0.0300	0.00983	0.00295	3,061	918	0.220	0.066

Particulate Export Measurements from Volusia Blue Spring - 1/22/08 & 2/06/08

											Laboratory Analysis					Total Sample							
Segment	Date	Start Time	Sample #	Upsteam Area (m^2)	Time of Tow (s)	Flow Rate (m^3/s)	Net Area (m^2)	Water Velocity (m/s)	Volume Filtered (m^3)	Total Sample Volume (mL)	Vol. Dried (mL)	Dry Wt. (g)	Ash Wt. (g)	% Ash	Ash-Free Dry Wt. (g)	Dry Wt. (g)	Ash-Free Dry Wt. (g)	Dry Matter (g/m^3)	Organic Matter (g/m^3)	Dry Matter (g/d)	Organic Matter (g/d)	Dry Matter ($g/m^2/d$)	Organic Matter ($g/m^2/d$)
VBS35	1/22/08	13:38	1	718	589	3.90	0.1886	0.216	24.02	57	57	0.58	0.49	84.48	0.0900	0.580	0.0900	0.02415	0.00375	8,127	1,261	11.327	1.758
		13:52	2	718	587	3.90	0.1886	0.229	25.28	53	53	0.40	0.35	87.50	0.0500	0.400	0.0500	0.01582	0.00198	5,324	665	7.420	0.928
		14:07	3	718	596	3.90	0.1886	0.253	28.42	39	39	0.19	0.14	73.68	0.0500	0.190	0.0500	0.00668	0.00176	2,250	592	3.135	0.825
VBS355	1/22/08	14:40	1	7,163	594	3.90	0.1886	0.186	20.81	49	49	0.16	0.11	68.75	0.0500	0.160	0.0500	0.00769	0.00240	2,587	809	0.361	0.113
		14:55	2	7,163	608	3.90	0.1886	0.180	20.60	46	46	0.13	0.08	61.54	0.0500	0.130	0.0500	0.00631	0.00243	2,123	817	0.296	0.114
		15:10	3	7,163	601	3.90	0.1886	0.180	20.37	41	41	0.13	0.10	76.92	0.0300	0.130	0.0300	0.00638	0.00147	2,148	496	0.300	0.069
VBS570	1/22/08	15:40	1	13,233	600	3.90	0.1886	0.067	7.59	37	37	0.13	0.08	61.54	0.0500	0.130	0.0500	0.01712	0.00659	5,762	2,216	0.435	0.167
		15:53	2	13,233	602	3.90	0.1886	0.085	9.68	39	39	0.18	0.11	61.11	0.0700	0.180	0.0700	0.01859	0.00723	6,256	2,433	0.473	0.184
		16:07	3	13,233	638	3.90	0.1886	0.073	8.80	32	32	0.08	0.05	62.50	0.0300	0.080	0.0300	0.00909	0.00341	3,058	1,147	0.231	0.087
VBS35	2/6/08	13:59	1	718	601	3.83	0.1886	0.274	31.08	73	69	0.30	0.21	70.00	0.0900	0.317	0.0952	0.01021	0.00306	3,382	1,014	4.713	1.414
		14:13	2	718	482	3.83	0.1886	0.262	23.85	82	65	0.21	0.16	76.19	0.0500	0.265	0.0631	0.01111	0.00265	3,679	876	5.128	1.221
		14:27	3	718	481	3.83	0.1886	0.265	24.04	83	68	0.21	0.16	76.19	0.0500	0.256	0.0610	0.01066	0.00254	3,531	841	4.921	1.172
VBS355	2/6/08	13:09	1	6,839	604	3.83	0.1886	0.213	24.29	65	65	0.21	0.14	66.67	0.0700	0.210	0.0700	0.00865	0.00288	2,863	954	0.419	0.140
		13:24	2	6,839	604	3.83	0.1886	0.219	25.00	47	47	0.20	0.15	75.00	0.0500	0.200	0.0500	0.00800	0.00200	2,649	662	0.387	0.097
		13:38	3	6,839	603	3.83	0.1886	0.198	22.54	66	66	0.19	0.14	73.68	0.0500	0.190	0.0500	0.00843	0.00222	2,791	734	0.408	0.107
VBS570	2/6/08	12:20	1	12,747	675	3.83	0.1886	0.073	9.31	44	44	0.13	0.09	69.23	0.0400	0.130	0.0400	0.01397	0.00430	4,627	1,424	0.363	0.112
		12:35	2	12,747	612	3.83	0.1886	0.049	5.63	40	40	0.10	0.06	60.00	0.0400	0.100	0.0400	0.01777	0.00711	5,885	2,354	0.462	0.185
		12:50	3	12,747	603	3.83	0.1886	0.101	11.43	63	63	0.11	0.08	72.73	0.0300	0.110	0.0300	0.00962	0.00262	3,187	869	0.250	0.068

APPENDIX J. Blue Spring particulate export detail and summary by sampling location and date.

Particulate Export Measurements from Volusia Blue Spring - 03/18/08 & 04/01/08

											Laboratory Analysis					Total Sample							
Segment	Date	Start Time	Sample #	Upsteam Area (m^2)	Time of Tow (s)	Flow Rate (m^3/s)	Net Area (m^2)	Water Velocity (m/s)	Volume Filtered (m^3)	Total Sample Volume (mL)	Vol. Dried (mL)	Dry Wt. (g)	Ash Wt. (g)	% Ash	Ash-Free Dry Wt. (g)	Dry Wt. (g)	Ash-Free Dry Wt. (g)	Dry Matter (g/m^3)	Organic Matter (g/m^3)	Dry Matter (g/d)	Organic Matter (g/d)	Dry Matter ($g/m^2/d$)	Organic Matter ($g/m^2/d$)
VBS35	3/18/08	12:07	1	718	476	4.01	0.1886	0.244	21.89	55	55	0.12	0.10	83.33	0.0200	0.120	0.0200	0.00548	0.00091	1,898	316	2.645	0.441
		12:20	2	718	465	4.01	0.1886	0.274	24.05	36	36	0.09	0.07	77.78	0.0200	0.090	0.0200	0.00374	0.00083	1,295	288	1.805	0.401
		12:30	3	718	406	4.01	0.1886	0.268	20.54	40	40	0.17	0.16	94.12	0.0100	0.170	0.0100	0.00828	0.00049	2,865	169	3.993	0.235
VBS355	3/18/08	10:22	1	6,839	332	4.01	0.1886	0.253	15.84	39	39	0.10	0.08	80.00	0.0200	0.100	0.0200	0.00631	0.00126	2,185	437	0.320	0.064
		10:31	2	6,839	323	4.01	0.1886	0.241	14.67	70	70	6.40	6.29	98.28	0.1100	6.400	0.1100	0.43637	0.00750	151,032	2,596	22.083	0.380
		10:43	3	6,839	332	4.01	0.1886	0.247	15.46	48	48	1.21	1.10	90.91	0.1100	1.210	0.1100	0.07828	0.00712	27,094	2,463	3.962	0.360
VBS570	3/18/08	8:48	1	12,747	215	4.01	0.1886	0.061	2.47	30	30	0.07	0.06	85.71	0.0100	0.070	0.0100	0.02832	0.00405	9,803	1,400	0.769	0.110
		9:04	2	12,747	370	4.01	0.1886	0.070	4.89	28	28	0.05	0.05	100.00	0.0000	0.050	0.0000	0.01022	0.00000	3,538	0	0.278	0.000
		9:18	3	12,747	474	4.01	0.1886	0.079	7.08	35	35	0.05	0.05	100.00	0.0000	0.050	0.0000	0.00706	0.00000	2,443	0	0.192	0.000
VBS35	4/1/08	12:36	1	718	369	3.83	0.1886	0.293	20.36	60	60	0.54	0.49	90.74	0.0500	0.540	0.0500	0.02652	0.00246	8,784	813	12.242	1.134
		12:45	2	718	361	3.83	0.1886	0.317	21.58	70	70	2.96	2.82	95.27	0.1400	2.957	0.1400	0.13703	0.00649	45,383	2,149	63.252	2.995
		12:57	3	718	379	3.83	0.1886	0.311	22.22	60	60	1.90	1.77	93.16	0.1300	1.900	0.1300	0.08551	0.00585	28,320	1,938	39.471	2.701
VBS355	4/1/08	11:54	1	6,839	435	3.83	0.1886	0.223	18.25	46	46	0.42	0.34	80.95	0.0800	0.420	0.0800	0.02301	0.00438	7,621	1,452	1.114	0.212
		12:06	2	6,839	368	3.83	0.1886	0.213	14.81	58	58	1.49	1.29	86.58	0.2000	1.490	0.2000	0.10063	0.01351	33,329	4,474	4.873	0.654
		12:16	3	6,839	404	3.83	0.1886	0.232	17.65	54	54	0.89	0.71	79.78	0.1800	0.890	0.1800	0.05043	0.01020	16,702	3,378	2.442	0.494
VBS570	4/1/08	11:05	1	12,747	562	3.83	0.1886	0.088	9.37	45	45	0.13	0.09	69.23	0.0400	0.130	0.0400	0.01388	0.00427	4,596	1,414	0.361	0.111
		11:20	2	12,747	706	3.83	0.1886	0.113	15.01	40	40	0.10	0.07	70.00	0.0300	0.100	0.0300	0.00666	0.00200	2,206	662	0.173	0.052
		11:36	3	12,747	545	3.83	0.1886	0.104	10.65	36	36	0.10	0.07	70.00	0.0300	0.100	0.0300	0.00939	0.00282	3,110	933	0.244	0.073

