Rainbow Springs Baseline Ecosystem Assessment

September 2016

Prepared by

The Howard T. Odum Florida Springs Institute

Howard T. Odum
FLORIDA
SPRINGS
INSTITUTE

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Acknowledgements

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As with collection and analysis of all environmental data, techniques and interpretations may change over time. The raw data collected for this study are available from the Florida Springs Institute upon written request. The Director and staff of the Florida Springs Institute take full responsibility for any errors or omissions in this report.

Section 1.0 Introduction

1.1 Background

Florida's 1,000+ artesian springs are undergoing rapid environmental changes due to a variety of stressors, including reduced discharge, increased nitrate-nitrogen levels, excessive recreation, side effects of aquatic plant management, and structural alterations. These changes result in a shifting ecological baseline for each spring. As the state embarks on comprehensive restoration activities at these springs, there is often little historic data available to assess recovery or continuing decline. The Howard T. Odum Florida Springs Institute (FSI) is embarking on a number of projects to document existing baseline ecological conditions in the springs of Florida. Data collected for these baseline assessments, in combination with ecological data from previous studies will be used to provide a continuing record of changes, both positive and negative, in Florida's endangered springs and spring runs.

Rainbow Springs consists of twelve named vents that discharge groundwater from the Floridan Aquifer System at a combined historic average discharge of more than 485 million gallons per day (MGD), making it one of the largest first magnitude spring systems in Florida. A one-mile section of the Rainbow Spring run ecosystem, approximately 2.2 miles downstream of Rainbow Spring, was sampled for this springs baseline assessment project (Figure 1). Rainbow Springs forms the headwaters of the Rainbow River, which is nearly 6 miles long and merges with the Withlacoochee River at Dunnellon, Marion County.

The entire Rainbow River is a Registered National Landmark listed in 1972, an Aquatic Preserve listed in 1986, and an Outstanding Florida Waterway listed in 1987. The state purchased the original area that was the Rainbow Springs Attraction in 1990 and officially opened Rainbow Springs State Park in March 1995 managed by the Florida Department of Environmental Protection's Division of Recreation and Parks.

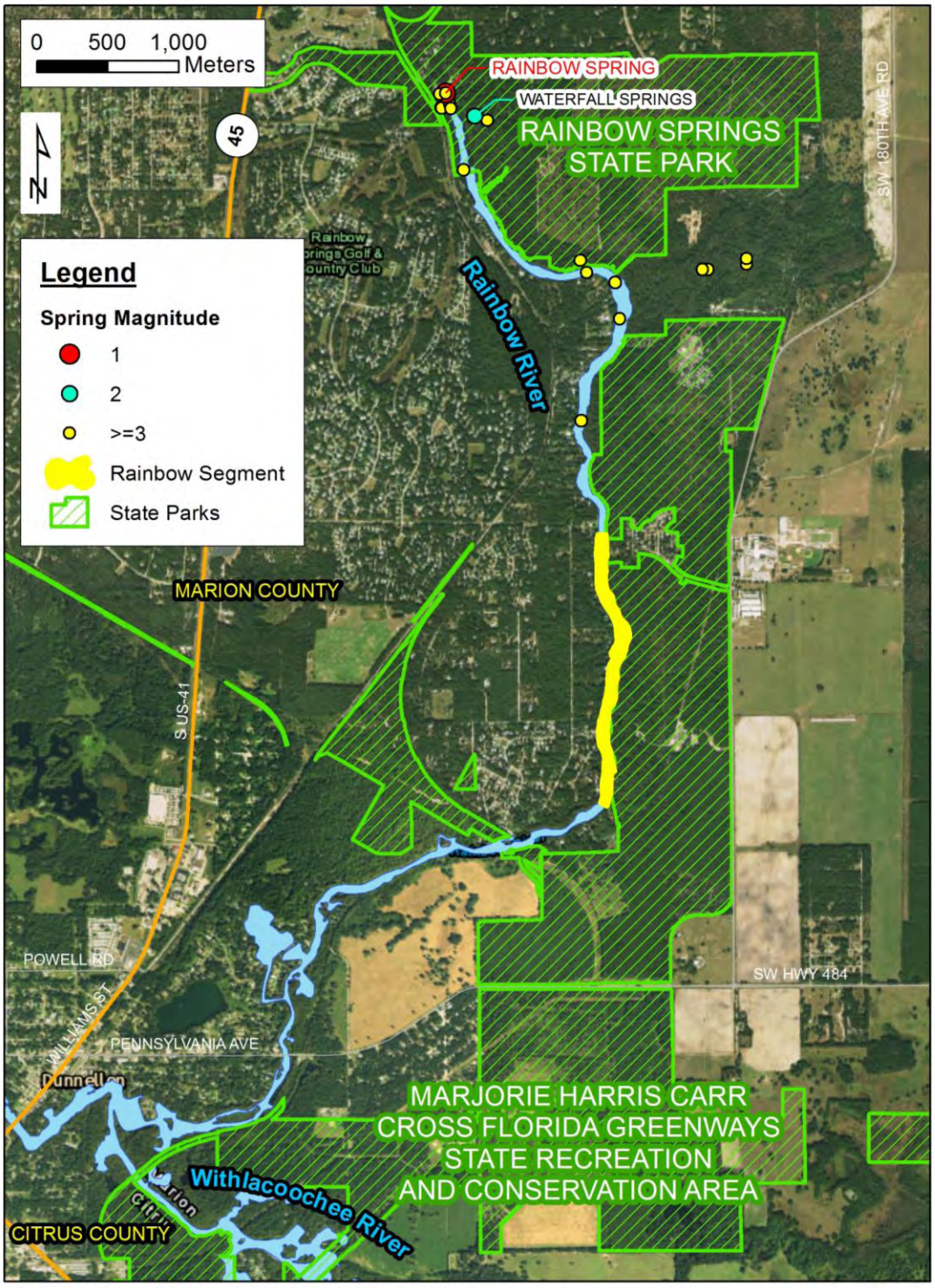


Figure 1. Rainbow River ecological baseline project location

Section 2.0 Methods

2.1 Introduction

Florida's springs and spring runs are composed of a diverse and interconnected ecosystem of physical, chemical, and biological components. While most aquatic biological systems vary considerably due to seasonal changes in sunlight, temperature, and precipitation, this forcing function variation is greatly reduced in spring-fed aquatic ecosystems due to their groundwater supply. These natural groundwater discharges demonstrate relatively consistent water temperature, inflow volume, and water chemistry (Odum 1957; Knight 2015). The one major environmental factor that is seasonally variable in springs is the input of solar energy. This seasonal variability was accounted for in springs data collection and analysis.

Ecosystem data collection occurred over two, 2-week periods (August 31-September 9, 2015 and February 8–19, 2016), and included as many environmental variables as practical. The following ecological metrics were measured in the one-mile long Rainbow River Segment that was the location of this ecosystem baseline assessment (Figure 2):

Physical Environment

- Insolation and photosynthetically active radiation (PAR) and underwater transmission of PAR
- Stream discharge (water level and flow) and current velocity
- Horizontal Secchi disk visibility
- Segment morphometry (water surface area, water depth, and water volume)
- Water quality field parameters (temperature, pH, dissolved oxygen, conductance)

Water Chemistry

- Water chemistry (total Kjeldahl nitrogen [TKN], nitrate+nitrite nitrogen [NOx-N], and ammonia nitrogen [NH_4-N]. Total nitrogen [TN] and organic nitrogen [ON] were calculated.)

Biology

- Plant community characterization (species, coverage)
- Macrofauna observations (species and counts for emerging insects, snails, fish, turtles, and birds)
- Human uses

Ecosystem Level

- Ecosystem metrics (gross primary productivity [GPP], net primary productivity [NPP], community respiration [CR], P/R ratio, and photosynthetic efficiency)
- Nutrient assimilation
- Community export (fine particulate export)

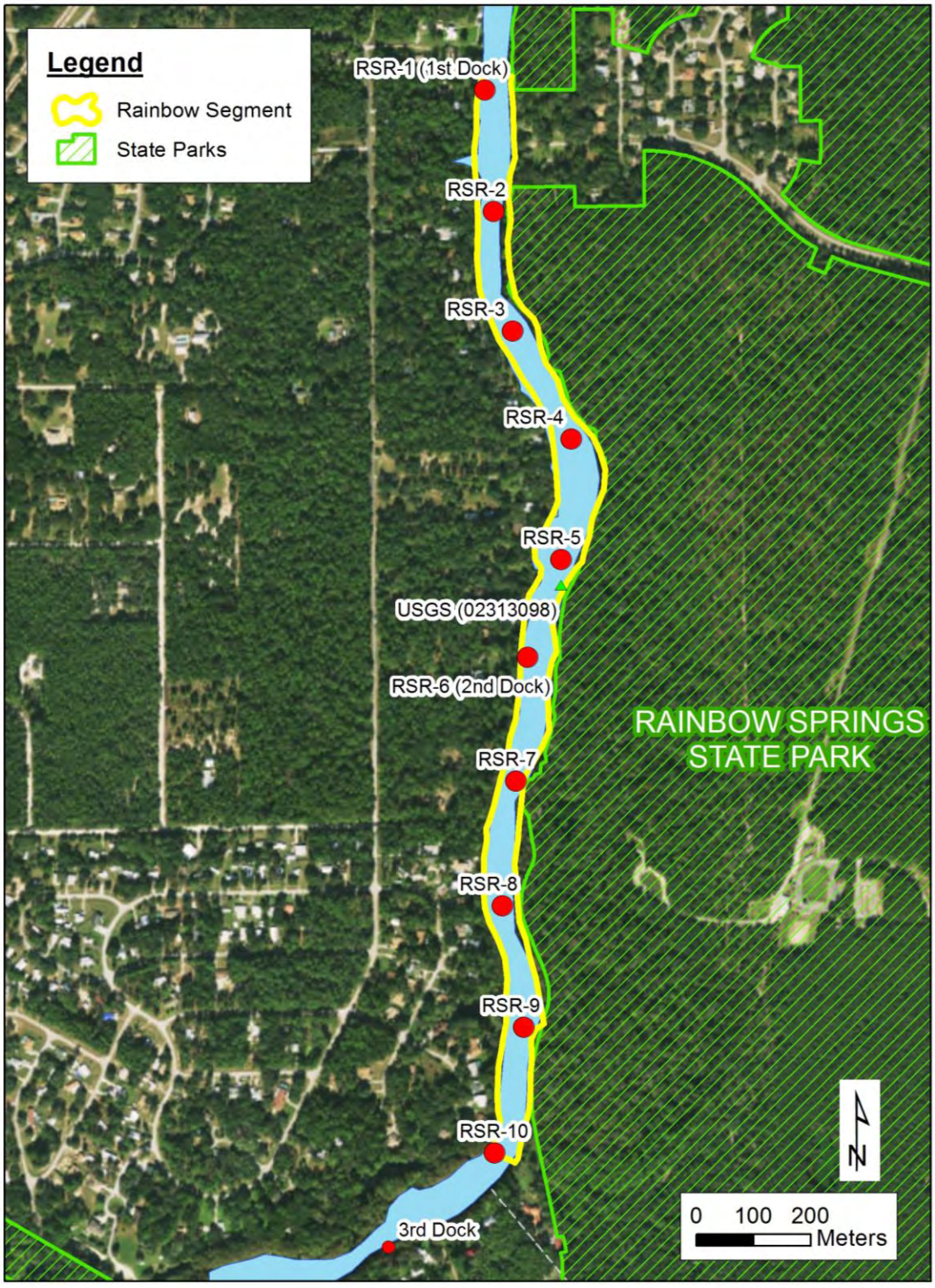


Figure 2. Rainbow River Ecosystem Baseline Assessment segment station locations

2.2 Physical Environment

2.2.1 Underwater Light Transmission

Photosynthetically Active Radiation (PAR) underwater light transmission and attenuation coefficients were measured within the study segment at RSR-1, RSR-5, and RSR-10 in the Rainbow River (Figure 2) using LI-COR brand sensors; LI-200SA (surface quantum sensor), and LI-192 (underwater quantum sensor). Figure 3 provides a typical light sensor installation. A LI-200SA sensor was used to measure PAR energy reaching the water surface, while an underwater LI-COR LI-192 sensor was used to measure PAR energy at multiple water depths. The underwater PAR sensor was attached to a weighted frame and readings were logged at 15 to 30 cm (0.5 to 1 ft) depth intervals from the surface to the bottom of the water column. Measurements at each depth were collected following at least a ten-second stabilization period. Light extinction (attenuation) coefficients were calculated from these data using the Lambert-Beer equation (Wetzel 2001):

$$Iz = Io(e-kz)$$

Where:

Iz = PAR at depth z

Io = PAR at the water surface

k = diffuse attenuation coefficient, m^{-1}

z = water depth, m

Figure 3. Underwater LI COR sensor used to measure PAR

2.2.2 Stream Discharge and Current Velocity

Stream discharge and velocity were measured at the upstream and downstream ends of the study segment using the following equipment;

- Marsh-McBirney Flo-Mate portable flow meter (September 2015)
- SonTek River Surveyor S5 portable acoustic Doppler current profiler/discharge measurement system (February 2016)

During the September 2015 monitoring period, a fiberglass tape was stretched across the stream channel perpendicular to the flow direction, allowing depth and velocity to be measured in approximately 25 evenly-spaced segments with a Marsh-McBirney Flo-Mate portable flow meter. At water depths less than 2.5 ft, velocity was measured at 0.6 of the water column depth. For water depths greater than 2.5 ft, velocity was measured at 0.2, 0.6, and 0.8 fractional depths of the water column. For each of the resulting cross-section sub-segments, velocity was multiplied by width and depth to calculate sub-segment discharge. The total discharge was calculated from the cumulative discharge of all cross-section sub-segments.

For the February 2016 monitoring period, a SonTek River Surveyor S5 portable acoustic Doppler current profiler was used to measure discharge. This equipment was mounted on a Hydroboard (Figure 4) and towed from one side of the river to the other, perpendicular to the direction of flow, to collect water current velocity simultaneously at multiple depths through the water column. These velocities are combined with the bathymetry of the cross section to calculate discharge.

The USGS also maintains two discharge stations within the study segment near RSR-5 (USGS 02313098, Figure 2) and downstream at Highway 484 in Dunnellon (USGS 02313100). These stations were used to estimate daily discharge within the study segment.

2.2.3 Stream Segment Morphometry

Segment depths were measured by use of a boat-mounted recording depth finder linked to the Global Positioning System (GPS). These data were processed using ArcGIS software to extrapolate the wetted surface area and volume of the spring study segment. Nominal hydraulic residence times were calculated in a spreadsheet for the study segment based on these estimated water volumes and the upstream and downstream flow estimates. These data were used to estimate the wetted surface area, mean depth, and water volume of the study segment. Nominal hydraulic residence times were calculated in a spreadsheet for the study segment based on these estimated water volumes and the upstream and downstream flow estimates.

2.2.4 Horizontal Secchi Disk Visibility

Water clarity was rapidly assessed using Secchi disk visibility, the distance where the disk disappears from sight. In spring systems, this distance is commonly greater than the depth of the water column and Secchi disk visibility is measured horizontally. Secchi distance was measured with a 20-centimeter diameter black and white disk attached to the end of a tape measure and held below the surface of the water. A skin diver extended the tape while moving away from the disk until it is no longer visible.

Figure 4. Stream discharge measurement collected along a cross-section of the Rainbow River.

2.2.5 Weather Station

Local area weather (rainfall, air temperature, solar radiation, and evapotranspiration) was estimated using the University of Florida – Florida Automated Weather Network (FAWN, http://fawn.ifas.ufl.edu/). The FAWN network includes a total of 44 weather stations throughout Florida reporting weather data at 15-minute increments. The closest FAWN station to the Rainbow River Study Segment was in Lecanto (17 miles).

2.2.6 Water Quality

During each 2-week sampling period, field variables (water temperature, dissolved oxygen concentration, oxygen percent saturation, pH, conductivity and specific conductance) were measured and logged at 30-minute intervals using upstream and downstream YSI 6920 recording data sondes.

Oxygen data were collected using optical sensors with automated wipers, which improve calibration and reduce instrument drift during deployment. Data sondes were deployed near the middle of the water column at the upstream and downstream ends of the study segment for periods up to 2-weeks (Figure 5). Data sondes were calibrated prior to deployment and subsequent to their retrieval for each sampling period following the manufacturers protocol.

Water chemistry samples were collected at the beginning and end of each study period, at the upstream, midpoint, and downstream stations. Water chemistry samples were collected as sub-surface grabs. A rinsed water collection bottle was used to collect water samples from about 1 foot below the water surface and used to fill acid-preserved sample bottles. Following collection, samples were placed in an ice-filled cooler and delivered to the analytical laboratory for analysis within 24 hours. Water depth and field variables (temperature, dissolved oxygen, pH, and specific conductance) were also recorded during all water chemistry sampling events.

Water chemistry samples were analyzed for TKN, NOx-N, and NH_4-N by Advanced Environmental Labs in Gainesville, Florida (FDOH certified laboratory # E82620).

2.3 Biology

2.3.1 Plant Community Characterization

The distribution and percent cover of aquatic plant communities (macroalgae and submerged aquatic vegetation) in the study segment were visually estimated during the baseline sampling events. Aquatic vegetative cover was documented along transects at station RSR-1, RSR-5, and RSR-10 in the Rainbow River (Figure 2) using the line-intercept method. A tape measure was stretched along the transect, and all aquatic vegetation intercepting the vertical plane of line was recorded. Line-intercept data were used to estimate percent cover, frequency, relative cover, and relative frequency. Frequency was based on dividing the transect into eight equal sized sub-transects. Values by species were summed and averaged to yield an importance value as follows:

$$\text{Linear Cover Distance for Species A} = \sum \text{line intercept distances for Species A (m)}$$

$$\text{Percent Cover} = \frac{\text{Linear cover distance of Species A (m)}}{\text{Total transect distance (m)}} \times 100$$

$$\text{Relative Percent Cover} = \frac{\text{Linear cover distance of Species A (m)}}{\text{Total linear cover distance of all species (m)}} \times 100$$

$$\text{Absolute Frequency} = \frac{\text{Number of subtransects in which Species A occurred}}{\text{Total number of subtransects}}$$

$$\text{Relative Frequency} = \frac{\text{Absolute frequency of Species A}}{\sum \text{absolute frequencies of all species}} \times 100$$

$$\text{Importance Value} = \frac{(\text{Relative Vegetative Cover} + \text{Relative Frequency})}{2}$$

Observed plants were identified to species or lowest practicable taxonomic classification. No quantitative plant biomass samples are collected.

Figure 5. Image of data sonde housing with holes that allow free movement of water, while the locking cap and cable provide security.

2.3.2 General Faunal Observations

Bird surveys were conducted at the beginning and end of each study period on the Rainbow River from the association park to Highway 484 in Dunnellon (Figure 2). Surveys started at the upstream location at sunrise and worked their way downstream with the current in canoe/kayak. All birds observed (visually or audibility) on the spring run and upland areas were counted and identified to species. These data were used to estimate bird population and diversity in the study area.

2.3.3 Adult Aquatic Insects

Aquatic insect species diversity and populations were characterized based on collections of adults as they emerge from the water. Insect emergence was measured through the use of floating pyramidal traps, each with a sampling area of 0.25 m^2 (Figure 6). The trap design was based on traps used for midge and mosquito sampling from wetland and aquatic environments (Walton et al. 1999). Each trap was constructed of wood and has four sides covered with fiberglass window screen. Flotation was provided by foam "noodles" attached along the bottom wooden supports. The traps work under the premise that insects emerging into the trap generally seek the highest spot and in the process travel through an inverted funnel into a 500 mL jar inverted over the end of the funnel. A maximum of ten traps were deployed at locations along the periphery of the spring run. At each location the substrate was noted. Traps were deployed and the jars containing the emergent insects collected at 24 to 48 hour intervals during each study period. Insect identifications were made to the lowest practical taxonomic level. The number of insects captured in traps was used to calculate emergence rates and extrapolated across the wetted area of the study segment.

2.3.4 Snails

A visual survey for apple snail egg clutches was conducted within the Rainbow River (Figure 2). The number of egg masses and estimated clutch size (number of eggs per clutch) was documented along each shoreline within the study segment.

2.3.5 Fish

Visual surveys of the fish communities were made in the Rainbow River along the entire length of the study segment (Figure 2). The study segment was divided into two survey areas from RSR 1-5 (14.3 ac) and RSR 5-10 (13.2 ac). Multiple visual surveys of fish communities were made by four to six people using mask and snorkel gear. The fish observers started at an upstream location and worked their way downstream with the current. The spring run segment was partitioned into approximately equal sections from bank-to-bank with one observer observing and counting in each section. Observers noted the fish species or groups of similar species (lowest practical taxonomic level) of all observed fish, and these observations were reported to a data recorder, who followed the observers in a boat. Following each survey, observers estimated the total length (average and range) for each fish species/group. Fish density was calculated for each sub-section by dividing the average number of individuals counted, by the area sampled. Biomass of fish species was estimated using published length-weight relationships (Schneider et al. 2000) and average species total lengths and numbers. Fish assemblage diversity was calculated using the Shannon-Wiener diversity index based on the calculated densities of individual species (Zar 1984).

2.3.6 Turtles

Eckerd College students and volunteers directed by Dr. Peter Meylan (Professor of Natural Sciences, Eckerd College) conducted quantitative monitoring of the aquatic turtle community on the portion of the study segment between RSR-1 and RSR-8 (21.8 ac survey area) on September 12, 2015 and February 13, 2016. During each sampling event, snorkelers who swam upstream along the study segment, captured all observed turtles by hand or net, and delivered them to volunteers in the accompanying boats for data collection and recording.

All turtles were identified to species, sexed, measured for straight carapace and plastron length, checked for previous tagging, and capture location was documented by GPS. The aquatic turtle population density was reported as the number of individuals for each species divided by the surface area of the study segment.

Figure 6. Trap used to collect adult aquatic insects as they emerge from the water

Figure 7. Apple snail egg clutch example

2.3.7 Human Use

Detailed observations of human use were made throughout the time that the study segment was visited, including both weekdays and weekends. These observations were made from docks located at stations RSR-1, RSR-6, and Dock 3 (Figure 2) for the visible portions of the spring run and surrounding upland areas. The count area was referred to as the "observation area". Primary water contact activities were categorized as: wading (less than waist deep), bathing (greater than waist deep and less than neck deep), swimming, snorkeling, tubing, canoeing/kayaking, power boating, and fishing. Primary out-of-water activities included: sitting, walking, sunbathing, and nature study.

For each of these activity categories, the counts of all persons within the observation area were made at 15-minute intervals. Individual counts were multiplied by 0.25 hours (15 minutes) to estimate the average person-hours throughout the period of observation. The total human-use during a one-day period, reported in units of person-hours, was estimated as the sum of the 15-minute counts as follows:

$$\sum_{t1}^{t2} no.persons.dt = \text{person-hours}$$

Where:

T = time (hours)

t1 = time (start)

t2 = time (finish)

Person-hour estimates were divided by the total observation interval in hours to estimate an average number of persons involved in in-water and out-of-water activities for each day of observation. Water and upland observation areas were estimated from maps and aerial photographs to normalize data on a per-area basis:

Human-Use Density = no. persons/area counted

The resulting data were tabulated and reported as the average number of persons and human-use density (persons per area) basis by activity and location.

2.4 Ecosystem Level Monitoring

2.4.1 Ecosystem Metabolism

Ecosystem metabolism was calculated in the study segment using an Excel spreadsheet adaptation of the upstream/downstream dissolved oxygen (DO) change methods of H.T. Odum (1957a, 1957b). 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 (when DO is less than 100% saturation), 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 result of these gains and losses as shown in the following conceptual equation:

Δ DO = GPP – CR + Din + A

Where:

Δ 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 $O_2/m^2/d$

The DO measurements used to estimate segment ecosystem metabolism were collected at the upstream and downstream end of each study segment at 30 minute intervals using recording YSI 6920 data sondes with optical DO sensors.

Upstream and downstream DO data were each shifted by one-half of the estimated travel time between the upstream and downstream study segment stations and an oxygen rate-of-change curve was prepared. Areas, volumes, current velocities and diffusion measurements were used to estimate ecosystem metabolism. Water surface area was estimated for the study segment using the survey methods described above and corrected hourly using an estimated stage: area relationship. Average velocities were estimated from the stage:volume relationship and 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.

This DO rate-of-change curve was corrected for atmospheric diffusion based on measured percent oxygen saturation in the water, and oxygen diffusion rates corrected for water velocity. The corrected oxygen rate-of-change curve for each 24-hour period was used to estimate gross primary productivity (GPP), community respiration (CR), net primary productivity (NPP), production/respiration (P/R) ratio, and photosynthetic efficiency. Figure 8 illustrates these metabolism measurements based on development of a typical oxygen rate-of-change curve.

Descriptions of the ecosystem metabolism parameters follow below:

- Gross primary productivity (GPP) is estimated as the entire area under the oxygen rate-of-change curve, calculated by extending the nighttime corrected oxygen rate-of-change through the daylight hours and estimating the entire area under the daytime curve in g $O_2/m^2/d$. GPP is a measure of all aquatic plant productivity occurring below the water surface within the study segment. GPP includes primary productivity of both algae (including photosynthetic bacteria) and submerged vascular plants.
- Community respiration (CR) is the average of the corrected nighttime oxygen rate-of-change values in g $O_2/m^2/d$. CR is a measure of the total dark metabolism of the entire submerged ecosystem within each study segment. CR includes the respiration of all microbes in the sediments and water column, respiration of bacteria, algae, and plants in the water column, and respiration of most aquatic animals, including protozoans, macroinvertebrates, crustaceans, and fish. Respiration of turtles, alligators, frogs, snakes, manatees, and other air-breathing aquatic fauna is not included in this calculation.
- Net primary productivity (NPP) is equal to the difference between these two estimates (GPP-CR). NPP provides an estimate of the net fixed carbon that remains each day after the respiratory needs of the aquatic ecosystem are met. CR may be higher than GPP in some streams and during some periods of time, indicating that there are unmeasured inputs of fixed carbon or losses of fixed carbon that were previously stored in the ecosystem.
- The P/R ratio or ecological quotient is equal to GPP/CR. A P/R ratio of one indicates that production and consumption are equally balanced. A ratio greater than one indicates an autotrophic aquatic ecosystem while a value less than one indicates a heterotrophic ecosystem.

- Photosynthetic efficiency (PE) is equal to the rate of gross primary productivity divided by the incident PAR during a specified time interval. It estimates the overall efficiency of an aquatic ecosystem to utilize the visible fraction of incident solar radiation, the principal forcing function for autotrophic stream ecosystems. PAR reaching the plant level is estimated based on river stage, the plant community characterization data for segment depth, and the light attenuation coefficient estimated for each sampling event. PE is reported as PAR Efficiency by dividing GPP in $O_2/m^2/d$ by $mol/m^2/d$, resulting in units of g O_2/mol. PAR Efficiency is also reported as a percentage using the conversion factors employed by Knight (1980; 1983): 4.22 Kcal/g O_2 and 52.27 Kcal/mole of photons (McCree 1972).

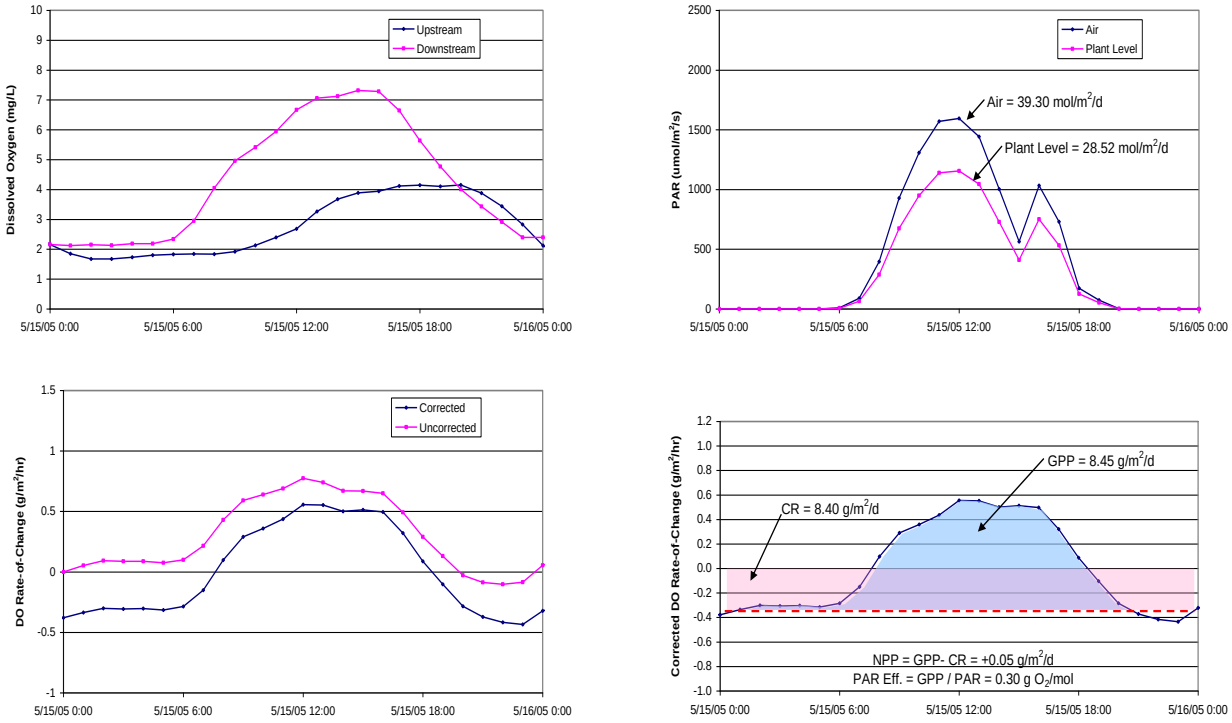


Figure 8. Example determination of ecosystem metabolism based on upstream-downstream dissolved oxygen data (from WSI 2007).

2.4.2 Nutrient Assimilation

Nutrient assimilation/dissimilation rates for TN, NOx-N, and NH_4-N were estimated for the study segment by calculating upstream-downstream changes in nutrient mass. Average nutrient mass inputs and outputs were estimated based on average water chemistry concentrations and flows over the period of study. Positive nutrient mass changes indicate assimilation/dissimilation of nutrients, while negative changes indicate an increase in nutrient mass with travel of the spring flow downstream.

2.4.3 Community Export

Community export was measured at both the upstream (RSR-1) and downstream (RSR-10) end of the study segment to provide a supplemental method for estimating net ecosystem production within the segment. Community export of particulate suspended matter was quantified for the study segment using a plankton net suspended in the current at mid-depth (Figure 9). The mesh size on the plankton net was 153 µm. Three replicate plankton net samples were collected at the upstream and downstream end of each segment. Sample material collected in the plankton net was rinsed into a sample bottle and returned to the laboratory for wet, dry, and ash-free (combusted at an oven temperature of 450 °C) dry weight analyses. The velocity of the water at the mouth of the net was measured as was the time of net deployment. These data allowed calculation of the volume of water passing through the net. The amount of particulate material collected in the net was expressed on an area (based on upstream wetted-area) basis. Particulate export results were 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). Overall particulate export for the study segment was calculated as the difference between the upstream and downstream export rates.

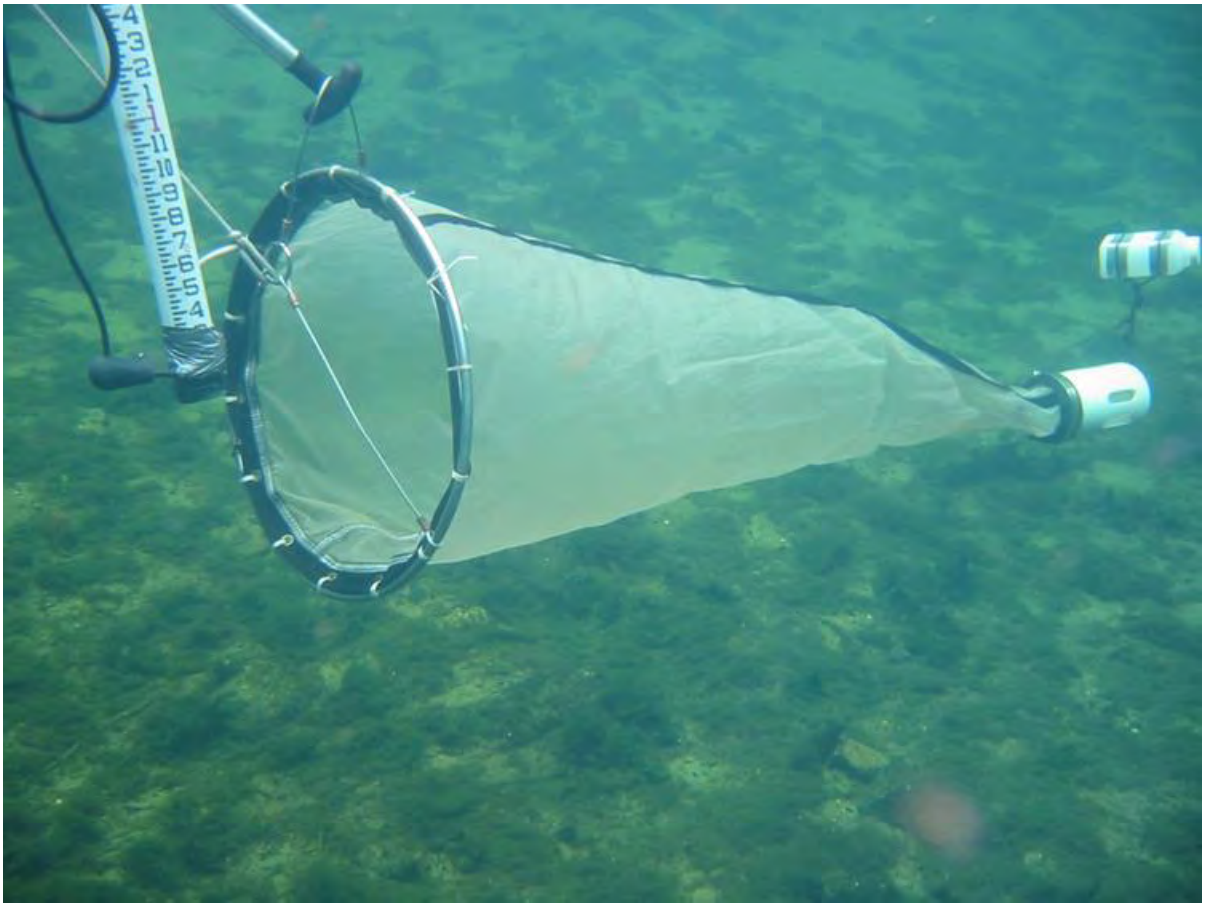


Figure 9. Image of plankton net capturing suspended material with flow meter upstream

Section 3.0 Results

3.1 Physical Environment

3.1.1 Underwater Light Transmission

The input of solar energy is the most important environmental forcing function that is seasonally variable in springs. The influx of light is the most important determinant of overall ecosystem primary productivity in clear-water springs. Light attenuation by dissolved and particulate matter in spring water limits solar energy available to submersed aquatic plants and other primary producers.

Figure 10 and Figure 11 provide a summary of the percent transmittance and diffuse attenuation coefficient by station and by monitoring date. Detailed light measurement data are provided in Appendix A.

The percent transmittance between the stations averaged 64.2 percent at 1 m, ranging from 62.9 percent (RSR-10) to 65.8 percent (RSR-5), while the diffuse attenuation coefficient averaged 0.46 m^{-1} (range 0.44 to 0.49 m^{-1}).

The average percent transmittance for the entire spring run segment varied from 52.0 percent at 1 m (September 8, 2015) to 76.4 percent at 1 m (February 8, 2016), during the two baseline monitoring events. The diffuse attenuation coefficient ranged from 0.27 m^{-1} to 0.67 m^{-1} for the same time period.

Light transmittance values from the study segment were compared to other spring run systems in Florida and showed similar ranges for average light transmittance values as shown in Figure 12. Light transmittance results from the Rainbow River in 2009 are also included in this figure; however, these were measured just downstream of the main spring vent (WSI 2010). Light transmittance values measured near spring vents generally are higher and show less variability than measurements farther downstream in the spring run. Much of this decline is the direct result of increasing particulate matter, resulting from the release of attached algal cells from plants and sediments with distance downstream. This release of particulate matter in spring runs is the combined result of natural causes like flow velocity and human causes from physical disturbance.

3.1.2 Stream Discharge and Current Velocity

Spring discharge is second only to solar input as one of the most important forcing functions that regulates overall spring habitat support of plant, fish, and wildlife communities. Stream discharge and velocity were measured at the upstream and downstream ends of the study segment using portable flow meters.

Table 1 provides a summary of discharges measured during the baseline assessment at the upstream and downstream ends of the study segment, while Appendix B provides detailed discharge measurements. Stream discharges averaged 602 cfs and 608 cfs during the September 2015 and February 2016 events, respectively. Flows reported by the USGS in the study segment on the same day as these measurements were about 20% higher in September 2015. This discrepancy indicates that the discharge estimates at USGS 02313098 are suspect and rating data for this station need to be carefully examined.

Figure 13 and Figure 14 provide summaries of average daily discharges along the Rainbow River for USGS 02313098 (RSR-5) and USGS 02313100 at Highway 484. Stream discharges at USGS 0213098 averaged 652 cfs (range 517 cfs to 738 cfs) since 2013, while USGS 02313100 averaged 676 cfs (range 391 cfs to 1065 cfs) since 1965 displaying a general decline over time. This decline (about 25% since the 1960s) was estimated to be 11% due to rainfall declines and the remaining 14% decline (about 100 cfs or 65 MGD) due to human groundwater extraction (WSI/FSI 2013).