Particulate Export Measurements from Volusia Blue Spring - 05/08/08 & 05/23/08

											Laboratory Analysis					Total Sample							
Segment	Date	Start Time	Sample #	Upsteam Area (m^2)	Time of Tow (s)	Flow Rate (m^3/s)	Net Area (m^2)	Water Velocity (m/s)	Volume Filtered (m^3)	Total Sample Volume (mL)	Vol. Dried (mL)	Dry Wt. (g)	Ash Wt. (g)	% Ash	Ash-Free Dry Wt. (g)	Dry Wt. (g)	Ash-Free Dry Wt. (g)	Dry Matter (g/m^3)	Organic Matter (g/m^3)	Dry Matter (g/d)	Organic Matter (g/d)	Dry Matter ($g/m^2/d$)	Organic Matter ($g/m^2/d$)
VBS35	5/8/08	12:23	1	718	330	3.65	0.1886	0.229	14.22	48	48	0.49	0.42	85.71	0.0700	0.490	0.0700	0.03446	0.00492	10,870	1,553	15.150	2.164
		12:51	2	718	333	3.65	0.1886	0.244	15.32	33	33	0.10	0.08	80.00	0.0200	0.100	0.0200	0.00653	0.00131	2,059	412	2.870	0.574
		12:59	3	718	317	3.65	0.1886	0.253	15.11	52	52	0.26	0.21	80.77	0.0500	0.260	0.0500	0.01721	0.00331	5,429	1,044	7.567	1.455
VBS355	5/8/08	11:42	1	6,880	503	3.65	0.1886	0.219	20.80	46	46	0.18	0.15	83.33	0.0300	0.180	0.0300	0.00865	0.00144	2,730	455	0.397	0.066
		11:53	2	6,880	344	3.65	0.1886	0.198	12.85	36	36	0.12	0.10	83.33	0.0200	0.120	0.0200	0.00934	0.00156	2,947	491	0.428	0.071
		12:04	3	6,880	352	3.65	0.1886	0.213	14.15	33	33	0.22	0.19	86.36	0.0300	0.220	0.0300	0.01554	0.00212	4,903	669	0.713	0.097
VBS570	5/8/08	10:40	1	12,828	646	3.65	0.1886	0.055	6.68	43	43	0.21	0.18	85.71	0.0300	0.210	0.0300	0.03143	0.00449	9,913	1,416	0.773	0.110
		10:56	2	12,828	590	3.65	0.1886	0.055	6.11	42	42	0.14	0.10	71.43	0.0400	0.140	0.0400	0.02292	0.00655	7,231	2,066	0.564	0.161
		11:07	3	12,828	597	3.65	0.1886	0.076	8.57	43	43	0.09	0.08	88.89	0.0100	0.090	0.0100	0.01050	0.00117	3,311	368	0.258	0.029
VBS35	5/23/08	11:52	1	718	607	3.70	0.1886	0.305	34.89	64	64	1.63	1.50	92.02	0.1300	1.630	0.1300	0.04672	0.00373	14,940	1,192	20.823	1.661
		12:06	2	718	595	3.70	0.1886	0.323	36.25	76	61	1.04	0.94	90.38	0.1000	1.296	0.1246	0.03574	0.00344	11,430	1,099	15.931	1.532
		12:20	3	718	601	3.70	0.1886	0.320	36.27	50	50	0.66	0.57	86.36	0.0900	0.660	0.0900	0.01820	0.00248	5,819	793	8.110	1.106
VBS355	5/23/08	10:48	1	6,880	593	3.70	0.1886	0.213	23.86	37	37	0.28	0.20	71.43	0.0800	0.280	0.0800	0.01174	0.00335	3,753	1,072	0.546	0.156
		11:08	2	6,880	621	3.70	0.1886	0.213	24.99	48	48	1.26	1.03	81.75	0.2300	1.260	0.2300	0.05043	0.00921	16,127	2,944	2.344	0.428
		11:27	3	6,880	604	3.70	0.1886	0.213	24.30	48	48	1.21	0.98	80.99	0.2300	1.210	0.2300	0.04979	0.00946	15,923	3,027	2.314	0.440
VBS570	5/23/08	13:05	1	12,828	599	3.70	0.1886	0.094	10.67	36	36	0.31	0.22	70.97	0.0900	0.310	0.0900	0.02905	0.00843	9,288	2,697	0.724	0.210
		13:23	2	12,828	630	3.70	0.1886	0.094	11.23	47	47	0.23	0.17	73.91	0.0600	0.230	0.0600	0.02049	0.00535	6,552	1,709	0.511	0.133
		13:38	3	12,828	600	3.70	0.1886	0.098	11.04	53	53	0.24	0.16	66.67	0.0800	0.240	0.0800	0.02175	0.00725	6,955	2,318	0.542	0.181

APPENDIX J. Blue Spring particulate export detail and summary by sampling location and date.

Particulate Export Measurements from Volusia Blue Spring - 06/24/08 & 07/08/08

											Laboratory Analysis					Total Sample							
Segment	Date	Start Time	Sample #	Upsteam Area (m^2)	Time of Tow (s)	Flow Rate (m^3/s)	Net Area (m^2)	Water Velocity (m/s)	Volume Filtered (m^3)	Total Sample Volume (mL)	Vol. Dried (mL)	Dry Wt. (g)	Ash Wt. (g)	% Ash	Ash-Free Dry Wt. (g)	Dry Wt. (g)	Ash-Free Dry Wt. (g)	Dry Matter (g/m^3)	Organic Matter (g/m^3)	Dry Matter (g/d)	Organic Matter (g/d)	Dry Matter ($g/m^2/d$)	Organic Matter ($g/m^2/d$)
VBS35	6/24/08	11:17	1	718	298	3.67	0.1886	0.253	14.22	55	55	8.74	8.51	97.37	0.2300	8.740	0.2300	0.61478	0.01618	194,986	5,131	271.757	7.151
		11:30	2	718	293	3.67	0.1886	0.238	13.14	52	52	1.36	1.29	94.85	0.0700	1.360	0.0700	0.10353	0.00533	32,837	1,690	45.766	2.356
		11:40	3	718	380	3.67	0.1886	0.189	13.54	63	63	1.75	1.65	94.29	0.1000	1.750	0.1000	0.12923	0.00738	40,987	2,342	57.125	3.264
VBS355	6/24/08	12:03	1	6,839	319	3.67	0.1886	0.180	10.82	72	67	0.61	0.41	67.21	0.2000	0.656	0.2149	0.06060	0.01987	19,219	6,301	2.810	0.921
		12:17	2	6,839	237	3.67	0.1886	0.168	7.49	59	59	0.73	0.59	80.82	0.1400	0.730	0.1400	0.09743	0.01869	30,903	5,927	4.519	0.867
		12:25	3	6,839	245	3.67	0.1886	0.146	6.76	58	58	3.03	2.62	86.47	0.4100	3.030	0.4100	0.44827	0.06066	142,174	19,238	20.788	2.813
VBS570	6/24/08	13:14	1	12,747	450	3.67	0.1886	0.079	6.72	67	67	0.37	0.22	59.46	0.1500	0.370	0.1500	0.05502	0.02231	17,450	7,074	1.369	0.555
		13:30	2	12,747	409	3.67	0.1886	0.085	6.58	47	47	0.29	0.18	62.07	0.1100	0.290	0.1100	0.04406	0.01671	13,973	5,300	1.096	0.416
		13:41	3	12,747	434	3.67	0.1886	0.073	5.99	47	47	0.26	0.16	61.54	0.1000	0.260	0.1000	0.04343	0.01670	13,774	5,298	1.081	0.416
VBS35	7/8/08	10:34	1	718	188	3.88	0.1886	0.268	9.51	35	35	0.30	0.26	86.67	0.0400	0.300	0.0400	0.03155	0.00421	10,575	1,410	14.738	1.965
		10:41	2	718	187	3.88	0.1886	0.283	10.00	27	27	0.28	0.27	96.43	0.0100	0.280	0.0100	0.02801	0.00100	9,389	335	13.086	0.467
		10:50	3	718	185	3.88	0.1886	0.277	9.68	33	33	0.15	0.13	86.67	0.0200	0.150	0.0200	0.01550	0.00207	5,196	693	7.242	0.966
VBS355	7/8/08	11:07	1	6,839	210	3.88	0.1886	0.219	8.69	49	49	0.89	0.72	80.90	0.1700	0.890	0.1700	0.10241	0.01956	34,326	6,557	5.019	0.959
		11:15	2	6,839	216	3.88	0.1886	0.238	9.68	45	45	0.61	0.48	78.69	0.1300	0.610	0.1300	0.06299	0.01342	21,114	4,500	3.087	0.658
		11:21	3	6,839	213	3.88	0.1886	0.223	8.94	36	36	0.27	0.18	66.67	0.0900	0.270	0.0900	0.03021	0.01007	10,126	3,375	1.481	0.494
VBS570	7/8/08	12:20	1	12,747	432	3.88	0.1886	0.070	5.71	43	43	0.21	0.13	61.90	0.0800	0.210	0.0800	0.03677	0.01401	12,325	4,695	0.967	0.368
		12:36	2	12,747	448	3.88	0.1886	0.079	6.69	40	40	0.20	0.13	65.00	0.0700	0.200	0.0700	0.02987	0.01046	10,013	3,505	0.785	0.275
		12:48	3	12,747	441	3.88	0.1886	0.061	5.07	31	31	0.16	0.09	56.25	0.0700	0.160	0.0700	0.03156	0.01381	10,579	4,628	0.830	0.363

Particulate Export Measurements from Volusia Blue Spring - 08/05/08 & 08/29/08

											Laboratory Analysis					Total Sample							
Segment	Date	Start Time	Sample #	Upsteam Area (m^2)	Time of Tow (s)	Flow Rate (m^3/s)	Net Area (m^2)	Water Velocity (m/s)	Volume Filtered (m^3)	Total Sample Volume (mL)	Vol. Dried (mL)	Dry Wt. (g)	Ash Wt. (g)	% Ash	Ash-Free Dry Wt. (g)	Dry Wt. (g)	Ash-Free Dry Wt. (g)	Dry Matter (g/m^3)	Organic Matter (g/m^3)	Dry Matter (g/d)	Organic Matter (g/d)	Dry Matter ($g/m^2/d$)	Organic Matter ($g/m^2/d$)
VBS35	8/5/08	10:50	1	718	245	3.81	0.1886	0.207	9.58	39	39	0.15	0.13	86.67	0.0200	0.150	0.0200	0.01566	0.00209	5,159	688	7.191	0.959
		11:02	2	718	305	3.81	0.1886	0.213	12.27	43	43	0.21	0.18	85.71	0.0300	0.210	0.0300	0.01711	0.00244	5,636	805	7.856	1.122
		11:12	3	718	292	3.81	0.1886	0.183	10.07	50	50	1.40	1.31	93.57	0.0900	1.400	0.0900	0.13903	0.00894	45,791	2,944	63.820	4.103
VBS355	8/5/08	11:50	1	7,325	326	3.81	0.1886	0.055	3.37	36	36	0.30	0.22	73.33	0.0800	0.300	0.0800	0.08895	0.02372	29,297	7,812	4.000	1.067
		11:59	2	7,325	300	3.81	0.1886	0.076	4.31	44	44	0.29	0.20	68.97	0.0900	0.290	0.0900	0.06727	0.02088	22,158	6,877	3.025	0.939
		12:08	3	7,325	252	3.81	0.1886	0.055	2.61	40	40	0.43	0.30	69.77	0.1300	0.430	0.1300	0.16493	0.04986	54,323	16,423	7.416	2.242
VBS570	8/5/08	12:45	1	13,476	280	3.81	0.1886	0.076	4.02	35	35	0.17	0.12	70.59	0.0500	0.170	0.0500	0.04225	0.01243	13,917	4,093	1.033	0.304
		12:56	2	13,476	294	3.81	0.1886	0.079	4.39	34	34	0.17	0.11	64.71	0.0600	0.170	0.0600	0.03869	0.01366	12,744	4,498	0.946	0.334
		13:04	3	13,476	312	3.81	0.1886	0.073	4.30	40	40	0.19	0.12	63.16	0.0700	0.190	0.0700	0.04415	0.01626	14,540	5,357	1.079	0.398
VBS35	8/29/08	12:05	1	718	464	3.26	0.1886	0.034	2.93	45	45	0.24	0.20	83.33	0.0400	0.240	0.0400	0.08181	0.01363	23,018	3,836	32.080	5.347
		12:16	2	718	190	3.26	0.1886	0.027	0.98	16	16	0.05	0.04	80.00	0.0100	0.050	0.0100	0.05087	0.01017	14,313	2,863	19.949	3.990
		12:26	3	718	195	3.26	0.1886	0.027	1.01	22	22	0.05	0.04	80.00	0.0100	0.050	0.0100	0.04957	0.00991	13,946	2,789	19.437	3.887

Note(s):
8/5/08 VBS570 samples collected 20m upstream of normal location due to river water intrusion into spring run, with corresponding lack of flow.
8/29/08 VBS355 & VBS570 not collected, St. Johns flood stage, spring run flowing upstream at these two locations

Appendix K

Blue Spring Pollutant Assimilation Estimates (from USGS and WSI)

APPENDIX K. Blue Spring estimated ammonia mass removals by spring run segment and date.

			Inflow				Outflow								
	Segment		Segment - Up				Segment - Down				Removal				
	Area		Conc	Flow	Mass	Mass	Conc	Flow	Mass	Mass	Conc		Mass		
Site	(ha)	Month	(mg/L)	(m^3/d)	(kg/d)	(kg/ha/d)	(mg/L)	(m^3/d)	(kg/d)	(kg/ha/d)	(mg/L)	(%)	(kg/d)	(kg/ha/d)	(%)
VBS 35 - VBS 355	0.72	200710	0.12	315,608	37.9	52.9	0.11	315,608	34.7	48.5	0.010	8.3	3.2	4.41	8.3
		200711	0.11	318,055	35.0	48.8	0.10	318,055	31.8	44.4	0.010	9.1	3.2	4.44	9.1
		200712	0.09	332,734	29.9	41.8	0.08	332,734	26.6	37.2	0.010	11.1	3.3	4.65	11.1
		200801	0.10	325,395	32.5	45.4	0.09	325,395	29.3	40.9	0.010	10.0	3.3	4.54	10.0
		200802	0.12	330,288	39.6	55.3	0.10	330,288	33.0	46.1	0.020	16.7	6.6	9.22	16.7
		200803	0.12	335,181	40.2	56.2	0.11	335,181	36.9	51.5	0.010	8.3	3.4	4.68	8.3
		200804	0.12	318,055	38.2	53.3	*0.11*	318,055	35.0	48.8	0.010	8.3	3.2	4.44	8.3
		200805	0.10	313,162	31.3	43.7	0.25	313,162	78.3	109.3	-0.150	-150.0	-47.0	-65.58	-150.0
		200806	0.10	313,162	31.3	43.7	0.09	313,162	28.2	39.3	0.010	10.0	3.1	4.37	10.0
		200807	0.12	325,395	39.0	54.5	0.11	325,395	35.8	50.0	0.010	8.3	3.3	4.54	8.3
		200808	0.14	327,841	45.9	64.1	0.12	327,841	39.3	54.9	0.020	14.3	6.6	9.15	14.3
		200809	0.04	*327,841*	13.1	18.3	0.04	327,841	13.1	18.3	0.000	0.0	0.0	0.00	0.0
		POR	0.11	323,560	34.5	48.2	0.11	323,560	35.2	49.1	-0.002	-1.9	-0.7	-0.93	-1.9
VBS 355 - VBS 570	0.61	200710	0.11	315,608	34.7	57.2	0.12	315,608	37.9	62.4	-0.010	-9.1	-3.2	-5.20	-9.1
		200711	0.10	318,055	31.8	52.4	0.10	318,055	31.8	52.4	0.000	0.0	0.0	0.00	0.0
		200712	0.08	332,734	26.6	43.9	0.08	332,734	26.6	43.9	0.000	0.0	0.0	0.00	0.0
		200801	0.09	325,395	29.3	48.2	0.10	325,395	32.5	53.6	-0.010	-11.1	-3.3	-5.36	-11.1
		200802	0.10	330,288	33.0	54.4	0.10	330,288	33.0	54.4	0.000	0.0	0.0	0.00	0.0
		200803	0.11	335,181	36.9	60.7	0.11	335,181	36.9	60.7	0.000	0.0	0.0	0.00	0.0
		200804	0.11	318,055	35.0	57.6	0.11	318,055	35.0	57.6	0.000	0.0	0.0	0.00	0.0
		200805	0.25	313,162	78.3	129.0	0.09	313,162	28.2	46.4	0.160	64.0	50.1	82.54	64.0
		200806	0.09	313,162	28.2	46.4	0.09	313,162	28.2	46.4	0.000	0.0	0.0	0.00	0.0
		200807	0.11	325,395	35.8	59.0	0.10	325,395	32.5	53.6	0.010	9.1	3.3	5.36	9.1
		200808	0.12	327,841	39.3	64.8	0.11	327,841	36.1	59.4	0.010	8.3	3.3	5.40	8.3
		200809	0.04	327,841	13.1	21.6	0.05	327,841	16.4	27.0	-0.010	-25.0	-3.3	-5.40	-25.0
		POR	0.11	323,560	35.2	57.9	0.10	323,560	31.3	51.5	0.012	11.1	3.9	6.45	11.1
VBS 35 - VBS 570	1.32	200710	0.12	315,608	37.9	28.6	0.12	315,608	37.9	28.6	0.000	0.0	0.0	0.00	0.0
		200711	0.11	318,055	35.0	26.4	0.10	318,055	31.8	24.0	0.010	9.1	3.2	2.40	9.1
		200712	0.09	332,734	29.9	22.6	0.08	332,734	26.6	20.1	0.010	11.1	3.3	2.51	11.1
		200801	0.10	325,395	32.5	24.6	0.10	325,395	32.5	24.6	0.000	0.0	0.0	0.00	0.0
		200802	0.12	330,288	39.6	30.0	0.10	330,288	33.0	25.0	0.020	16.7	6.6	4.99	16.7
		200803	0.12	335,181	40.2	30.4	0.11	335,181	36.9	27.9	0.010	8.3	3.4	2.53	8.3
		200804	0.12	318,055	38.2	28.8	0.11	318,055	35.0	26.4	0.010	8.3	3.2	2.40	8.3
		200805	0.10	313,162	31.3	23.7	0.09	313,162	28.2	21.3	0.010	10.0	3.1	2.37	10.0
		200806	0.10	313,162	31.3	23.7	0.09	313,162	28.2	21.3	0.010	10.0	3.1	2.37	10.0
		200807	0.12	325,395	39.0	29.5	0.10	325,395	32.5	24.6	0.020	16.7	6.5	4.92	16.7
		200808	0.14	327,841	45.9	34.7	0.11	327,841	36.1	27.3	0.030	21.4	9.8	7.43	21.4
		200809	0.04	327,841	13.1	9.9	0.05	327,841	16.4	12.4	-0.010	-25.0	-3.3	-2.48	-25.0
		POR	0.11	323,560	34.5	26.1	0.10	323,560	31.3	23.6	0.010	9.4	3.2	2.45	9.4

Note: No flow data available for Sept 08 due to equipment damage from Tropical Storm Fay (estimated using Aug 08 average)

APPENDIX K. Blue Spring estimated nitrate+nitrite-nitrogen mass removals by spring run segment and date.