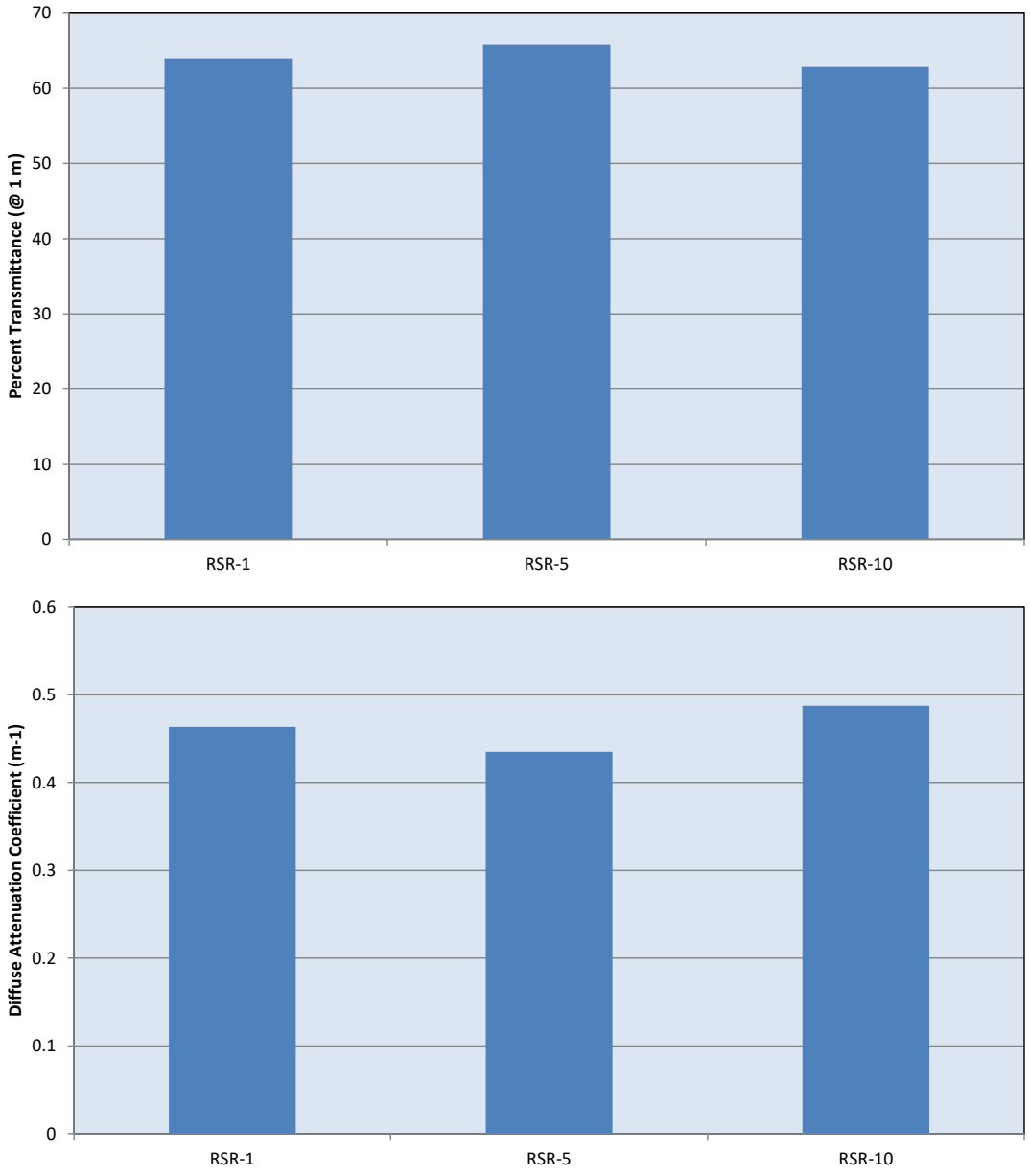


Figure 10. PAR percent transmittance (@ 1m) and diffuse attenuation coefficient estimates by station (August/September 2015, February 2016)

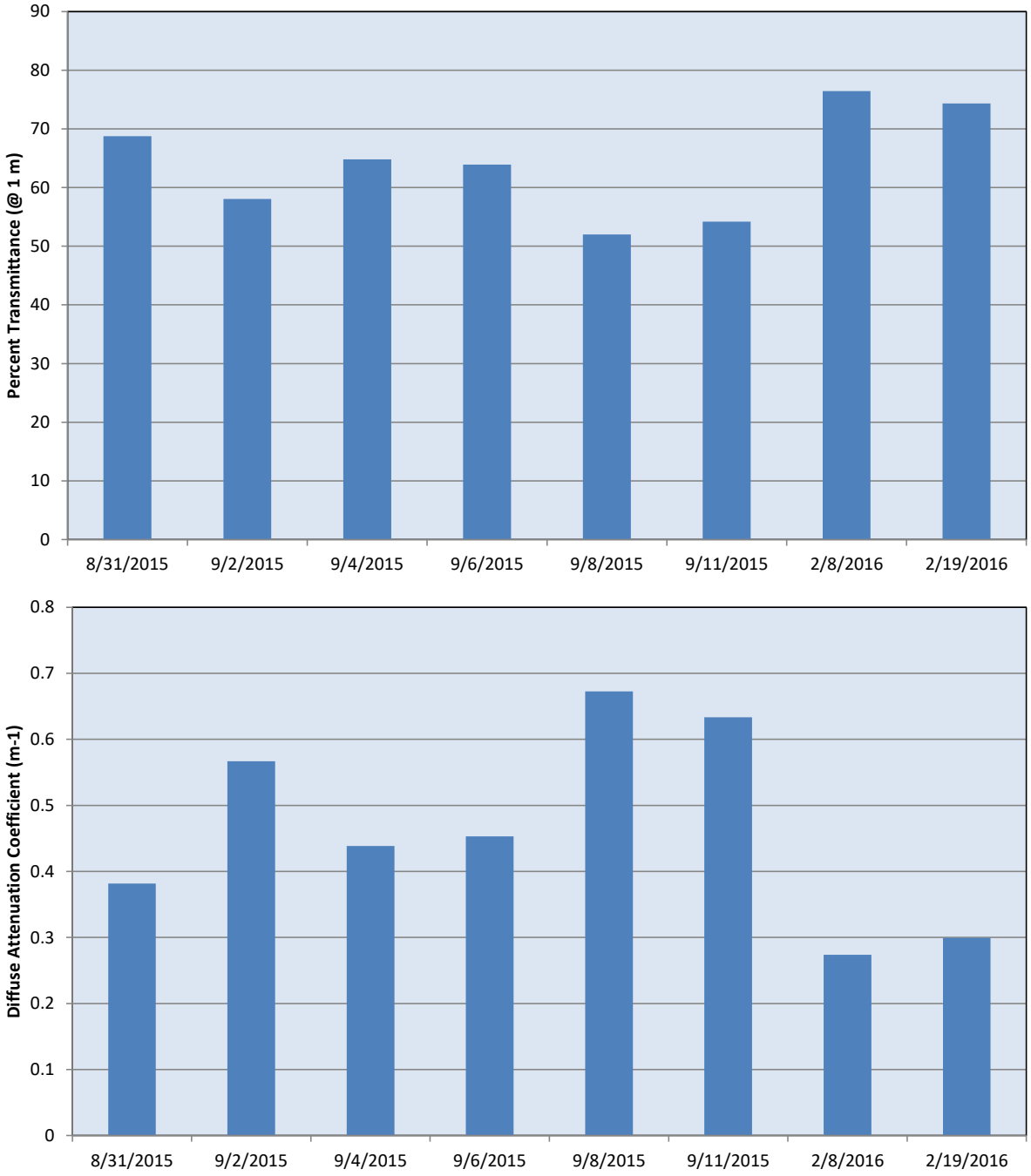


Figure 11. Average PAR percent transmittance (@ 1m) and diffuse attenuation coefficient estimates by monitoring date

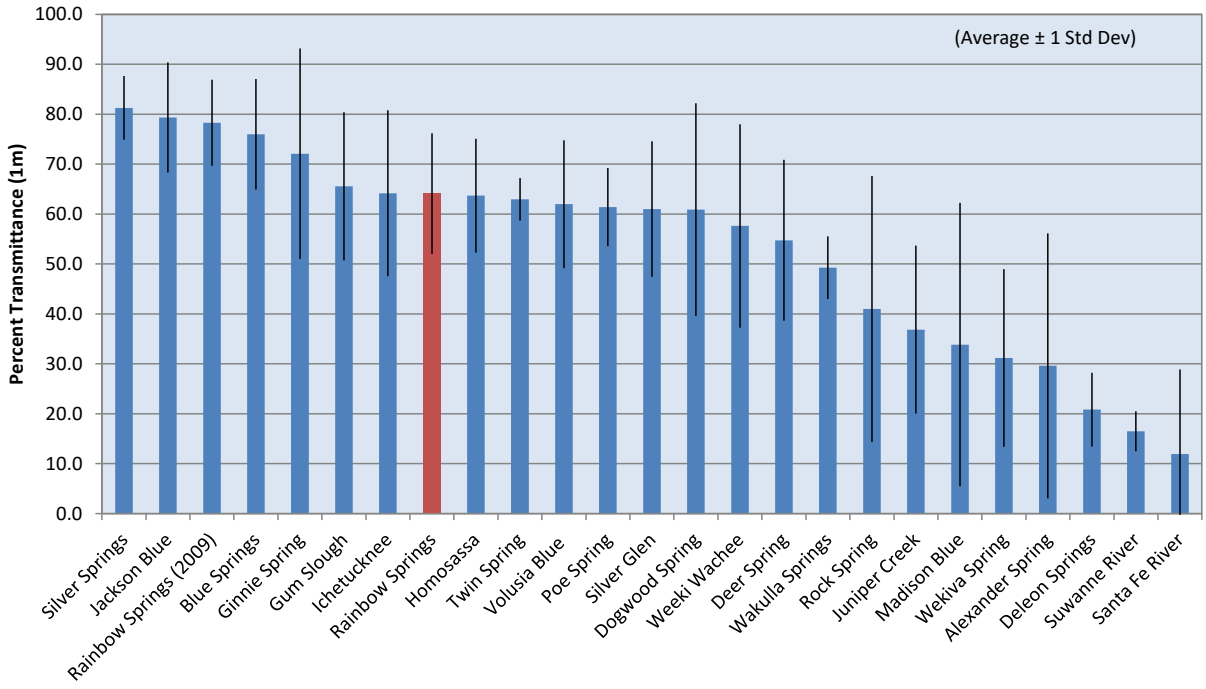


Figure 12. Average PAR percent transmittance (@ 1m) for Florida spring runs

Table 1. Rainbow River flow measurements

Date	Station	Width (ft)	Avg. Depth (ft)	Discharge (cfs)	USGS 02313098		USGS 02313100	
					Discharge (cfs)	Stage (ft NAVD88)	Discharge (cfs)	Stage (ft NAVD88)
9/2/2015	RSR-10	138	5.7	602.6	721	33.09	717	27.83
9/9/2015	RSR-1	169	5.8	600.8	723	33.30	723	28.22
2/19/2016	RSR-1	126	4.4[a]	594.6	nd	32.66	587	27.49
2/19/2016	RSR-6	160	4.3[a]	620.8	nd	32.66	587	27.49

[a] calculated depth (area / width)
nd – no data available

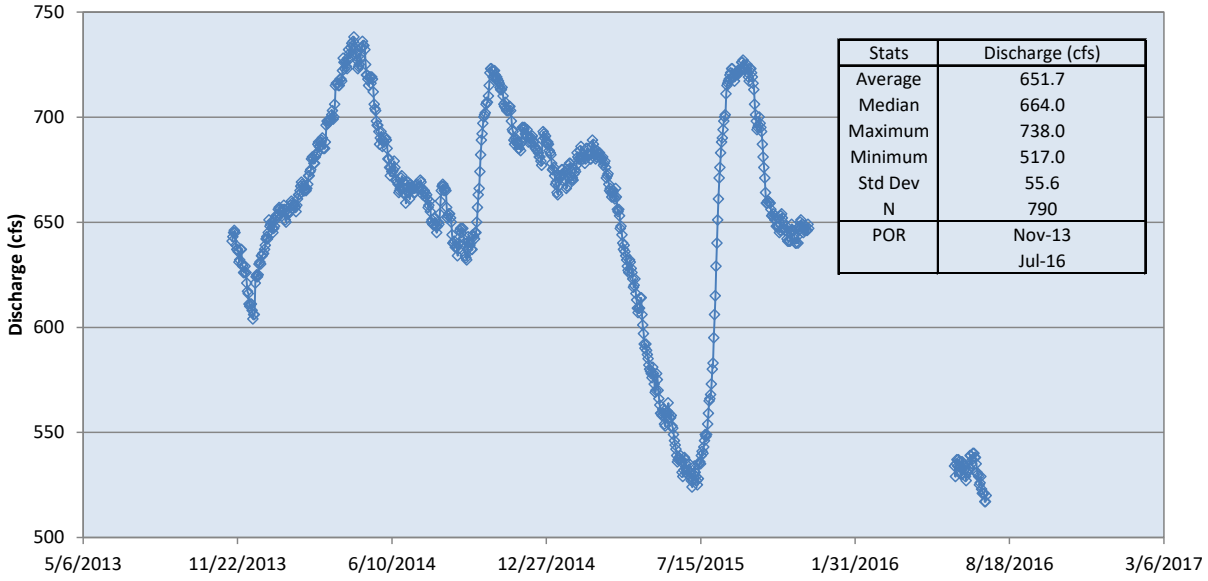


Figure 13. USGS 02313098 Rainbow River near Dunnellon, FL (@ RSR-5) – daily average discharge

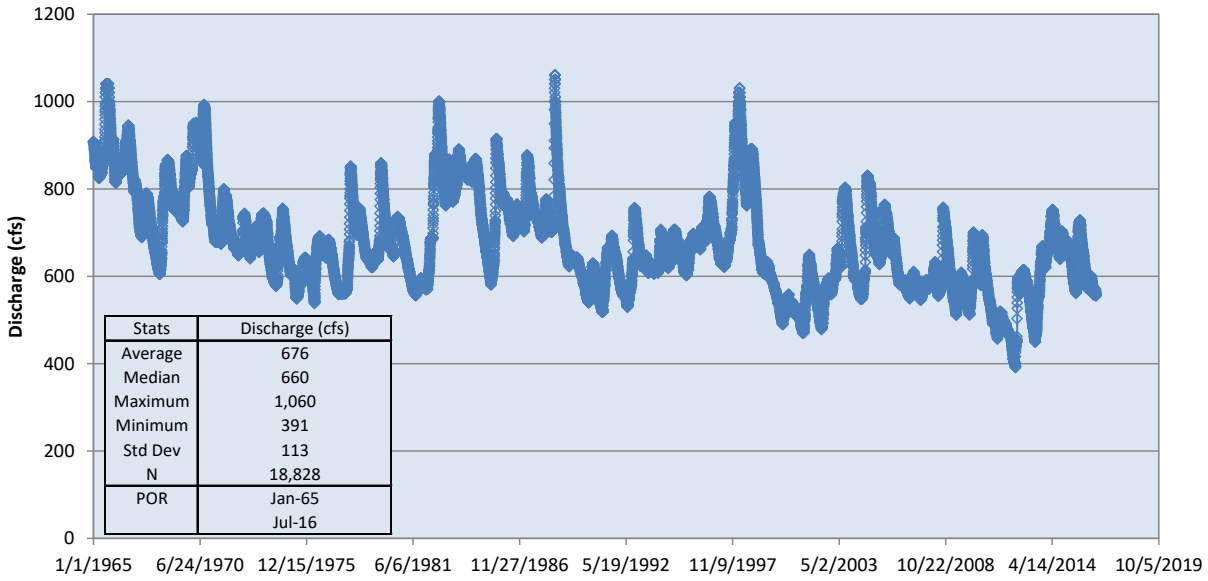


Figure 14. USGS 02313100 Rainbow River at Dunnellon, FL (Hwy 484) – daily average discharge

3.1.3 Stream Segment Morphometry

Table 2 summarizes segment wetted area and volume relative to water elevation, estimated from depth data collected within the study segment (Figure 15) with stage area/volume curves provided in Figure 16.

The average wetted surface area and volume of the study segment during the study was 17,152 ft^2 (26.8 ac) and 4,247,100 ft^3 (97.5 ac-ft), respectively. Nominal hydraulic residence time was estimated at 1.9 hours based on this estimated water volume and an average flow of 605 cfs during this period.

Table 2. Rainbow River stage - area / volume relationship (August 2015) for the one-mile segment sampled during this baseline assessment

Water Elev.	Area		Volume	
(ft NAVD88)	(ac)	(ft^2)	(ac-ft)	(ft^3)
33	27.2	1,186,334	99.2	4,320,150
32	24.9	1,085,723	72.5	3,159,180
31	22.3	970,582	48.2	2,097,974
30	16.2	703,874	27.1	1,180,499
29	9.5	412,505	12.6	549,496
28	4.3	185,677	4.6	201,541
27	1.5	67,038	1.2	51,630
26	0.16	7,061	0.12	5,333
25	0.03	1,302	0.02	671

Figure 15. Rainbow River bathymetry – August 2015

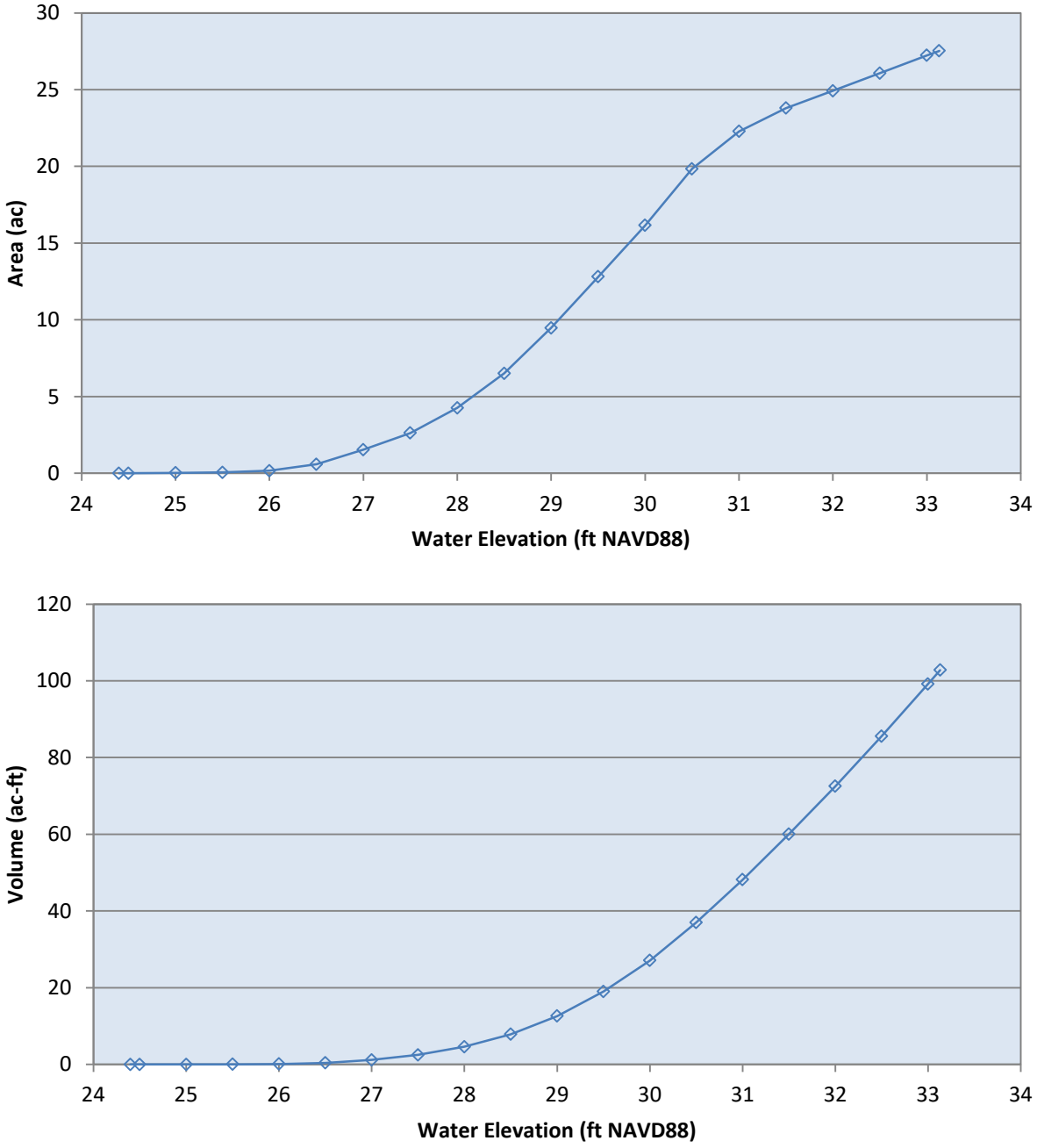


Figure 16. Rainbow River Study Segment stage area / volume curves – August 2015

3.1.4 Secchi Disk Visibility

Table 3 summarizes horizontal Secchi disk visibility measurements at the upstream, midpoint, and downstream stations for multiple dates. These measurements provide additional information concerning water clarity and the light attenuation properties of the spring run. Secchi disk visibility generally decreased from upstream to downstream with an average difference of 8.2

feet between RSR-1 and RSR-10. Water clarity in the Rainbow River is very high at over 200 feet near the headspring area, however clarity has been observed to decrease with increasing distance downstream (SWFWMD 2008).

Table 3. Horizontal Secchi Disk (ft) measurements in the Rainbow River

Date	Upstream	Midpoint	Downstream
8/31/2015	40.0	30.8	24.9
9/2/2015	46.6	---	27.6
9/5/2015	38.1	---	---
9/11/2015	39.4	32.5	32.2
2/8/2016	61.0	60.0	60.0
2/19/2016	55.1	53.1	47.2
Average	46.6	44.0	38.4

Upstream: RSR-1; Midpoint: RSR-5; Downstream; RSR-10

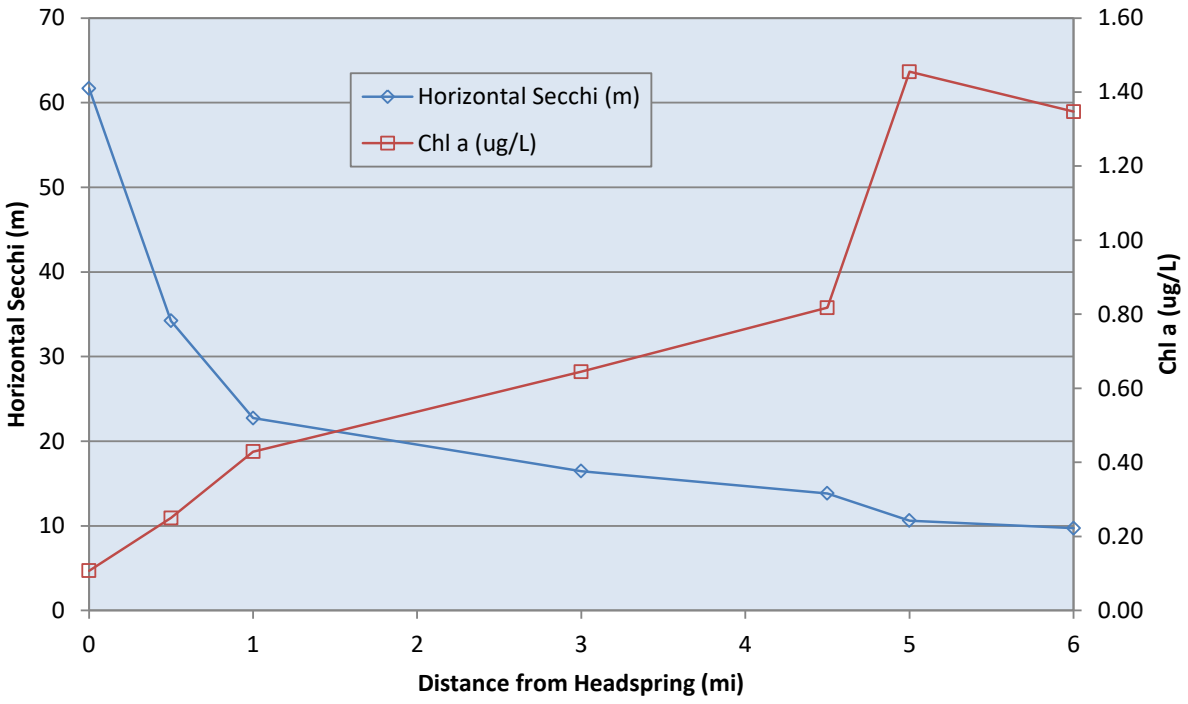


Figure 17. Horizontal Secchi measurements and chlorophyll-a concentrations in the Rainbow River (SWFWMD 2008)

3.1.5 Weather Station

Table 4 provides a monthly summary for air temperature, rainfall, solar radiation, and evapotranspiration during the study period.

Table 4. Weather Summary – University of Florida FAWN Lecanto Station

Parameter	Stats	Aug-15	Sep-15	Feb-16
Air Temperature (C)	Average	26.6	25.5	13.8
	Min	20.2	15.5	-3.5
	Max	36.3	34.1	30.7
Rainfall (in)	Total	13.4	4.46	3.14
Solar Radiation (W/m^2)	Average	193.3	169.7	179.4
	Max	1,074	942	887
Evapotranspiration (in)	Total	4.52	3.72	2.42

Long-term (97 year) average rainfall in the springshed is about 54 in/yr, and more recently is averaging about 50 in/yr (Figure 18; WSI/FSI 2013).

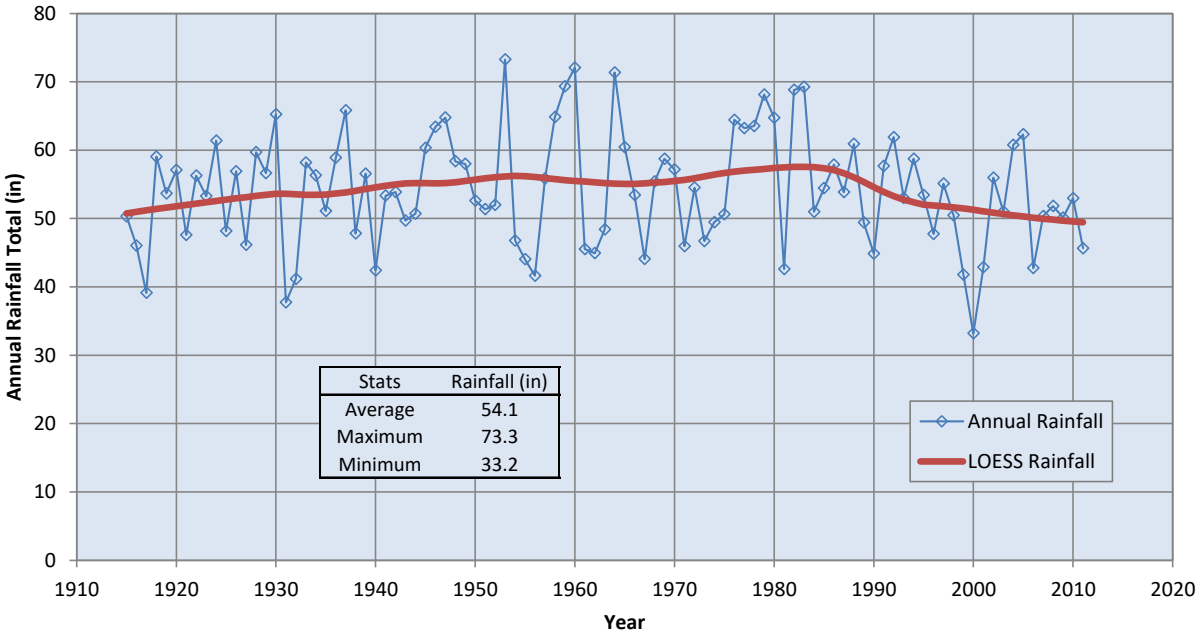


Figure 18. Annual rainfall record for Marion County (1915-2011)

3.1.6 Water Quality

Water quality field parameters and grab samples for water chemistry analyses were collected at upstream (RSR-1), midpoint (RSR-5), and downstream (RSR-10) stations during each 2-week sampling period. These parameters characterize water quality conditions concurrent with the other intensive sampling. Table 5 provides a summary of average water quality grab sample results. Detailed water quality data are presented in Appendix C.

Average TN concentrations decreased from 1.85 mg/L at the upstream station to 1.75 mg/L at the downstream station. The predominant form of nitrogen was NOx-N with an average low concentration of 1.70 mg/L at the downstream station to an average high concentration of 1.80 mg/L at the midpoint station.

Dissolved oxygen and pH increased from the upstream to downstream station, while conductivity and water temperature remained relatively unchanged on average. Turbidity was low throughout the Rainbow River segment with average measured values less than 0.3 NTU.

Table 5. Rainbow River average water quality grab sample results

PARAMETER GROUP	PARAMETER	UNITS	RSR-1	RSR-5	RSR-10
September 2015					
DISSOLVED OXYGEN	DO	%	74.50	75.70	80.40
	DO	mg/L	6.41	6.49	6.88
NITROGEN	NH_4-N	mg/L	0.025	0.030	0.040
	NOx-N	mg/L	1.75	1.90	1.70
	OrgN	mg/L	0.09	0.02	0.01
	TKN	mg/L	0.10	0.03	0.03
	TN	mg/L	1.86	1.95	1.75
PHYSICAL	pH	SU	7.60	7.44	7.67
	SpCond	umhos/cm	289	291	291
	Turb	NTU	< 0.3	---	< 0.3
TEMPERATURE	Wtr Temp	C	22.82	22.99	23.10
January 2016					
DISSOLVED OXYGEN	DO	%	97.85	102.5	104.1
	DO	mg/L	8.50	8.92	9.10
NITROGEN	NH_4-N	mg/L	0.008	0.008	0.008
	NOx-N	mg/L	1.70	1.70	1.70
	OrgN	mg/L	0.13	0.04	0.04
	TKN	mg/L	0.13	0.03	0.03
	TN	mg/L	1.84	1.75	1.75
PHYSICAL	pH	SU	8.16	8.25	8.27
	SpCond	umhos/cm	289	288	288
	Turb	NTU	---	---	< 0.3
TEMPERATURE	Wtr Temp	C	22.26	22.06	21.96

Dissolved oxygen data from the study segment were compared to other Florida springs (near the spring vents) as shown in Figure 19.

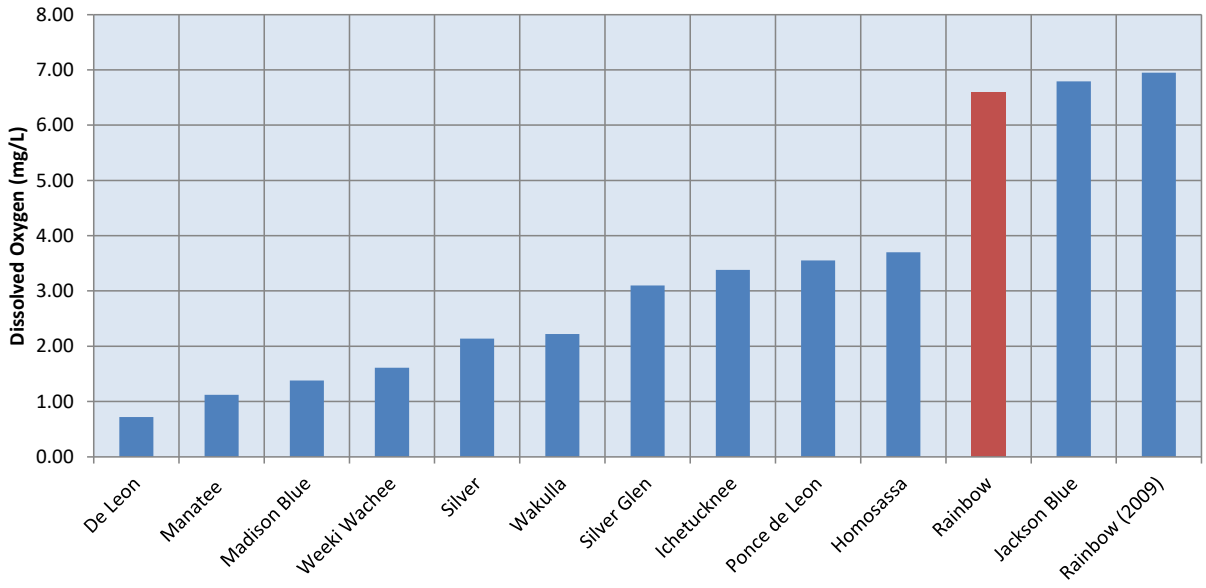


Figure 19. Average dissolved oxygen concentrations in Florida springs near the spring vents (study segment in red)

Figure 20 and Figure 21 provide summaries of average daily NOx-N concentrations within the Rainbow River reported by the SWFWMD for USGS 02313098 (RSR-5) and USGS 02313100 at Highway 484 since October 2015. NOx-N concentrations averaged 1.83 mg/L and 1.77 mg/L for USGS 0213098 and USGS 02313100, respectively.

Nitrate data from the study segment were compared to other Florida springs as shown in Figure 22. The FGS, USGS, and SWFWMD have reported nitrate concentration data at the Rainbow Springs complex from 1927 through 2011 (Figure 23). These data show an increase in nitrate at the head spring area from 0.08 mg/L to over 2 mg/L in 2012. The sources of nitrates have been investigated by Jones et al. (1996) and inorganic fertilizer (via agricultural application) was implicated as the dominant source.