			Inflow				Outflow								
	Segment		Segment - Up				Segment - Down				Removal				
	Area		Conc	Flow	Mass	Mass	Conc	Flow	Mass	Mass	Conc		Mass		
Site	(ha)	Month	(mg/L)	(m^3/d)	(kg/d)	(kg/ha/d)	(mg/L)	(m^3/d)	(kg/d)	(kg/ha/d)	(mg/L)	(%)	(kg/d)	(kg/ha/d)	(%)
VBS 35 - VBS 355	0.72	200710	0.31	315,608	97.8	136.6	0.30	315,608	94.7	132.2	0.010	3.2	3.2	4.41	3.2
		200711	0.35	318,055	111.3	155.4	0.34	318,055	108.1	151.0	0.010	2.9	3.2	4.44	2.9
		200712	0.39	332,734	129.8	181.2	0.40	332,734	133.1	185.8	-0.010	-2.6	-3.3	-4.65	-2.6
		200801	0.34	325,395	110.6	154.5	0.35	325,395	113.9	159.0	-0.010	-2.9	-3.3	-4.54	-2.9
		200802	0.36	330,288	118.9	166.0	0.35	330,288	115.6	161.4	0.010	2.8	3.3	4.61	2.8
		200803	0.32	335,181	107.3	149.7	0.31	335,181	103.9	145.1	0.010	3.1	3.4	4.68	3.1
		200804	0.30	318,055	95.4	133.2	*0.31*	318,055	98.6	137.6	-0.010	-3.3	-3.2	-4.44	-3.3
		200805	0.39	313,162	122.1	170.5	0.39	313,162	122.1	170.5	0.000	0.0	0.0	0.00	0.0
		200806	0.39	313,162	122.1	170.5	0.38	313,162	119.0	166.1	0.010	2.6	3.1	4.37	2.6
		200807	0.31	325,395	100.9	140.8	0.30	325,395	97.6	136.3	0.010	3.2	3.3	4.54	3.2
		200808	0.21	327,841	68.8	96.1	0.20	327,841	65.6	91.5	0.010	4.8	3.3	4.58	4.8
		200809	1.13	*327,841*	370.5	517.2	1.10	327,841	360.6	503.5	0.030	2.7	9.8	13.73	2.7
		POR	0.40	323,560	129.6	181.0	0.39	323,560	127.7	178.3	0.006	1.5	1.9	2.64	1.5
VBS 355 - VBS 570	0.61	200710	0.30	315,608	94.7	156.0	0.30	315,608	94.7	156.0	0.000	0.0	0.0	0.00	0.0
		200711	0.34	318,055	108.1	178.1	0.34	318,055	108.1	178.1	0.000	0.0	0.0	0.00	0.0
		200712	0.40	332,734	133.1	219.3	0.39	332,734	129.8	213.8	0.010	2.5	3.3	5.48	2.5
		200801	0.35	325,395	113.9	187.6	0.34	325,395	110.6	182.3	0.010	2.9	3.3	5.36	2.9
		200802	0.35	330,288	115.6	190.4	0.35	330,288	115.6	190.4	0.000	0.0	0.0	0.00	0.0
		200803	0.31	335,181	103.9	171.2	0.31	335,181	103.9	171.2	0.000	0.0	0.0	0.00	0.0
		200804	0.31	318,055	98.6	162.4	0.28	318,055	89.1	146.7	0.030	9.7	9.5	15.72	9.7
		200805	0.39	313,162	122.1	201.2	0.38	313,162	119.0	196.0	0.010	2.6	3.1	5.16	2.6
		200806	0.38	313,162	119.0	196.0	0.38	313,162	119.0	196.0	0.000	0.0	0.0	0.00	0.0
		200807	0.30	325,395	97.6	160.8	0.24	325,395	78.1	128.7	0.060	20.0	19.5	32.16	20.0
		200808	0.20	327,841	65.6	108.0	0.16	327,841	52.5	86.4	0.040	20.0	13.1	21.60	20.0
		200809	1.10	327,841	360.6	594.1	0.75	327,841	245.9	405.1	0.350	31.8	114.7	189.03	31.8
		POR	0.39	323,560	127.7	210.4	0.35	323,560	113.9	187.6	0.043	10.9	13.9	22.88	10.9
VBS 35 - VBS 570	1.32	200710	0.31	315,608	97.8	73.9	0.30	315,608	94.7	71.5	0.010	3.2	3.2	2.38	3.2
		200711	0.35	318,055	111.3	84.1	0.34	318,055	108.1	81.7	0.010	2.9	3.2	2.40	2.9
		200712	0.39	332,734	129.8	98.1	0.39	332,734	129.8	98.1	0.000	0.0	0.0	0.00	0.0
		200801	0.34	325,395	110.6	83.6	0.34	325,395	110.6	83.6	0.000	0.0	0.0	0.00	0.0
		200802	0.36	330,288	118.9	89.9	0.35	330,288	115.6	87.4	0.010	2.8	3.3	2.50	2.8
		200803	0.32	335,181	107.3	81.1	0.31	335,181	103.9	78.5	0.010	3.1	3.4	2.53	3.1
		200804	0.30	318,055	95.4	72.1	0.28	318,055	89.1	67.3	0.020	6.7	6.4	4.81	6.7
		200805	0.39	313,162	122.1	92.3	0.38	313,162	119.0	89.9	0.010	2.6	3.1	2.37	2.6
		200806	0.39	313,162	122.1	92.3	0.38	313,162	119.0	89.9	0.010	2.6	3.1	2.37	2.6
		200807	0.31	325,395	100.9	76.2	0.24	325,395	78.1	59.0	0.070	22.6	22.8	17.21	22.6
		200808	0.21	327,841	68.8	52.0	0.16	327,841	52.5	39.6	0.050	23.8	16.4	12.39	23.8
		200809	1.13	327,841	370.5	279.9	0.75	327,841	245.9	185.8	0.380	33.6	124.6	94.14	33.6
		POR	0.40	323,560	129.6	98.0	0.35	323,560	113.9	86.0	0.049	12.2	15.8	11.92	12.2

Note: No flow data available for Sept 08 due to equipment damage from Tropical Storm Fay (estimated using Aug 08 average)

APPENDIX K. Blue Spring estimated organic nitrogen mass removals by spring run segment and date.

			Inflow				Outflow				Removal				
			Segment - Up				Segment - Down								
	Segment Area		Conc	Flow	Mass	Mass	Conc	Flow	Mass	Mass	Conc		Mass		
Site	(ha)	Month	(mg/L)	(m^3/d)	(kg/d)	(kg/ha/d)	(mg/L)	(m^3/d)	(kg/d)	(kg/ha/d)	(mg/L)	(%)	(kg/d)	(kg/ha/d)	(%)
VBS 35 - VBS 355	0.72	200710	0.06	315,608	18.9	26.4	0.06	315,608	18.9	26.4	0.000	0.0	0.0	0.00	0.0
		200711	0.07	318,055	22.3	31.1	0.07	318,055	22.3	31.1	0.000	0.0	0.0	0.00	0.0
		200712	0.08	332,734	26.6	37.2	0.06	332,734	20.0	27.9	0.020	25.0	6.7	9.29	25.0
		200801	0.05	325,395	16.3	22.7	0.07	325,395	22.8	31.8	-0.020	-40.0	-6.5	-9.09	-40.0
		200802	0.09	330,288	29.7	41.5	0.05	330,288	16.5	23.1	0.040	44.4	13.2	18.44	44.4
		200803	0.10	335,181	33.5	46.8	0.10	335,181	33.5	46.8	0.000	0.0	0.0	0.00	0.0
		200804	0.08	318,055	25.4	35.5	*0.10*	318,055	31.8	44.4	-0.020	-25.0	-6.4	-8.88	-25.0
		200805	0.08	313,162	25.1	35.0	0.10	313,162	31.3	43.7	-0.020	-25.0	-6.3	-8.74	-25.0
		200806	0.07	313,162	21.9	30.6	0.06	313,162	18.8	26.2	0.010	14.3	3.1	4.37	14.3
		200807	0.07	325,395	22.8	31.8	0.10	325,395	32.5	45.4	-0.030	-42.9	-9.8	-13.63	-42.9
		200808	0.10	327,841	32.8	45.8	0.23	327,841	75.4	105.3	-0.130	-130.0	-42.6	-59.50	-130.0
		200809	0.02	327,841	6.6	9.2	0.13	327,841	42.6	59.5	-0.110	-550.0	-36.1	-50.35	-550.0
		POR	0.07	323,560	23.5	32.8	0.09	323,560	30.5	42.6	-0.022	-30.0	-7.0	-9.84	-30.0
VBS 355 - VBS 570	0.61	200710	0.06	315,608	18.9	31.2	0.06	315,608	18.9	31.2	0.000	0.0	0.0	0.00	0.0
		200711	0.07	318,055	22.3	36.7	0.08	318,055	25.4	41.9	-0.010	-14.3	-3.2	-5.24	-14.3
		200712	0.06	332,734	20.0	32.9	0.06	332,734	20.0	32.9	0.000	0.0	0.0	0.00	0.0
		200801	0.07	325,395	22.8	37.5	0.06	325,395	19.5	32.2	0.010	14.3	3.3	5.36	14.3
		200802	0.05	330,288	16.5	27.2	0.06	330,288	19.8	32.6	-0.010	-20.0	-3.3	-5.44	-20.0
		200803	0.10	335,181	33.5	55.2	0.09	335,181	30.2	49.7	0.010	10.0	3.4	5.52	10.0
		200804	0.10	318,055	31.8	52.4	0.08	318,055	25.4	41.9	0.020	20.0	6.4	10.48	20.0
		200805	0.10	313,162	31.3	51.6	0.08	313,162	25.1	41.3	0.020	20.0	6.3	10.32	20.0
		200806	0.06	313,162	18.8	31.0	0.08	313,162	25.1	41.3	-0.020	-33.3	-6.3	-10.32	-33.3
		200807	0.10	325,395	32.5	53.6	0.82	325,395	266.8	439.6	-0.720	-720.0	-234.3	-385.95	-720.0
		200808	0.23	327,841	75.4	124.2	0.70	327,841	229.5	378.1	-0.470	-204.3	-154.1	-253.84	-204.3
		200809	0.13	327,841	42.6	70.2	0.57	327,841	186.9	307.8	-0.440	-338.5	-144.3	-237.63	-338.5
		POR	0.09	323,560	30.5	50.3	0.23	323,560	74.4	122.5	-0.136	-143.6	-43.8	-72.23	-143.6
VBS 35 - VBS 570	1.32	200710	0.06	315,608	18.9	14.3	0.06	315,608	18.9	14.3	0.000	0.0	0.0	0.00	0.0
		200711	0.07	318,055	22.3	16.8	0.08	318,055	25.4	19.2	-0.010	-14.3	-3.2	-2.40	-14.3
		200712	0.08	332,734	26.6	20.1	0.06	332,734	20.0	15.1	0.020	25.0	6.7	5.03	25.0
		200801	0.05	325,395	16.3	12.3	0.06	325,395	19.5	14.8	-0.010	-20.0	-3.3	-2.46	-20.0
		200802	0.09	330,288	29.7	22.5	0.06	330,288	19.8	15.0	0.030	33.3	9.9	7.49	33.3
		200803	0.10	335,181	33.5	25.3	0.09	335,181	30.2	22.8	0.010	10.0	3.4	2.53	10.0
		200804	0.08	318,055	25.4	19.2	0.08	318,055	25.4	19.2	0.000	0.0	0.0	0.00	0.0
		200805	0.08	313,162	25.1	18.9	0.08	313,162	25.1	18.9	0.000	0.0	0.0	0.00	0.0
		200806	0.07	313,162	21.9	16.6	0.08	313,162	25.1	18.9	-0.010	-14.3	-3.1	-2.37	-14.3
		200807	0.07	325,395	22.8	17.2	0.82	325,395	266.8	201.6	-0.750	-1071.4	-244.0	-184.42	-1071.4
		200808	0.10	327,841	32.8	24.8	0.70	327,841	229.5	173.4	-0.600	-600.0	-196.7	-148.64	-600.0
		200809	0.02	327,841	6.6	5.0	0.57	327,841	186.9	141.2	-0.550	-2750.0	-180.3	-136.26	-2750.0
		POR	0.07	323,560	23.5	17.8	0.23	323,560	74.4	56.2	-0.157	-216.7	-50.9	-38.46	-216.7