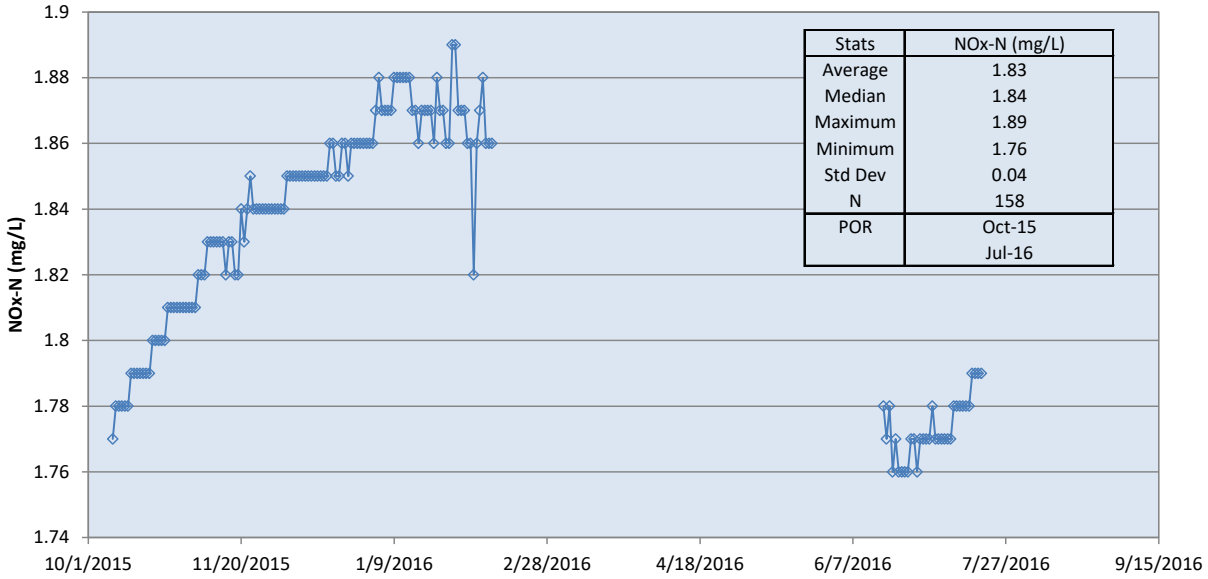


Figure 20. USGS 02313098 Rainbow River near Dunnellon, FL (@ RSR-5) – daily average Nitrate+Nitrite-N

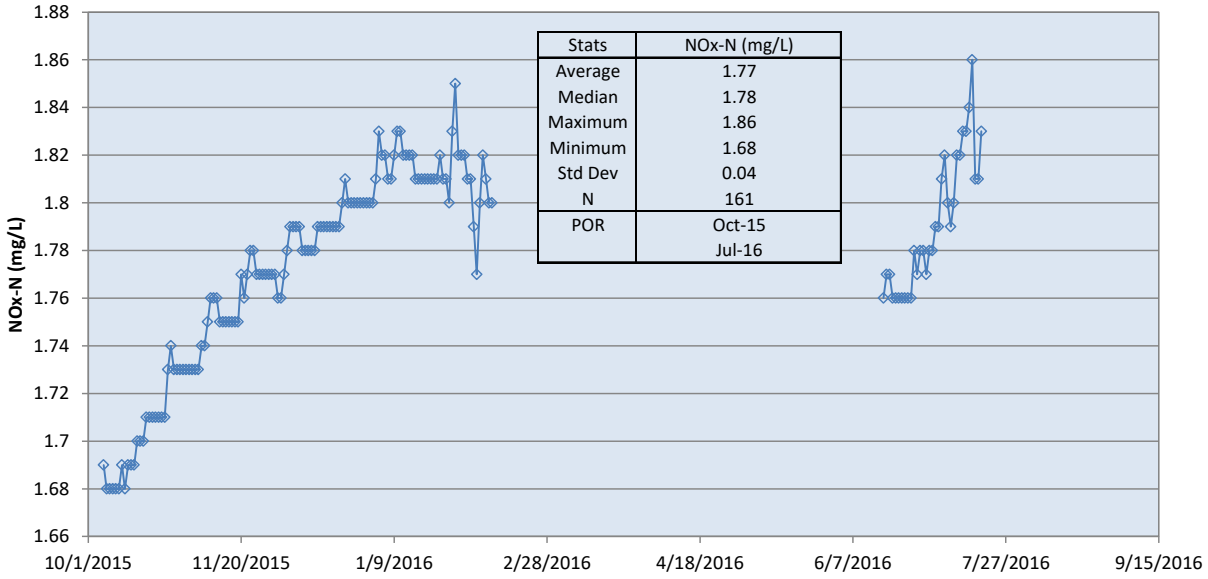
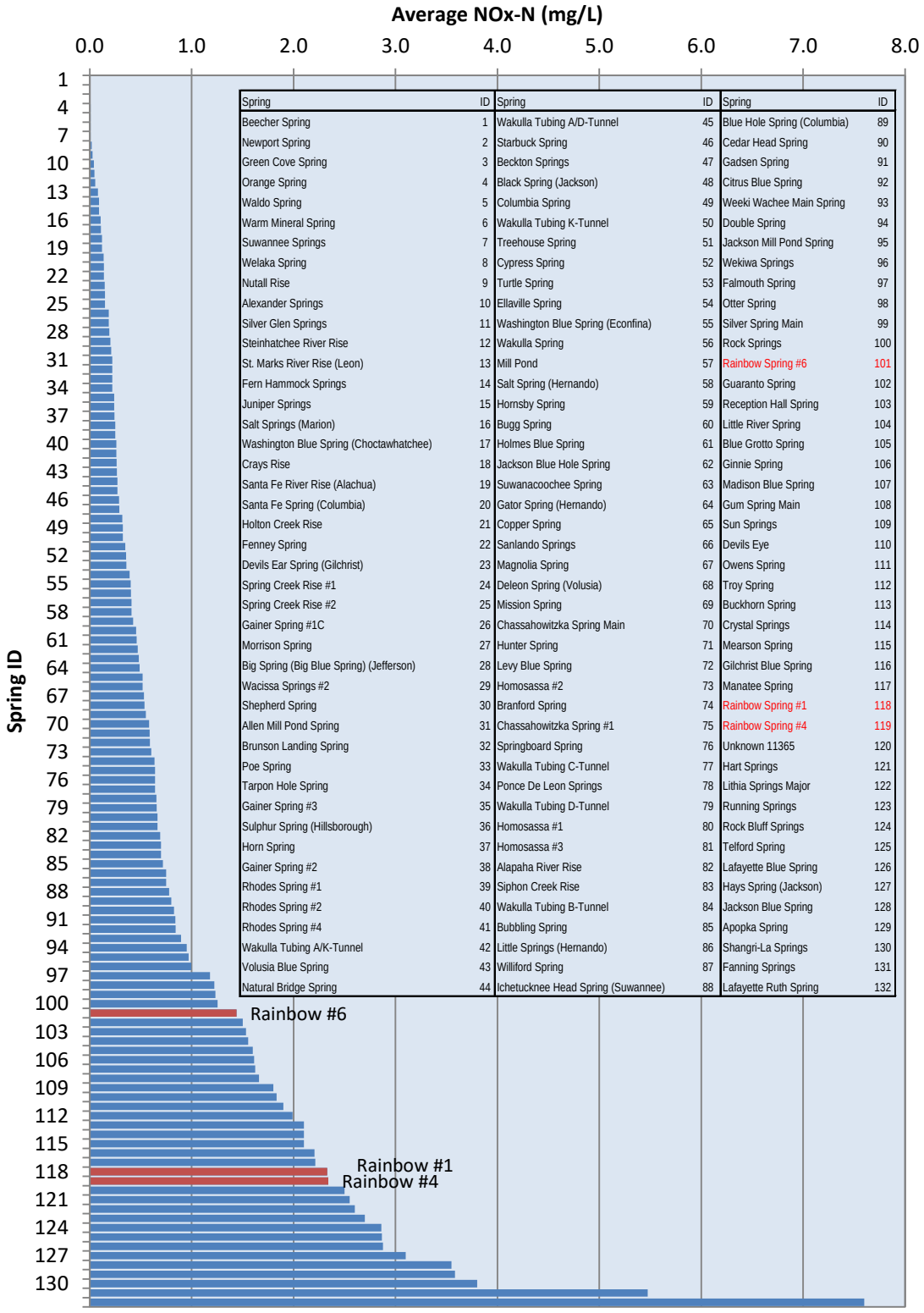


Figure 21. USGS 02313100 Rainbow River at Dunnellon, FL (Hwy 484) – daily average Nitrate+Nitrite-N



Spring	ID	Spring	ID	Spring	ID
Beecher Spring	1	Wakulla Tubing A/D-Tunnel	45	Blue Hole Spring (Columbia)	89
Newport Spring	2	Starbuck Spring	46	Cedar Head Spring	90
Green Cove Spring	3	Beckton Springs	47	Gadsen Spring	91
Orange Spring	4	Black Spring (Jackson)	48	Citrus Blue Spring	92
Waldo Spring	5	Columbia Spring	49	Weeki Wachee Main Spring	93
Warm Mineral Spring	6	Wakulla Tubing K-Tunnel	50	Double Spring	94
Suwannee Springs	7	Treehouse Spring	51	Jackson Mill Pond Spring	95
Welaka Spring	8	Cypress Spring	52	Wekiwa Springs	96
Nutall Rise	9	Turtle Spring	53	Falmouth Spring	97
Alexander Springs	10	Ellaville Spring	54	Otter Spring	98
Silver Glen Springs	11	Washington Blue Spring (Econfina)	55	Silver Spring Main	99
Steinhatchee River Rise	12	Wakulla Spring	56	Rock Springs	100
St. Marks River Rise (Leon)	13	Mill Pond	57	Rainbow Spring #6	101
Fern Hammock Springs	14	Salt Spring (Hernando)	58	Guaranto Spring	102
Juniper Springs	15	Hornsby Spring	59	Reception Hall Spring	103
Salt Springs (Marion)	16	Bugg Spring	60	Little River Spring	104
Washington Blue Spring (Choctawhatchee)	17	Holmes Blue Spring	61	Blue Grotto Spring	105
Crays Rise	18	Jackson Blue Hole Spring	62	Ginnie Spring	106
Santa Fe River Rise (Alachua)	19	Suwanacoochee Spring	63	Madison Blue Spring	107
Santa Fe Spring (Columbia)	20	Gator Spring (Hernando)	64	Gum Spring Main	108
Holton Creek Rise	21	Copper Spring	65	Sun Springs	109
Fenney Spring	22	Sanlando Springs	66	Devils Eye	110
Devils Ear Spring (Gilchrist)	23	Magnolia Spring	67	Owens Spring	111
Spring Creek Rise #1	24	Deleon Spring (Volusia)	68	Troy Spring	112
Spring Creek Rise #2	25	Mission Spring	69	Buckhorn Spring	113
Gainer Spring #1C	26	Chassahowitzka Spring Main	70	Crystal Springs	114
Morrison Spring	27	Hunter Spring	71	Mearson Spring	115
Big Spring (Big Blue Spring) (Jefferson)	28	Levy Blue Spring	72	Gilchrist Blue Spring	116
Wacissa Springs #2	29	Homosassa #2	73	Manatee Spring	117
Shepherd Spring	30	Branford Spring	74	Rainbow Spring #1	118
Allen Mill Pond Spring	31	Chassahowitzka Spring #1	75	Rainbow Spring #4	119
Brunson Landing Spring	32	Springboard Spring	76	Unknown 11365	120
Poe Spring	33	Wakulla Tubing C-Tunnel	77	Hart Springs	121
Tarpon Hole Spring	34	Ponce De Leon Springs	78	Lithia Springs Major	122
Gainer Spring #3	35	Wakulla Tubing D-Tunnel	79	Running Springs	123
Sulphur Spring (Hillsborough)	36	Homosassa #1	80	Rock Bluff Springs	124
Horn Spring	37	Homosassa #3	81	Telford Spring	125
Gainer Spring #2	38	Alapaha River Rise	82	Lafayette Blue Spring	126
Rhodes Spring #1	39	Siphon Creek Rise	83	Hays Spring (Jackson)	127
Rhodes Spring #2	40	Wakulla Tubing B-Tunnel	84	Jackson Blue Spring	128
Rhodes Spring #4	41	Bubbling Spring	85	Apopka Spring	129
Wakulla Tubing A/K-Tunnel	42	Little Springs (Hernando)	86	Shangri-La Springs	130
Volusia Blue Spring	43	Williford Spring	87	Fanning Springs	131
Natural Bridge Spring	44	Ichetucknee Head Spring (Suwannee)	88	Lafayette Ruth Spring	132

Figure 22. Average nitrate nitrogen concentrations in Florida springs (2001-2016)

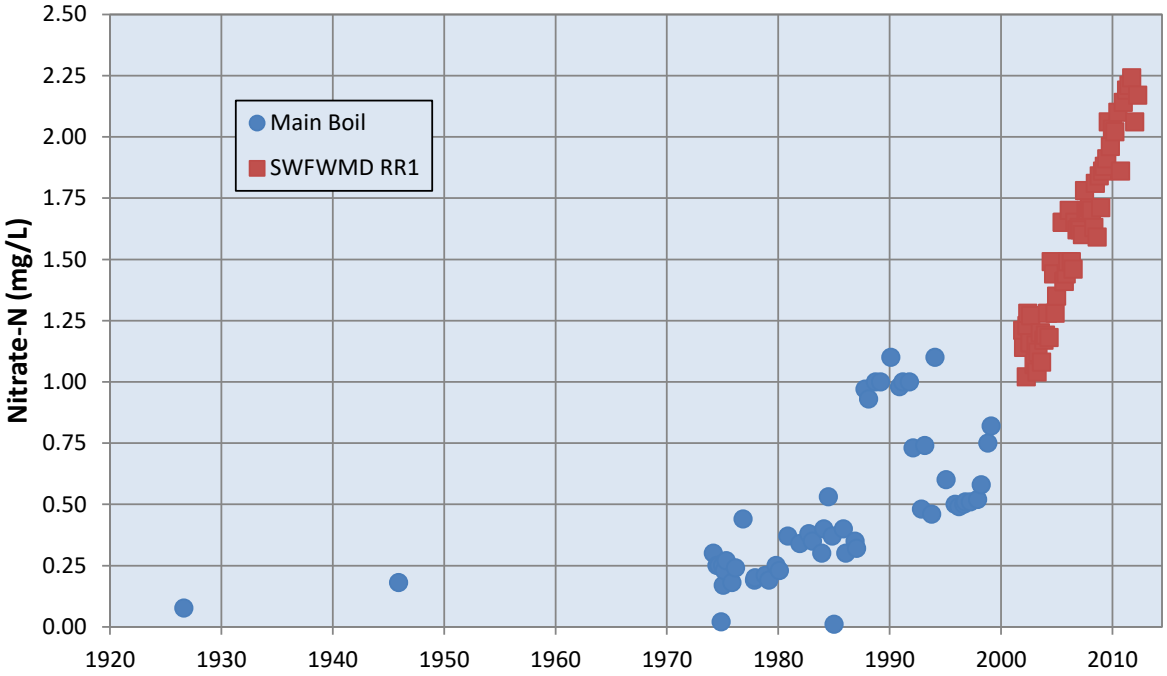


Figure 23. Nitrate concentrations in the vicinity of the Main Boil at Rainbow Springs (WSI/FSI 2013)

Table 6 summarizes average field parameter data collected every 30 minutes with the water quality data sondes at the upstream (RSR-1), midpoint (RSR-5), and downstream (RSR-10) stations during the baseline monitoring events. Detailed time series plots are presented in Appendix C.

Dissolved oxygen concentrations and pH were observed to vary in a diurnal pattern (Figure 24), showing a rise in concentration during the day due to primary productivity and decreasing concentrations at night as a result of community respiration.

Table 6. Rainbow River average water quality sonde measurements

PARAMETER GROUP	PARAMETER	UNITS	RSR-UP	RSR-MID	RSR-DOWN
August 30 - September 11, 2015					
DISSOLVED OXYGEN	DO	%	87.89	86.45	89.94
	DO	mg/L	7.49	7.34	7.62
PHYSICAL	pH	SU	7.82	7.78	7.97
	SpCond	umhos/cm	288	289	290
	Turb	NTU	< 0.3	---	< 0.3
TEMPERATURE	Wtr Temp	C	23.18	23.35	23.45
February 8 - 19, 2016					
DISSOLVED OXYGEN	DO	%	87.31	85.59	85.96
	DO	mg/L	7.84	7.32	7.84
PHYSICAL	pH	SU	7.98		8.10
	SpCond	umhos/cm	290	282	288
	Turb	NTU	---	---	1.7
TEMPERATURE	Wtr Temp	C	22.23	22.58	22.00

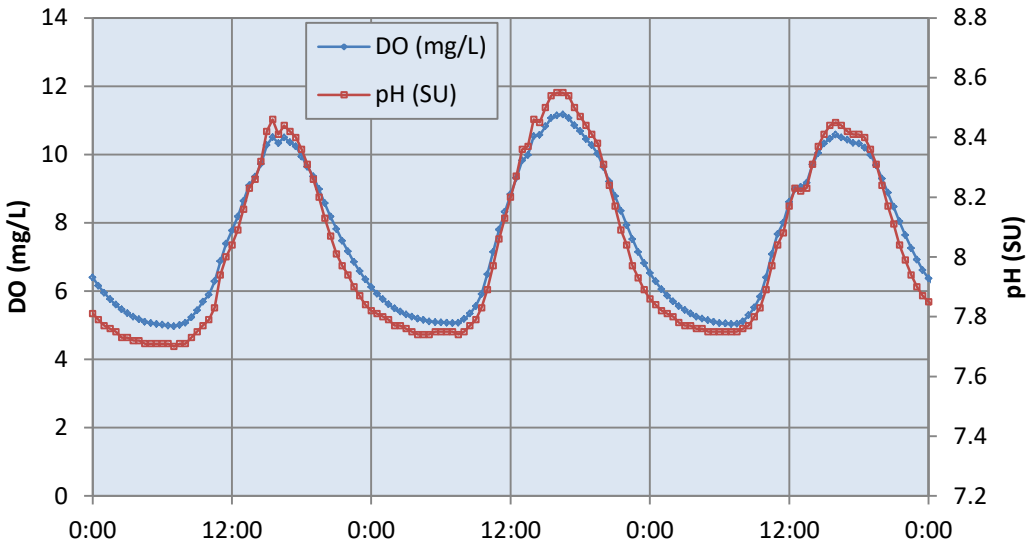


Figure 24. Typical diurnal pattern for dissolved oxygen and pH in the Rainbow River

3.2 Biology

3.2.1 Plant Community Characterization

The distribution and percent cover of aquatic plant communities (macroalgae and submerged aquatic vegetation) within the spring run at Rainbow River study area is summarized in Table 8 and Table 9. Detailed aquatic plant data are provided in Appendix D.

A total of 10 plant and algal species or groups were identified at the Rainbow River monitoring transects during the August 2015 monitoring event. The most common species occurring were strap-leaf sagittaria (*Sagittaria kurziana*), filamentous algae, hydrilla (*Hydrilla verticillata*), and tape grass (*Vallisneria americana*). Bare sand and mud had an average percent cover of approximately 15 percent, while all aquatic vegetation combined averaged 79 percent (submerged aquatic vegetation 59%, algae 18%, floating aquatic plants 2%, and emergent vegetation <1%). A range of 5 to 9 aquatic vegetation species occurred within the three vegetation transects.

Table 7. Rainbow River aquatic vegetation summary overall average for the Study Segment (August 2015).

		Linear	Cover		Frequency		Importance
Scientific Name	Common Name	Distance (m)	Percent	Relative	Absolute	Relative	Value
Sagittaria kurziana	Strap-leaf sagittaria	39.2	24.6	31.0	0.50	19.0	25.0
Algae	Algae	28.4	17.8	22.5	0.46	17.5	20.0
Hydrilla verticillata	Hydrilla	21.0	13.1	16.6	0.58	22.1	19.3
Vallisneria americana	Tape grass	25.6	16.1	20.3	0.42	16.0	18.1
Najas guadalupensis	Southern naiad	8.87	5.55	7.01	0.25	9.51	8.26
Lemna minor	Duckweed	2.99	1.87	2.36	0.08	3.04	2.70
Ceratophyllum demersum	Coontail	0.19	0.12	0.15	0.13	4.94	2.55
Paspalum distichum	Knot grass	0.18	0.11	0.14	0.13	4.94	2.54
Hydrocotyle sp.	Penny-wort	0.01	0.01	0.01	0.04	1.52	0.77
Pistia stratiotes	Water lettuce	0.01	0.01	0.01	0.04	1.52	0.77
Total		**126.0**	**79.2**	**100.0**	**2.63**	**100.0**	**100.0**

Table 8. Rainbow River aquatic vegetation transect importance value summary by station (August 2015)

Scientific Name	Common Name	RSR-1	RSR-5	RSR-10
Algae	Algae	13.0	13.7	44.6
Ceratophyllum demersum	Coontail	6.2	---	---
Hydrilla verticillata	Hydrilla	4.0	24.5	36.4
Hydrocotyle sp.	Penny-wort	2.0	---	---
Lemna minor	Duckweed	4.0		6.6
Najas guadalupensis	Southern naiad	2.5	12.9	8.6
Paspalum distichum	Knot grass	6.2	---	---
Pistia stratiotes	Water lettuce	---	---	3.9
Sagittaria kurziana	Strap-leaf sagittaria	30.5	33.2	---
Vallisneria americana	Tape grass	31.6	15.8	---
Total		**100.0**	**100.0**	**100.0**

Table 9. Rainbow River aquatic vegetation transect percent cover summary by station (August 2015)

Scientific Name	Common Name	RSR-1	RSR-5	RSR-10
Algae	Algae	12.7	16.8	22.4
Ceratophyllum demersum	Coontail	0.44	---	---
Hydrilla verticillata	Hydrilla	3.52	18.4	15.1
Hydrocotyle sp.	Penny-wort	0.02	---	---
Lemna minor	Duckweed	3.52	---	2.4
Najas guadalupensis	Southern naiad	0.85	10.7	4.2
Paspalum distichum	Knot grass	0.42	---	---
Pistia stratiotes	Water lettuce	---	---	0.02
Sagittaria kurziana	Strap-leaf sagittaria	37.1	41.8	---
Vallisneria americana	Tape grass	31.9	21.4	---
Total		**90.4**	**109.1**	**44.1**

Aquatic vegetation has been surveyed in the entire Rainbow River (203 ac sampling area) since 1991 and was summarized in the Rainbow Springs Restoration Action Plan (WSI/FSI 2013). Findings from the 2011 survey identified strap-leaved sagittaria, hydrilla, tape grass, and southern naiad as the most common vascular plant species in the Rainbow River. The percent coverage of aquatic vegetation decreased by 22 percent (28 ac) between 1996 (131 ac) and 2011 (102 ac) while exposed bare substrate increased by 161% (28 ac) for the same period. Benthic algae were observed to have nearly 60% coverage along the river with epiphytic algae having 27% coverage. The total submerged aquatic vegetation coverage from the 2011 survey of the entire Rainbow River was approximately 50% (102 ac), slightly lower than the 59% measured in the study area.

3.2.2 General Faunal Observations

Along the spring run and upland areas, there was a total of 72 bird species observed (47 species in September 2015; 60 species in February 2016) [Figure 25]. The most commonly occurring species were the tree swallow, yellow-rumped warbler, wood duck, turkey vulture, anhinga, and northern cardinal. Detailed bird survey data are provided in Appendix E.

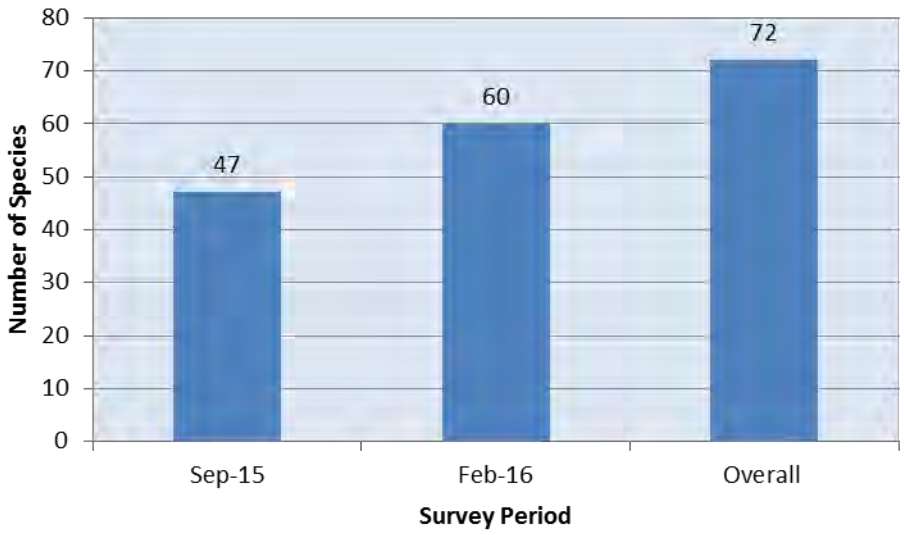


Figure 25. Rainbow River bird survey summary for 2015-2016

3.2.3 Adult Aquatic Insects

Table 10 presents a summary of adult aquatic insect emergence rates from the Rainbow River spring run study segment. Insect emergence rates averaged 80 organisms/m^2/d and 51 organisms/m^2/d in September 2015 and February 2015, respectively. This equates to approximately 7,071,350 organisms/day over the study segment area on average. The most commonly collected insects were non-biting midges (Diptera), with 90% of the sample belonging to this family.

Figure 26 provides a summary of estimated adult aquatic insect emergence rates compared with other Florida spring run systems studied using the same emergent trap technique, including results from Rainbow Springs in 2009 (WSI 2010). The Rainbow River study segment had a greater estimated emergence rate than eight of the other springs studied.

Table 10. Rainbow River adult aquatic insect emergence rates

Order	Suborder	Family	Deployment Date					
			8/31/15	9/9/15	Avg	2/8/16	2/17/16	Avg
Dermapotera	-	-		1	0.5			0
Diptera	Brachyera	Ephydridae	4		2			0
		Stratiomyidae		2	1			0
	Nematocera	Ceratopogonidae	1	3	2			0
		Chironomidae	205	443	324	484	125	305
		Tipulidae	2		1			0
Ephemeroptera	-	-	1	1	1		1	0.5
Hemiptera	Heteroptera	Veliidae	3		1.5			0
Lepidoptera	Glossata	Pyralidae			0	3	3	3
Odonata	Anisoptera	-			0	2	1	1.5
	Zygoptera	-			0		1	0.5
Trichoptera	-	-	24	4	14	101	2	52
Total			**240**	**454**	**347**	**590**	**133**	**362**
Emergence Rate (#/m^2/d)			**55**	**105**	**80**	**73**	**28**	**51**

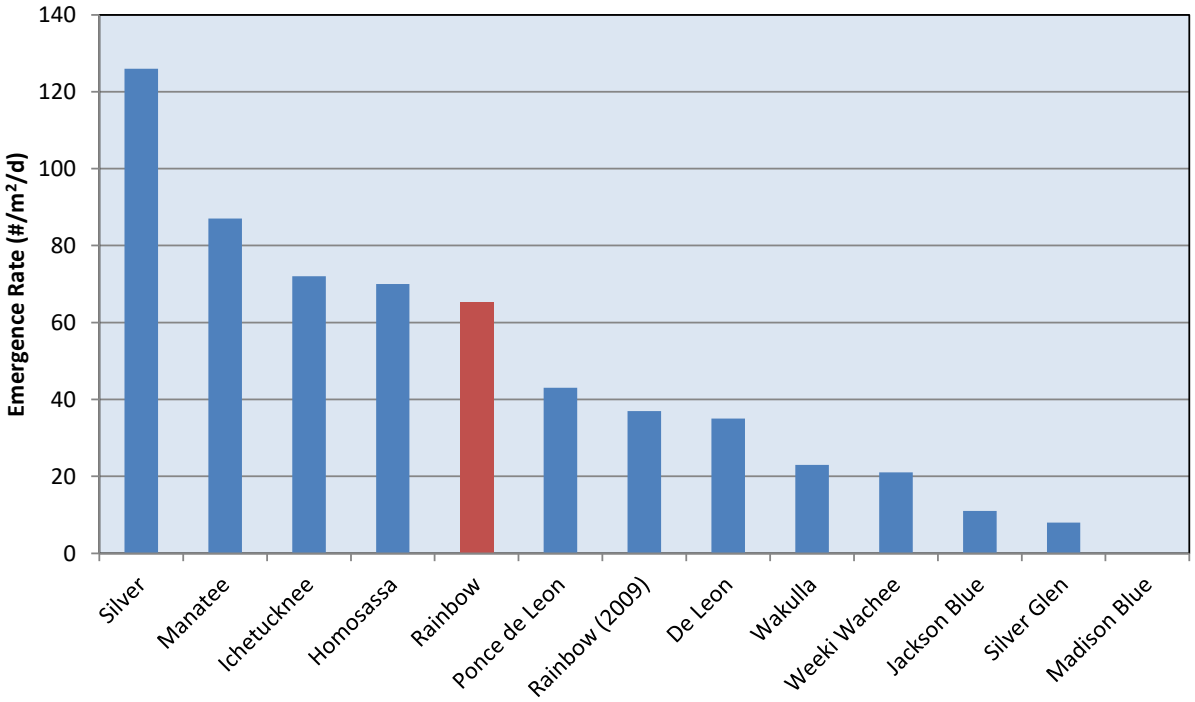


Figure 26. Rainbow River adult aquatic insect emergence rates compared to other Florida spring runs

3.2.4 Snails

Table 11 provides a summary of Florida apple snail egg counts conducted in August 2015 by segment (Figure 2). A total of 283 egg clutches were observed, averaging 18 eggs/clutch (4,997 eggs or 1.6 eggs/meter of shoreline). No apple snail eggs were observed during the February 2016 monitoring period.

Table 11. Rainbow River apple snail egg count – August 2015

Segment	West Side			East Side			Totals		
	# Egg Masses	# Eggs	Eggs/ Mass	# Egg Masses	# Eggs	Eggs/ Mass	# Egg Masses	# Eggs	Eggs/ Mass
1	3	50	17	0	0	0	3	50	17
2	16	204	13	0	0	0	16	204	13
3-6	28	637	23	52	925	18	80	1,562	20
7	8	117	15	14	178	13	22	295	13
8	12	242	20	15	170	11	27	412	15
9	46	952	21	89	1,522	17	135	2474	18
Totals	**113**	**2,202**	**19**	**170**	**2,795**	**16**	**283**	**4,997**	**18**
Density *	**1.4**			**1.8**			**1.6**		

*Eggs per meter of shoreline

3.2.5 Fish

Table 11 presents the fish survey data from September 2015 and Table 12 presents the fish survey data from February 2016. Detailed fish data are provided in Appendix F. A total of 9 fish species or groups of similar species were observed, with 9 in September 2015 and 7 in February 2016. Fish density in the Rainbow River spring run study segment averaged 258 fish/ac, with 318 fish/ac in September 2015 and 198 fish/ac in February 2016 (Table 14). Sunfish (*Lepomis sp.*), minnows (*Notropis sp.*), largemouth bass (*Micropterus salmoides*), and gizzard shad (*Dorosoma cepedianum*) were observed at the highest densities over the study period. Total estimated fish biomass averaged 71 lbs/ac with 108 lbs/ac in September 2015 and 33 lbs/ac in February 2016. A higher Shannon-Wiener diversity index was observed in September 2015 (H' = 1.86) compared with February 2016 (H' = 1.34).

Estimated fish biomass and population densities were compared with other Florida springs (includes spring boils and spring runs) studied using the same visual count technique, including results from Rainbow Springs in 2009 (WSI 2010). Figure 27 visually displays this comparison of the Rainbow River study segment to other Florida springs. For the study segment, the estimated fish densities were the lowest of the other studied springs. For fish biomass, the Rainbow River study segment had a greater estimated fish biomass than seven of the other springs studied. Fish biomass from this study was similar to those measured in 2009 in Rainbow Spring and the upper spring run, while population densities were lower.

Table 12. Rainbow River fish summary – September 2015

Scientific Name	Common Name	9/2/15 Count	9/2/15 Density (#/ac)	9/2/15 Biomass (lbs/ac)	9/9/15 Count	9/9/15 Density (#/ac)	9/9/15 Biomass (lbs/ac)	Average Count	Average Density (#/ac)	Average Biomass (lbs/ac)
Amia calva	Bowfin	2	0.07	0.352	---	---	---	1	0.04	0.176
Dorosoma cepedianum	Gizzard shad	1,664	60.4	118	346	12.6	24.5	1,005	36.5	71.2
Erimyzon sucetta	Lake Chubsucker	21	0.76	2.25	---	---	---	11	0.38	1.12
Fundulus sp.	Killifish sp.	102	3.71	0.085	135	4.90	0.112	119	4.30	0.099
Lepisosteus platyrhincus	Florida Gar	36	1.31	11.5	6	0.22	1.92	21	0.76	6.71
Lepomis sp.	Sunfish sp.	6,344	230	23.8	2,544	92.4	11.2	4,444	161	17.5
Micropterus salmoides	Largemouth Bass	1,125	40.9	7.13	441	16.0	13.5	783	28.4	10.3
Notropis sp.	Minnows	2,699	98.0	0.356	1,875	68.1	0.248	2,287	83.1	0.302
Strongylura marina	Atlantic Needlefish	57	2.07	0.332	114	4.14	0.664	86	3.11	0.498
Total		**12,050**	**438**	**164**	**5,461**	**198**	**52.2**	**8,756**	**318**	**108**

Survey Area: 27.5 ac

Table 13. Rainbow River fish summary – February 2016

Scientific Name	Common Name	Count	Density (#/ac)	Biomass (lbs/ac)
Erimyzon sucetta	Lake Chubsucker	7	0.25	0.749
Fundulus sp.	Killifish sp.	229	8.32	0.190
Lepisosteus platyrhincus	Florida Gar	32	1.16	10.2
Lepomis sp.	Sunfish sp.	3,860	140	18.6
Micropterus salmoides	Largemouth Bass	546	19.8	3.46
Notropis sp.	Minnows	774	28.1	0.102
Strongylura marina	Atlantic Needlefish	13	0.47	0.076
Total		**5,461**	**198**	**33.4**

Survey Area: 27.5 ac

Table 14. Rainbow River fish summary

		Density (#/ac)			Biomass (lbs/ac)		
Scientific Name	**Common Name**	**Sep-15**	**Feb-16**	**Average**	**Sep-15**	**Feb-16**	**Average**
Amia calva	Bowfin	0.036	0.00	0.018	0.176	0.00	0.088
Dorosoma cepedianum	Gizzard shad	36.5	0.00	18.3	71.2	0.00	35.6
Erimyzon sucetta	Lake Chubsucker	0.381	0.254	0.318	1.12	0.749	0.94
Fundulus sp.	Killifish sp.	4.3	8.3	6.3	0.099	0.190	0.145
Lepisosteus platyrhincus	Florida Gar	0.76	1.16	0.96	6.71	10.2	8.47
Lepomis sp.	Sunfish sp.	161	140	151	17.5	18.6	18.1
Micropterus salmoides	Largemouth Bass	28.4	19.8	24.1	10.3	3.46	6.89
Notropis sp.	Minnows	83	28.1	56	0.302	0.102	0.202
Strongylura marina	Atlantic Needlefish	3.11	0.47	1.79	0.498	0.076	0.287
Total		**318**	**198**	**258**	**108**	**33.4**	**70.7**

Survey Area: 27.5 ac

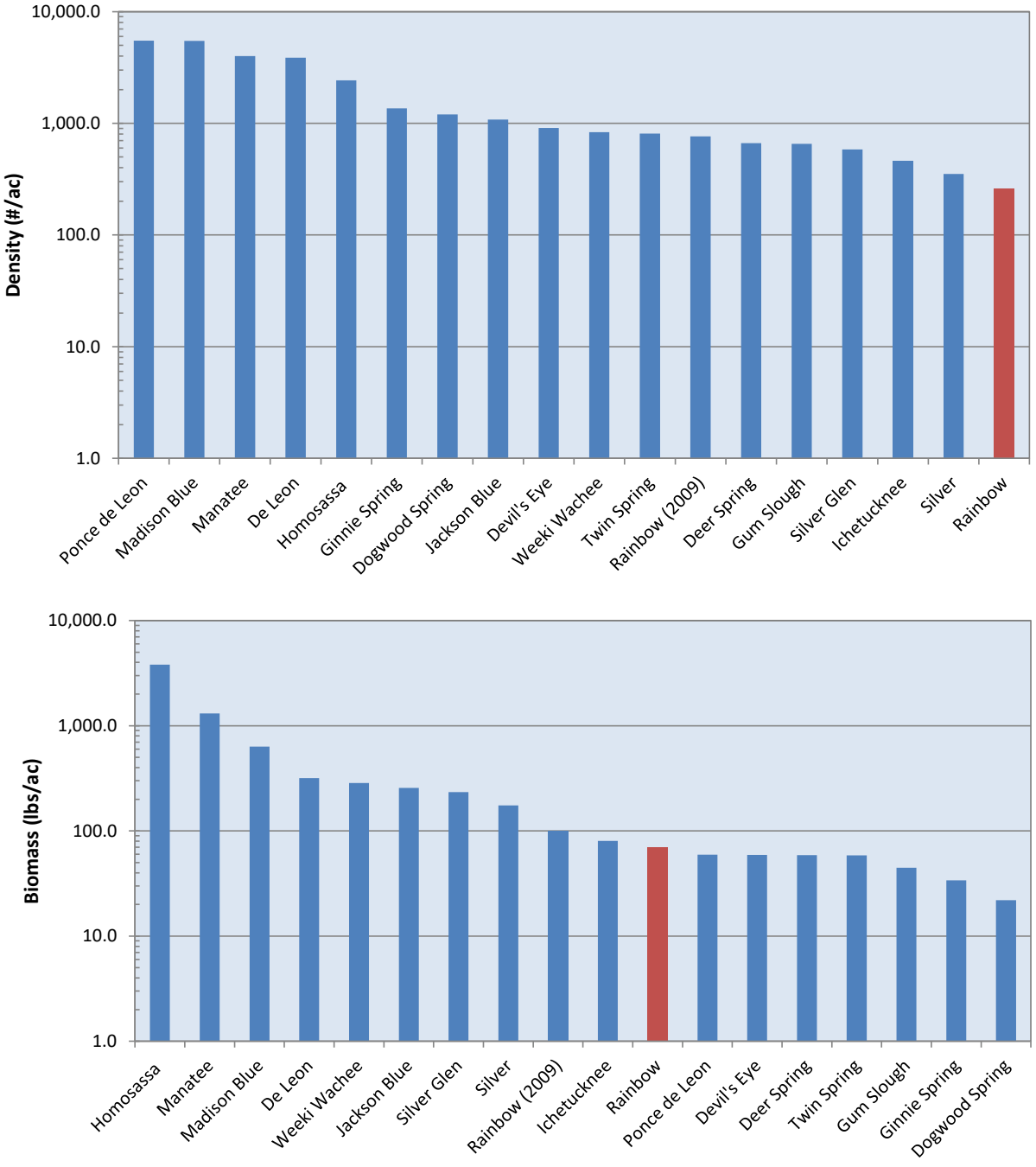


Figure 27. Rainbow River fish density and biomass compared to other Florida springs

3.2.6 Turtles

In September 2015, a total of 5 species and 134 individual turtles were captured, while 6 species and 155 individuals were captured in February 2016 (Table 15). The loggerhead musk (*Sternotherus minor*) and Suwannee cooter (*Pseudemys cocinna*) were the most common for both surveys. This resulted in a turtle population density of 6.1 and 7.1 turtles/ac for this section of the spring run in September 2015 and February 2016, respectively. Detailed capture data are provided in Appendix G.

Table 15. Rainbow River turtle summary – September 2015 and February 2016

Common Name	Scientific Name	Juvenile	Female	Male	Unknown	Total
September 2015						
Florida Softshell Turtle	*Apalone ferox*			1		1
Loggerhead Musk Turtle	*Sternotherus minor minor*	29	22	36	2	89
Peninsular Cooter	*Pseudemys floridana*		1	6		7
Stinkpot	*Sternotherus odoratus*		1	1		2
Suwannee Cooter	*Pseudemys cocinna*	7	14	14		35
Total		**36**	**38**	**58**	**2**	**134**
Density (#/ac)		**1.65**	**1.74**	**2.66**	**0.09**	**6.15**
February 2016						
Florida Redbelly Cooter	*Pseudemys nelsoni*		1	2		3
Florida Snapping Turtle	*Chelydra serpentina osceola*				1	1
Loggerhead Musk Turtle	*Sternotherus minor minor*	15	15	64		94
Peninsular Cooter	*Pseudemys floridana*		5	3		8
Suwannee Cooter	*Pseudemys cocinna*	2	23	23		48
Unknown					1	1
Total		**17**	**44**	**92**	**2**	**155**
Density (#/ac)		**0.78**	**2.02**	**4.22**	**0.09**	**7.11**

Survey area: 21.8 ac

3.2.7 Human Use

Figure 28 and Figure 29 provide summaries for total in-water and out-of-water activities, while detailed activities are summarized in Appendix H. Rainbow River is utilized for recreation through the Rainbow Springs State Park and KP Hole Park (Marion Co.) as a tube, canoe and kayak rental site as well as a boat launch point.

Based on these results, it is clear that this area of the spring run received higher levels of human activity during the warmer season (September 2015), particularly during the weekend survey periods. In September 2015, in-water activities averaged 1.2 people/ac during the weekday and 17 people/ac during the weekend survey (Figure 28), with tubing, canoe/kayaking, and power

boating being the most common activities. In February 2016, in-water activities only averaged less than 1 person/ac during weekdays and 2.4 people/ac during the weekend (

Figure 29), with power boating and canoeing/kayaking being the most common.