Note: No flow data available for Sept 08 due to equipment damage from Tropical Storm Fay (estimated using Aug 08 average)

APPENDIX K. Blue Spring estimated total Kjeldahl nitrogen mass removals by spring run segment and date.

Site	Segment Area (ha)	Month	Inflow Segment - Up Conc (mg/L)	Inflow Segment - Up Flow (m^3/d)	Inflow Segment - Up Mass (kg/d)	Inflow Segment - Up Mass (kg/ha/d)	Outflow Segment - Down Conc (mg/L)	Outflow Segment - Down Flow (m^3/d)	Outflow Segment - Down Mass (kg/d)	Outflow Segment - Down Mass (kg/ha/d)	Removal Conc (mg/L)	Removal Conc (%)	Removal Mass (kg/d)	Removal Mass (kg/ha/d)	Removal Mass (%)
VBS 35 - VBS 355	0.72	200710	0.17	315,608	53.7	74.9	0.17	315,608	53.7	74.9	0.000	0.0	0.0	0.00	0.0
		200711	0.18	318,055	57.2	79.9	0.18	318,055	57.2	79.9	0.000	0.0	0.0	0.00	0.0
		200712	0.16	332,734	53.2	74.3	0.14	332,734	46.6	65.0	0.020	12.5	6.7	9.29	12.5
		200801	0.14	325,395	45.6	63.6	0.16	325,395	52.1	72.7	-0.020	-14.3	-6.5	-9.09	-14.3
		200802	0.20	330,288	66.1	92.2	0.14	330,288	46.2	64.6	0.060	30.0	19.8	27.67	30.0
		200803	0.21	335,181	70.4	98.3	0.21	335,181	70.4	98.3	0.000	0.0	0.0	0.00	0.0
		200804	0.20	318,055	63.6	88.8	*0.21*	318,055	66.8	93.2	-0.010	-5.0	-3.2	-4.44	-5.0
		200805	0.18	313,162	56.4	78.7	0.34	313,162	106.5	148.6	-0.160	-88.9	-50.1	-69.95	-88.9
		200806	0.17	313,162	53.2	74.3	0.15	313,162	47.0	65.6	0.020	11.8	6.3	8.74	11.8
		200807	0.19	325,395	61.8	86.3	0.21	325,395	68.3	95.4	-0.020	-10.5	-6.5	-9.09	-10.5
		200808	0.24	327,841	78.7	109.8	0.35	327,841	114.7	160.2	-0.110	-45.8	-36.1	-50.35	-45.8
		200809	0.06	327,841	19.7	27.5	0.13	327,841	42.6	59.5	-0.070	-116.7	-22.9	-32.04	-116.7
		POR	0.18	323,560	56.6	79.1	0.20	323,560	64.3	89.8	-0.024	-13.6	-7.7	-10.77	-13.6
VBS 355 - VBS 570	0.61	200710	0.17	315,608	53.7	88.4	0.17	315,608	53.7	88.4	0.000	0.0	0.0	0.00	0.0
		200711	0.18	318,055	57.2	94.3	0.19	318,055	60.4	99.6	-0.010	-5.6	-3.2	-5.24	-5.6
		200712	0.14	332,734	46.6	76.7	0.14	332,734	46.6	76.7	0.000	0.0	0.0	0.00	0.0
		200801	0.16	325,395	52.1	85.8	0.16	325,395	52.1	85.8	0.000	0.0	0.0	0.00	0.0
		200802	0.14	330,288	46.2	76.2	0.16	330,288	52.8	87.1	-0.020	-14.3	-6.6	-10.88	-14.3
		200803	0.21	335,181	70.4	116.0	0.20	335,181	67.0	110.4	0.010	4.8	3.4	5.52	4.8
		200804	0.21	318,055	66.8	110.0	0.19	318,055	60.4	99.6	0.020	9.5	6.4	10.48	9.5
		200805	0.34	313,162	106.5	175.4	0.17	313,162	53.2	87.7	0.170	50.0	53.2	87.70	50.0
		200806	0.15	313,162	47.0	77.4	0.17	313,162	53.2	87.7	-0.020	-13.3	-6.3	-10.32	-13.3
		200807	0.21	325,395	68.3	112.6	0.91	325,395	296.1	487.8	-0.700	-333.3	-227.8	-375.23	-333.3
		200808	0.35	327,841	114.7	189.0	0.81	327,841	265.6	437.5	-0.460	-131.4	-150.8	-248.43	-131.4
		200809	0.13	327,841	42.6	70.2	0.62	327,841	203.3	334.8	-0.490	-376.9	-160.6	-264.64	-376.9
		POR	0.20	323,560	64.3	106.0	0.33	323,560	105.4	173.6	-0.127	-63.8	-41.0	-67.59	-63.8
VBS 35 - VBS 570	1.32	200710	0.17	315,608	53.7	40.5	0.17	315,608	53.7	40.5	0.000	0.0	0.0	0.00	0.0
		200711	0.18	318,055	57.2	43.3	0.19	318,055	60.4	45.7	-0.010	-5.6	-3.2	-2.40	-5.6
		200712	0.16	332,734	53.2	40.2	0.14	332,734	46.6	35.2	0.020	12.5	6.7	5.03	12.5
		200801	0.14	325,395	45.6	34.4	0.16	325,395	52.1	39.3	-0.020	-14.3	-6.5	-4.92	-14.3
		200802	0.20	330,288	66.1	49.9	0.16	330,288	52.8	39.9	0.040	20.0	13.2	9.98	20.0
		200803	0.21	335,181	70.4	53.2	0.20	335,181	67.0	50.7	0.010	4.8	3.4	2.53	4.8
		200804	0.20	318,055	63.6	48.1	0.19	318,055	60.4	45.7	0.010	5.0	3.2	2.40	5.0
		200805	0.18	313,162	56.4	42.6	0.17	313,162	53.2	40.2	0.010	5.6	3.1	2.37	5.6
		200806	0.17	313,162	53.2	40.2	0.17	313,162	53.2	40.2	0.000	0.0	0.0	0.00	0.0
		200807	0.19	325,395	61.8	46.7	0.91	325,395	296.1	223.8	-0.720	-378.9	-234.3	-177.04	-378.9
		200808	0.24	327,841	78.7	59.5	0.81	327,841	265.6	200.7	-0.570	-237.5	-186.9	-141.21	-237.5
		200809	0.06	327,841	19.7	14.9	0.62	327,841	203.3	153.6	-0.560	-933.3	-183.6	-138.73	-933.3
		POR	0.18	323,560	56.6	42.8	0.33	323,560	105.4	79.6	-0.151	-86.1	-48.7	-36.83	-86.1

Note: No flow data available for Sept 08 due to equipment damage from Tropical Storm Fay (estimated using Aug 08 average)

APPENDIX K. Blue Spring estimated total nitrogen mass removals by spring run segment and date.