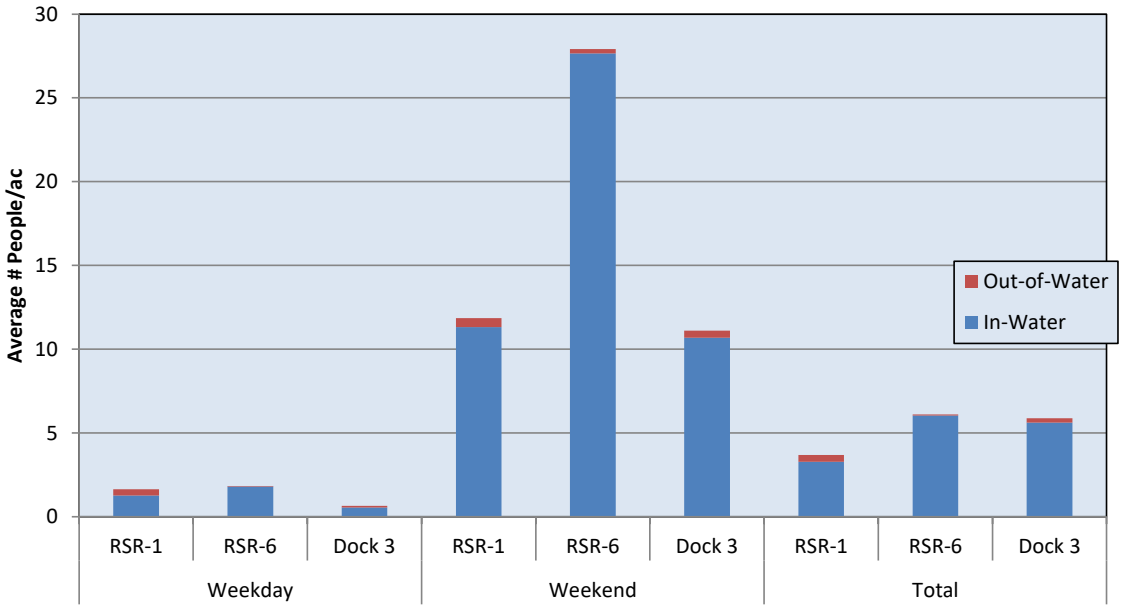


Figure 28. Rainbow River human use summary – August/September 2015

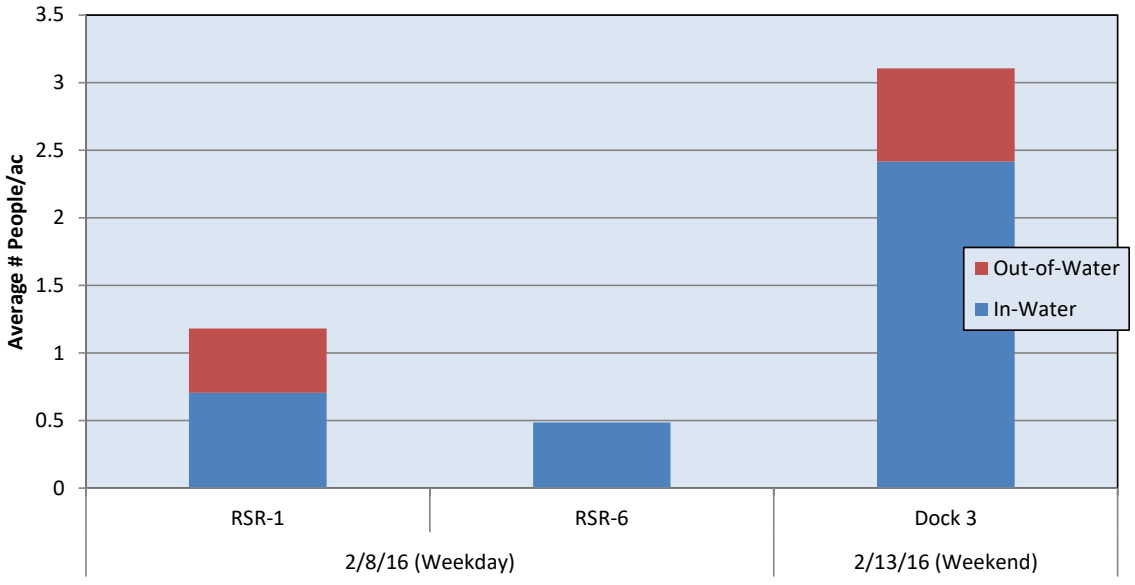


Figure 29. Rainbow River human use summary – February 2016

3.3 Ecosystem Level Monitoring

3.3.1 Ecosystem Metabolism

Table 16 provides a summary of ecosystem metabolism parameters collected in the study segment with detailed results in Appendix I. Average GPP ranged from 12.97 g $O_2/m^2/d$ (September 2015) to 10.73 g $O_2/m^2/d$ (February 2016) over the study period. CR ranged from 13.80 g $O_2/m^2/d$ (September 2015) to 9.33 g $O_2/m^2/d$ (February 2016), resulting in an average NPP of -0.81 g $O_2/m^2/d$ in September 2015, to +1.45 g $O_2/m^2/d$ in February 2016. For these data the estimated P/R ratio ranged from 0.94 (September 2015) to 1.16 (February 2016), and the photosynthetic efficiency ranged was from 5.35% (or 0.66 g O_2/mol) in September 2015, to 3.62% (or 0.45 g O_2/mol) in February 2016.

Ecosystem metabolism estimates from the study segment were compared to similar data from other Florida springs that have previously been studied (Figure 30). This comparison indicates that the study segment has a high GPP compared to other spring systems and similar values for NPP and CR. When normalized for the amount of incident solar radiation, the study segment was found to have a photosynthetic efficiency a little below average for Florida springs during February 2016 and above average during September 2015.

Figure 31 and Figure 32 shows the existing data relating photosynthetic efficiency, spring discharge, and NOx-N concentration for the studied Florida spring systems. The study segment follows the same general relationship observed for other springs. In general, spring photosynthetic efficiency increases with increasing spring discharge (Figure 31), while NOx-N concentration may have a subsidy-stress effect on photosynthetic efficiency (Figure 32).

Table 16. Rainbow River ecosystem metabolism estimates

Stats	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)
September 1 – 11, 2015							
Avg	12.97	-0.81	13.80	0.94	20.62	5.35	0.66
Max	14.47	0.62	14.06	1.04	27.21	8.04	1.00
Min	10.82	-2.96	13.33	0.79	10.86	3.75	0.46
February 8 – 19, 2016							
Avg	10.73	1.45	9.33	1.16	25.19	3.62	0.45
Max	11.76	2.41	9.98	1.26	28.88	6.53	0.81
Min	9.40	-0.36	8.08	0.96	11.63	2.91	0.36

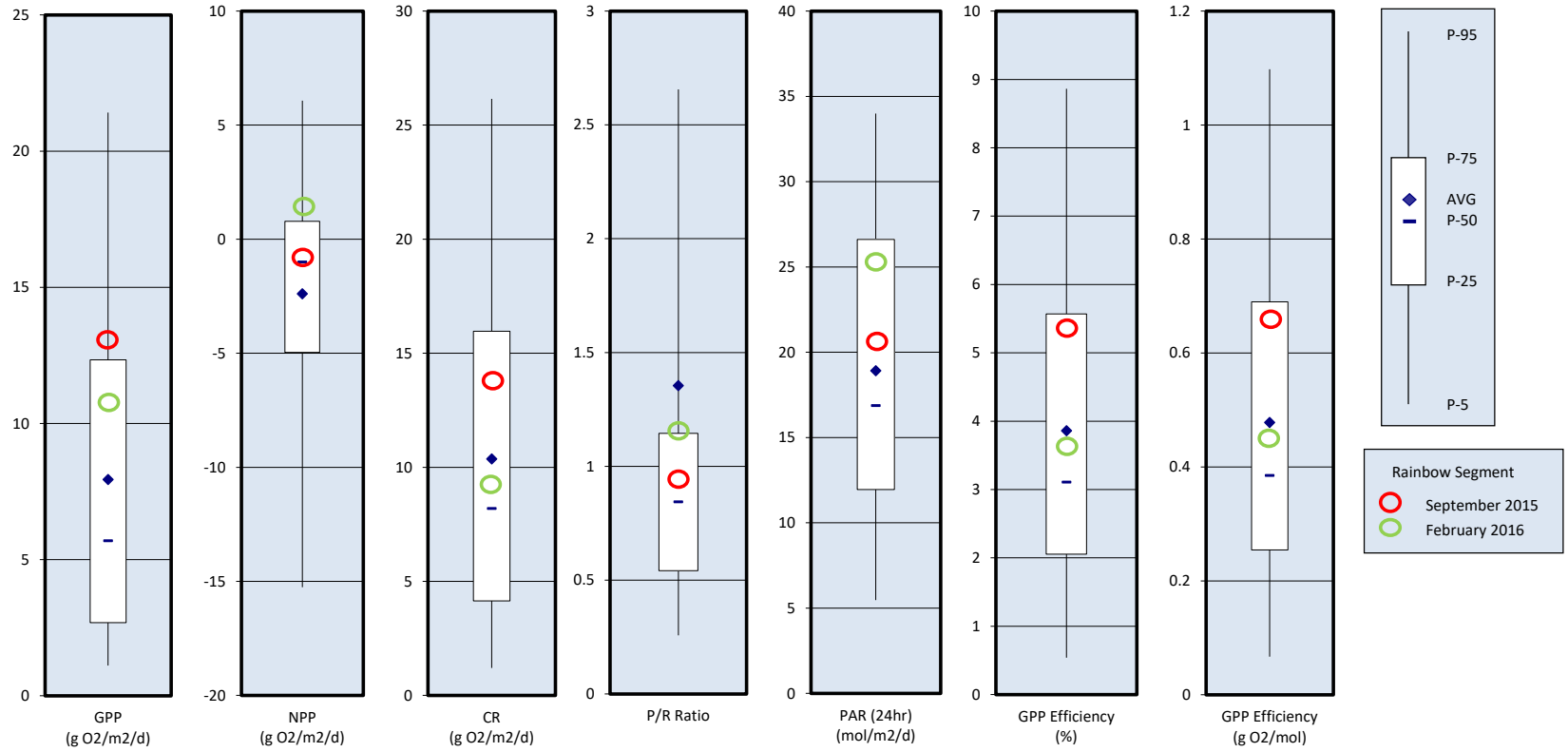


Figure 30. Comparison of ecosystem productivity and photosynthetic efficiency in Florida springs (based on historic data from 22 Florida springs). Recent data for the Rainbow River study segment are shown for comparison as bright circles.

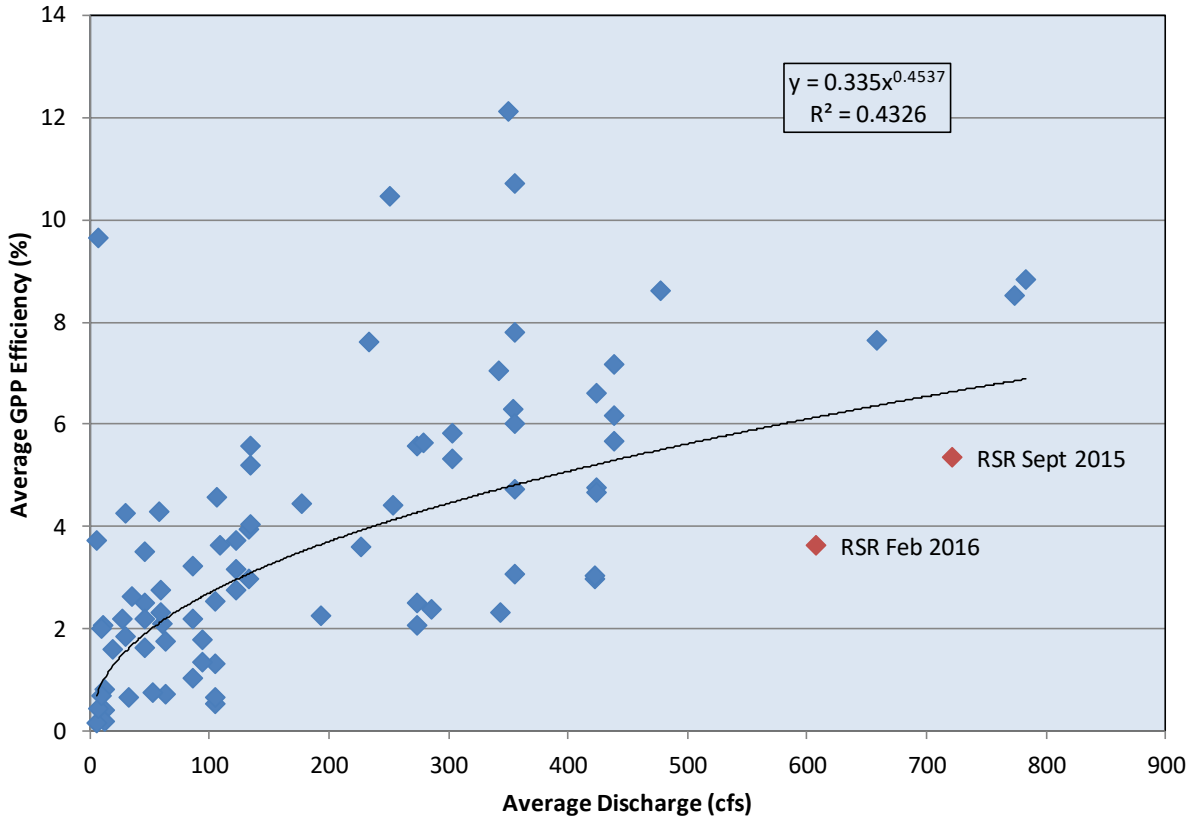


Figure 31. Gross primary productivity efficiency versus discharge in Florida springs (based on historic data from 22 Florida springs). Recent data from the Rainbow study segment are shown with red diamonds.

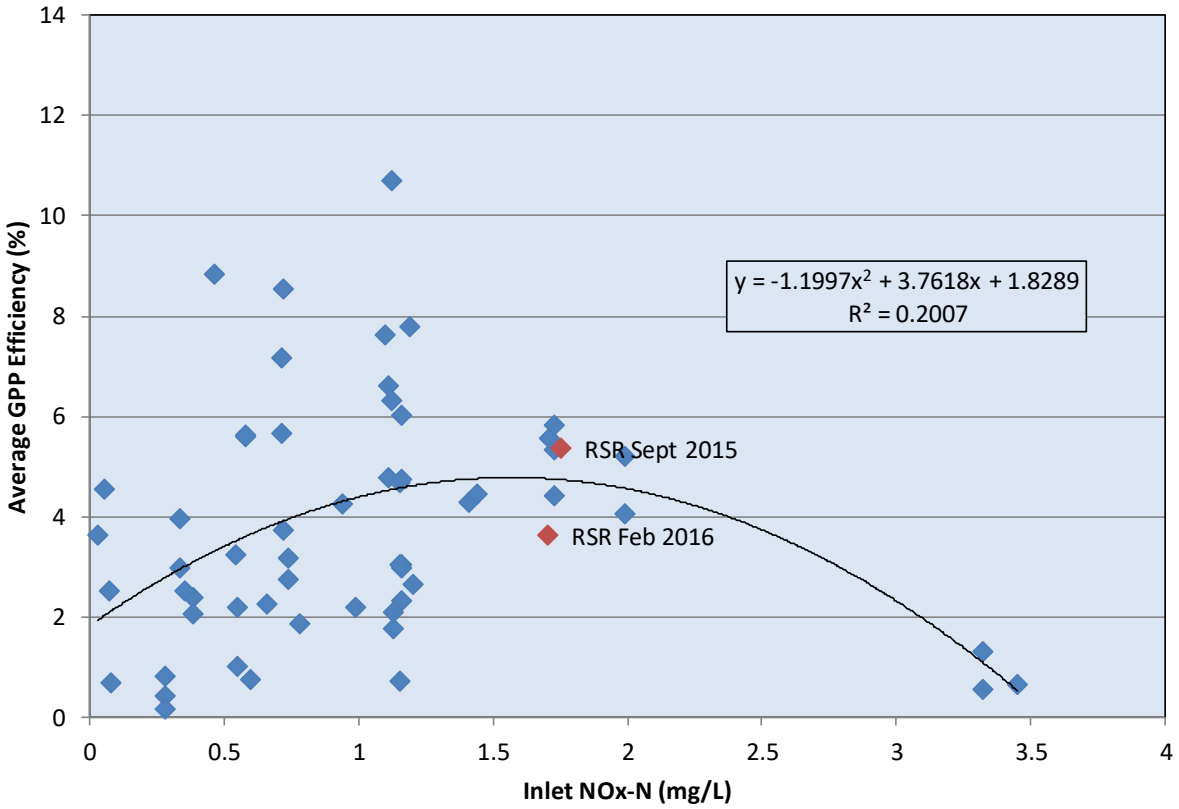


Figure 32. Gross primary productivity efficiency versus NOx-N concentration in Florida springs (based on historic and recent data from 22 Florida springs)

3.3.2 Nutrient Assimilation

Figure 33 provides a summary of the average mass removals in the study segment with details provided in Appendix J. The mass of TN was reduced by an average of 13.3 lbs/ac/d within the study segment with OrgN and NOx-N being the dominant fractions (11.1 and 3.6 lbs/ac/d, respectively). The mass of NH_4-N slightly increased within the study segment (-1.1 lbs/ac/d).

Nutrient mass removal data from the study segment were compared to other Florida springs runs as shown Figure 34. This comparison indicates that the study segment mass removal rates are within ranges observed in other Florida springs. Downstream increases in NOx-N mass occurred at Rainbow (2009) unlike results from this study. This increase was presumably due to the location of the Rainbow (2009) study area, at the upper Rainbow Spring run, where inputs of additional nitrate-rich water occur from the multiple spring vents in that spring run.

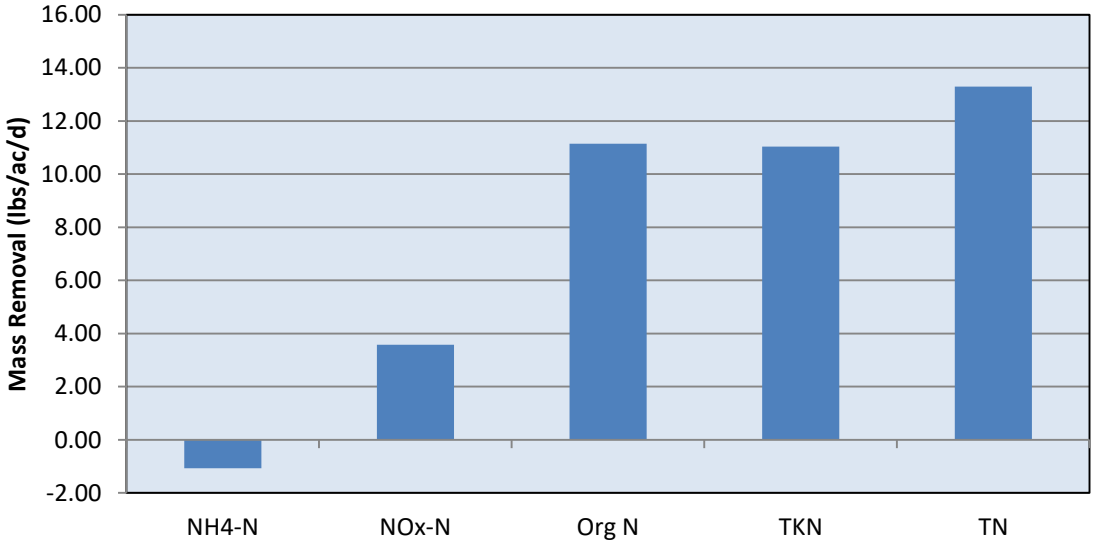


Figure 33. Rainbow River estimated nutrient mass removals

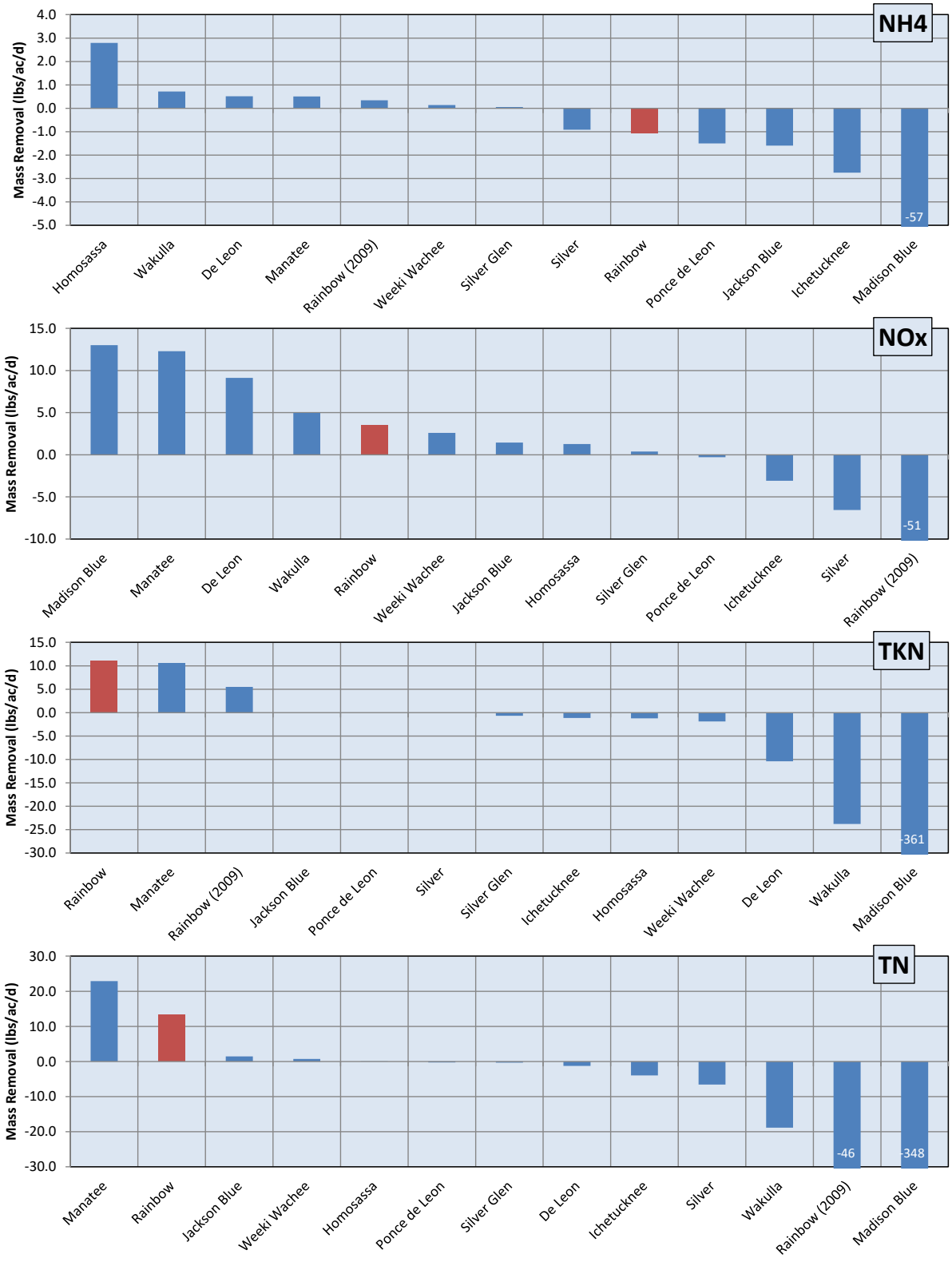


Figure 34. Nutrient mass removals for Florida spring runs

3.3.3 Community Export

Community export data for the study segment are summarized in Table 17 with detailed data provided in Appendix K. Segment particulate organic matter export rates varied widely. Positive values indicate a net production of detrital material (material leaving the study segment), while negative values indicate a net accrual of detrital material (material being deposited in the study segment). For September 2015, organic matter export rates were positive for the first event (0.132 g/m^2/d) and negative for the second event (-0.099 g/m^2/d). Estimated net organic matter export rates were negative for both February 2016 sampling events (-0.069 and -0.250 g/m^2/d).

Particulate organic matter export data from the study segment were compared to other Florida spring runs as shown Figure 35.

Table 17. Rainbow River particulate export

Date	Station	Dry Matter (g/d)	Organic Matter (g/d)	Dry Matter (g/m^2/d)	Organic Matter (g/m^2/d)
9/2/15	RSR-1	82,299	30,026	0.434	0.158
	RSR-10	247,872	87,161	0.826	0.291
	Segment	165,573	57,135	0.393	0.132
9/9/15	RSR-1	204,254	60,599	1.076	0.319
	RSR-10	192,246	66,129	0.641	0.220
	Segment	-12,008	5,530	-0.435	-0.099
2/8/16	RSR-1	168,796	70,547	0.889	0.372
	RSR-10	229,709	90,728	0.766	0.302
	Segment	60,913	20,181	-0.124	-0.069
2/19/16	RSR-1	406,359	126,671	2.141	0.667
	RSR-10	442,518	125,291	1.475	0.418
	Segment	36,159	-1,380	-0.666	-0.250

Segment Areas: Head Spring to RSR-1 (189,785 m^2); Head Spring to RSR-10 (300,000 m^2); RSR-1 to RSR-10 (110,214 m^2)

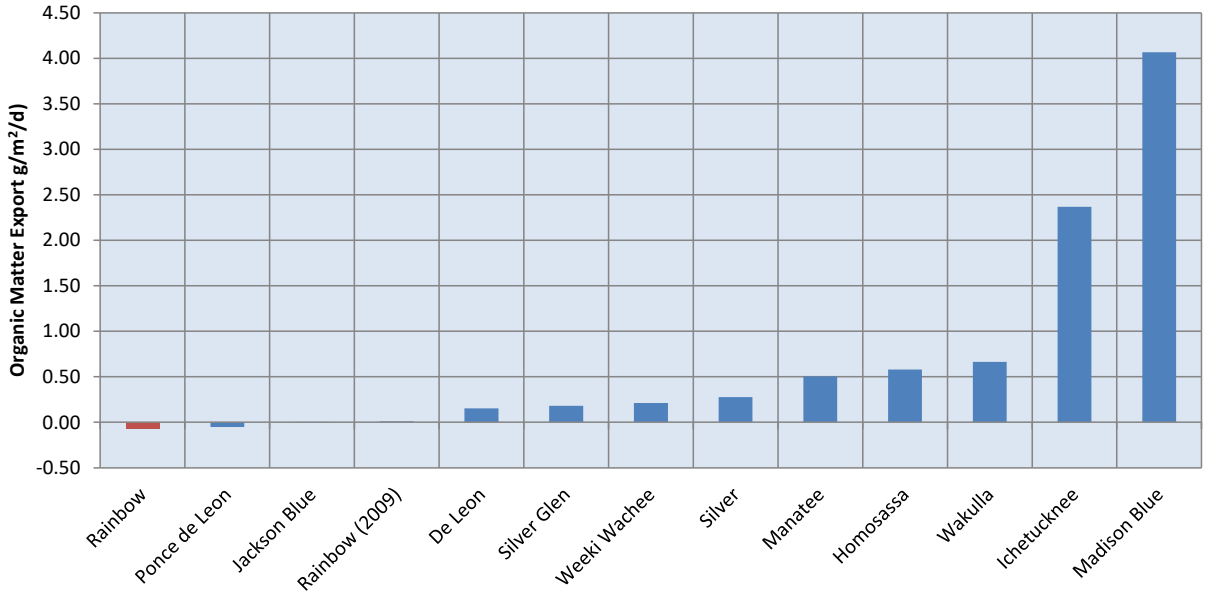


Figure 35. Particulate organic material export in Florida spring runs

Section 4.0 Discussion

4.1 Overview

The Rainbow Springs and River are one of the most polluted and impacted spring systems in the state of Florida (WSI/FSI 2013). Nitrate levels continue to rise in the feeder springs, apparently due to increasing nitrogen loads from fertilizers and septic tanks in the large springs recharge basin. Average spring flows continue to decline in response to increased groundwater pumping and a declining trend in average rainfall throughout North and Central Florida. Human use is increasing yearly and direct impacts to the spring run plant communities due to tubing, swimming, and pleasure boating are evident.

The Rainbow River spring run baseline study segment was about one mile in length, had a wetted surface area of about 26.8 ac, a water volume of about 98 ac-ft, and an average water depth of 3.6 ft. The 2015/2016 monitoring data reported during this baseline study from the Rainbow River indicate that this segment is impaired in several respects, but retains a relatively healthy ecological structure compared to other spring runs. Average flows in the Rainbow River have been declining since the 1960s. The baseline flows averaged 605 cfs compared to a period-of-record average flow of 676 cfs (an 11% decline). Dissolved oxygen concentrations in the Rainbow River were always above 5 mg/L, pH varies around 7.8 standard units, temperature between 22 and 23 ^{o}C in summer and winter, and specific conductance varies around 290 uS.

Nitrate+nitrite nitrogen concentrations at the springs feeding the Rainbow River average more than 2.2 mg/L, about 28 times higher than background levels of this nutrient (about 0.08 mg/L) and more than six times higher than the Florida numeric springs standard of 0.35 mg/L. These nitrate nitrogen concentrations are higher than concentrations in about 89% of Florida's springs. The Rainbow River ecosystem naturally attenuates some of this excessive nitrate+nitrite nitrogen, resulting in an average concentration of about 1.75 in the study reach. Little additional nitrate+nitrite assimilation was measured in the study segment (about 96 lbs/d).

Based on the results of other Florida spring studies, declining flow and elevated nitrogen are often associated with ecological changes. The Rainbow River baseline study segment with higher spring inflows and higher levels of nitrogen contamination than other springs, has a relatively high natural cover of submerged aquatic plants (about 61%), but also a significant cover (18%) of filamentous algae. Five species of submerged aquatic vascular plants were relatively common in this study reach and were dominated by sagittaria, hydrilla, and eelgrass. This plant community supports moderate to low levels of aquatic insects, snails, fish, turtles, and mammals. Gross ecosystem primary productivity was relatively high (about 12 g/O_2/m^2/d), as was community respiration (about 12 g/O_2/m^2/d), resulting in a photosynthetic quotient equal to 1.0, and no measurable net production. Photosynthetic efficiency of this plant community was above average, but low in proportion to the river's discharge. This result indicates the river is impaired and does not measure up to expected ecological function. Human use of the Rainbow River is highest on spring weekends and generally much lower during week days and during colder months.

In spite of this human-induced pollution and depletion, the Rainbow Springs Ecosystem continues to be one of the most resilient springs studied by the Florida Springs Institute. Plant community structure and function continue to be high compared to many other springs, and fish and turtle populations are fairly diverse and healthy. Other springs subjected to lower nitrate nitrogen concentrations, similar flow reductions, and comparable human use pressures have lost their native plant communities, their fish and many of their turtles, and have greatly reduced primary productivity. In other words, they are in a state of near or actual ecosystem collapse.

It has been speculated that the resilience to harm documented at Rainbow Springs is due to at least two factors, possibly in this order, the naturally high DO of the source groundwater and the relatively high flow of this system (Knight 2015). High DO apparently provides a considerable buffer that lessens the effects of other stressors affecting springs. Since all of the most important plants and animals that occur in springs are dependent on adequate DO in the sediments and in the water column, it is interesting how springs with relatively higher DO, such as Rainbow, Jackson Blue, Ichetucknee, and Silver, have managed to retain some of their natural vascular plant diversity and cover.

4.2 Rainbow Springs Updated Report Card

The updated 2016 Rainbow Springs report card is presented in Figure 36 with detailed data provided in Appendix L. The impaired ecology of the Rainbow Springs System is indicated by a lower-than-average ecosystem health grade using this quantitative approach.

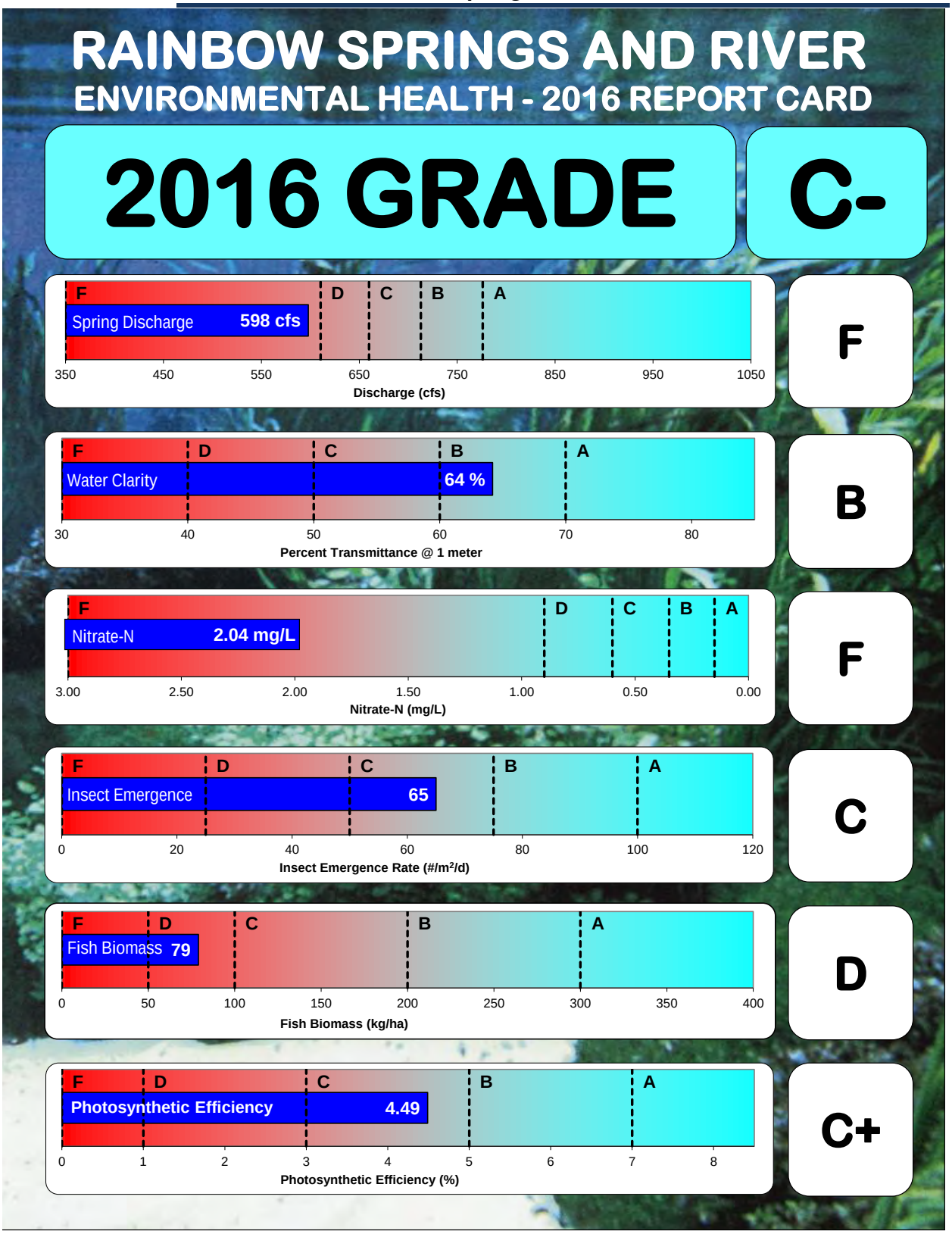


Figure 36. Rainbow Springs 2016 Report Card

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Appendix A

PAR Attenuation Estimates

Site	Stn	Date	Time	Rep	Depth (m) z	corr Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	k (diffuse attenuation coefficient = slope, m-1) k (m-1)	Percent Transmittance (1m)	Birgean Percentile Absorption (1m)	Flag
RSR	RSR-1	8/31/2015	9:50	1	Air	328.4	328.4				0.476	62.15	37.85	
					0.03	328.4	296.7	5.69						
					0.15	328.4	220.5	5.40	0.398	2.614				
					0.30	328.4	210.1	5.35	0.447	1.465				
					0.61	328.4	174.3	5.16	0.634	1.039				
					0.91	328.4	154.9	5.04	0.752	0.822				
					1.22	328.4	133.9	4.90	0.897	0.736				
RSR	RSR-1	8/31/2015	9:58	2	Air	207.0	207.0				0.445	64.08	35.92	
					0.03	207.0	228.6	5.43						
					0.15	207.0	204.4	5.32	0.013	0.083				
					0.30	207.0	199.1	5.29	0.039	0.128				
					0.61	207.0	174.0	5.16	0.174	0.285				
					0.91	207.0	147.4	4.99	0.340	0.372				
					1.22	207.0	129.8	4.87	0.467	0.383				
RSR	RSR-5	8/31/2015	10:23	1	Air	391.6	391.6				0.531	58.83	41.17	
					0.03	391.6	340.3	5.83						
					0.15	391.6	312.2	5.74	0.227	1.487				
					0.30	391.6	280.4	5.64	0.334	1.096				
					0.61	391.6	248.4	5.52	0.455	0.747				
					0.91	391.6	205.1	5.32	0.647	0.707				
RSR	RSR-5	8/31/2015	10:31	2	Air	415.8	415.8				0.297	74.27	25.73	
					0.03	415.8	273.8	5.61						
					0.15	415.8	296.2	5.69	0.339	2.226				
					0.30	415.8	287.6	5.66	0.369	1.209				
					0.61	415.8	257.5	5.55	0.479	0.786				
					0.91	415.8	238.1	5.47	0.558	0.610				
RSR	RSR-10	8/31/2015	10:51	1	Air	608.9	608.9				0.206	81.34	18.66	
					0.03	608.9	591.6	6.38						
					0.15	608.9	546.6	6.30	0.108	0.708				
					0.30	608.9	520.2	6.25	0.157	0.517				
					0.61	608.9	477.7	6.17	0.243	0.398				
					0.91	608.9	458.6	6.13	0.283	0.310				
					1.22	608.9	436.8	6.08	0.332	0.272				
RSR	RSR-10	8/31/2015	10:59	2	Air	795.7	795.7				0.457	63.34	36.66	
					0.03	795.7	600.8	6.40						
					0.15	795.7	753.5	6.62	0.054	0.358				
					0.30	795.7	759.9	6.63	0.046	0.151				
					0.61	795.7	661.9	6.50	0.184	0.302				
					0.91	795.7	555.2	6.32	0.360	0.394				
					1.22	795.7	476.6	6.17	0.513	0.420				
RSR	RSR-1	8/31/2015	11:35	1	Air	760.2	760.2				0.420	65.69	34.31	
					0.03	760.2	648.5	6.47						
					0.15	760.2	589.4	6.38	0.254	1.670				
					0.30	760.2	559.8	6.33	0.306	1.004				
					0.61	760.2	487.0	6.19	0.445	0.731				
					0.91	760.2	430.2	6.06	0.569	0.623				
RSR	RSR-1	8/31/2015	11:42	2	Air	788.6	788.6				0.219	80.32	19.68	
					0.03	788.6	594.6	6.39						
					0.15	788.6	434.1	6.07	0.597	3.917				
					0.30	788.6	461.5	6.13	0.536	1.758				
					0.61	788.6	434.2	6.07	0.597	0.979				
					0.91	788.6	373.1	5.92	0.748	0.818				
RSR	RSR-1	9/2/2015	10:18	1	Air	428.0	428.0				0.383	68.21	31.79	
					0.03	428.0	426.4	6.06						
					0.15	428.0	418.1	6.04	0.023	0.154				
					0.30	428.0	320.1	5.77	0.290	0.953				
					0.61	428.0	305.2	5.72	0.338	0.555				
					0.91	428.0	276.4	5.62	0.437	0.478				
					1.22	428.0	259.1	5.56	0.502	0.412				

Site	Stn	Date	Time	Rep	Depth (m) z	corr Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	k (diffuse attenuation coefficient = slope, m-1) k (m-1)	Percent Transmittance (1m)	Birgean Percentile Absorption (1m)	Flag
RSR	RSR-1	9/2/2015	10:24	2	Air	448.9	448.9				0.338	71.30	28.70	
					0.03	448.9	400.5	5.99						
					0.15	448.9	361.6	5.89	0.216	1.419				
					0.30	448.9	323.9	5.78	0.326	1.071				
					0.61	448.9	298.7	5.70	0.407	0.668				
					0.91	448.9	261.8	5.57	0.539	0.590				
					1.22	448.9	250.8	5.52	0.582	0.477				
RSR	RSR-5	9/2/2015	10:36	1	Air	950.2	950.2				0.486	61.50	38.50	
					0.03	950.2	841.2	6.73						
					0.15	950.2	830.4	6.72	0.135	0.884				
					0.30	950.2	688.4	6.53	0.322	1.057				
					0.61	950.2	642.8	6.47	0.391	0.641				
					0.91	950.2	549.6	6.31	0.547	0.599				
RSR	RSR-5	9/2/2015	10:42	2	Air	674.0	674.0				0.459	63.18	36.82	
					0.03	674.0	651.5	6.48						
					0.15	674.0	663.2	6.50	0.016	0.106				
					0.30	674.0	607.2	6.41	0.104	0.342				
					0.61	674.0	516.3	6.25	0.267	0.437				
					0.91	674.0	468.7	6.15	0.363	0.397				
RSR	RSR-10	9/2/2015	11:02	1	Air	867.7	867.7				0.943	38.96	61.04	
					0.03	867.7	741.0	6.61						
					0.15	867.7	634.2	6.45	0.313	2.057				
					0.30	867.7	615.1	6.42	0.344	1.129				
					0.61	867.7	503.2	6.22	0.545	0.894				
					0.91	867.7	329.5	5.80	0.968	1.059				
					1.22	867.7	242.9	5.49	1.273	1.044				
RSR	RSR-10	9/2/2015	11:07	2	Air	982.7	982.7				0.793	45.27	54.73	
					0.03	982.7	685.4	6.53						
					0.15	982.7	631.1	6.45	0.443	2.906				
					0.30	982.7	635.6	6.45	0.436	1.430				
					0.61	982.7	490.9	6.20	0.694	1.139				
					0.91	982.7	490.5	6.20	0.695	0.760				
					1.22	982.7	248.4	5.52	1.375	1.128				
RSR	RSR-1	9/8/2015	12:03	1	Air	563.5	563.5				0.798	45.04	54.96	
					0.03	563.5	656.1	6.49						
					0.15	563.5	527.7	6.27	0.066	0.431				
					0.30	563.5	511.6	6.24	0.097	0.317				
					0.61	563.5	410.0	6.02	0.318	0.522				
					0.91	563.5	290.4	5.67	0.663	0.725				
RSR	RSR-1	9/8/2015	12:03	2	Air	547.4	547.4				0.335	71.54	28.46	
					0.03	547.4	434.4	6.07						
					0.15	547.4	312.1	5.74	0.562	3.687				
					0.30	547.4	300.0	5.70	0.601	1.973				
					0.61	547.4	266.5	5.59	0.720	1.181				
					0.91	547.4	243.4	5.49	0.810	0.886				
RSR	RSR-5	9/8/2015	12:17	1	Air	781.5	781.5				0.897	40.76	59.24	
					0.03	781.5	786.4	6.67						
					0.15	781.5	772.0	6.65	0.012	0.080				
					0.30	781.5	691.3	6.54	0.123	0.402				
					0.61	781.5	503.3	6.22	0.440	0.722				
					0.91	781.5	396.2	5.98	0.679	0.743				
RSR	RSR-5	9/8/2015	12:17	2	Air	707.9	707.9				0.535	58.58	41.42	
					0.03	707.9	548.7	6.31						
					0.15	707.9	536.3	6.28	0.278	1.822				
					0.30	707.9	522.3	6.26	0.304	0.998				
					0.61	707.9	453.7	6.12	0.445	0.730				
					0.91	707.9	358.2	5.88	0.681	0.745				

Rainbow Springs Baseline Assessment

Site	Stn	Date	Time	Rep	Depth (m) z	corr Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	k (diffuse attenuation coefficient = slope, m-1) k (m-1)	Percent Transmittance (1m)	Birgean Percentile Absorption (1m)	Flag
RSR	RSR-10	9/8/2015	12:33	1	Air	1,007.0	1,007.0				0.660	51.70	48.30	
					0.03	1,007.0	831.1	6.72						
					0.15	1,007.0	672.2	6.51	0.404	2.652				
					0.30	1,007.0	568.3	6.34	0.572	1.877				
					0.61	1,007.0	422.8	6.05	0.868	1.424				
					0.91	1,007.0	428.1	6.06	0.855	0.935				
					1.22	1,007.0	309.5	5.73	1.180	0.968				
RSR	RSR-10	9/8/2015	12:33	2	Air	618.8	618.8				0.812	44.41	55.59	
					0.03	618.8	1,027.8	6.94						
					0.15	618.8	841.1	6.73	-0.307	-2.014				
					0.30	618.8	423.4	6.05	0.379	1.245				
					0.61	618.8	401.6	6.00	0.432	0.709				
					0.91	618.8	430.1	6.06	0.364	0.398				
					1.22	618.8	256.8	5.55	0.879	0.721				
RSR	RSR-1	9/11/2015	9:48	1	Air	1,358.7	1,358.7				0.961	38.24	61.76	
					0.03	1,358.7	982.7	6.89						
					0.15	1,358.7	998.3	6.91	0.308	2.023				
					0.30	1,358.7	917.5	6.82	0.393	1.288				
					0.61	1,358.7	703.4	6.56	0.658	1.080				
					0.91	1,358.7	666.1	6.50	0.713	0.780				
					1.22	1,358.7	319.2	5.77	1.448	1.188				
RSR	RSR-1	9/11/2015	9:48	2	Air	506.0	506.0				0.335	71.54	28.46	X
					0.03	506.0	733.4	6.60						
					0.15	506.0	1,027.4	6.93	-0.708	-4.647				
					0.30	506.0	312.8	5.75	0.481	1.578				
					0.61	506.0	349.3	5.86	0.371	0.608				
					0.91	506.0	476.5	6.17	0.060	0.066				
					1.22	506.0	451.6	6.11	0.114	0.093				
RSR	RSR-5	9/11/2015	10:07	1	Air	714.8	714.8				0.509	60.14	39.86	
					0.03	714.8	419.7	6.04						
					0.15	714.8	411.5	6.02	0.552	3.623				
					0.30	714.8	478.8	6.17	0.401	1.315				
					0.61	714.8	373.4	5.92	0.649	1.065				
					0.91	714.8	298.7	5.70	0.873	0.954				
RSR	RSR-5	9/11/2015	10:07	2	Air	656.9	656.9				0.786	45.55	54.45	
					0.03	656.9	554.2	6.32						
					0.15	656.9	522.4	6.26	0.229	1.503				
					0.30	656.9	448.1	6.11	0.383	1.255				
					0.61	656.9	375.7	5.93	0.559	0.917				
					0.91	656.9	280.3	5.64	0.852	0.931				
RSR	RSR-10	9/11/2015	10:29	1	Air	1,033.4	1,033.4				0.525	59.16	40.84	
					0.03	1,033.4	879.3	6.78						
					0.15	1,033.4	1,027.4	6.93	0.006	0.038				
					0.30	1,033.4	894.1	6.80	0.145	0.475				
					0.61	1,033.4	724.2	6.59	0.356	0.583				
					0.91	1,033.4	596.6	6.39	0.549	0.601				
					1.22	1,033.4	603.6	6.40	0.538	0.441				
RSR	RSR-10	9/11/2015	10:29	2	Air	1,111.7	1,111.7				0.387	67.94	32.06	
					0.03	1,111.7	990.0	6.90						
					0.15	1,111.7	950.5	6.86	0.157	1.028				
					0.30	1,111.7	794.6	6.68	0.336	1.102				
					0.61	1,111.7	643.5	6.47	0.547	0.897				
					0.91	1,111.7	641.3	6.46	0.550	0.602				
					1.22	1,111.7	608.3	6.41	0.603	0.495				
RSR	RSR-1	9/4/2015	9:15	1	Air	296.2	296.2				0.475	62.21	37.79	
					0.03	296.2	263.0	5.57						
					0.15	296.2	222.5	5.40	0.286	1.877				
					0.30	296.2	200.7	5.30	0.389	1.277				
					0.61	296.2	176.0	5.17	0.521	0.854				
					0.91	296.2	153.6	5.03	0.657	0.719				

Site	Stn	Date	Time	Rep	Depth (m) z	corr Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	k (diffuse attenuation coefficient = slope, m-1) k (m-1)	Percent Transmittance (1m)	Birgean Percentile Absorption (1m)	Flag
RSR	RSR-1	9/4/2015	9:15	2	Air	331.0	331.0				0.395	67.37	32.63	
					0.03	331.0	264.6	5.58						
					0.15	331.0	207.8	5.34	0.466	3.055				
					0.30	331.0	199.4	5.30	0.507	1.663				
					0.61	331.0	176.9	5.18	0.627	1.028				
					0.91	331.0	154.3	5.04	0.763	0.835				
RSR	RSR-5	9/4/2015	9:31	1	Air	452.3	452.3				0.368	69.19	30.81	
					0.03	452.3	349.0	5.86						
					0.15	452.3	342.2	5.84	0.279	1.830				
					0.30	452.3	324.9	5.78	0.331	1.085				
					0.61	452.3	298.6	5.70	0.415	0.681				
					0.91	452.3	256.7	5.55	0.566	0.619				
RSR	RSR-5	9/4/2015	9:31	2	Air	490.9	490.9				0.447	63.98	36.02	
					0.03	490.9	386.0	5.96						
					0.15	490.9	361.9	5.89	0.305	2.000				
					0.30	490.9	328.1	5.79	0.403	1.322				
					0.61	490.9	288.5	5.66	0.532	0.872				
					0.91	490.9	255.6	5.54	0.653	0.714				
RSR	RSR-10	9/4/2015	9:48	1	Air	495.8	495.8				0.627	53.41	46.59	
					0.03	495.8	457.4	6.13						
					0.15	495.8	436.9	6.08	0.126	0.830				
					0.30	495.8	351.6	5.86	0.344	1.128				
					0.61	495.8	272.6	5.61	0.598	0.981				
					0.91	495.8	242.0	5.49	0.717	0.784				
					1.22	495.8	217.9	5.38	0.822	0.674				
RSR	RSR-10	9/4/2015	9:48	2	Air	390.7	390.7				0.318	72.76	27.24	
					0.03	390.7	366.5	5.90						
					0.15	390.7	305.4	5.72	0.246	1.616				
					0.30	390.7	294.1	5.68	0.284	0.932				
					0.61	390.7	254.1	5.54	0.430	0.706				
					0.91	390.7	239.6	5.48	0.489	0.535				
					1.22	390.7	218.5	5.39	0.581	0.477				
RSR	RSR-1	9/6/2015	9:04	1	Air	290.2	290.2				0.458	63.28	36.72	
					0.03	290.2	202.4	5.31						
					0.15	290.2	179.8	5.19	0.479	3.142				
					0.30	290.2	164.9	5.11	0.565	1.855				
					0.61	290.2	135.3	4.91	0.763	1.252				
					0.91	290.2	128.5	4.86	0.815	0.891				
RSR	RSR-1	9/6/2015	9:04	2	Air	332.3	332.3				0.638	52.84	47.16	
					0.03	332.3	304.2	5.72						
					0.15	332.3	224.5	5.41	0.392	2.573				
					0.30	332.3	180.2	5.19	0.612	2.008				
					0.61	332.3	148.3	5.00	0.807	1.323				
					0.91	332.3	135.1	4.91	0.900	0.985				
RSR	RSR-5	9/6/2015	9:19	1	Air	340.9	340.9				0.395	67.38	32.62	
					0.03	340.9	287.7	5.66						
					0.15	340.9	236.9	5.47	0.364	2.388				
					0.30	340.9	207.4	5.33	0.497	1.630				
					0.61	340.9	178.4	5.18	0.647	1.062				
					0.91	340.9	174.5	5.16	0.670	0.732				
RSR	RSR-5	9/6/2015	9:19	2	Air	257.6	257.6				0.344	70.90	29.10	
					0.03	257.6	272.1	5.61						
					0.15	257.6	253.8	5.54	0.015	0.098				
					0.30	257.6	254.0	5.54	0.014	0.046				
					0.61	257.6	239.2	5.48	0.074	0.122				
					0.91	257.6	194.8	5.27	0.279	0.306				

Site	Stn	Date	Time	Rep	Depth (m) z	corr Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	k (diffuse attenuation coefficient = slope, m-1) k (m-1)	Percent Transmittance (1m)	Birgean Percentile Absorption (1m)	Flag
RSR	RSR-10	9/6/2015	9:34	1	Air	322.1	322.1				0.348	70.64	29.36	
					0.03	322.1	261.5	5.57						
					0.15	322.1	197.1	5.28	0.491	3.223				
					0.30	322.1	181.3	5.20	0.574	1.885				
					0.61	322.1	159.5	5.07	0.703	1.153				
					0.91	322.1	144.4	4.97	0.802	0.878				
					1.22	322.1	136.3	4.91	0.860	0.706				
RSR	RSR-10	9/6/2015	9:34	2	Air	397.2	397.2				0.537	58.44	41.56	
					0.03	397.2	302.8	5.71						
					0.15	397.2	270.9	5.60	0.383	2.511				
					0.30	397.2	262.7	5.57	0.413	1.356				
					0.61	397.2	252.5	5.53	0.453	0.743				
					0.91	397.2	196.8	5.28	0.702	0.768				
					1.22	397.2	152.2	5.02	0.960	0.787				
RSR	RSR-1	2/8/2016	10:36	1	Air	947.6	947.6				0.333	71.65	28.35	
					0.03	947.6	818.2	6.71						
					0.15	947.6	807.0	6.69	0.161	1.054				
					0.30	947.6	726.2	6.59	0.266	0.873				
					0.61	947.6	653.3	6.48	0.372	0.610				
					0.91	947.6	607.7	6.41	0.444	0.486				
					1.22	947.6	553.9	6.32	0.537	0.440				
RSR	RSR-5	2/8/2016	11:04	1	Air	919.0	919.0				0.114	89.22	10.78	
					0.03	919.0	699.3	6.55						
					0.15	919.0	680.6	6.52	0.300	1.971				
					0.30	919.0	675.0	6.51	0.309	1.012				
					0.61	919.0	628.5	6.44	0.380	0.623				
					0.91	919.0	600.7	6.40	0.425	0.465				
					1.22	919.0	615.9	6.42	0.400	0.328				
RSR	RSR-5	2/8/2016	11:04	2	Air	845.0	845.0				0.231	79.37	20.63	
					0.03	845.0	702.3	6.55						
					0.15	845.0	786.5	6.67	0.072	0.471				
					0.30	845.0	720.6	6.58	0.159	0.522				
					0.61	845.0	675.8	6.52	0.223	0.367				
					0.91	845.0	631.6	6.45	0.291	0.318				
					1.22	845.0	607.2	6.41	0.330	0.271				
RSR	RSR-5	2/8/2016	11:04	3	Air	865.4	865.4				0.227	79.72	20.28	
					0.03	865.4	762.2	6.64						
					0.15	865.4	822.6	6.71	0.051	0.333				
					0.30	865.4	806.5	6.69	0.070	0.231				
					0.61	865.4	668.5	6.51	0.258	0.423				
					0.91	865.4	697.5	6.55	0.216	0.236				
					1.22	865.4	645.5	6.47	0.293	0.240				
RSR	RSR-10	2/8/2016	11:35	1	Air	1,098.2	1,098.2				0.296	74.39	25.61	
					0.03	1,098.2	883.8	6.78						
					0.15	1,098.2	938.9	6.84	0.157	1.028				
					0.30	1,098.2	963.3	6.87	0.131	0.430				
					0.61	1,098.2	779.6	6.66	0.343	0.562				
					0.91	1,098.2	758.3	6.63	0.370	0.405				
					1.22	1,098.2	707.5	6.56	0.440	0.361				
RSR	RSR-10	2/8/2016	11:35	2	Air	1,034.4	1,034.4				0.442	64.29	35.71	
					0.03	1,034.4	994.9	6.90						
					0.15	1,034.4	1,043.1	6.95	-0.008	-0.055				
					0.30	1,034.4	954.1	6.86	0.081	0.265				
					0.61	1,034.4	834.7	6.73	0.215	0.352				
					0.91	1,034.4	718.4	6.58	0.365	0.399				
					1.22	1,034.4	653.3	6.48	0.460	0.377				

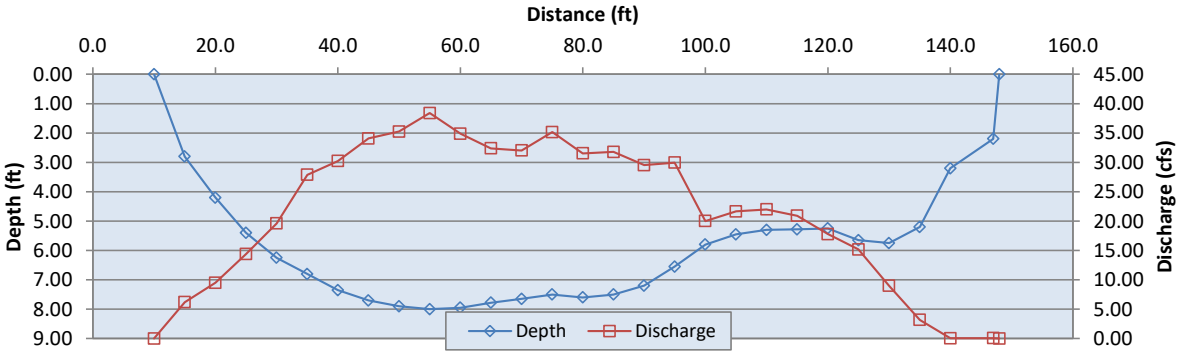
Site	Stn	Date	Time	Rep	Depth (m) z	corr Air (Io)	Water (Iz)	ln(Iz)	ln(Io/Iz)	k (m-1)	k (diffuse attenuation coefficient = slope, m-1) k (m-1)	Percent Transmittance (1m)	Birgean Percentile Absorption (1m)	Flag
RSR	RSR-1	2/19/2016	12:56	1	Air	1,433.0	1,433.0				0.275	75.98	24.02	
					0.03	1,433.0	927.9	6.83						
					0.15	1,433.0	836.1	6.73	0.539	3.535				
					0.30	1,433.0	798.6	6.68	0.585	1.918				
					0.61	1,433.0	727.7	6.59	0.678	1.112				
					0.91	1,433.0	671.4	6.51	0.758	0.829				
					1.22	1,433.0	624.8	6.44	0.830	0.681				
RSR	RSR-1	2/19/2016	13:08	2	Air	1,946.0	1,946.0				0.155	85.68	14.32	X
					0.03	1,946.0	925.5	6.83						
					0.15	1,946.0	879.9	6.78	0.794	5.208				
					0.30	1,946.0	804.7	6.69	0.883	2.897				
					0.61	1,946.0	772.3	6.65	0.924	1.516				
					0.91	1,946.0	805.9	6.69	0.882	0.964				
					1.22	1,946.0	705.9	6.56	1.014	0.832				
RSR	RSR-5	2/19/2016	11:54	1	Air	1,357.0	1,357.0				0.383	68.19	31.81	
					0.03	1,357.0	1,052.2	6.96						
					0.15	1,357.0	1,242.3	7.12	0.088	0.579				
					0.30	1,357.0	1,103.4	7.01	0.207	0.679				
					0.61	1,357.0	978.0	6.89	0.328	0.537				
					0.91	1,357.0	859.0	6.76	0.457	0.500				
					1.22	1,357.0	824.3	6.71	0.498	0.409				
RSR	RSR-5	2/19/2016	12:10	2	Air	1,232.0	1,232.0				0.387	67.88	32.12	
					0.03	1,232.0	1,197.2	7.09						
					0.15	1,232.0	1,155.9	7.05	0.064	0.418				
					0.30	1,232.0	1,112.1	7.01	0.102	0.336				
					0.61	1,232.0	980.2	6.89	0.229	0.375				
					0.91	1,232.0	901.0	6.80	0.313	0.342				
					1.22	1,232.0	757.5	6.63	0.486	0.399				
RSR	RSR-10	2/19/2016	11:03	1	Air	1,090.6	1,090.6				0.240	78.67	21.33	
					0.03	1,090.6	1,065.2	6.97						
					0.15	1,090.6	909.4	6.81	0.182	1.192				
					0.30	1,090.6	870.3	6.77	0.226	0.740				
					0.61	1,090.6	804.3	6.69	0.305	0.500				
					0.91	1,090.6	737.9	6.60	0.391	0.427				
					1.22	1,090.6	709.3	6.56	0.430	0.353				
RSR	RSR-10	2/19/2016	11:10	2	Air	991.3	991.3				0.212	80.89	19.11	
					0.03	991.3	964.5	6.87						
					0.15	991.3	928.1	6.83	0.066	0.432				
					0.30	991.3	903.3	6.81	0.093	0.305				
					0.61	991.3	802.6	6.69	0.211	0.346				
					0.91	991.3	771.3	6.65	0.251	0.274				
					1.22	991.3	748.8	6.62	0.281	0.230				

Appendix B

Stream Discharge Measurements

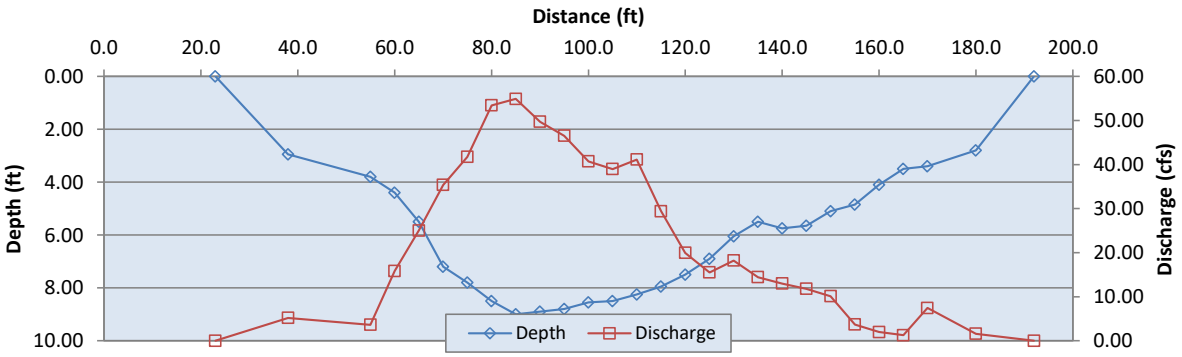
Station: Rainbow River
Stn No.: RSR-10 **Start Time:** 14:00 **Staff (ft) Start:** 6.15 **Field Team:** FSI
Date: 9/2/2015 **End Time:** **Staff (ft) End:** **Access:** Boat

	Distance from Initial Point (ft.)	Segment Width (ft.)	Total Depth (ft.)	Velocity (ft/s) 0.2 x depth	Velocity (ft/s) 0.6 x depth	Velocity (ft/s) 0.8 x depth	Segment Area (ft^2)	Discharge (ft^3/s)	Discharge (m^3/d)	Discharge (MGD)
Start	10.0	2.5	0.00		0.00		0.00	0.00	0	0.00
	15.0	5.0	2.8	0.55	0.43	0.36	14.00	6.20	15,157	4.00
	20.0	5.0	4.2	0.45	0.47	0.42	21.00	9.50	23,249	6.14
	25.0	5.0	5.4	0.58	0.55	0.45	27.00	14.38	35,176	9.29
	30.0	5.0	6.3	0.62	0.63	0.63	31.25	19.61	47,976	12.67
	35.0	5.0	6.8	0.84	0.90	0.64	34.00	27.88	68,211	18.02
	40.0	5.0	7.4	0.89	0.80	0.80	36.75	30.23	73,952	19.54
	45.0	5.0	7.7	1.05	0.88	0.73	38.50	34.07	83,361	22.02
	50.0	5.0	7.9	1.04	0.86	0.81	39.50	35.25	86,251	22.79
	55.0	5.0	8.0	1.04	0.95	0.90	40.00	38.40	93,949	24.82
	60.0	5.0	8.0	0.98	0.84	0.85	39.75	34.88	85,338	22.54
	65.0	5.0	7.8	0.92	0.85	0.71	38.90	32.38	79,231	20.93
	70.0	5.0	7.7	0.97	0.87	0.64	38.25	32.03	78,375	20.70
	75.0	5.0	7.5	1.05	0.91	0.88	37.50	35.16	86,012	22.72
	80.0	5.0	7.6	1.03	0.74	0.81	38.00	31.54	77,165	20.39
	85.0	5.0	7.5	1.06	0.81	0.71	37.50	31.78	77,755	20.54
	90.0	5.0	7.2	0.86	0.92	0.58	36.00	29.52	72,223	19.08
	95.0	5.0	6.6	0.97	0.95	0.79	32.75	29.97	73,315	19.37
	100.0	5.0	5.8	0.78	0.64	0.70	29.00	20.01	48,956	12.93
	105.0	5.0	5.5	0.86	0.81	0.70	27.25	21.66	53,002	14.00
	110.0	5.0	5.3	0.98	0.79	0.76	26.50	22.00	53,812	14.22
	115.0	5.0	5.3	0.77	0.90	0.60	26.40	20.92	51,187	13.52
	120.0	5.0	5.3	0.88	0.74	0.35	26.25	17.78	43,511	11.49
	125.0	5.0	5.7	0.66	0.44	0.61	28.25	15.18	37,150	9.81
	130.0	5.0	5.8	0.36	0.30	0.29	28.75	8.98	21,981	5.81
	135.0	5.0	5.2	0.19	0.12	0.06	26.00	3.19	7,792	2.06
	140.0	6.0	3.2	0.01	0.01	-0.02	19.20	0.05	117	0.03
	147.0	4.0	2.2		0.01		8.80	0.09	215	0.06
End	148.0	0.5	0.00		0.00		0.00	0.00	0	0.00
		138.0	5.7	0.78	0.70	0.61	827.1	602.6	1,474,418	389.5



Station: Rainbow River
Stn No.: RSR-1 **Start Time:** 11:55 **Staff (ft) Start:** 6.15 **Field Team:** FSI
Date: 9/9/2015 **End Time:** 12:55 **Staff (ft) End:** **Access:** Boat

	Distance from Initial Point (ft.)	Segment Width (ft.)	Total Depth (ft.)	Velocity (ft/s) 0.2 x depth	Velocity (ft/s) 0.6 x depth	Velocity (ft/s) 0.8 x depth	Segment Area (ft^2)	Discharge (ft^3/s)	Discharge (m^3/d)	Discharge (MGD)
Start	23.0	7.5	0.00		0.00		0.00	0.00	0	0.00
	38.0	16.0	3.0	0.13	0.13	0.05	47.20	5.19	12,703	3.36
	55.0	11.0	3.8	0.28	0.03	0.01	41.80	3.66	8,948	2.36
	60.0	5.0	4.4	0.90	0.69	0.60	22.00	15.84	38,754	10.24
	65.0	5.0	5.5	0.93	1.06	0.59	27.50	25.03	61,226	16.17
	70.0	5.0	7.2	0.99	1.20	0.54	36.00	35.37	86,535	22.86
	75.0	5.0	7.8	1.60	0.91	0.86	39.00	41.73	102,096	26.97
	80.0	5.0	8.5	1.60	1.29	0.85	42.50	53.44	130,754	34.54
	85.0	5.0	9.0	1.39	1.24	1.01	45.00	54.90	134,317	35.48
	90.0	5.0	8.9	1.35	1.02	1.08	44.50	49.73	121,665	32.14
	95.0	5.0	8.8	1.34	1.07	0.75	44.00	46.53	113,839	30.07
	100.0	5.0	8.6	1.04	1.03	0.71	42.75	40.72	99,623	26.32
	105.0	5.0	8.5	1.08	0.82	0.95	42.50	38.99	95,401	25.20
	110.0	5.0	8.3	1.12	1.07	0.73	41.25	41.15	100,669	26.59
	115.0	5.0	8.0	1.17	0.68	0.43	39.75	29.42	71,966	19.01
	120.0	5.0	7.5	0.82	0.63	0.05	37.50	19.97	48,855	12.91
	125.0	5.0	6.9	0.89	0.38	0.15	34.50	15.53	37,983	10.03
	130.0	5.0	6.1	0.93	0.72	0.04	30.25	18.23	44,590	11.78
	135.0	5.0	5.5	0.86	0.61	0.02	27.50	14.44	35,322	9.33
	140.0	5.0	5.8	0.97	0.43	-0.02	28.75	13.01	31,828	8.41
	145.0	5.0	5.7	0.84	0.40	0.03	28.25	11.79	28,856	7.62
	150.0	5.0	5.1	0.93	0.28	0.10	25.50	10.14	24,799	6.55
	155.0	5.0	4.9	0.47	0.06	0.02	24.25	3.70	9,048	2.39
	160.0	5.0	4.1	0.39	0.03	-0.06	20.50	2.00	4,890	1.29
	165.0	5.0	3.5	0.20	0.05	-0.01	17.50	1.27	3,104	0.82
	170.0	7.5	3.4	0.03	0.07	1.00	25.50	7.46	18,248	4.82
	180.0	11.0	2.8	0.07	0.07	0.00	30.80	1.62	3,956	1.05
End	192.0	6.0	0.00		0.00		0.00	0.00	0	0.00
		169.0	5.8	0.89	0.64	0.42	886.6	600.8	1,469,977	388.3



Discharge Measurement Summary

Date Measured: Friday, February 19, 2016

Site Information	
Site Name	Rainbow_house
Station Number	RSR1
Location	housewboat

Measurement Information	
Party	
Boat/Motor	
Meas. Number	

System Information	
System Type	RS-S5
Serial Number	2563
Firmware Version	3.80
Software Version	3.7

System Setup	
Transducer Depth (ft)	0.66
Salinity (ppt)	0.0
Magnetic Declination (deg)	5.4

Units	
Distance	ft
Velocity	ft/s
Area	ft2
Discharge	cfs
Temperature	degF

Discharge Calculation Settings			
Track Reference	Bottom-Track	Left Method	Sloped Bank
Depth Reference	Vertical Beam	Right Method	Sloped Bank
Coordinate System	ENU	Top Fit Type	Power Fit
		Bottom Fit Type	Power Fit

Discharge Results	
Width (ft)	123.297
Area (ft2)	547.512
Mean Speed (ft/s)	-1.086
Total Q (cfs)	-594.566
Maximum Measured Depth	8.425
Maximum Measured Speed	3.533

Measurement Results

Tr		Time			Distance				Mean Vel		Discharge							%
#		Time	Duration	Temp.	Track	DMG	Width	Area	Boat	Water	Left	Right	Top	Middle	Bottom	Total	MBTotal	Measured
1	L	10:14:50 AM	0:04:37	70.3	132.28	106.46	126.148	562.964	0.478	-1.073	-2.38	-8.07	-116.72	-398.60	-78.13	-603.891	--	66.0
2	R	10:20:09 AM	0:04:17	71.2	126.52	100.76	120.446	532.059	0.492	-1.100	-2.24	-7.73	-111.75	-399.62	-63.90	-585.240	--	68.3
			Mean	70.8	129.40	103.61	123.297	547.512	0.485	-1.086	-2.31	-7.90	-114.24	-399.11	-71.01	-594.566	0.000	67.1
			Std Dev	0.4	2.88	2.85	2.851	15.452	0.007	0.014	0.07	0.17	2.48	0.51	7.12	9.326	0.000	1.1
			COV	0.0	0.022	0.028	0.023	0.028	0.015	-0.013	-0.030	-0.021	-0.022	-0.001	-0.100	-0.016	0.000	0.017

Exposure Time: 0:08:54

Tr1=20160219101449r.rivr; Tr2=20160219102008r.rivr;

Comments

Tr1=20160219101449r.rivr - at house where FSI boat kep; Tr2=20160219102008r.rivr - at house where FSI boat kep;

Compass Calibration

Passed Calibration
Calibration duration = 83 seconds
M3.00 = Magnetic influence is acceptable
Q9 = Magnetic field is uniform
H9 = Complete horizontal rotation
V5 = High pitch/roll
Recommendation(s):
Avoid any changes to the instrument setup or its orientation to the magnetic influences detected during the compass calibration.
Measurements should be made in locations with similar magnetic influences as the location of the compass calibration.

System Test

System Test: PASS

Parameters and settings marked with a * are not constant for all files.

Report generated using SonTek RiverSurveyor Live v3.7

Discharge Measurement Summary

Date Measured: Friday, February 19, 2016

Site Information		Measurement Information	
Site Name	RSR6	Party	
Station Number		Boat/Motor	
Location		Meas. Number	

System Information		System Setup		Units	
System Type	RS-S5	Transducer Depth (ft)	0.66	Distance	ft
Serial Number	2563	Salinity (ppt)	0.0	Velocity	ft/s
Firmware Version	3.80	Magnetic Declination (deg)	5.4	Area	ft2
Software Version	3.7			Discharge	cfs
				Temperature	degF

Discharge Calculation Settings			
Track Reference	Bottom-Track	Left Method	Sloped Bank
Depth Reference	Vertical Beam	Right Method	Sloped Bank
Coordinate System	ENU	Top Fit Type	Power Fit
		Bottom Fit Type	Power Fit

Discharge Results	
Width (ft)	159.632
Area (ft2)	689.254
Mean Speed (ft/s)	0.901
Total Q (cfs)	620.791
Maximum Measured Depth	7.234
Maximum Measured Speed	4.094

Measurement Results

Tr		Time			Distance				Mean Vel		Discharge							%
#		Time	Duration	Temp.	Track	DMG	Width	Area	Boat	Water	Left	Right	Top	Middle	Bottom	Total	MBTotal	Measured
1	R	12:23:28 PM	0:07:57	73.0	160.67	149.11	160.595	679.073	0.337	0.892	14.56	0.00	124.78	402.72	63.79	605.843	--	66.5
2	L	12:31:39 PM	0:02:50	73.3	162.92	147.19	158.669	699.436	0.958	0.909	13.51	0.00	138.53	405.59	78.11	635.739	--	63.8
			Mean	73.2	161.79	148.15	159.632	689.254	0.648	0.901	14.04	0.00	131.65	404.15	70.95	620.791	0.000	65.1
			Std Dev	0.2	1.12	0.96	0.963	10.181	0.311	0.008	0.53	0.00	6.88	1.44	7.16	14.948	0.000	1.3
			COV	0.0	0.007	0.006	0.006	0.015	0.480	0.009	0.037	0.000	0.052	0.004	0.101	0.024	0.000	0.021

Exposure Time: 0:10:47

Tr1=20160219122328r.rivr; Tr2=20160219123138r.rivr;

Comments

Tr1=20160219122328r.rivr - Rainbow downstream; Tr2=20160219123138r.rivr - Rainbow downstream;

Compass Calibration

Passed Calibration
Calibration duration = 71 seconds
M0.00 = Magnetic influence is acceptable
Q9 = Magnetic field is uniform
H9 = Complete horizontal rotation
V5 = High pitch/roll
Recommendation(s):
Avoid any changes to the instrument setup or its orientation to the magnetic influences detected during the compass calibration.
Measurements should be made in locations with similar magnetic influences as the location of the compass calibration.

System Test

System Test: PASS

Parameters and settings marked with a * are not constant for all files.