Site	Segment Area (ha)	Month	Inflow Segment - Up Conc (mg/L)	Flow (m³/d)	Mass (kg/d)	Mass (kg/ha/d)	Outflow Segment - Down Conc (mg/L)	Flow (m³/d)	Mass (kg/d)	Mass (kg/ha/d)	Removal Conc (mg/L)	Conc (%)	Mass (kg/d)	Mass (kg/ha/d)	Mass (%)
VBS 35 - VBS 355	0.72	200710	0.48	315,608	151.5	211.5	0.47	315,608	148.3	207.1	0.010	2.1	3.2	4.41	2.1
		200711	0.53	318,055	168.6	235.3	0.52	318,055	165.4	230.9	0.010	1.9	3.2	4.44	1.9
		200712	0.56	332,734	186.3	260.1	0.55	332,734	183.0	255.5	0.010	1.8	3.3	4.65	1.8
		200801	0.49	325,395	159.4	222.6	0.51	325,395	166.0	231.7	-0.020	-4.1	-6.5	-9.09	-4.1
		200802	0.56	330,288	185.0	258.2	0.49	330,288	161.8	225.9	0.070	12.5	23.1	32.28	12.5
		200803	0.53	335,181	177.6	248.0	0.52	335,181	174.3	243.3	0.010	1.9	3.4	4.68	1.9
		200804	0.50	318,055	159.0	222.0	*0.52*	318,055	165.4	230.9	-0.020	-4.0	-6.4	-8.88	-4.0
		200805	0.58	313,162	181.6	253.6	0.73	313,162	228.6	319.2	-0.150	-25.9	-47.0	-65.58	-25.9
		200806	0.55	313,162	172.2	240.5	0.54	313,162	169.1	236.1	0.010	1.8	3.1	4.37	1.8
		200807	0.50	325,395	162.7	227.1	0.52	325,395	169.2	236.2	-0.020	-4.0	-6.5	-9.09	-4.0
		200808	0.45	327,841	147.5	206.0	0.55	327,841	180.3	251.7	-0.100	-22.2	-32.8	-45.77	-22.2
		200809	1.20	327,841	393.4	549.2	1.20	327,841	393.4	549.2	0.000	0.0	0.0	0.00	0.0
		POR	0.58	323,560	187.1	261.2	0.59	323,560	192.1	268.1	-0.015	-2.7	-5.0	-6.96	-2.7
VBS 355 - VBS 570	0.61	200710	0.47	315,608	148.3	244.4	0.47	315,608	148.3	244.4	0.000	0.0	0.0	0.00	0.0
		200711	0.52	318,055	165.4	272.5	0.53	318,055	168.6	277.7	-0.010	-1.9	-3.2	-5.24	-1.9
		200712	0.55	332,734	183.0	301.5	0.53	332,734	176.3	290.5	0.020	3.6	6.7	10.96	3.6
		200801	0.51	325,395	166.0	273.4	0.50	325,395	162.7	268.0	0.010	2.0	3.3	5.36	2.0
		200802	0.49	330,288	161.8	266.6	0.51	330,288	168.4	277.5	-0.020	-4.1	-6.6	-10.88	-4.1
		200803	0.52	335,181	174.3	287.1	0.50	335,181	167.6	276.1	0.020	3.8	6.7	11.04	3.8
		200804	0.52	318,055	165.4	272.5	0.47	318,055	149.5	246.3	0.050	9.6	15.9	26.20	9.6
		200805	0.73	313,162	228.6	376.6	0.55	313,162	172.2	283.7	0.180	24.7	56.4	92.86	24.7
		200806	0.54	313,162	169.1	278.6	0.55	313,162	172.2	283.7	-0.010	-1.9	-3.1	-5.16	-1.9
		200807	0.52	325,395	169.2	278.7	1.10	325,395	357.9	589.6	-0.580	-111.5	-188.7	-310.91	-111.5
		200808	0.55	327,841	180.3	297.0	0.97	327,841	318.0	523.9	-0.420	-76.4	-137.7	-226.83	-76.4
		200809	1.20	327,841	393.4	648.1	1.40	327,841	459.0	756.1	-0.200	-16.7	-65.6	-108.01	-16.7
		POR	0.59	323,560	192.1	316.4	0.68	323,560	218.4	359.8	-0.081	-13.7	-26.3	-43.38	-13.7
VBS 35 - VBS 570	1.32	200710	0.48	315,608	151.5	114.5	0.47	315,608	148.3	112.1	0.010	2.1	3.2	2.38	2.1
		200711	0.53	318,055	168.6	127.4	0.53	318,055	168.6	127.4	0.000	0.0	0.0	0.00	0.0
		200712	0.56	332,734	186.3	140.8	0.53	332,734	176.3	133.3	0.030	5.4	10.0	7.54	5.4
		200801	0.49	325,395	159.4	120.5	0.50	325,395	162.7	122.9	-0.010	-2.0	-3.3	-2.46	-2.0
		200802	0.56	330,288	185.0	139.8	0.51	330,288	168.4	127.3	0.050	8.9	16.5	12.48	8.9
		200803	0.53	335,181	177.6	134.2	0.50	335,181	167.6	126.6	0.030	5.7	10.1	7.60	5.7
		200804	0.50	318,055	159.0	120.2	0.47	318,055	149.5	113.0	0.030	6.0	9.5	7.21	6.0
		200805	0.58	313,162	181.6	137.3	0.55	313,162	172.2	130.2	0.030	5.2	9.4	7.10	5.2
		200806	0.55	313,162	172.2	130.2	0.55	313,162	172.2	130.2	0.000	0.0	0.0	0.00	0.0
		200807	0.50	325,395	162.7	122.9	1.10	325,395	357.9	270.5	-0.600	-120.0	-195.2	-147.54	-120.0
		200808	0.45	327,841	147.5	111.5	0.97	327,841	318.0	240.3	-0.520	-115.6	-170.5	-128.83	-115.6
		200809	1.20	327,841	393.4	297.3	1.40	327,841	459.0	346.8	-0.200	-16.7	-65.6	-49.55	-16.7
		POR	0.58	323,560	187.1	141.4	0.68	323,560	218.4	165.0	-0.097	-16.7	-31.3	-23.67	-16.7

Note: No flow data available for Sept 08 due to equipment damage from Tropical Storm Fay (estimated using Aug 08 average)

APPENDIX K. Blue Spring estimated ortho-phosphorus mass removals by spring run segment and date.

Site	Segment Area (ha)	Month	Inflow Segment - Up Conc (mg/L)	Inflow Flow (m^3/d)	Inflow Mass (kg/d)	Inflow Mass (kg/ha/d)	Outflow Segment - Down Conc (mg/L)	Outflow Flow (m^3/d)	Outflow Mass (kg/d)	Outflow Mass (kg/ha/d)	Removal Conc (mg/L)	Removal Conc (%)	Removal Mass (kg/d)	Removal Mass (kg/ha/d)	Removal Mass (%)
VBS 35 - VBS 355	0.72	200710	0.065	315,608	20.5	28.6	0.066	315,608	20.8	29.1	-0.001	-1.5	-0.3	-0.44	-1.5
		200711	0.060	318,055	19.1	26.6	0.067	318,055	21.3	29.7	-0.007	-11.7	-2.2	-3.11	-11.7
		200712	0.070	332,734	23.3	32.5	0.066	332,734	22.0	30.7	0.004	5.7	1.3	1.86	5.7
		200801	0.071	325,395	23.1	32.3	0.072	325,395	23.4	32.7	-0.001	-1.4	-0.3	-0.45	-1.4
		200802	0.070	330,288	23.1	32.3	0.068	330,288	22.5	31.4	0.002	2.9	0.7	0.92	2.9
		200803	0.070	335,181	23.5	32.8	0.072	335,181	24.1	33.7	-0.002	-2.9	-0.7	-0.94	-2.9
		200804	0.071	318,055	22.6	31.5	*0.072*	318,055	22.9	32.0	-0.001	-1.4	-0.3	-0.44	-1.4
		200805	0.078	313,162	24.4	34.1	0.078	313,162	24.4	34.1	0.000	0.0	0.0	0.00	0.0
		200806	0.077	313,162	24.1	33.7	0.076	313,162	23.8	33.2	0.001	1.3	0.3	0.44	1.3
		200807	0.081	325,395	26.4	36.8	0.079	325,395	25.7	35.9	0.002	2.5	0.7	0.91	2.5
		200808	0.072	327,841	23.6	33.0	0.072	327,841	23.6	33.0	0.000	0.0	0.0	0.00	0.0
		200809	0.066	327,841	21.6	30.2	0.065	327,841	21.3	29.7	0.001	1.5	0.3	0.46	1.5
		POR	0.071	323,560	22.9	32.0	0.071	323,560	23.0	32.1	0.000	-0.2	0.0	-0.07	-0.2
VBS 355 - VBS 570	0.61	200710	0.066	315,608	20.8	34.3	0.063	315,608	19.9	32.8	0.003	4.5	0.9	1.56	4.5
		200711	0.067	318,055	21.3	35.1	0.065	318,055	20.7	34.1	0.002	3.0	0.6	1.05	3.0
		200712	0.066	332,734	22.0	36.2	0.065	332,734	21.6	35.6	0.001	1.5	0.3	0.55	1.5
		200801	0.072	325,395	23.4	38.6	0.072	325,395	23.4	38.6	0.000	0.0	0.0	0.00	0.0
		200802	0.068	330,288	22.5	37.0	0.067	330,288	22.1	36.5	0.001	1.5	0.3	0.54	1.5
		200803	0.072	335,181	24.1	39.8	0.066	335,181	22.1	36.4	0.006	8.3	2.0	3.31	8.3
		200804	0.072	318,055	22.9	37.7	0.069	318,055	21.9	36.2	0.003	4.2	1.0	1.57	4.2
		200805	0.078	313,162	24.4	40.2	0.076	313,162	23.8	39.2	0.002	2.6	0.6	1.03	2.6
		200806	0.076	313,162	23.8	39.2	0.079	313,162	24.7	40.8	-0.003	-3.9	-0.9	-1.55	-3.9
		200807	0.079	325,395	25.7	42.3	0.063	325,395	20.5	33.8	0.016	20.3	5.2	8.58	20.3
		200808	0.072	327,841	23.6	38.9	0.069	327,841	22.6	37.3	0.003	4.2	1.0	1.62	4.2
		200809	0.065	327,841	21.3	35.1	0.118	327,841	38.7	63.7	-0.053	-81.5	-17.4	-28.62	-81.5
		POR	0.071	323,560	23.0	37.9	0.073	323,560	23.5	38.7	-0.002	-2.3	-0.5	-0.86	-2.3
VBS 35 - VBS 570	1.32	200710	0.065	315,608	20.5	15.5	0.063	315,608	19.9	15.0	0.002	3.1	0.6	0.48	3.1
		200711	0.060	318,055	19.1	14.4	0.065	318,055	20.7	15.6	-0.005	-8.3	-1.6	-1.20	-8.3
		200712	0.070	332,734	23.3	17.6	0.065	332,734	21.6	16.3	0.005	7.1	1.7	1.26	7.1
		200801	0.071	325,395	23.1	17.5	0.072	325,395	23.4	17.7	-0.001	-1.4	-0.3	-0.25	-1.4
		200802	0.070	330,288	23.1	17.5	0.067	330,288	22.1	16.7	0.003	4.3	1.0	0.75	4.3
		200803	0.070	335,181	23.5	17.7	0.066	335,181	22.1	16.7	0.004	5.7	1.3	1.01	5.7
		200804	0.071	318,055	22.6	17.1	0.069	318,055	21.9	16.6	0.002	2.8	0.6	0.48	2.8
		200805	0.078	313,162	24.4	18.5	0.076	313,162	23.8	18.0	0.002	2.6	0.6	0.47	2.6
		200806	0.077	313,162	24.1	18.2	0.079	313,162	24.7	18.7	-0.002	-2.6	-0.6	-0.47	-2.6
		200807	0.081	325,395	26.4	19.9	0.063	325,395	20.5	15.5	0.018	22.2	5.9	4.43	22.2
		200808	0.072	327,841	23.6	17.8	0.069	327,841	22.6	17.1	0.003	4.2	1.0	0.74	4.2
		200809	0.066	327,841	21.6	16.4	0.118	327,841	38.7	29.2	-0.052	-78.8	-17.0	-12.88	-78.8
		POR	0.071	323,560	22.9	17.3	0.073	323,560	23.5	17.8	-0.002	-2.5	-0.6	-0.43	-2.5

Note: No flow data available for Sept 08 due to equipment damage from Tropical Storm Fay (estimated using Aug 08 average)

APPENDIX K. Blue Spring estimated total phosphorus mass removals by spring run segment and date.