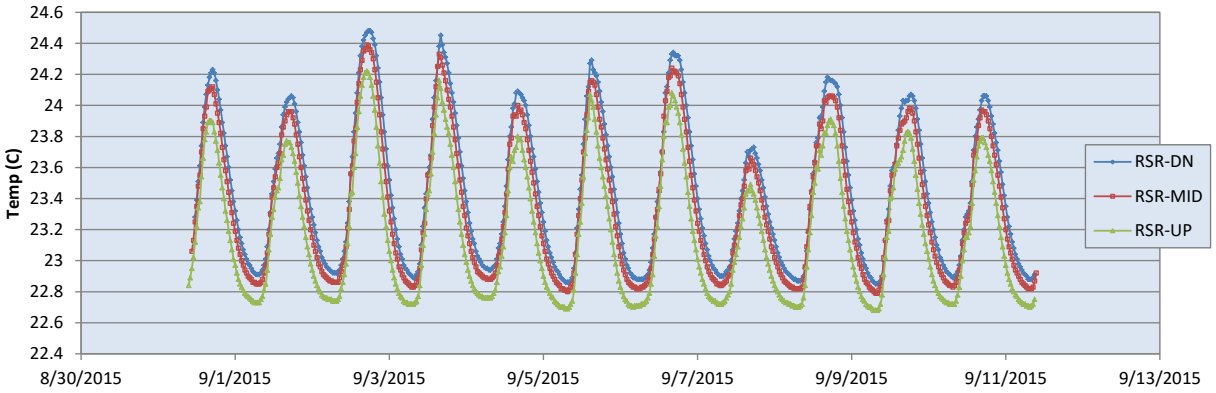
Report generated using SonTek RiverSurveyor Live v3.7

Appendix C

Water Quality Results

PARAMETER GROUP	PARAMETER	UNITS	MMDDYY	RSR-1	RSR-5	RSR-10
DISSOLVED OXYGEN	DO	%	8/31/15	79.5	81.3	95.8
			9/11/15	69.5	70.1	65.0
			2/8/16	88.1	96.8	101
			2/19/16	108	108	107
	DO	mg/L	8/31/15	6.83	6.96	8.17
			9/11/15	5.99	6.02	5.58
			2/8/16	7.73	8.48	8.90
			2/19/16	9.27	9.35	9.30
NITROGEN	NH4-N	mg/L	8/31/15	0.020	0.030	0.040
			9/11/15	0.030	0.030	0.040
			2/8/16	0.010	0.01 I	0.01 U
			2/19/16	0.01 U	0.01 U	0.010
	NOx-N	mg/L	8/31/15	1.70	2.00	1.70
			9/11/15	1.80	1.80	1.70
			2/8/16	1.70	1.70	1.70
			2/19/16	1.70	1.70	1.70
	OrgN	mg/L	8/31/15	0.030	0.020	0.010
			9/11/15	0.140	0.020	0.010
			2/8/16	0.220	0.040	0.040
			2/19/16	0.040	0.040	0.040
	TKN	mg/L	8/31/15	0.05 U	0.05 U	0.05 U
			9/11/15	0.170	0.05 U	0.05 U
			2/8/16	0.230	0.05 U	0.05 U
			2/19/16	0.05 U	0.05 U	0.05 U
	TN	mg/L	8/31/15	1.75	2.05	1.75
			9/11/15	1.97	1.85	1.75
			2/8/16	1.93	1.75	1.75
			2/19/16	1.75	1.75	1.75
PHYSICAL	pH	SU	8/31/15	7.52	7.20	7.54
			9/11/15	7.68	7.68	7.80
			2/8/16	7.99	8.11	8.12
			2/19/16	8.33	8.38	8.41
	Secchi-H	m	8/31/15	12.2	9.45	7.62
			9/2/15	14.2	---	8.38
			9/5/15	13.0	---	---
			9/11/15	12.0	9.91	9.75
			2/8/16	18.6	18.3	18.3
			2/19/16	16.8	15.9	14.4
	SpCond	umhos/cm	8/31/15	289	291	291
			9/11/15	289	292	291
			2/8/16	289	288	288
			2/19/16	288	288	288

PARAMETER GROUP	PARAMETER	UNITS	MMDDYY	RSR-1	RSR-5	RSR-10
PHYSICAL	Stage	ft	9/2/15	---	6.15	---
			9/11/15	---	6.40	---
			2/8/16	---	5.68	---
			2/12/16	---	5.71	---
	Turb	NTU	8/31/15	< 0.3	---	< 0.3
			9/11/15	< 0.3	---	< 0.3
			2/19/16	---	---	< 0.3
TEMPERATURE	Wtr Temp	C	8/31/15	22.9	23.1	23.3
			9/11/15	22.8	22.9	22.9
			2/8/16	21.8	21.7	21.8
			2/19/16	22.8	22.4	22.1


Temp (C)
24.6
24.4
24.2
24
23.8
23.6
23.4
23.2
23
22.8
22.6
22.4
8/30/2015
9/1/2015
9/3/2015
9/5/2015
9/7/2015
9/9/2015
9/11/2015
9/13/2015
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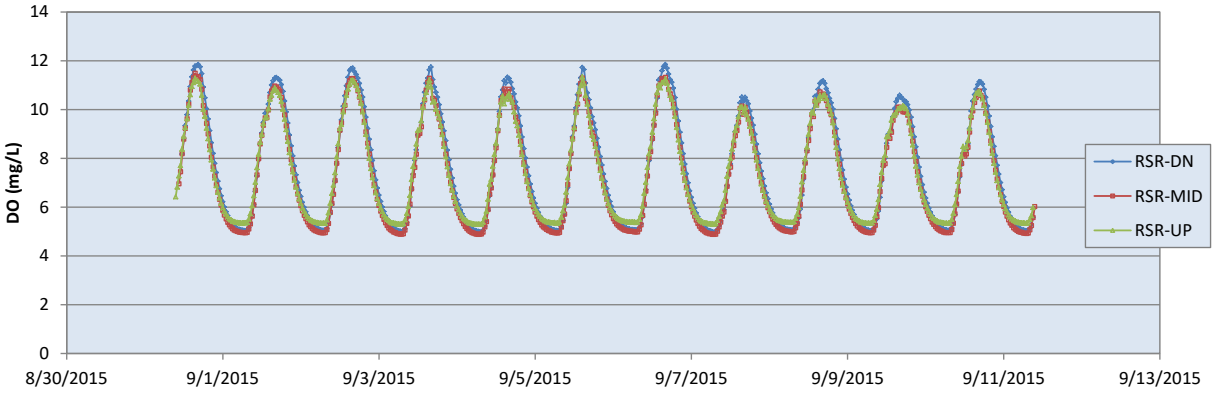
RSR-MID
RSR-UP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6
4
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9/1/2015
9/3/2015
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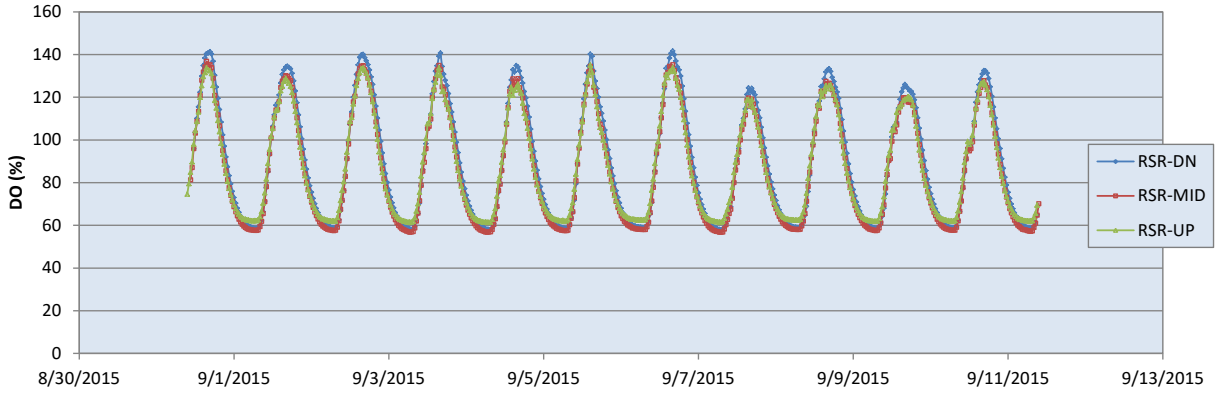
9/7/2015
9/9/2015
9/11/2015
9/13/2015
RSR-DN
RSR-MID
RSR-UP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9/7/2015
9/9/2015
9/11/2015
9/13/2015
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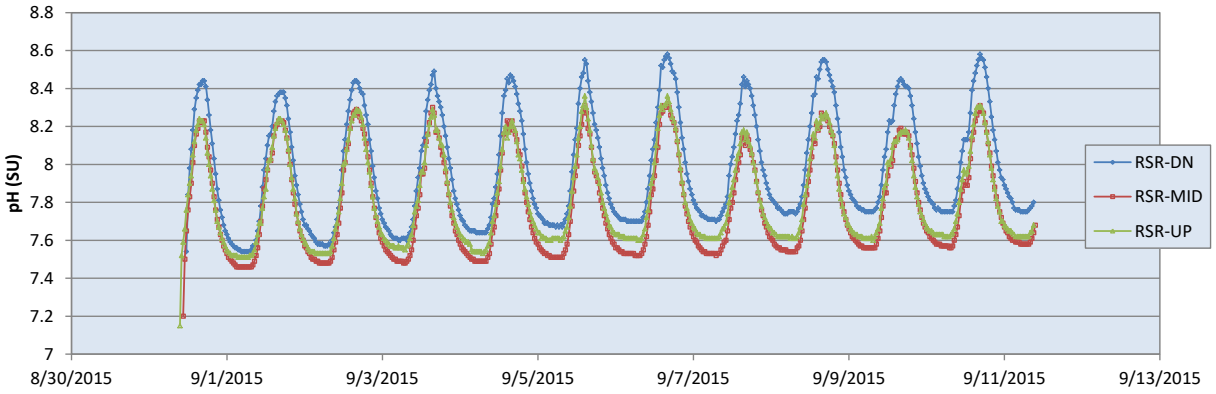
RSR-MID
RSR-UP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8.4
8.2
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7.6
7.4
7.2
7
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9/1/2015
9/3/2015
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9/11/2015
9/13/2015
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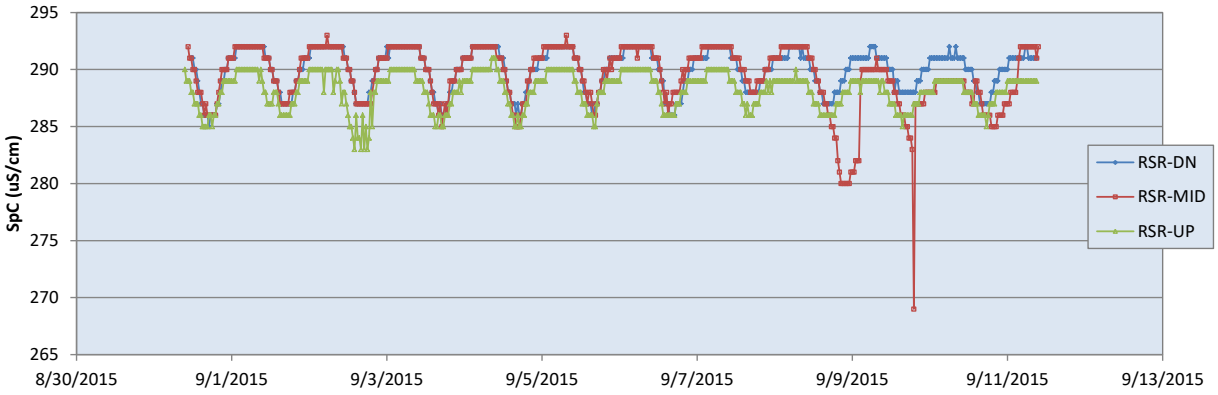
RSR-MID
RSR-UP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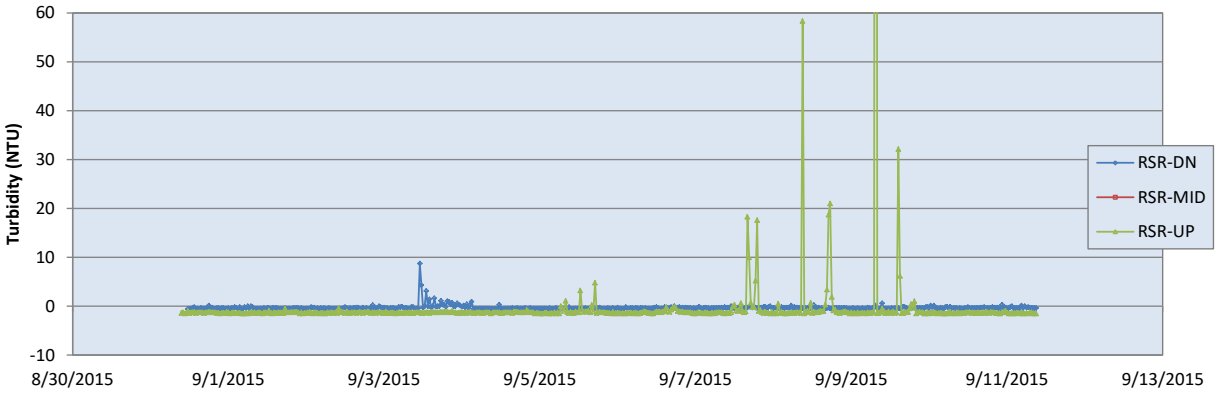
RSR-MID
RSR-UP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20
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-10
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9/1/2015
9/3/2015
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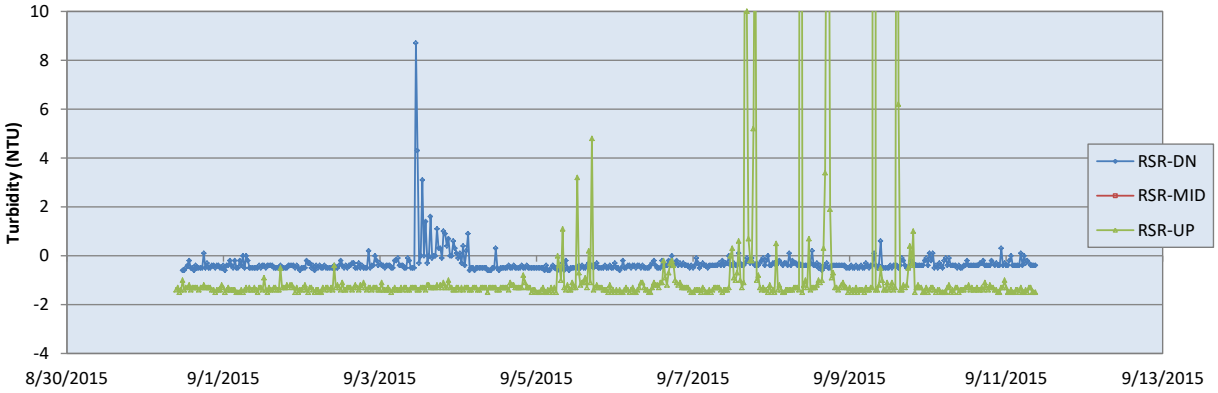
9/7/2015
9/9/2015
9/11/2015
9/13/2015
RSR-DN
RSR-MID
RSR-UP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6
4
2
0
-2
-4
8/30/2015
9/1/2015
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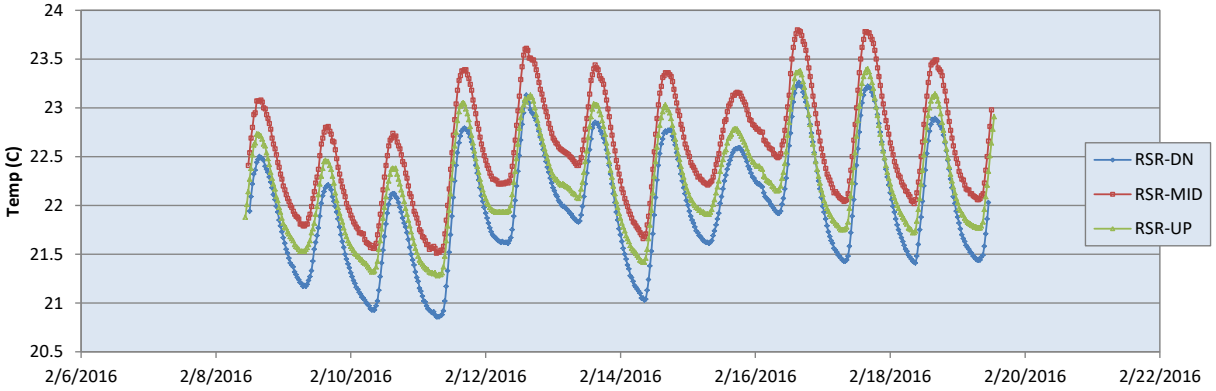
9/7/2015
9/9/2015
9/11/2015
9/13/2015
RSR-DN
RSR-MID
RSR-UP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22.5
22
21.5
21
20.5
2/6/2016
2/8/2016
2/10/2016
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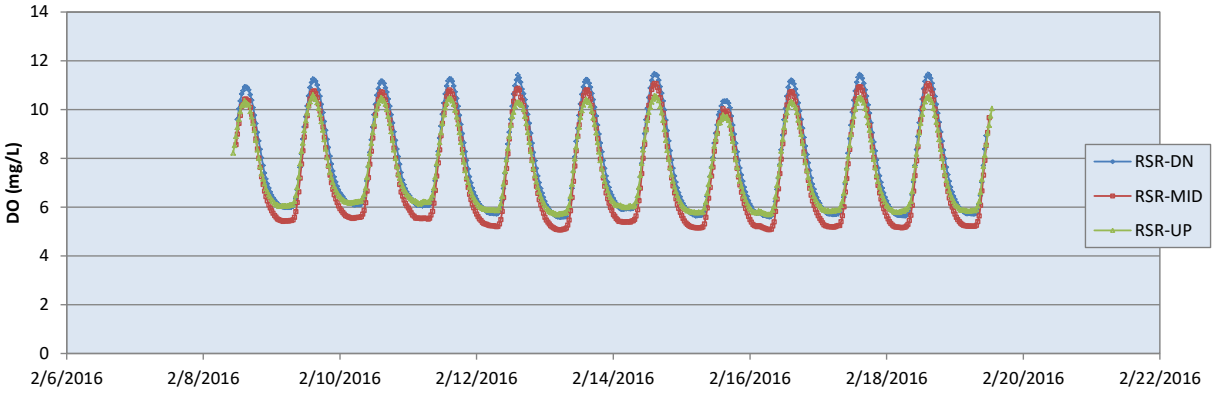
RSR-MID
RSR-UP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6
4
2
0
2/6/2016
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2/10/2016
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2/16/2016
2/18/2016
2/20/2016
2/22/2016
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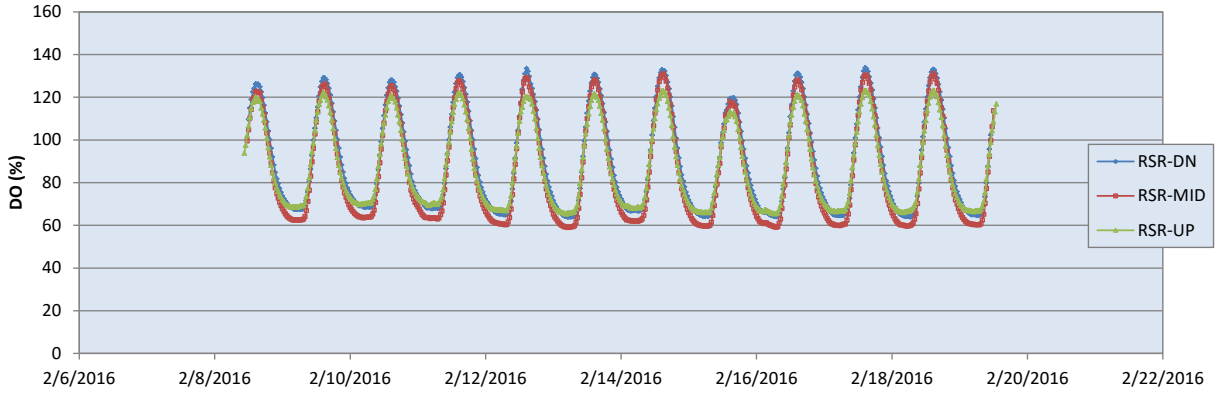
RSR-MID
RSR-UP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120
100
80
60
40
20
0
2/6/2016
2/8/2016
2/10/2016
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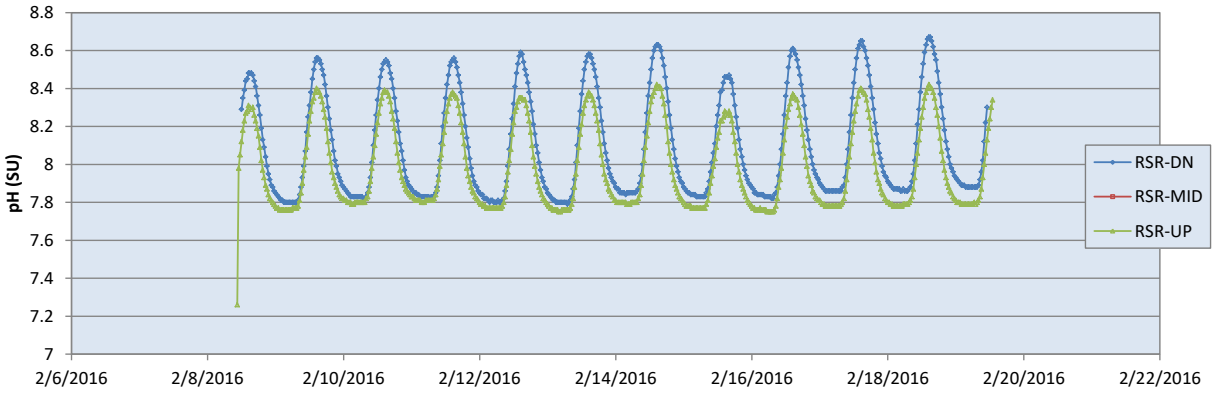
2/22/2016
RSR-DN
RSR-MID
RSR-UP


pH (SU)
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8.6
8.4
8.2
8
7.8
7.6
7.4
7.2
7
2/6/2016
2/8/2016
2/10/2016
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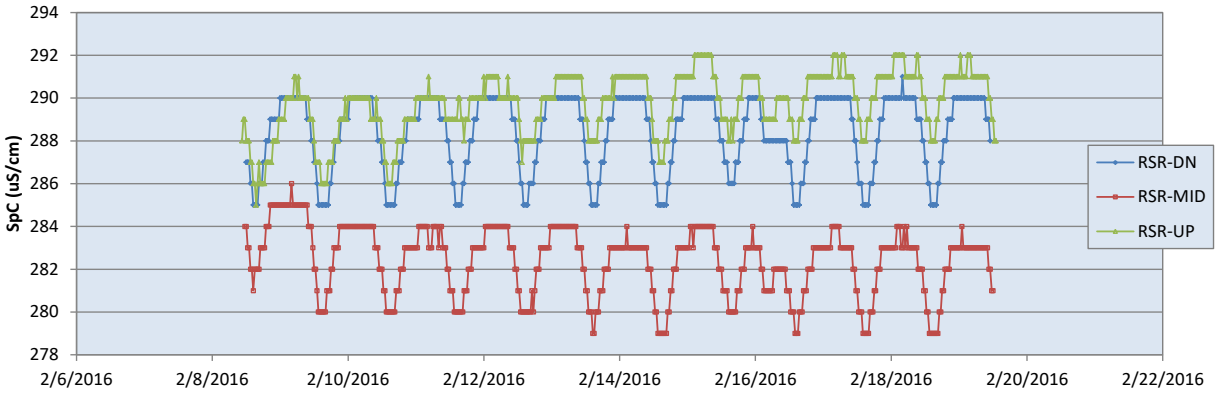
RSR-MID
RSR-UP


SpC (uS/cm)
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292
290
288
286
284
282
280
278
2/6/2016
2/8/2016
2/10/2016
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2/16/2016
2/18/2016
2/20/2016
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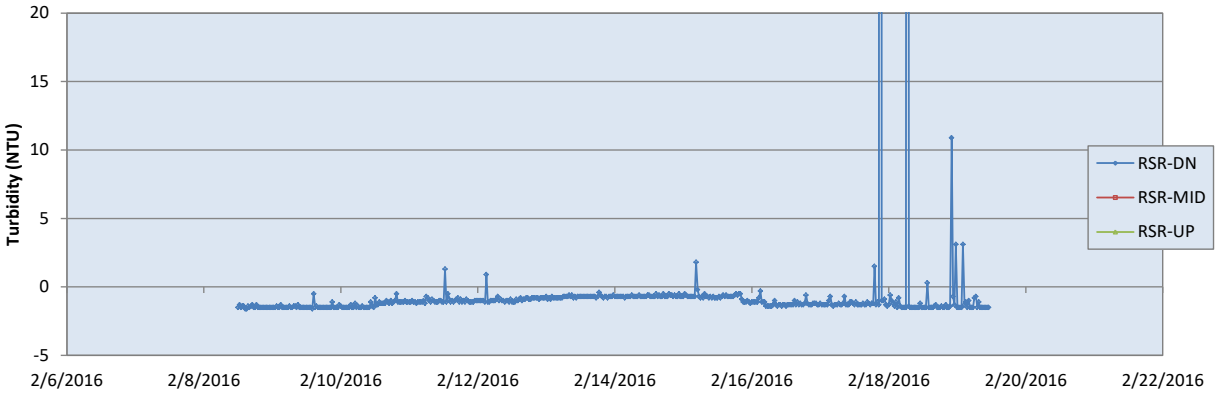
RSR-DN
RSR-MID
RSR-UP


Turbidity (NTU)
20
15
10
5
0
-5
2/6/2016
2/8/2016
2/10/2016
2/12/2016
2/14/2016
2/16/2016
2/18/2016
2/20/2016
2/22/2016
RSR-DN
RSR-MID
RSR-UP

Appendix D

Aquatic Vegetation Summary

Rainbow River

Summary of Aquatic Vegetation - Line Intercept Method

Site	Transect	Date	Distance (m)
BA-RB	RSR-1	8/31/2015	43.28

		Linear Distance (m)									Cover		Frequency		Importance
SPECIES	COMMON	A	B	C	D	E	F	G	H	Total	Percent	Relative	Absolute	Relative	Value
Algae	Algae	0.00	1.01	3.25	1.23	0.00	0.00	0.00	0.00	5.49	12.68	14.03	0.38	12.00	13.01
Ceratophyllum demersum	Coontail	0.00	0.00	0.00	0.00	0.13	0.06	0.00	0.00	0.19	0.44	0.49	0.38	12.00	6.24
Hydrilla verticillata	Waterthyme	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.52	1.52	3.52	3.89	0.13	4.00	3.95
Hydrocotyle sp.	Penny-wort	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.03	0.13	4.00	2.01
Lemna minor	Duckweed	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.52	1.52	3.52	3.89	0.13	4.00	3.95
Najas guadalupensis	Southern naiad	0.00	0.00	0.00	0.00	0.37	0.00	0.00	0.00	0.37	0.85	0.94	0.13	4.00	2.47
Paspalum distichum	Knot grass	0.00	0.03	0.11	0.04	0.00	0.00	0.00	0.00	0.18	0.42	0.47	0.38	12.00	6.23
Sagittaria kurziana	Strap-leaf sagittaria	1.95	4.21	0.00	4.66	4.40	0.82	0.00	0.00	16.04	37.06	41.01	0.63	20.00	30.51
Vallisneria americana	Tape grass	2.35	4.51	5.41	0.67	0.27	0.08	0.50	0.00	13.79	31.86	35.26	0.88	28.00	31.63
Total		4.30	9.76	8.76	6.61	5.16	0.96	0.50	3.06	39.11	90.36	100.00	3.13	100.00	100.00

Site	Transect	Date	Distance (m)
BA-RB	RSR-10	8/31/2015	60.96

		Linear Distance (m)									Cover		Frequency		Importance
SPECIES	COMMON	A	B	C	D	E	F	G	H	Total	Percent	Relative	Absolute	Relative	Value
Algae	Algae	3.63	0.00	3.23	3.35	0.67	2.74	0.00	0.00	13.62	22.35	50.72	0.63	38.46	44.59
Hydrilla verticillata	Waterthyme	3.02	0.00	0.91	0.37	1.62	3.29	0.00	0.00	9.20	15.10	34.27	0.63	38.46	36.36
Lemna minor	Duckweed	0.00	0.00	0.00	0.00	0.00	1.46	0.00	0.00	1.46	2.40	5.45	0.13	7.69	6.57
Najas guadalupensis	Southern naiad	0.00	0.00	0.00	2.56	0.00	0.00	0.00	0.00	2.56	4.20	9.53	0.13	7.69	8.61
Pistia stratiotes	Water lettuce	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.02	0.04	0.13	7.69	3.86
Total		6.64	0.00	4.15	6.28	2.29	7.51	0.00	0.00	26.86	44.07	100.00	1.63	100.00	100.00

Rainbow River

Summary of Aquatic Vegetation - Line Intercept Method

Site	Transect	Date	Distance (m)
BA-RB	RSR-5	8/31/2015	55.47

		Linear Distance (m)								Cover		Frequency		Importance
SPECIES	COMMON	A	B	C	D	E	F	G	H	Total	Percent	Relative	Absolute	Relative	Value
Algae	Algae	0.00	5.64	2.29	0.00	0.00	0.00	0.00	1.37	9.30	16.76	15.37	0.38	12.00	13.68
Hydrilla verticillata	Waterthyme	0.69	0.13	0.20	0.05	3.36	1.23	3.54	1.03	10.23	18.44	16.91	1.00	32.00	24.45
Najas guadalupensis	Southern naiad	1.55	0.13	0.00	0.00	0.00	0.00	2.21	2.06	5.94	10.71	9.83	0.50	16.00	12.91
Sagittaria kurziana	Strap-leaf sagittaria	0.23	6.93	6.02	3.16	1.99	3.89	0.95	0.00	23.16	41.76	38.30	0.88	28.00	33.15
Vallisneria americana	Tape grass	10.86	0.39	0.61	0.00	0.00	0.00	0.00	0.00	11.86	21.38	19.60	0.38	12.00	15.80
Total		13.33	13.22	9.11	3.20	5.35	5.12	6.69	4.46	60.49	109.05	100.00	3.13	100.00	100.00

Appendix E

Bird Survey Data

Rainbow River Bird Survey (from Association Park to SR 484)

Species	Fall Surveys			Winter Surveys			Overall
	9/1/15	9/8/15	Fall	2/11/16	2/16/16	Winter	
Wood Duck	75	71	75	53	23	53	75
Woodstork	2	5	5	3	1	3	5
Pied-billed Grebe				40	26	40	40
Double-crested Cormorant	23	30	30	23	30	30	30
Anhinga	58	51	58	50	56	56	58
Great Blue Heron	3	2	3	6	6	6	6
Great Egret	2	1	2	4	6	6	6
Snowy Egret				1	1	1	1
Little Blue Heron	4	1	4	5	3	5	5
Tricolored Heron				2	1	2	2
Green Heron	4	6	6	5	1	5	6
White Ibis	6	4	6	17	16	17	17
Black Vulture	7	7	7	20	3	20	20
Turkey Vulture	4	6	6	68	51	68	68
Bald Eagle		1	1	2		2	2
Coopers Hawk		1	1				1
Red-tailed Hawk		1	1	2	1	2	2
Red-shouldered Hawk	4	3	4	11	18	18	18
Mississippi Kite	1		1				1
Common Gallinule	11	19	19	23	22	23	23
American Coot				10	14	14	14
Limpkin				4	2	4	4
Spotted Sandpiper	1	1	1				1
Mourning Dove	6	1	6	7	9	9	9
Chimney Swift	9	13	13				13
Ruby-throated Hummingbird	1	1	1				1
Belted Kingfisher	3	4	4	8	9	9	9
Red-bellied Woodpecker	6	19	19	18	20	20	20
Yellow-bellied Sapsucker				4	2	4	4
Downy Woodpecker	4	4	4	3	8	8	8
Northern Flicker					1	1	1
Pileated Woodpecker	5	12	12	10	13	13	13
Barred Owl		1	1	1	4	4	4
Veery		1	1				1
Acadian Flycatcher	1		1				1
Eastern Kingbird	1		1				1
Eastern Phoebe				33	9	33	33
White-eyed Vireo	2	6	6		2	2	6
Yellow-throated Vireo	2		2				2
Red-eyed Vireo	12	5	12				12

Species	Fall Surveys			Winter Surveys			Overall
	9/1/15	9/8/15	Fall	2/11/16	2/16/16	Winter	
Blue-headed Vireo				2	4	4	4
Blue Jay	2	1	2	1	1	1	2
American Crow	8	32	32	27	29	29	32
Fish Crow	26	11	26	5	36	36	36
Crow sp.	7		7	5		5	7
Purple Martin	14	7	14		1	1	14
Barn Swallow	6	3	6				6
Tree Swallow				10	412	412	412
Carolina Chickadee	1	3	3	7	4	7	7
Tufted Titmouse	13	10	13	20	32	32	32
Carolina Wren	7	34	34	18	25	25	34
Ruby-crowned Kinglet				13	5	13	13
Blue-gray Gnatcatcher	6	6	6	15	9	15	15
Eastern Bluebird	1	4	4	11	4	11	11
Hermit Thrush					1	1	1
American Robin				9	8	9	9
Gray Catbird				5	4	5	5
Northern Mockingbird				1	2	2	2
Cedar Waxwing				9	2	9	9
Orange-crowned Warbler					1	1	1
Yellow-rumped Warbler				118	80	118	118
Black-and-white Warbler	1		1		2	2	2
Yellow-throated Warbler	2		2	3	5	5	5
Pine Warbler				2	8	8	8
Palm Warbler				15	6	15	15
Common Yellowthroat				2	5	5	5
Northern Parula	5	4	4				5
Northern Cardinal	6	9	9	18	57	57	57
Common Grackle				15	4	15	15
Brown-headed Cowbird				1		1	1
American Goldfinch				9	2	9	9

Appendix F

Fish Counts

Location	Date	Family	Scientific Name	Common Name	Count	Density (#/ha)	Biomass (kg/ha)
RSR 1-5	9/2/15	Amiidae	*Amia calva*	Bowfin	2	0.35	0.76
		Belonidae	*Strongylura marina*	Atlantic Needlefish	30	5.19	0.38
		Catostomidae	*Erimyzon sucetta*	Lake Chubsucker	21	3.63	4.85
		Centrarchidae	*Lepomis sp.*	Sunfish sp.	2,724	471	22.1
			Micropterus salmoides	Largemouth Bass	217	37.5	2.97
		Clupeidae	*Dorosoma cepedianum*	Gizzard shad	381	65.9	58.3
		Cyprinidae	*Notropis sp.*	Minnows	1,298	224	0.37
		Fundulidae	*Fundulus sp.*	Killifish sp.	10	1.73	0.02
		Lepisosteidae	*Lepisosteus platyrhincus*	Florida Gar	36	6.23	24.8
	9/9/15	Belonidae	*Strongylura marina*	Atlantic Needlefish	62	10.7	0.78
		Centrarchidae	*Lepomis sp.*	Sunfish sp.	60	10.4	1.75
			Micropterus salmoides	Largemouth Bass	219	37.9	18.5
		Clupeidae	*Dorosoma cepedianum*	Gizzard shad	51	8.82	7.80
		Cyprinidae	*Notropis sp.*	Minnows	703	122	0.20
		Fundulidae	*Fundulus sp.*	Killifish sp.	77	13.3	0.14
		Lepisosteidae	*Lepisosteus platyrhincus*	Florida Gar	6	1.04	4.14
	2/12/16	Belonidae	*Strongylura marina*	Atlantic Needlefish	6	1.04	0.08
		Catostomidae	*Erimyzon sucetta*	Lake Chubsucker	6	1.04	1.39
		Centrarchidae	*Lepomis sp.*	Sunfish sp.	2,339	404	22.5
			Micropterus salmoides	Largemouth Bass	187	32.3	2.56
		Cyprinidae	*Notropis sp.*	Minnows	303	52.4	0.09
		Fundulidae	*Fundulus sp.*	Killifish sp.	116	20.1	0.21
		Lepisosteidae	*Lepisosteus platyrhincus*	Florida Gar	26	4.50	17.9
RSR 5-10	9/2/15	Belonidae	*Strongylura marina*	Atlantic Needlefish	27	5.04	0.37
		Centrarchidae	*Lepomis sp.*	Sunfish sp.	3,620	676	31.6
			Micropterus salmoides	Largemouth Bass	908	169	13.4
		Clupeidae	*Dorosoma cepedianum*	Gizzard shad	1,283	239	212
		Cyprinidae	*Notropis sp.*	Minnows	1,401	261	0.43
		Fundulidae	*Fundulus sp.*	Killifish sp.	92	17.2	0.18
	9/9/15	Belonidae	*Strongylura marina*	Atlantic Needlefish	52	9.71	0.71
		Centrarchidae	*Lepomis sp.*	Sunfish sp.	2,484	464	24.2
			Micropterus salmoides	Largemouth Bass	222	41.4	11.5
		Clupeidae	*Dorosoma cepedianum*	Gizzard shad	295	55.1	48.7
		Cyprinidae	*Notropis sp.*	Minnows	1,172	219	0.36
		Fundulidae	*Fundulus sp.*	Killifish sp.	58	10.8	0.11
	2/12/16	Belonidae	*Strongylura marina*	Atlantic Needlefish	7	1.31	0.10
		Catostomidae	*Erimyzon sucetta*	Lake Chubsucker	1	0.19	0.25
		Centrarchidae	*Lepomis sp.*	Sunfish sp.	1,521	284	19.2
			Micropterus salmoides	Largemouth Bass	359	67.0	5.30
		Cyprinidae	*Notropis sp.*	Minnows	471	87.9	0.14
		Fundulidae	*Fundulus sp.*	Killifish sp.	113	21.1	0.22
		Lepisosteidae	*Lepisosteus platyrhincus*	Florida Gar	6	1.12	4.47

Appendix G

Turtle Survey Data

Date	Time	Common Name	Species	Sex	SCL Midline (cm)	Plastron Length (cm)	New Drill	PIT tag #	Recapture from 9/15	Code	Latitude	Longitude
9/12/15	11:07	Loggerhead Musk Turtle	*Sternotherus minor minor*	J	8.46		J				29.0688	82.42712
9/12/15	11:10	Loggerhead Musk Turtle	*Sternotherus minor minor*	J	4.59		J				29.0693	82.42687
9/12/15	11:10	Loggerhead Musk Turtle	*Sternotherus minor minor*	F	12.83		J				29.0695	82.42867
9/12/15	11:10	Loggerhead Musk Turtle	*Sternotherus minor minor*	J	7.8		J				29.0645	82.42867
9/12/15	11:13	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	9.85		J				29.0695	82.42685
9/12/15	11:14	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	11.03		J				29.0696	82.42686
9/12/15	11:15	Peninsular Cooter	*Pseudemys floridana*	M	24.5		J				29.0696	82.42686
9/12/15	11:15	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	7.43		J				29.0696	82.42686
9/12/15	11:16	Suwannee Cooter	*Pseudemys cocinna*	F	37.1		J				29.0707	82.42684
9/12/15	11:16	Loggerhead Musk Turtle	*Sternotherus minor minor*	F	9.29		J				29.0707	82.42696
9/12/15	11:20	Stinkpot	*Sternotherus odoratus*	F	5.58		J				29.0707	82.42696
9/12/15	11:20	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	6.72		J				29.0707	82.42696
9/12/15	11:20	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	7.01		J				29.0707	82.42696
9/12/15	11:21	Loggerhead Musk Turtle	*Sternotherus minor minor*	F	11.07		J				29.0708	82.42683
9/12/15	11:23	Loggerhead Musk Turtle	*Sternotherus minor minor*	J	4.44		J				29.0708	82.42683

Date	Time	Common Name	Species	Sex	SCL Midline (cm)	Plastron Length (cm)	New Drill	PIT tag #	Recapture from 9/15	Code	Latitude	Longitude
9/12/15	11:23	Loggerhead Musk Turtle	*Sternotherus minor minor*	F	10.25		J				29.0708	82.42683
9/12/15	11:23	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	9.09		J				29.0708	82.42683
9/12/15	11:23	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	10.78		J				29.0708	82.4268
9/12/15	11:30	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	7.22		J					
9/12/15	11:30	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	6.69		J					
9/12/15	11:31	Loggerhead Musk Turtle	*Sternotherus minor minor*	F	10.14		J				29.0724	82.42622
9/12/15	11:32	Loggerhead Musk Turtle	*Sternotherus minor minor*	J	5.06		J					
9/12/15	11:32	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	10.8		J					
9/12/15	11:32	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	12.3		J					
9/12/15	11:34	Suwannee Cooter	*Pseudemys cocinna*	M	26.9		J				29.0724	82.84622
9/12/15	11:35	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	7.11		J				29.072	82.42649
9/12/15	11:35	Florida Softshell Turtle	*Apalone ferox*	M	40.5		J				29.072	82.42649
9/12/15	11:35	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	10.56		J				29.072	82.42649
9/12/15	11:36	Loggerhead Musk Turtle	*Sternotherus minor minor*	F	11.24		J					
9/12/15	11:36	Suwannee Cooter	*Pseudemys cocinna*	F	16		J					
9/12/15	11:39	Loggerhead Musk Turtle	*Sternotherus minor minor*	F	6.88		J				29.0715	82.4267
9/12/15	11:39	Loggerhead Musk Turtle	*Sternotherus minor minor*	J	4.77		J				29.0715	82.4267

Date	Time	Common Name	Species	Sex	SCL Midline (cm)	Plastron Length (cm)	New Drill	PIT tag #	Recapture from 9/15	Code	Latitude	Longitude
9/12/15	11:40	Suwannee Cooter	*Pseudemys cocinna*	F	34.3		J				29.0724	82.4262
9/12/15	11:40	Suwannee Cooter	*Pseudemys cocinna*	M	24.1		J				29.0724	82.4262
9/12/15	11:40	Loggerhead Musk Turtle	*Sternotherus minor minor*	J	74.3		J				29.0724	82.4262
9/12/15	11:40	Loggerhead Musk Turtle	*Sternotherus minor minor*	F	11.62		J				29.0715	82.4267
9/12/15	11:45	Suwannee Cooter	*Pseudemys cocinna*	M	26.3		J					
9/12/15	11:45	Suwannee Cooter	*Pseudemys cocinna*	J	13.48		J					
9/12/15	11:46	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	9.06		J					
9/12/15	11:46	Suwannee Cooter	*Pseudemys cocinna*	F	3.14		J					
9/12/15	11:46	Loggerhead Musk Turtle	*Sternotherus minor minor*	F	12.82		J					
9/12/15	11:46	Suwannee Cooter	*Pseudemys cocinna*	J	9.41		J					
9/12/15	11:50	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	10.53		J				29.0735	82.42614
9/12/15	11:50	Loggerhead Musk Turtle	*Sternotherus minor minor*	J	7.95		J				29.0735	82.42614
9/12/15	11:50	Suwannee Cooter	*Pseudemys cocinna*	M	23.1		J				29.0735	82.42614
9/12/15	11:50	Loggerhead Musk Turtle	*Sternotherus minor minor*	F	8.78		J				29.0735	82.42614
9/12/15	11:50	Loggerhead Musk Turtle	*Sternotherus minor minor*	U	9.6		J				29.0732	82.4261
9/12/15	11:53	Loggerhead Musk Turtle	*Sternotherus minor minor*	U	9.8		J					
9/12/15	11:55	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	10.39		J				29.0735	82.42632
9/12/15	11:55	Loggerhead Musk Turtle	*Sternotherus minor minor*	J	4.85		J				29.0735	82.42632
9/12/15	11:55	Suwannee Cooter	*Pseudemys cocinna*	M	23.4		J				29.0735	82.42632

Date	Time	Common Name	Species	Sex	SCL Midline (cm)	Plastron Length (cm)	New Drill	PIT tag #	Recapture from 9/15	Code	Latitude	Longitude
9/12/15	11:56	Suwannee Cooter	*Pseudemys cocinna*	M			J				29.0735	82.42641
9/12/15	11:57	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	8.76		J					
9/12/15	11:57	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	10.82		J					
9/12/15	12:02	Suwannee Cooter	*Pseudemys cocinna*	M	27.5			25793600		BKO		
9/12/15	12:02	Loggerhead Musk Turtle	*Sternotherus minor minor*	J	4.87		J					
9/12/15	12:02	Stinkpot	*Sternotherus odoratus*	M	6.6		J					
9/12/15	12:02	Suwannee Cooter	*Pseudemys cocinna*	J	7.15		J					
9/12/15	12:03	Suwannee Cooter	*Pseudemys cocinna*	F	15.7		J				29.0735	82.42642
9/12/15	12:03	Suwannee Cooter	*Pseudemys cocinna*	J	8.29		J				29.0748	82.42722
9/12/15	12:07	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	10		J					
9/12/15	12:07	Loggerhead Musk Turtle	*Sternotherus minor minor*	F	11.49		J					
9/12/15	12:07	Loggerhead Musk Turtle	*Sternotherus minor minor*	J	4.77		J					
9/12/15	12:08	Suwannee Cooter	*Pseudemys cocinna*	M	29		J				29.0746	82.4271
9/12/15	12:10	Loggerhead Musk Turtle	*Sternotherus minor minor*	J	6.5		J				29.0752	82.4276
9/12/15	12:11	Loggerhead Musk Turtle	*Sternotherus minor minor*	J	4.51		J					
9/12/15	12:11	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	69.7		J					
9/12/15	12:13	Suwannee Cooter	*Pseudemys cocinna*	F	37.1		J				29.0741	82.42735
9/12/15	12:16	Loggerhead Musk Turtle	*Sternotherus minor minor*	J	4.45		J					

Date	Time	Common Name	Species	Sex	SCL Midline (cm)	Plastron Length (cm)	New Drill	PIT tag #	Recapture from 9/15	Code	Latitude	Longitude
9/12/15	12:16	Loggerhead Musk Turtle	*Sternotherus minor minor*	J	4.97		J					
9/12/15	12:16	Loggerhead Musk Turtle	*Sternotherus minor minor*	J	4.85		J					
9/12/15	12:18	Loggerhead Musk Turtle	*Sternotherus minor minor*	J	4.94		J				29.0749	82.42751
9/12/15	12:19	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	10.2		J					
9/12/15	12:19	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	10.16		J					
9/12/15	12:19	Peninsular Cooter	*Pseudemys floridana*	M	29.4		J					
9/12/15	12:19	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	10.68		J					
9/12/15	12:19	Loggerhead Musk Turtle	*Sternotherus minor minor*	J	4.24		J				29.0749	82.42751
9/12/15	12:20	Loggerhead Musk Turtle	*Sternotherus minor minor*	J	4.84		J				29.0747	82.42743
9/12/15	12:26	Loggerhead Musk Turtle	*Sternotherus minor minor*	J	5.19		J					
9/12/15	12:40	Loggerhead Musk Turtle	*Sternotherus minor minor*	F	8.15		J					
9/12/15	12:40	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	9.92		J					
9/12/15	12:47	Peninsular Cooter	*Pseudemys floridana*	M	14.39		J					
9/12/15	12:47	Suwannee Cooter	*Pseudemys cocinna*	M	27.9		J					
9/12/15	13:00	Suwannee Cooter	*Pseudemys cocinna*	F	15.9		J					
9/12/15	13:00	Suwannee Cooter	*Pseudemys cocinna*	M	27.6		J					
9/12/15	13:02	Loggerhead Musk Turtle	*Sternotherus minor minor*	F	11.37		J				29.0802	82.42774

Date	Time	Common Name	Species	Sex	SCL Midline (cm)	Plastron Length (cm)	New Drill	PIT tag #	Recapture from 9/15	Code	Latitude	Longitude
9/12/15	13:02	Loggerhead Musk Turtle	*Sternotherus minor minor*	F	10.22						29.0802	82.42773
9/12/15	13:02	Peninsular Cooter	*Pseudemys floridana*	M	20.5		J				29.0802	82.4278
9/12/15	13:12	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	11.73		J					
9/12/15	13:12	Loggerhead Musk Turtle	*Sternotherus minor minor*	J	5.49		J					
9/12/15	13:12	Loggerhead Musk Turtle	*Sternotherus minor minor*	J	4.71		J					
9/12/15	13:13	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	11.65		J					
9/12/15	13:20	Suwannee Cooter	*Pseudemys cocinna*	F	16.4		J				29.0804	82.42789
9/12/15	13:26	Suwannee Cooter	*Pseudemys cocinna*	F	9.6		J					
9/12/15	13:30	Loggerhead Musk Turtle	*Sternotherus minor minor*	J	4.67		J					
9/12/15	13:30	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	10.82		I					
9/12/15	13:30	Loggerhead Musk Turtle	*Sternotherus minor minor*	F	9.02		J					
9/12/15	13:30	Loggerhead Musk Turtle	*Sternotherus minor minor*	F	7.68		J					
9/12/15	13:34	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	11.48		J					
9/12/15	13:36	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	7.24		J					
9/12/15	13:37	Loggerhead Musk Turtle	*Sternotherus minor minor*	F	7.84		J					
9/12/15	13:37	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	8.26		J					
9/12/15	13:40	Loggerhead Musk Turtle	*Sternotherus minor minor*	F	99.1		J					

Date	Time	Common Name	Species	Sex	SCL Midline (cm)	Plastron Length (cm)	New Drill	PIT tag #	Recapture from 9/15	Code	Latitude	Longitude
9/12/15	13:40	Suwannee Cooter	*Pseudemys cocinna*	M	11.01		J					
9/12/15	13:42	Peninsular Cooter	*Pseudemys floridana*	F	23.5		J					
9/12/15	13:42	Suwannee Cooter	*Pseudemys cocinna*	F	23.4		J					
9/12/15		Peninsular Cooter	*Pseudemys floridana*	M	21		J				29.0803	82.42793
9/12/15		Loggerhead Musk Turtle	*Sternotherus minor minor*	J	8.47		J				29.0803	82.42799
9/12/15		Loggerhead Musk Turtle	*Sternotherus minor minor*	F	10.38		J				29.0781	
9/12/15		Loggerhead Musk Turtle	*Sternotherus minor minor*	M	9.1		J				29.0781	
9/12/15		Peninsular Cooter	*Pseudemys floridana*	M	26.9		J	89039084		B		
9/12/15		Suwannee Cooter	*Pseudemys cocinna*	F	9.83		J					
9/12/15		Suwannee Cooter	*Pseudemys cocinna*	M	20.6		J					
9/12/15		Loggerhead Musk Turtle	*Sternotherus minor minor*	F	116.8		J					
9/12/15		Suwannee Cooter	*Pseudemys cocinna*	M	25.8		J				29.0811	82.42879
9/12/15		Suwannee Cooter	*Pseudemys cocinna*	M	17.6		J				29.0911	82.42879
9/12/15		Loggerhead Musk Turtle	*Sternotherus minor minor*	M	7.4		J				29.0811	82.4288
9/12/15		Suwannee Cooter	*Pseudemys cocinna*	F	11.6		J					
9/12/15		Loggerhead Musk Turtle	*Sternotherus minor minor*	F	11.5		J				29.0792	82.42764
9/12/15		Loggerhead Musk Turtle	*Sternotherus minor minor*	M	9.89		J				29.0784	82.4276
9/12/15		Suwannee Cooter	*Pseudemys cocinna*	J	7.26		J				29.0788	82.42768
9/12/15		Suwannee Cooter	*Pseudemys cocinna*	J	7.92		J				29.0788	82.42762
9/12/15		Suwannee Cooter	*Pseudemys cocinna*	F	33		J				29.0789	82.42742

Date	Time	Common Name	Species	Sex	SCL Midline (cm)	Plastron Length (cm)	New Drill	PIT tag #	Recapture from 9/15	Code	Latitude	Longitude
9/12/15		Loggerhead Musk Turtle	*Sternotherus minor minor*	F	11.1		J				29.0789	82.42751
9/12/15		Loggerhead Musk Turtle	*Sternotherus minor minor*	J	6.2		J				29.079	82.42757
9/12/15		Loggerhead Musk Turtle	*Sternotherus minor minor*	J	2.94		J				29.0789	82.42755
9/12/15		Suwannee Cooter	*Pseudemys cocinna*	F	28.3		J				29.0788	82.42746
9/12/15		Loggerhead Musk Turtle	*Sternotherus minor minor*	M	11		J				29.0789	82.42747
9/12/15		Loggerhead Musk Turtle	*Sternotherus minor minor*	J	7.3		J				29.0789	82.42743
9/12/15		Loggerhead Musk Turtle	*Sternotherus minor minor*	M	6.7		J				29.0784	82.42746
9/12/15		Loggerhead Musk Turtle	*Sternotherus minor minor*	J	4.77		J				29.0751	82.42761
9/12/15		Loggerhead Musk Turtle	*Sternotherus minor minor*	M	10.7		J				29.0783	82.42753
9/12/15		Suwannee Cooter	*Pseudemys cocinna*	J	8.82		J				29.0781	82.42758
9/12/15		Loggerhead Musk Turtle	*Sternotherus minor minor*	J	7.9		J				29.0786	82.4251
2/13/16	14:24	Suwannee Cooter	*Pseudemys cocinna*	F	19.5		O				29.0811	82.42871
2/13/16	14:26	Suwannee Cooter	*Pseudemys cocinna*	M	26.3		O	89291 354			29.0813	82.42873
2/13/16	14:18	Suwannee Cooter	*Pseudemys cocinna*	F	35.4		O				29.0809	82.42856
2/13/16	14:19	Suwannee Cooter	*Pseudemys cocinna*	M	26.2		O		J	AB	29.0809	82.42856
2/13/16	14:15	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	9.06						29.0808	82.42858
2/13/16	14:15	Suwannee Cooter	*Pseudemys cocinna*	F	25.2		O		J		29.0808	82.42858
2/13/16	14:10	Suwannee Cooter	*Pseudemys cocinna*	M	25.9		O	10255 0365	J	ABH	29.0806	82.285
2/13/16	14:12	Suwannee Cooter	*Pseudemys cocinna*	F	17		O				29.0757	82.35928

Date	Time	Common Name	Species	Sex	SCL Midline (cm)	Plastron Length (cm)	New Drill	PIT tag #	Recapture from 9/15	Code	Latitude	Longitude
2/13/16	13:58	Suwannee Cooter	*Pseudemys cocinna*	F			O			OK	29.0793	82.42738
2/13/16	14:03	Suwannee Cooter	*Pseudemys cocinna*	M	24.25						29.0801	82.2809
2/13/16	13:49	Suwannee Cooter	*Pseudemys cocinna*	F	32.5					K	29.0779	82.42751
2/13/16	13:56	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	9.9		O				29.0791	82.42744
2/13/16	13:45	Loggerhead Musk Turtle	*Sternotherus minor minor*	J	8.3						29.0782	82.42729
2/13/16	13:49	Loggerhead Musk Turtle	*Sternotherus minor minor*	F	11.7		O				29.0787	82.4277
2/13/16	13:31	Loggerhead Musk Turtle	*Sternotherus minor minor*	J	6.7						29.0781	82.42751
2/13/16	13:35	Loggerhead Musk Turtle	*Sternotherus minor minor*	F	10.8		O				29.0786	82.42784
2/13/16	13:06	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	9.4		O				29.0781	82.42746
2/13/16		Loggerhead Musk Turtle	*Sternotherus minor minor*	F	11.6		O				29.0754	82.42775
2/13/16	12:59	Loggerhead Musk Turtle	*Sternotherus minor minor*	F	12.7		O				29.0774	82.42768
2/13/16	13:01	Florida Snapping Turtle	*Chelydra serpentina osceola*	U	31.5		O				29.0733	82.42748
2/13/16	12:42	Florida Redbelly Cooter	*Pseudemys nelsoni*	M	24.3		O				29.0769	82.42737
2/13/16	12:47	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	9.3		O				29.0767	82.42769
2/13/16	12:51	Suwannee Cooter	*Pseudemys cocinna*	F	14.1		O				29.0778	82.42751
2/13/16	12:55	Loggerhead Musk Turtle	*Sternotherus minor minor*	J	6.3						29.078	82.42754
2/13/16	12:25	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	6.5						29.075	82.42738

Date	Time	Common Name	Species	Sex	SCL Midline (cm)	Plastron Length (cm)	New Drill	PIT tag #	Recapture from 9/15	Code	Latitude	Longitude
2/13/16	12:25	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	11.5		O				29.0753	82.42749
2/13/16	12:25	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	11		O				29.075	82.42738
2/13/16	12:33	Suwannee Cooter	*Pseudemys cocinna*	M	27.4		O				29.0752	82.42764
2/13/16	12:21	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	7.2						29.0748	82.42721
2/13/16	12:21	Suwannee Cooter	*Pseudemys cocinna*	M	32		O				29.0748	82.42721
2/13/16	12:20	Suwannee Cooter	*Pseudemys cocinna*	M	27.8		O				29.0748	82.42721
2/13/16	12:21	Suwannee Cooter	*Pseudemys cocinna*	M	28.7		O				29.0748	82.42721
2/13/16	11:59	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	9.08		O				29.0737	82.42647
2/13/16	12:00	Suwannee Cooter	*Pseudemys cocinna*	F	35.5		O	64296 601	J		29.0737	82.42647
2/13/16	12:05	Suwannee Cooter	*Pseudemys cocinna*	F	26.4		O				29.0742	82.42684
2/13/16	12:07	Suwannee Cooter	*Pseudemys cocinna*	M	24		O				29.0743	82.42677
2/13/16	12:09	Peninsular Cooter	*Pseudemys floridana*	M	21		O		J		29.0743	82.4267
2/13/16	12:09	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	12.3		O				29.0743	82.4267
2/13/16	12:12	Suwannee Cooter	*Pseudemys cocinna*	M	25.5					UO	29.0743	82.4267
2/13/16	12:12	Suwannee Cooter	*Pseudemys cocinna*	M	28.7		O				29.0748	82.42706
2/13/16	11:54	Suwannee Cooter	*Pseudemys cocinna*	F	38						29.0738	82.42646
2/13/16	11:57	Peninsular Cooter	*Pseudemys floridana*	F	31.3		O				29.0738	82.42646
2/13/16	11:39	Suwannee Cooter	*Pseudemys cocinna*	F	35		JO				29.074	82.42683
2/13/16	11:49	Loggerhead Musk Turtle	*Sternotherus minor minor*	F	89.3		O				29.0744	82.42677
2/13/16	13:09	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		7.65	O				29.0477	82.25644

Date	Time	Common Name	Species	Sex	SCL Midline (cm)	Plastron Length (cm)	New Drill	PIT tag #	Recapture from 9/15	Code	Latitude	Longitude
2/13/16	13:04	Loggerhead Musk Turtle	*Sternotherus minor minor*	J		3.56					29.0495	82.257
2/13/16	13:07	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		7.96	O				29.0483	82.25714
2/13/16	10:42	Suwannee Cooter	*Pseudemys cocinna*	F		23.3					29.0423	82.2235
2/13/16	10:43	Loggerhead Musk Turtle	*Sternotherus minor minor*	F		6.97	O				29.0432	82.25578
2/13/16	10:46	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		3.23					29.045	82.25584
2/13/16	10:48	Unknown	*#N/A*	U		32.6					29.045	82.25584
2/13/16	10:55	Loggerhead Musk Turtle	*Sternotherus minor minor*	J		3.51					29.0414	82.245644
2/13/16	10:57	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		9.51					29.0415	82.245639
2/13/16	10:53	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		8.3	O				29.0426	82.25607
2/13/16	10:53	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		5.95					29.0417	82.25615
2/13/16	10:56	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		5.77					29.0414	82.25634
2/13/16	11:09	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		4.79					29.0421	82.25617
2/13/16	10:50	Peninsular Cooter	*Pseudemys floridana*	F		27.9	O				29.0415	82.25611
2/13/16	10:53	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		4.98					29.0415	82.25635
2/13/16	11:12	Loggerhead Musk Turtle	*Sternotherus minor minor*	J		2.28					29.0421	82.25613
2/13/16	11:15	Suwannee Cooter	*Pseudemys cocinna*	F		9.68	O				29.0422	82.2561
2/13/16	11:19	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		5.72	O				29.0429	82.25605

Date	Time	Common Name	Species	Sex	SCL Midline (cm)	Plastron Length (cm)	New Drill	PIT tag #	Recapture from 9/15	Code	Latitude	Longitude
2/13/16	11:21	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		7.25	O				29.045	82.25573
2/13/16	11:26	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		4.97	O				29.0433	82.25589
2/13/16	11:27	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		8.6	O				29.0433	82.25589
2/13/16	11:22	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		5.87	O				29.0432	82.25595
2/13/16	11:23	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		7.79	O				29.0452	82.25597
2/13/16	11:40	Loggerhead Musk Turtle	*Sternotherus minor minor*	J		5.39					29.0436	82.25566
2/13/16	11:46	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		6.91	O				29.044	82.25594
2/13/16	11:47	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		7.14	O				29.0441	82.25596
2/13/16	11:50	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		6.66	O				29.0444	82.25602
2/13/16	12:01	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		6.13	O				29.0449	82.25639
2/13/16	12:02	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		6.65	O		J		29.0446	82.25626
2/13/16	12:11	Loggerhead Musk Turtle	*Sternotherus minor minor*	J		3.12					29.0456	82.25652
2/13/16	12:14	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		6.35					29.046	82.25648
2/13/16	12:21	Suwannee Cooter	*Pseudemys cocinna*	M		23.8					29.0482	82.25685
2/13/16	12:21	Suwannee Cooter	*Pseudemys cocinna*	F		29.3	O		J		29.0483	82.25686
2/13/16	12:26	Suwannee Cooter	*Pseudemys cocinna*	M		21.4	O				29.0478	82.25642
2/13/16	12:27	Peninsular Cooter	*Pseudemys floridana*	F	28.95		O				29.0476	82.25647

Date	Time	Common Name	Species	Sex	SCL Midline (cm)	Plastron Length (cm)	New Drill	PIT tag #	Recapture from 9/15	Code	Latitude	Longitude
2/13/16	12:05	Loggerhead Musk Turtle	*Sternotherus minor minor*	F		7.45					29.0446	82.25628
2/13/16	12:31	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		7.45					29.0471	82.27658
2/13/16	11:20	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		8.48					29.043	82.25601
2/13/16	11:41	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		5.1					29.0437	82.25587
2/13/16	12:28	Loggerhead Musk Turtle	*Sternotherus minor minor*	J		0.88					29.0472	82.25658
2/13/16	12:29	Peninsular Cooter	*Pseudemys floridana*	M		20.5	O				29.0471	82.25652
2/13/16	12:32	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		8.4	O				29.0471	82.25658
2/13/16	12:33	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		4.95					29.0478	82.25656
2/13/16	12:40	Suwannee Cooter	*Pseudemys cocinna*	M		24.5		44545 890			29.0485	82.2572
2/13/16	12:44	Suwannee Cooter	*Pseudemys cocinna*	M		21.45	O	10255 03650		P	29.0486	82.25733
2/13/16	12:30	Suwannee Cooter	*Pseudemys cocinna*	F		8.91	O				29.0477	82.25648
2/13/16	12:37	Suwannee Cooter	*Pseudemys cocinna*	F		29.6	O				29.0477	82.25641
2/13/16	12:40	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		9.25					29.0485	82.2572
2/13/16	12:40	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		5.63					29.0487	82.25729
2/13/16	12:34	Loggerhead Musk Turtle	*Sternotherus minor minor*	F		8.18	J				29.0478	82.25651
2/13/16	12:36	Florida Redbelly Cooter	*Pseudemys nelsoni*	M		22.3	O		J		29.0476	82.25649
2/13/16	12:46	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		7.74	O				29.0488	82.25724

Date	Time	Common Name	Species	Sex	SCL Midline (cm)	Plastron Length (cm)	New Drill	PIT tag #	Recapture from 9/15	Code	Latitude	Longitude
2/13/16	12:48	Loggerhead Musk Turtle	*Sternotherus minor minor*	F		9.13	O				29.0488	82.25733
2/13/16	12:48	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		8.43	O				29.0488	82.25741
2/13/16	12:50	Suwannee Cooter	*Pseudemys cocinna*	M		22.2					29.0489	82.25728
2/13/16	12:51	Suwannee Cooter	*Pseudemys cocinna*	F		22.4	O				29.0459	82.25727
2/13/16	12:52	Suwannee Cooter	*Pseudemys cocinna*	M		21.7	O				29.0494	82.25704
2/13/16	12:48	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		5.02	O				29.0488	82.25733
2/13/16	12:46	Loggerhead Musk Turtle	*Sternotherus minor minor*	F	3.95						29.0488	82.25748
2/13/16	12:59	Suwannee Cooter	*Pseudemys cocinna*	F		30.5	O				29.0502	82.25735
2/13/16	13:01	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		6.81	O				29.0502	82.25735
2/13/16	12:53	Suwannee Cooter	*Pseudemys cocinna*	M		19.6	O				29.0495	82.25701
2/13/16	12:55	Suwannee Cooter	*Pseudemys cocinna*	F		24.1					29.0494	82.25728
2/13/16	13:03	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		6.8					29.0495	82.25708
2/13/16	13:04	Loggerhead Musk Turtle	*Sternotherus minor minor*	M		7.43					29.0495	82.25703
2/13/16	12:55	Florida Redbelly Cooter	*Pseudemys nelsoni*	F		25.25	O				29.0494	82.25728
2/13/16	13:01	Suwannee Cooter	*Pseudemys cocinna*	F		8.34					29.0501	82.25726
2/13/16	13:15	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	18.04		O				29.0819	82.4286
2/13/16	13:12	Suwannee Cooter	*Pseudemys cocinna*	F	29.1		O				29.0812	82.4288
2/13/16	13:05	Peninsular Cooter	*Pseudemys floridana*	F	13.7		O				29.0806	82.42839
2/13/16	13:00	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	26.7		O				29.0796	82.42729

Date	Time	Common Name	Species	Sex	SCL Midline (cm)	Plastron Length (cm)	New Drill	PIT tag #	Recapture from 9/15	Code	Latitude	Longitude
2/13/16	13:01	Loggerhead Musk Turtle	*Sternotherus minor minor*	J	29.8		O				29.0791	82.42743
2/13/16	13:55	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	25.02		O				29.0802	82.42761
2/13/16	13:00	Loggerhead Musk Turtle	*Sternotherus minor minor*	F	10.55		O				29.0797	82.42721
2/13/16	13:46	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	14.02		O				29.0798	82.42764
2/13/16	13:50	Suwannee Cooter	*Pseudemys cocinna*	M	27.2		O				29.0801	82.42776
2/13/16	12:06	Suwannee Cooter	*Pseudemys cocinna*	F	21.8		O				29.0734	82.42628
2/13/16	12:10	Loggerhead Musk Turtle	*Sternotherus minor minor*	F	10.4		O				29.0739	82.42645
2/13/16	12:01	Suwannee Cooter	*Pseudemys cocinna*	F	21.5						29.0734	82.42628
2/13/16	12:05	Loggerhead Musk Turtle	*Sternotherus minor minor*	J	7.35		O				29.0733	82.42617
2/13/16	12:40	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	9.48		O				29.074	82.4269
2/13/16	12:45	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	12.84		O				29.0742	82.42719
2/13/16	12:45	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	11.8		O				29.0742	82.42719
2/13/16	12:50	Loggerhead Musk Turtle	*Sternotherus minor minor*	F	11.53		O				29.0749	82.42728
2/13/16	12:55	Loggerhead Musk Turtle	*Sternotherus minor minor*	F	11.2		O				29.075	82.42765
2/13/16	13:00	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	9.99		O				29.0751	82.42763
2/13/16	12:53	Loggerhead Musk Turtle	*Sternotherus minor minor*	J	6.66		O				29.0751	82.42738
2/13/16	12:55	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	8.21		O				29.0749	82.42766

Date	Time	Common Name	Species	Sex	SCL Midline (cm)	Plastron Length (cm)	New Drill	PIT tag #	Recapture from 9/15	Code	Latitude	Longitude
2/13/16	11:55	Suwannee Cooter	*Pseudemys cocinna*	M	30		O				29.0733	82.42648
2/13/16	12:00	Suwannee Cooter	*Pseudemys cocinna*	M	19.3		O				29.073	82.42587
2/13/16	11:47	Loggerhead Musk Turtle	*Sternotherus minor minor*	J	4.96		O					
2/13/16	11:50	Suwannee Cooter	*Pseudemys cocinna*	J	10.56		O					
2/13/16	12:13	Peninsular Cooter	*Pseudemys floridana*	F	32.5		O				29.0734	82.42648
2/13/16	12:18	Suwannee Cooter	*Pseudemys cocinna*	M	20.3		O				29.0732	82.42648
2/13/16	12:20	Peninsular Cooter	*Pseudemys floridana*	M	18.6		O				29.0735	82.42664
2/13/16	13:07	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	8.42		O				29.0765	82.42766
2/13/16	13:10	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	8.6		O				29.0771	82.42747
2/13/16	13:01	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	8.24		O				29.0767	82.42753
2/13/16	13:01	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	6.36		O				29.0767	82.42753
2/13/16	12:36	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	10.7		O				29.0737	82.42681
2/13/16	12:37	Loggerhead Musk Turtle	*Sternotherus minor minor*	J	3.89						29.0732	82.42654
2/13/16	12:25	Suwannee Cooter	*Pseudemys cocinna*	M	25.9		O				29.0738	82.42657
2/13/16	12:31	Loggerhead Musk Turtle	*Sternotherus minor minor*	J	3.37						29.0732	82.42665
2/13/16	13:40	Suwannee Cooter	*Pseudemys cocinna*	J	9.64		O				29.0791	82.421739
2/13/16	13:45	Loggerhead Musk Turtle	*Sternotherus minor minor*	F	10.54		O				29.0792	82.4274
2/13/16	13:23	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	10.3		O				29.0767	82.42777

Date	Time	Common Name	Species	Sex	SCL Midline (cm)	Plastron Length (cm)	New Drill	PIT tag #	Recapture from 9/15	Code	Latitude	Longitude
2/13/16	13:25	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	10.15		O				29.0761	82.42776
2/13/16	13:16	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	6.81		O				29.0077	82.42749
2/13/16	13:23	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	7.41		O				29.0767	82.42777
2/13/16	13:15	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	7.36		O				29.0777	82.42773
2/13/16	13:16	Loggerhead Musk Turtle	*Sternotherus minor minor*	M	7.79		O				29.0779	82.42747

Appendix H

Human Use Surveys – August/September 2015 and February 2016

Rainbow River Human Use Survey – August/September 2015

		Average (Person-Hrs)									Average (# People)								
		Weekday			Weekend			Total			Weekday			Weekend			Total		
	Activity	RSR-1	RSR-6	Dock 3	RSR-1	RSR-6	Dock 3	RSR-1	RSR-6	Dock 3	RSR-1	RSR-6	Dock 3	RSR-1	RSR-6	Dock 3	RSR-1	RSR-6	Dock 3
In-Water	Wading	0.7	0.3	0.0	8.5	0.0	1.8	2.3	0.2	0.9	0.1	0.0	0.0	1.0	0.0	0.3	0.3	0.0	0.1
	Bathing	0.1	0.0	0.0	3.8	0.0	4.4	0.8	0.0	2.2	0.0	0.0	0.0	0.4	0.0	0.7	0.1	0.0	0.3
	Swimming	0.9	0.3	0.0	12.5	3.8	2.6	3.2	1.2	1.3	0.1	0.1	0.0	1.5	0.8	0.4	0.4	0.2	0.2
	Snorkeling	0.5	2.3	0.8	1.3	0.8	1.3	0.7	1.9	1.0	0.1	0.3	0.1	0.1	0.2	0.2	0.1	0.3	0.2
	SCUBA	0.0	1.3	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.0
	Tubing	15.5	25.5	3.6	303.5	393.0	142.8	73.1	117.4	73.2	2.6	4.1	0.6	35.7	82.7	23.0	9.3	17.1	11.8
	Canoeing/ Kayaking	6.3	6.3	7.6	33.0	60.0	59.9	11.7	19.7	33.8	1.1	1.1	1.2	3.9	12.6	9.7	1.7	2.9	5.4
	Power Boating	1.4	7.3	2.0	31.3	38.0	44.1	7.4	15.0	23.1	0.3	1.3	0.3	3.7	8.0	7.1	0.9	2.3	3.7
	Tour Boating	0.0	0.0	0.3	0.0	8.3	3.0	0.0	2.1	1.6	0.0	0.0	0.0	0.0	1.7	0.5	0.0	0.3	0.3
	Fishing	0.0	0.0	0.0	0.8	3.3	5.4	0.2	0.8	2.7	0.0	0.0	0.0	0.1	0.7	0.9	0.0	0.1	0.4
	Other	4.9	0.0	0.0	0.0	5.3	0.0	3.9	1.3	0.0	0.8	0.0	0.0	0.0	1.1	0.0	0.7	0.2	0.0
	Total	30.3	43.3	14.3	394.5	512.3	265.1	103.1	160.5	139.7	5.2	7.0	2.2	46.4	107.8	42.8	13.4	23.6	22.5
Out-of-Water	Sitting	2.8	0.3	1.0	10.8	4.8	9.9	4.4	1.4	5.4	0.5	0.1	0.1	1.3	1.0	1.6	0.7	0.2	0.9
	Walking	2.3	0.0	0.8	0.0	0.0	0.0	1.9	0.0	0.4	0.4	0.0	0.1	0.0	0.0	0.0	0.3	0.0	0.1
	Sunbathing	0.0	0.3	0.0	4.8	0.0	0.0	1.0	0.2	0.0	0.0	0.1	0.0	0.6	0.0	0.0	0.1	0.0	0.0
	Nature Study	3.3	0.0	0.5	0.3	0.0	0.0	2.7	0.0	0.3	0.6	0.0	0.1	0.0	0.0	0.0	0.5	0.0	0.0
	Other	0.3	0.2	0.0	2.8	0.0	0.0	0.8	0.1	0.0	0.1	0.0	0.0	0.3	0.0	0.0	0.1	0.0	0.0
	Total	8.7	0.7	2.3	18.5	4.8	9.9	10.7	1.7	6.1	1.5	0.1	0.4	2.2	1.0	1.6	1.7	0.3	1.0
Total		38.9	43.9	16.5	413.0	517.0	275.0	113.8	162.2	145.8	6.7	7.2	2.6	48.6	108.8	44.4	15.1	23.8	23.5

Note(s):

Hours of Observations:	22.8	18.0	12.0	8.5	7.0	12.5	31.3	25.0	24.5
RSR-1 Survey Area (ac):	4.1								
RSR-6 Survey Area (ac):	3.9								
Dock 3 Survey Area (ac):	4.0								

Rainbow River Human Use Survey - February 2016

		Monday		Saturday	Average (# People)			Average (# People/ha)		
		2/8/16		2/13/16	2/8/16		2/13/16	2/8/16		2/13/16
	Activity	RSR-1	RSR-6	Dock 3	RSR-1	RSR-6	Dock 3	RSR-1	RSR-6	Dock 3
In-Water	Wading	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Bathing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Swimming	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Snorkeling	0.0	0.0	4.5	0.0	0.0	1.5	0.0	0.0	0.9
	SCUBA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Tubing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Canoeing/ Kayaking	1.8	0.8	11.3	0.4	0.2	3.8	0.2	0.2	2.3
	Power Boating	7.5	4.3	12.8	1.6	1.3	4.3	1.0	0.9	2.6
	Tour Boating	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Fishing	0.5	0.0	0.5	0.1	0.0	0.2	0.1	0.0	0.1
	Other	4.0	1.0	0.0	0.8	0.3	0.0	0.5	0.2	0.0
	Total	13.8	6.0	29.0	2.9	1.9	9.7	1.7	1.2	6.0
Out-of-Water	Sitting	1.3	0.0	3.3	0.3	0.0	1.1	0.2	0.0	0.7
	Walking	3.3	0.0	4.5	0.7	0.0	1.5	0.4	0.0	0.9
	Sunbathing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Nature Study	4.3	0.0	0.0	0.9	0.0	0.0	0.5	0.0	0.0
	Other	0.5	0.0	0.5	0.1	0.0	0.2	0.1	0.0	0.1
	Total	9.3	0.0	8.3	1.9	0.0	2.8	1.2	0.0	1.7
Total		23.0	6.0	37.3	4.8	1.9	12.4	2.9	1.2	7.7

Note(s):

Hours of Observations:	4.8	3.2	3.0
RSR-1 Survey Area (ac):	4.1		
RSR-6 Survey Area (ac):	3.9		
Dock 3 Survey Area (ac):	4.0		

Human Use Surveys – August/September 2015 (Person-Hrs)

		Monday			Wednesday			Saturday		Sunday		Thursday	Friday	
		8/31/15			9/2/15			9/5/15		9/6/15		9/10/15	9/11/15	
	Activity	RSR-1	RSR-6	Dock 3	RSR-1	RSR-6	Dock 3	RSR-1	Dock 3	RSR-6	Dock 3	RSR-1	RSR-1	RSR-6
In-Water	Wading	0.0	0.0	0.0	0.5	0.0	0.0	8.5	0.0	0.0	3.5	0.3	2.0	0.8
	Bathing	0.0	0.0	0.0	0.0	0.0	0.0	3.8	7.8	0.0	1.0	0.0	0.3	0.0
	Swimming	0.0	0.3	0.0	1.5	0.0	0.0	12.5	2.8	3.8	2.5	0.3	1.8	0.8
	Snorkeling	0.3	0.5	1.5	0.3	5.8	0.0	1.3	0.0	0.8	2.5	0.5	1.0	0.5
	SCUBA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0
	Tubing	3.5	4.5	2.3	18.0	16.5	5.0	303.5	126.5	393.0	159.0	12.0	28.5	55.5
	Canoeing/ Kayaking	1.3	6.0	2.5	8.8	7.3	12.8	33.0	41.3	60.0	78.5	9.5	5.8	5.5
	Power Boating	0.0	8.0	0.0	0.3	5.8	4.0	31.3	32.8	38.0	55.5	2.3	3.3	8.3
	Tour Boating	0.0	0.0	0.0	0.0	0.0	0.5	0.0	1.8	8.3	4.3	0.0	0.0	0.0
	Fishing	0.0	0.0	0.0	0.0	0.0	0.0	0.8	6.8	3.3	4.0	0.0	0.0	0.0
	Other	8.3	0.0	0.0	8.8	0.0	0.0	0.0	0.0	5.3	0.0	0.0	2.5	0.0
	Total	13.3	19.3	6.3	38.0	35.3	22.3	394.5	219.5	512.3	310.8	24.8	45.0	75.3
Out-of-Water	Sitting	4.3	0.8	0.0	0.0	0.0	2.0	10.8	0.0	4.8	19.8	3.3	3.5	0.0
	Walking	2.3	0.0	0.0	3.3	0.0	1.5	0.0	0.0	0.0	0.0	0.8	3.0	0.0
	Sunbathing	0.0	0.8	0.0	0.0	0.0	0.0	4.8	0.0	0.0	0.0	0.0	0.0	0.0
	Nature Study	7.3	0.0	1.0	6.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
	Other	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	1.3	0.5
	Total	13.8	1.5	1.0	9.3	0.0	3.5	18.5	0.0	4.8	19.8	4.0	7.8	0.5
Total		27.0	20.8	7.3	47.3	35.3	25.8	413.0	219.5	517.0	330.5	28.8	52.8	75.8