Site	Segment Area (ha)	Month	Inflow Segment - Up Conc (mg/L)	Inflow Segment - Up Flow (m^3/d)	Inflow Segment - Up Mass (kg/d)	Inflow Segment - Up Mass (kg/ha/d)	Outflow Segment - Down Conc (mg/L)	Outflow Segment - Down Flow (m^3/d)	Outflow Segment - Down Mass (kg/d)	Outflow Segment - Down Mass (kg/ha/d)	Removal Conc (mg/L)	Removal Conc (%)	Removal Mass (kg/d)	Removal Mass (kg/ha/d)	Removal Mass (%)
VBS 35 - VBS 355	0.72	200710	0.070	315,608	22.1	30.8	0.070	315,608	22.1	30.8	0.000	0.0	0.0	0.00	0.0
		200711	0.080	318,055	25.4	35.5	0.080	318,055	25.4	35.5	0.000	0.0	0.0	0.00	0.0
		200712	0.080	332,734	26.6	37.2	0.080	332,734	26.6	37.2	0.000	0.0	0.0	0.00	0.0
		200801	0.070	325,395	22.8	31.8	0.080	325,395	26.0	36.3	-0.010	-14.3	-3.3	-4.54	-14.3
		200802	0.070	330,288	23.1	32.3	0.080	330,288	26.4	36.9	-0.010	-14.3	-3.3	-4.61	-14.3
		200803	0.080	335,181	26.8	37.4	0.080	335,181	26.8	37.4	0.000	0.0	0.0	0.00	0.0
		200804	0.080	318,055	25.4	35.5	*0.080*	318,055	25.4	35.5	0.000	0.0	0.0	0.00	0.0
		200805	0.080	313,162	25.1	35.0	0.080	313,162	25.1	35.0	0.000	0.0	0.0	0.00	0.0
		200806	0.090	313,162	28.2	39.3	0.080	313,162	25.1	35.0	0.010	11.1	3.1	4.37	11.1
		200807	0.090	325,395	29.3	40.9	0.090	325,395	29.3	40.9	0.000	0.0	0.0	0.00	0.0
		200808	0.130	327,841	42.6	59.5	0.080	327,841	26.2	36.6	0.050	38.5	16.4	22.88	38.5
		200809	0.060	327,841	19.7	27.5	0.070	327,841	22.9	32.0	-0.010	-16.7	-3.3	-4.58	-16.7
		POR	0.082	323,560	26.4	36.9	0.079	323,560	25.6	35.8	0.002	3.1	0.8	1.13	3.1
VBS 355 - VBS 570	0.61	200710	0.070	315,608	22.1	36.4	0.070	315,608	22.1	36.4	0.000	0.0	0.0	0.00	0.0
		200711	0.080	318,055	25.4	41.9	0.070	318,055	22.3	36.7	0.010	12.5	3.2	5.24	12.5
		200712	0.080	332,734	26.6	43.9	0.080	332,734	26.6	43.9	0.000	0.0	0.0	0.00	0.0
		200801	0.080	325,395	26.0	42.9	0.080	325,395	26.0	42.9	0.000	0.0	0.0	0.00	0.0
		200802	0.080	330,288	26.4	43.5	0.070	330,288	23.1	38.1	0.010	12.5	3.3	5.44	12.5
		200803	0.080	335,181	26.8	44.2	0.080	335,181	26.8	44.2	0.000	0.0	0.0	0.00	0.0
		200804	0.080	318,055	25.4	41.9	0.080	318,055	25.4	41.9	0.000	0.0	0.0	0.00	0.0
		200805	0.080	313,162	25.1	41.3	0.090	313,162	28.2	46.4	-0.010	-12.5	-3.1	-5.16	-12.5
		200806	0.080	313,162	25.1	41.3	0.080	313,162	25.1	41.3	0.000	0.0	0.0	0.00	0.0
		200807	0.090	325,395	29.3	48.2	0.150	325,395	48.8	80.4	-0.060	-66.7	-19.5	-32.16	-66.7
		200808	0.080	327,841	26.2	43.2	0.110	327,841	36.1	59.4	-0.030	-37.5	-9.8	-16.20	-37.5
		200809	0.070	327,841	22.9	37.8	0.140	327,841	45.9	75.6	-0.070	-100.0	-22.9	-37.81	-100.0
		POR	0.079	323,560	25.6	42.2	0.092	323,560	29.7	48.9	-0.013	-15.9	-4.1	-6.72	-15.9
VBS 35 - VBS 570	1.32	200710	0.070	315,608	22.1	16.7	0.070	315,608	22.1	16.7	0.000	0.0	0.0	0.00	0.0
		200711	0.080	318,055	25.4	19.2	0.070	318,055	22.3	16.8	0.010	12.5	3.2	2.40	12.5
		200712	0.080	332,734	26.6	20.1	0.080	332,734	26.6	20.1	0.000	0.0	0.0	0.00	0.0
		200801	0.070	325,395	22.8	17.2	0.080	325,395	26.0	19.7	-0.010	-14.3	-3.3	-2.46	-14.3
		200802	0.070	330,288	23.1	17.5	0.070	330,288	23.1	17.5	0.000	0.0	0.0	0.00	0.0
		200803	0.080	335,181	26.8	20.3	0.080	335,181	26.8	20.3	0.000	0.0	0.0	0.00	0.0
		200804	0.080	318,055	25.4	19.2	0.080	318,055	25.4	19.2	0.000	0.0	0.0	0.00	0.0
		200805	0.080	313,162	25.1	18.9	0.090	313,162	28.2	21.3	-0.010	-12.5	-3.1	-2.37	-12.5
		200806	0.090	313,162	28.2	21.3	0.080	313,162	25.1	18.9	0.010	11.1	3.1	2.37	11.1
		200807	0.090	325,395	29.3	22.1	0.150	325,395	48.8	36.9	-0.060	-66.7	-19.5	-14.75	-66.7
		200808	0.130	327,841	42.6	32.2	0.110	327,841	36.1	27.3	0.020	15.4	6.6	4.95	15.4
		200809	0.060	327,841	19.7	14.9	0.140	327,841	45.9	34.7	-0.080	-133.3	-26.2	-19.82	-133.3
		POR	0.082	323,560	26.4	20.0	0.092	323,560	29.7	22.4	-0.010	-12.4	-3.3	-2.47	-12.4

Note: No flow data available for Sept 08 due to equipment damage from Tropical Storm Fay (estimated using Aug 08 average)

Appendix L

Blue Spring Visitor Survey Findings (from Bonn Marketing Research Group, Inc.)

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Date	Avg. Party Size	Is This Your First Visit?	Plan To Return	If Plan to Return, within the next: 6 months	12 months	2 years	Importance of Florida State Springs, Rivers, Lakes To Your Life (scale 1-7)
2008	4.0	50.8%	65.3%	31.3%	29.0%	24.3%	5.4
2003	3.3	38.9	35.6	10.0	20.6	--	5.6

Top 10 Visitor Origins	2008	2003
Daytona Beach, FL	13.0%	20.1%
Orange City, FL	10.3	2.1
Melbourne, FL	6.8	--
Orlando, FL	5.5	0.9
Deltona, FL	5.0	19.0
New York	3.6	2.6
Eustice, FL	3.5	--
North Carolina	2.5	0.4
Port Orange, FL	2.3	0.9
Lakeland, FL	2.0	--

Main Purpose For Visit	2008	2003
Manatees	32.3%	64.8%
Swimming	15.3	--
Sightseeing	13.8	5.7
Picnic (Family Outing)	8.8	10.8
Canoeing	6.3	--
Hiking	5.3	--
Relaxation (Vacation)	4.3	7.9
Camping	2.8	--
Kayaking	2.8	--
Volunteer Work	1.8	--
No Answer	7.0	--

How Heard About Volusia Blue Springs	2008	2003
Family/Friends	58.9%	18.9%
Word of Mouth	8.9	11.6
Florida Welcome Center	4.6	--
AAA	1.1	--
Internet	1.1	4.8
Flyer	0.4	7.2
No Answer	25.0	--
Repeat Visitor	--	50.9

Activities Participated In	2008	2003
Watching manatees	92.9%	N/A
Sightseeing, sunbathing, Picnicking, strolling, birding, Nature study, photography	80.8	
Swimming, bathing, Floating, snorkeling, etc	32.6	
Canoeing, kayaking	12.8	

Visited Before 2003?	2008	2003
Yes	27.0%	N/A
No	71.3	
No Answer	1.8	

If yes, during this visit how would you rate the following:

Water Clarity	Swimmers	Divers	Walkers
Better	14.8%	15.4%	6.3%
About the same	40.7	53.8	33.7
Worse	40.7	15.4	41.1
Not Sure	3.7	15.4	18.9

Water Depth	Swimmers	Divers	Walkers
Better	7.1%	7.7%	2.2%
About the same	28.6	46.2	16.5
Worse	50.0	23.1	64.8
Not Sure	14.3	23.1	16.5

Should reduce flow To meet public demands	2008	2003
Yes	20.3%	17.6%
No	75.3	82.4
No Answer	4.5	--
Willing to pay more on bill for alternative water sources		
Yes	73.5%	79.5%
No	21.8	11.6
No Answer	4.8	8.9
If yes, would consider the following increase:		
None	14.2%	18.2%
Minimal	41.4	15.4
Moderate	33.6	54.5
Substantial	10.1	12.0
Not Sure	0.6	--
Willing to support local government for alternative water sources		
Yes	86.5%	97.0%
No	6.8	3.0
No Answer	6.8	--

Percentage of flow loss you would consider harmful to aesthetics of park	10.3%
Percentage of flow loss you would consider harmful for swimming/diving	10.4%
Percentage of flow loss you would consider harmful for positive experience	11.9%

Rate Overall Visit to Spring (Scale from 1-5)	2008	2003
	4.6	4.3

Education	2008	2003
Some College/College Grad	43.0%	50.4%
Post Graduate Degree	7.8	20.5
High School Graduate	17.5	5.9
Technical School	--	13.1
No Answer	31.8	10.1

Gender	2008	2003
Male	48.5%	40.8%
Female	49.3	59.2
No Answer	2.3	--

Marital Status	2008	2003
Married	56.3%	80.1%
Single	26.8	8.3
Divorced/Widowed	6.8	1.6
No Answer	10.3	10.0

Ethnicity	2008	2003
Caucasian	64.0%	94.2%
African-American	8.8	2.8
Hispanic	15.3	2.2
Other	9.0	0.6
No Answer	3.0	0.1

Income	2008	2003
Under $20,000	1.6%	4.0%
$20,000-$49,999	13.5	23.7
$50,000-$79,999	17.3	45.1
$80,000 or More	15.8	13.1
No Answer/Retired	52.8	10.0

APPENDIX L. Blue Spring State Park visitor survey (2008 versus 2003, from Bonn 2008).

Date	Avg. Party Size	Is This Your First Visit?	Plan To Return	If Plan to Return, within the next: 6 months	12 months	2 years	Importance of Florida State Springs, Rivers, Lakes To Your Life (scale 1-7)
Jan/Feb 2008	4.3	43.5%	85.5%	31.5%	34.0%	20.5%	5.7
Jan/Feb 2003	3.2	52.1	72.8	20.4	N/A	N/A	5.5

Top 10 Visitor Origins	2008	2003
Daytona Beach, FL	12.5%	7.9%
Melbourne, FL	10.0	--
Orlando, FL	6.5	1.5
Pennsylvania	6.5	2.3
Orange City, FL	6.0	--
New York	5.5	4.9
Deltona, FL	5.5	7.5
Port Orange, FL	4.0	1.5
North Carolina	3.5	0.8
Michigan	3.5	2.6

Activities Participated In	2008	2003
Watching manatees	89.0%	N/A
Sightseeing, sunbathing, Picnicking, strolling, birding, Nature study, photography	73.0	
Canoeing, kayaking	8.0	
Swimming, bathing, Floating, snorkeling, etc	1.0	

Should reduce flow To meet public demands	2008	2003
Yes	13.0%	17.0%
No	85.0	83.0
No Answer	2.0	--
Willing to pay more on bill for alternative water sources		
Yes	83.5%	74.7%
No	12.5	14.0
No Answer	4.0	11.3
If yes, would consider the following increase:		
None	1.8%	23.0%
Minimal	52.1	14.4
Moderate	38.9	51.8
Substantial	6.0	10.9
Not Sure	1.2	--
Willing to support local government for alternative water sources		
Yes	94.0%	97.7%
No	1.0	2.3
No Answer	5.0	--

Main Purpose For Visit	2008	2003
Manatees	53.5%	64.9%
Sightseeing	20.5	6.8
Picnic (Family Outing)	7.5	5.3
Canoeing	5.5	--
Relaxation (Vacation)	4.5	11.3
Hiking	3.0	--
Camping	1.0	--
Kayaking	1.0	--
Volunteer Work	0.5	--
No Answer	3.0	--

Visited Before 2003	2008	2003
Yes	33.5%	N/A
No	65.5	
No Answer	1.0	

If yes, during this visit how would you rate the following:

Water Clarity	Swimmers	Divers	Walkers
Better	N/A	N/A	3.2%
About the same			34.9
Worse			38.1
Not Sure			23.8

Water Depth	Swimmers	Divers	Walkers
Better	N/A	N/A	--
About the same			15.0
Worse			66.7
Not Sure			18.3

Percentage of flow loss you would consider harmful to aesthetics of park	9.5
Percentage of flow loss you would consider harmful for swimming/diving	9.8
Percentage of flow loss you would consider harmful for positive experience	9.5

How Heard About Volusia Blue Springs	2008	2003
Family/Friends	83.9%	6.0%
Word of Mouth	6.9	11.7
Welcome Center	1.1	--
AAA	1.1	--
Internet	1.1	4.9
Flyer	1.1	22.3
No Answer	4.6	--
Repeat Visitor	--	45.7

Rate Overall Visit to Spring (Scale from 1-5)	2008	2003
	4.6	4.3

Education	2008	2003
Some College/College Grad	41.5	51.3%
Post Graduate Degree	6.0	20.0
High School Graduate	34.0	5.7
Technical School	--	12.5
No Answer	18.5	10.6

Gender	2008	2003
Male	48.0%	41.5%
Female	52.0	58.5

Marital Status	2008	2003
Married	68.0%	80.4%
Single	23.5	7.5
Divorced/Widowed	7.0	1.5
No Answer	1.5	10.6

Ethnicity	2008	2003
Caucasian	74.0%	94.0%
African-American	10.5	2.6
Hispanic	10.5	2.3
Other	3.0	0.8
No Answer	2.0	0.4

Income	2008	2003
Under $20,000	2.0%	4.2%
$20,000-$49,999	13.0	23.4
$50,000-$79,999	20.5	45.7
$80,000 or More	16.5	12.8
No Answer	48.0	14.0

APPENDIX L. Blue Spring State Park visitor survey (2008 versus 2003, from Bonn 2008).

Date	Avg. Party Size	Is This Your First Visit?	Plan To Return	If Plan to Return, within the next: 6 months	12 months	2 years	Importance of Florida State Springs, Rivers, Lakes To Your Life (scale 1-7)
Jun/Jul 2008	3.8	58.0%	45.0%	31.0%	24.0%	28.0%	5.0
Jun/Jul 2003	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Top 10 Visitor Origins	2008	2003
Orange City, FL	14.5%	N/A
Daytona, FL	13.5	
Eustice, FL	6.5	
Orlando, FL	4.5	
Deltona, FL	4.5	
Melbourne, FL	3.5	
Miami, FL	3.0	
Sarasota, FL	3.0	
New York	3.0	
England	2.5	

Main Purpose For Visit	2008	2003
Swimming	30.5%	N/A
Manatees	11.0	
Picnic	10.0	
Hiking	7.5	
Canoeing	7.0	
Sightseeing	7.0	
Camping	4.5	
Kayaking	4.5	
Relaxation	4.0	
Volunteer Work	3.0	
No Answer	11.0	

How Heard About Volusia Blue Springs	2008	2003
Family/Friends	47.7%	N/A
Word of Mouth	9.8	
Welcome Center	6.2	
AAA	1.0	
Internet	1.0	
No Answer	34.3	

Activities Participated In	2008	2003
Watching manatees	100.0%	N/A
Sightseeing, sunbathing, Picnicking, strolling, birding, Nature study, photography	97.8	
Swimming, bathing, Floating, snorkeling, etc	93.3	
Canoeing, kayaking	66.7	

Visited Before 2003	2008	2003
Yes	20.5%	N/A
No	77.0	
No Answer	2.5	

If yes, during this visit how would you rate the following:

Water Clarity	Swimmers	Divers	Walkers
Better	14.8%	15.4%	12.5%
About the same	40.7	53.8	31.3
Worse	40.7	15.4	46.9
Not Sure	3.7	15.4	9.4

Water Depth	Swimmers	Divers	Walkers
Better	7.1%	7.7%	6.5%
About the same	28.6	46.2	19.4
Worse	50.0	23.1	61.3
Not Sure	14.3	23.1	12.9

Should reduce flow To meet public demands	2008	2003
Yes	27.5%	N/A
No	65.5	
No Answer	7.0	
Willing to pay more on bill for alternative water sources		
Yes	63.5%	N/A
No	31.0	
No Answer	5.5	
If yes, would consider the following increase:		
None	25.8%	N/A
Minimal	31.5	
Moderate	28.7	
Substantial	14.0	
Not Sure	--	
Willing to support local government for alternative water sources		
Yes	79.0%	N/A
No	12.5	
No Answer	8.5	

Percentage of flow loss you would consider harmful to aesthetics of park	12.1
Percentage of flow loss you would consider harmful for swimming/diving	11.6
Percentage of flow loss you would consider harmful for positive experience	16.9

Rate Overall Visit to Spring (Scale from 1-5)	2008	2003
	4.5	N/A

Education	2008	2003
Some College/College Grad	44.5%	N/A
Post Graduate Degree	9.5	
High School Graduate	1.0	
Technical School	--	
No Answer	45.0	

Gender	2008	2003
Male	49.0%	N/A
Female	48.5	
No Answer	2.5	

Marital Status	2008	2003
Married	44.5%	N/A
Single	30.0	
Divorced/Widowed	6.5	
No Answer	19.0	

Ethnicity	2008	2003
Caucasian	54.0%	N/A
African-American	7.0	
Hispanic	20.0	
Other	15.0	
No Answer	4.0	

Income	2008	2003
Under $20,000	1.0%	N/A
$20,000-$49,999	13.5	
$50,000-$79,999	13.5	
$80,000 or More	14.5	
No Answer	57.5	

APPENDIX L. Blue Spring State Park visitor survey (2008 versus 2003, from Bonn 2008).