Note(s):

Hours of Observations:	5.3	4.8	5.3	6.3	7.0	6.8	8.5	6.5	7.0	6.0	5.3	6.0	6.3
RSR-1 Survey Area (ac):	4.1												
RSR-6 Survey Area (ac):	3.9												
Dock 3 Survey Area (ac):	4.0												

Human Use Surveys – February 2016 (Person-Hrs)

	Activity	Monday 2/8/16 RSR-1	Monday 2/8/16 RSR-6	Saturday 2/13/16 Dock 3
In-Water	Wading	0.0	0.0	0.0
	Bathing	0.0	0.0	0.0
	Swimming	0.0	0.0	0.0
	Snorkeling	0.0	0.0	4.5
	SCUBA	0.0	0.0	0.0
	Tubing	0.0	0.0	0.0
	Canoeing/ Kayaking	1.8	0.8	11.3
	Power Boating	7.5	4.3	12.8
	Tour Boating	0.0	0.0	0.0
	Fishing	0.5	0.0	0.5
	Other	4.0	1.0	0.0
	Total	13.8	6.0	29.0
Out-of-Water	Sitting	1.3	0.0	3.3
	Walking	3.3	0.0	4.5
	Sunbathing	0.0	0.0	0.0
	Nature Study	4.3	0.0	0.0
	Other	0.5	0.0	0.5
	Total	9.3	0.0	8.3
Total		23.0	6.0	37.3

Note(s):

Hours of Observations:	4.8	3.2	3.0
RSR-1 Survey Area (ac):	4.1		
RSR-6 Survey Area (ac):	3.9		
Dock 3 Survey Area (ac):	4.0		

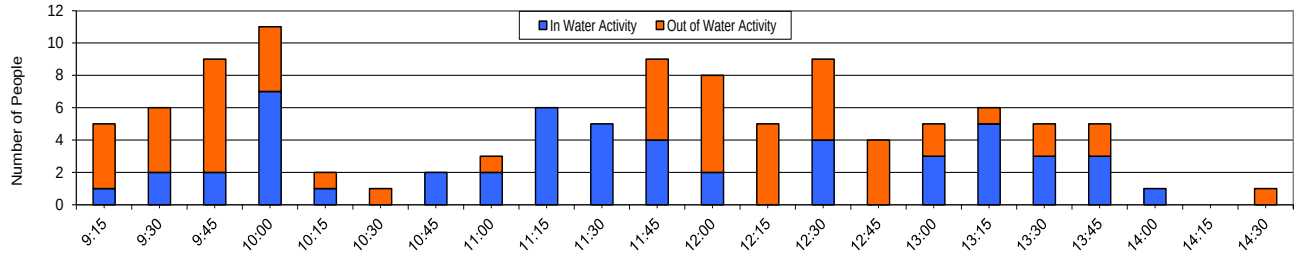
Human Use Activity Summary

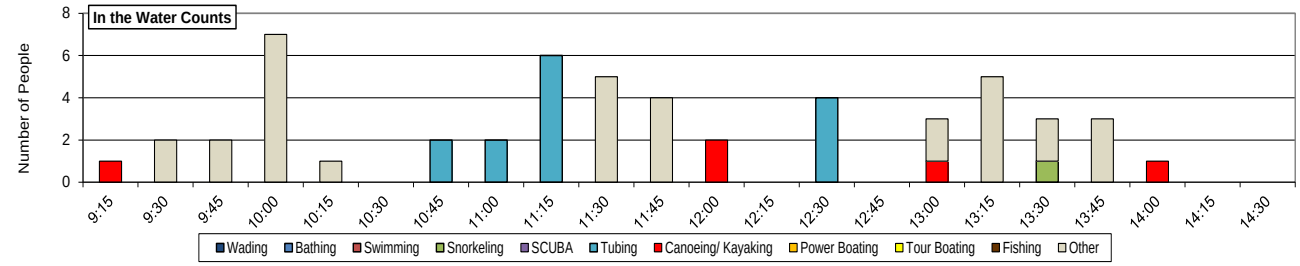
Site Rainbow River @ RSR-1 **Date** 8/31/2015 **Survey Period** 9:15 14:30

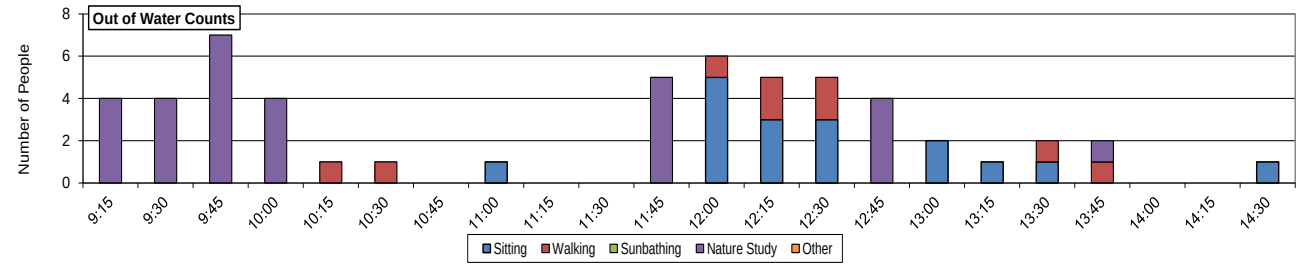
	Numbers of People																	
	In Water Activity											Out of Water Activity						
Time	Wading	Bathing	Swimming	Snorkeling	SCUBA	Tubing	Canoeing/ Kayaking	Power Boating	Tour Boating	Fishing	Other	Total	Sitting	Walking	Sunbathing	Nature Study	Other	Total
9:15							1					1				4		4
9:30											2	2				4		4
9:45											2	2				7		7
10:00											7	7				4		4
10:15											1	1		1				1
10:30												0		1				1
10:45						2						2						0
11:00						2						2	1					1
11:15						6						6						0
11:30											5	5						0
11:45											4	4				5		5
12:00							2					2	5	1				6
12:15												0	3	2				5
12:30						4						4	3	2				5
12:45												0				4		4
13:00							1				2	3	2					2
13:15											5	5	1					1
13:30				1							2	3	1	1				2
13:45											3	3		1		1		2
14:00							1					1						0
14:15												0						0
14:30												0	1					1
Total	0	0	0	1	0	14	5	0	0	0	33	53	17	9	0	29	0	55
Person-Hrs	0.00	0.00	0.00	0.25	0.00	3.50	1.25	0.00	0.00	0.00	8.25	13.25	4.25	2.25	0.00	7.25	0.00	13.75
Percentage	0.0%	0.0%	0.0%	1.9%	0.0%	26.4%	9.4%	0.0%	0.0%	0.0%	62.3%	100.0%	30.9%	16.4%	0.0%	52.7%	0.0%	100.0%

Note(s):
'Other' In Water Activity = Nature Study

Average Time Interval (hrs): 0.25







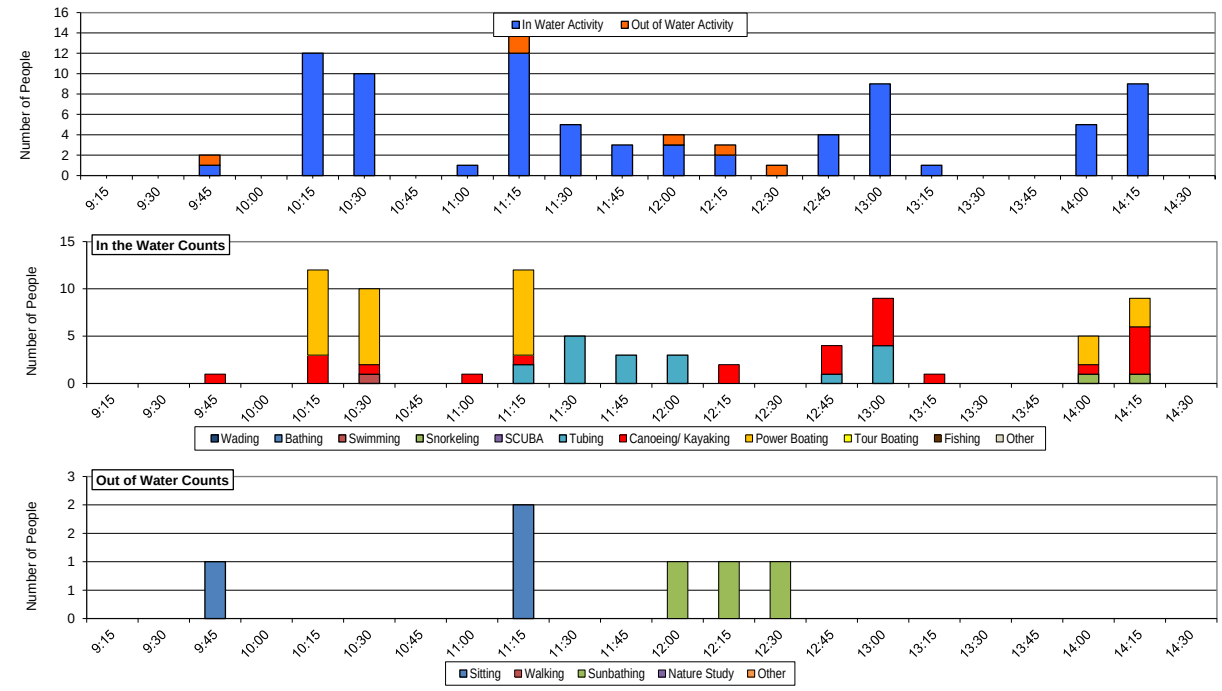
Human Use Activity Summary

Site Rainbow River @ RSR-6 **Date** 8/31/2015 **Survey Period** 9:45 14:30

	Numbers of People																	
	In Water Activity												Out of Water Activity					
Time	Wading	Bathing	Swimming	Snorkeling	SCUBA	Tubing	Canoeing/ Kayaking	Power Boating	Tour Boating	Fishing	Other	Total	Sitting	Walking	Sunbathing	Nature Study	Other	Total
9:15												0						0
9:30												0						0
9:45							1					1	1					1
10:00												0						0
10:15							3	9				12						0
10:30			1				1	8				10						0
10:45												0						0
11:00							1					1						0
11:15						2	1	9				12	2					2
11:30						5						5						0
11:45						3						3						0
12:00						3						3			1			1
12:15							2					2			1			1
12:30												0			1			1
12:45						1	3					4						0
13:00						4	5					9						0
13:15							1					1						0
13:30												0						0
13:45												0						0
14:00				1			1	3				5						0
14:15				1			5	3				9						0
14:30												0						0
Total	0	0	1	2	0	18	24	32	0	0	0	77	3	0	3	0	0	6
Person-Hrs	0.00	0.00	0.25	0.50	0.00	4.50	6.00	8.00	0.00	0.00	0.00	19.25	0.75	0.00	0.75	0.00	0.00	1.50
Percentage	0.0%	0.0%	1.3%	2.6%	0.0%	23.4%	31.2%	41.6%	0.0%	0.0%	0.0%	100.0%	50.0%	0.0%	50.0%	0.0%	0.0%	100.0%

Note(s):
'Other' In Water Activity = Nature Study

Average Time Interval (hrs): 0.25



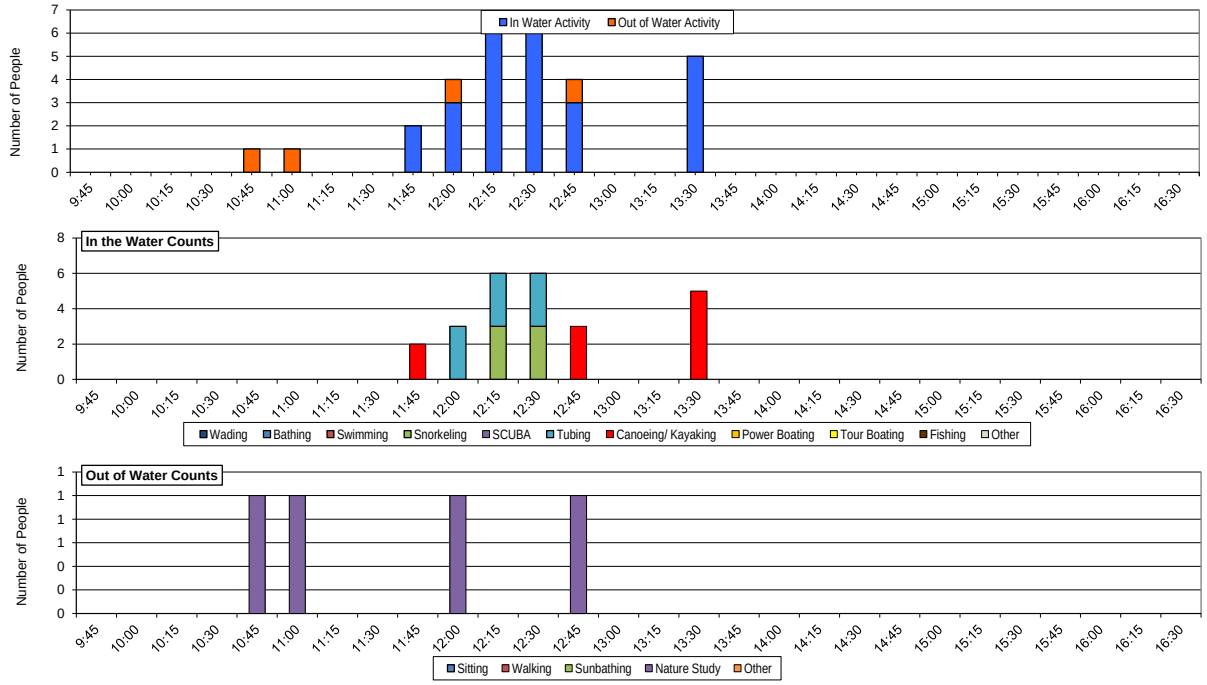
Human Use Activity Summary

Site Rainbow River @ Dock 3 **Date** 8/31/2015 **Survey Period** 10:15 15:30

	Numbers of People																
	In Water Activity											Out of Water Activity					
Time	Wading	Bathing	Swimming	Snorkeling	SCUBA	Tubing	Canoeing/ Kayaking	Power Boating	Tour Boating	Fishing	Other	Total	Sitting	Walking	Sunbathing	Nature Study	Other	Total
9:45												0						0
10:00												0						0
10:15												0						0
10:30												0						0
10:45												0				1		1
11:00												0				1		1
11:15												0						0
11:30												0						0
11:45							2					2						0
12:00						3						3				1		1
12:15				3		3						6						0
12:30				3		3						6						0
12:45							3					3				1		1
13:00												0						0
13:15												0						0
13:30							5					5						0
13:45												0						0
14:00												0						0
14:15												0						0
14:30												0						0
14:45												0						0
15:00												0						0
15:15												0						0
15:30												0						0
15:45												0						0
16:00												0						0
16:15												0						0
16:30												0						0
Total	0	0	0	6	0	9	10	0	0	0	0	25	0	0	0	4	0	4
Person-Hrs	0.00	0.00	0.00	1.50	0.00	2.25	2.50	0.00	0.00	0.00	0.00	6.25	0.00	0.00	0.00	1.00	0.00	1.00
Percentage	0.0%	0.0%	0.0%	24.0%	0.0%	36.0%	40.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%

Note(s):
'Other' In Water Activity = Nature Study

Average Time Interval (hrs): 0.25



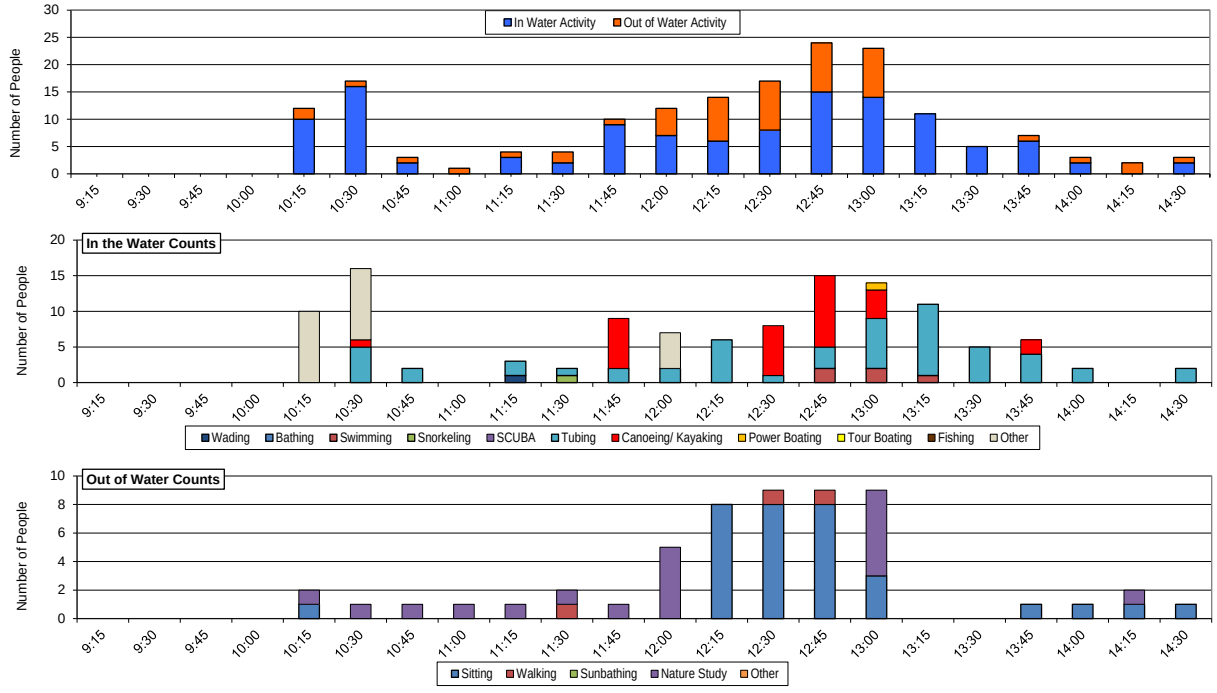
Human Use Activity Summary

Site Rainbow River @ RSR-1 **Date** 9/2/2015 **Survey Period** 10:15 16:30

	Numbers of People																	
	In Water Activity											Out of Water Activity						
Time	Wading	Bathing	Swimming	Snorkeling	SCUBA	Tubing	Canoeing/ Kayaking	Power Boating	Tour Boating	Fishing	Other	Total	Sitting	Walking	Sunbathing	Nature Study	Other	Total
9:15												0						0
9:30												0						0
9:45												0						0
10:00												0						0
10:15											10	10	1			1		2
10:30						5	1				10	16				1		1
10:45						2						2				1		1
11:00												0				1		1
11:15	1					2						3				1		1
11:30				1		1						2		1		1		2
11:45						2	7					9				1		1
12:00						2					5	7				5		5
12:15						6						6	8					8
12:30						1	7					8	8	1				9
12:45			2			3	10					15	8	1				9
13:00			2			7	4	1				14	3			6		9
13:15			1			10						11						0
13:30						5						5						0
13:45						4	2					6	1					1
14:00						2						2	1					1
14:15												0	1			1		2
14:30						2						2	1					1
Total	2	0	6	1	0	72	35	1	0	0	35	152		13	0	24	0	71
Person-Hrs	0.50	0.00	1.50	0.25	0.00	18.00	8.75	0.25	0.00	0.00	8.75	38.00	0.00	3.25	0.00	6.00	0.00	17.75
Percentage	1.3%	0.0%	3.9%	0.7%	0.0%	47.4%	23.0%	0.7%	0.0%	0.0%	23.0%	100.0%	0.0%	18.3%	0.0%	33.8%	0.0%	100.0%

Note(s):
'Other' In Water Activity = Nature Study

Average Time Interval (hrs): 0.25



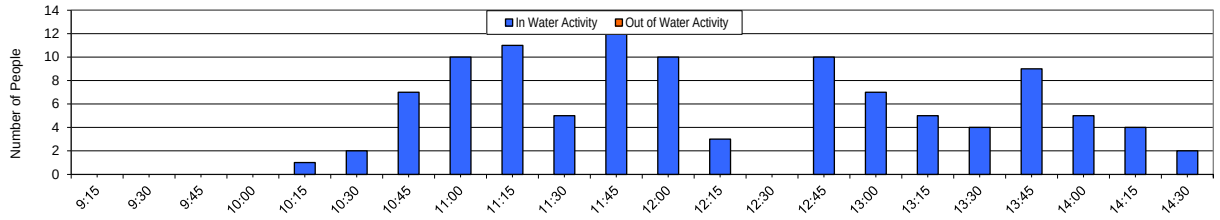
Human Use Activity Summary

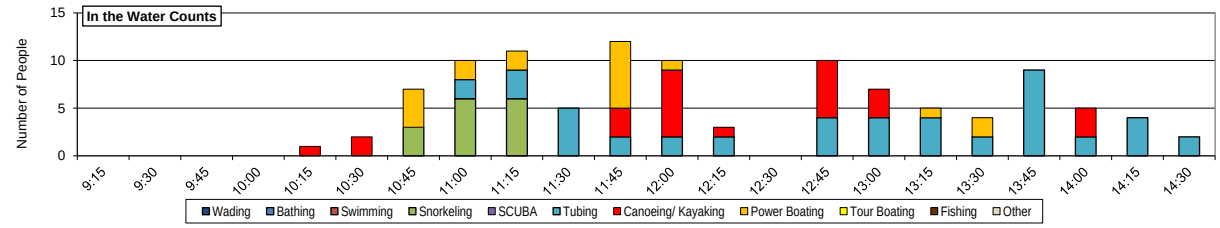
Site Rainbow River @ RSR-6 **Date** 9/2/2015 **Survey Period** 9:30 16:30

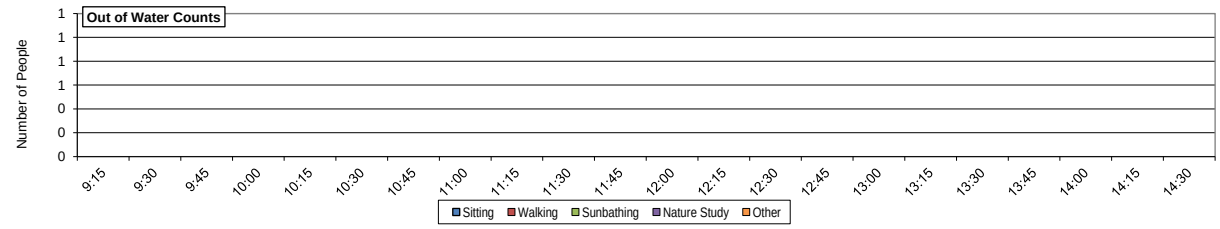
	Numbers of People																	
	In Water Activity												Out of Water Activity					
Time	Wading	Bathing	Swimming	Snorkeling	SCUBA	Tubing	Canoeing/ Kayaking	Power Boating	Tour Boating	Fishing	Other	Total	Sitting	Walking	Sunbathing	Nature Study	Other	Total
9:15												0						0
9:30												0						0
9:45												0						0
10:00												0						0
10:15							1					1						0
10:30							2					2						0
10:45				3				4				7						0
11:00				6		2		2				10						0
11:15				6		3		2				11						0
11:30						5						5						0
11:45						2	3	7				12						0
12:00						2	7	1				10						0
12:15						2	1					3						0
12:30												0						0
12:45						4	6					10						0
13:00						4	3					7						0
13:15						4		1				5						0
13:30						2		2				4						0
13:45						9						9						0
14:00						2	3					5						0
14:15						4						4						0
14:30						2						2						0
Total	0	0	0	23	0	66	29	23	0	0	0	141	0	0	0	0	0	0
Person-Hrs	0.00	0.00	0.00	5.75	0.00	16.50	7.25	5.75	0.00	0.00	0.00	35.25	0.00	0.00	0.00	0.00	0.00	0.00
Percentage	0.0%	0.0%	0.0%	16.3%	0.0%	46.8%	20.6%	16.3%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Note(s):
'Other' In Water Activity = Nature Study

Average Time Interval (hrs): 0.25







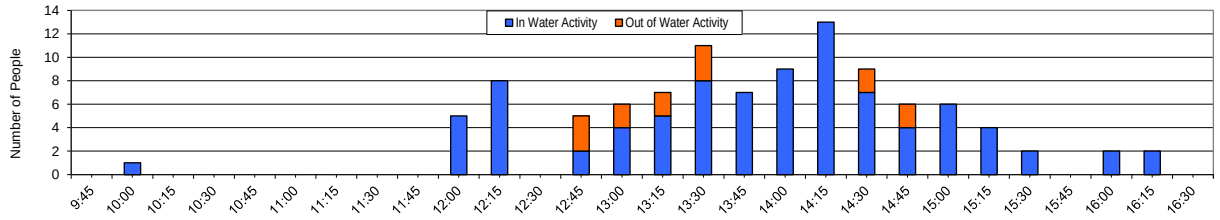
Human Use Activity Summary

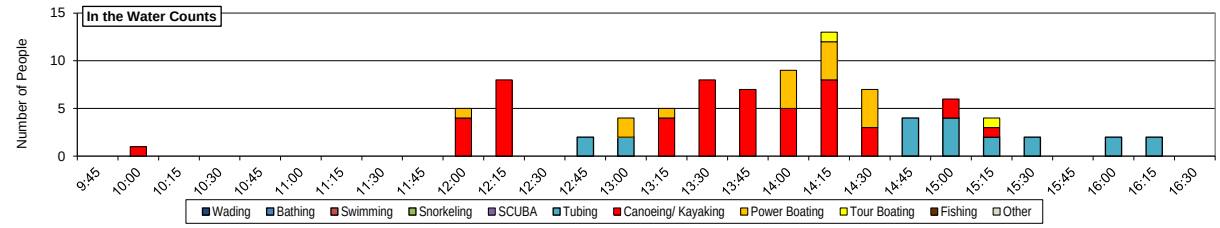
Site Rainbow River @ Dock 3 **Date** 9/2/2015 **Survey Period** 9:45 16:30

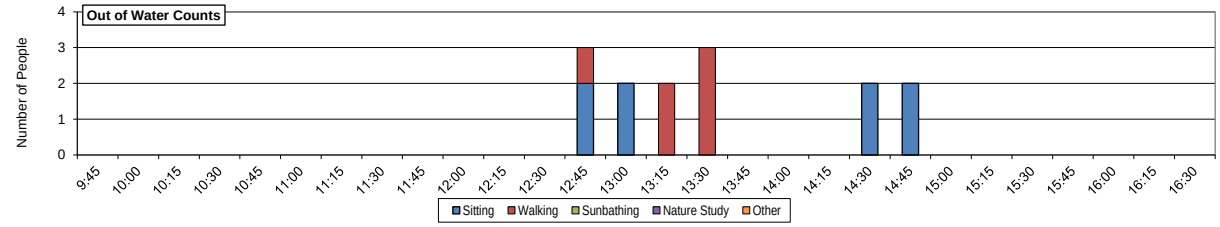
	Numbers of People																	
	In Water Activity											Out of Water Activity						
Time	Wading	Bathing	Swimming	Snorkeling	SCUBA	Tubing	Canoeing/ Kayaking	Power Boating	Tour Boating	Fishing	Other	Total	Sitting	Walking	Sunbathing	Nature Study	Other	Total
9:45												0						0
10:00							1					1						0
10:15												0						0
10:30												0						0
10:45												0						0
11:00												0						0
11:15												0						0
11:30												0						0
11:45												0						0
12:00							4	1				5						0
12:15							8					8						0
12:30												0						0
12:45						2						2	2	1				3
13:00						2		2				4	2					2
13:15							4	1				5		2				2
13:30							8					8		3				3
13:45							7					7						0
14:00							5	4				9						0
14:15							8	4	1			13						0
14:30							3	4				7	2					2
14:45						4						4	2					2
15:00						4	2					6						0
15:15						2	1		1			4						0
15:30						2						2						0
15:45												0						0
16:00						2						2						0
16:15						2						2						0
16:30												0						0
Total	0	0	0	0	0	20	51	16	2	0	0	89	8	6	0	0	0	14
Person-Hrs	0.00	0.00	0.00	0.00	0.00	5.00	12.75	4.00	0.50	0.00	0.00	22.25	2.00	1.50	0.00	0.00	0.00	3.50
Percentage	0.0%	0.0%	0.0%	0.0%	0.0%	22.5%	57.3%	18.0%	2.2%	0.0%	0.0%	100.0%	57.1%	42.9%	0.0%	0.0%	0.0%	100.0%

Note(s):
'Other' In Water Activity = Nature Study

Average Time Interval (hrs): 0.25







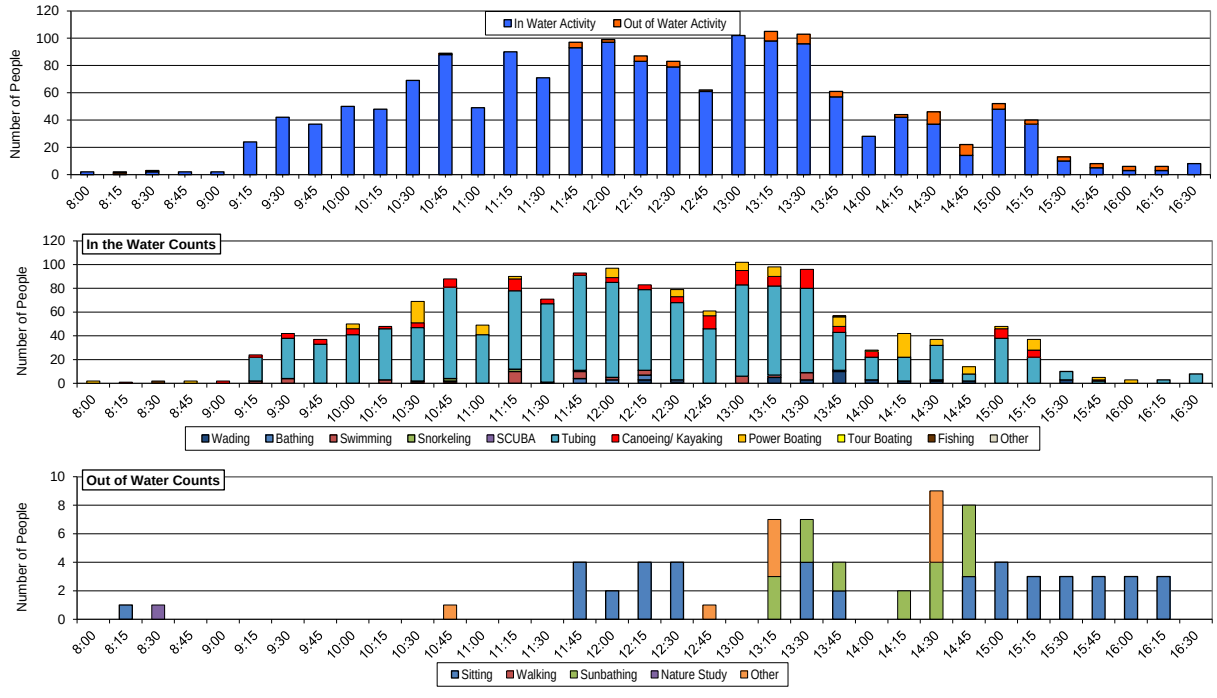
Human Use Activity Summary

Site Rainbow River @ RSR-1 **Date** 9/5/2015 **Survey Period** 8:00 16:30

	Numbers of People																	
	In Water Activity												Out of Water Activity					
Time	Wading	Bathing	Swimming	Snorkeling	SCUBA	Tubing	Canoeing/ Kayaking	Power Boating	Tour Boating	Fishing	Other	Total	Sitting	Walking	Sunbathing	Nature Study	Other	Total
8:00								2				2						0
8:15							1					1	1					1
8:30										2		2				1		1
8:45								2				2						0
9:00							2					2						0
9:15			2			20	2					24						0
9:30			4			34	4					42						0
9:45						33	4					37						0
10:00						41	5	4				50						0
10:15			3			43	2					48						0
10:30		1	1			45	4	18				69						0
10:45		1	1	2		77	7					88					1	1
11:00						41		8				49						0
11:15			10	2		66	10	2				90						0
11:30			1			66	4					71						0
11:45		4	6	1		80	2					93	4					4
12:00		3	2			80	4	8				97	2					2
12:15	3	4	4			68	4					83	4					4
12:30	1	2				65	5	6				79	4					4
12:45						46	11	4				61					1	1
13:00			6			77	12	7				102						0
13:15	5		2			75	8	8				98			3		4	7
13:30	3		6			71	16					96	4		3			7
13:45	10		1			32	5	8		1		57	2		2			4
14:00	3					19	5	1				28						0
14:15	2					20		20				42			2			2
14:30	2		1			29		5				37			4		5	9
14:45	2					6		6				14	3		5			8
15:00						38	8	2				48	4					4
15:15						22	6	9				37	3					3
15:30	3					7						10	3					3
15:45						2	1	2				5	3					3
16:00								3				3	3					3
16:15						3						3	3					3
16:30						8						8						0
Total	34	15	50	5	0	1,214	132	125	0	3	0	1,578	43	0	19	1	11	74
Person-Hrs	8.50	3.75	12.50	1.25	0.00	303.50	33.00	31.25	0.00	0.75	0.00	394.50	10.75	0.00	4.75	0.25	2.75	18.50
Percentage	2.2%	1.0%	3.2%	0.3%	0.0%	76.9%	8.4%	7.9%	0.0%	0.2%	0.0%	100.0%	58.1%	0.0%	25.7%	1.4%	14.9%	100.0%

Note(s):
'Other' In Water Activity = Nature Study
'Other' Out of Water Activity = Yard work

Average Time Interval (hrs): 0.25



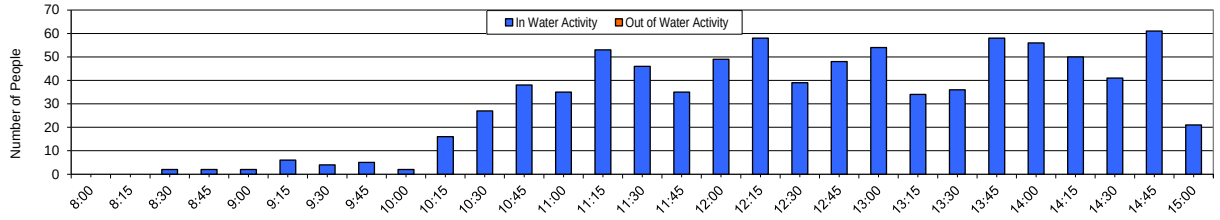
Human Use Activity Summary

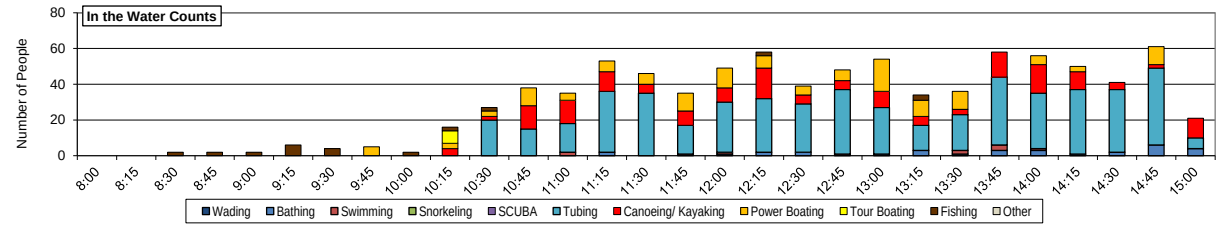
Site Rainbow River @ Dock 3 **Date** 9/5/2015 **Survey Period** 8:30 15:00

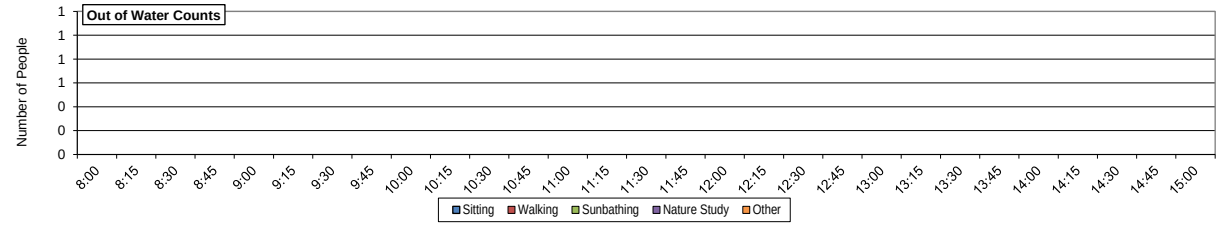
	Numbers of People																	
	In Water Activity												Out of Water Activity					
Time	Wading	Bathing	Swimming	Snorkeling	SCUBA	Tubing	Canoeing/ Kayaking	Power Boating	Tour Boating	Fishing	Other	Total	Sitting	Walking	Sunbathing	Nature Study	Other	Total
8:00												0						0
8:15												0						0
8:30										2		2						0
8:45										2		2						0
9:00										2		2						0
9:15										6		6						0
9:30										4		4						0
9:45								5				5						0
10:00										2		2						0
10:15							4	3	7	2		16						0
10:30						20	2	3		2		27						0
10:45						15	13	10				38						0
11:00			2			16	13	4				35						0
11:15		2				34	11	6				53						0
11:30						35	5	6				46						0
11:45			1			16	8	10				35						0
12:00		1	1			28	8	11				49						0
12:15		2				30	17	7		2		58						0
12:30		2				27	5	5				39						0
12:45			1			36	5	6				48						0
13:00		1				26	9	18				54						0
13:15		3				14	5	9		3		34						0
13:30		1	2			20	3	10				36						0
13:45		3	3			38	14					58						0
14:00		3	1			31	16	5				56						0
14:15		1				36	10	3				50						0
14:30		2				35	4					41						0
14:45		6				43	2	10				61						0
15:00		4				6	11					21						0
Total	0	31	11	0	0	506	165	131	7	27	0	878	0	0	0	0	0	0
Person-Hrs	0.00	7.75	2.75	0.00	0.00	126.50	41.25	32.75	1.75	6.75	0.00	219.50	0.00	0.00	0.00	0.00	0.00	0.00
Percentage	0.0%	3.5%	1.3%	0.0%	0.0%	57.6%	18.8%	14.9%	0.8%	3.1%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Note(s):
'Other' In Water Activity = Nature Study

Average Time Interval (hrs): 0.25







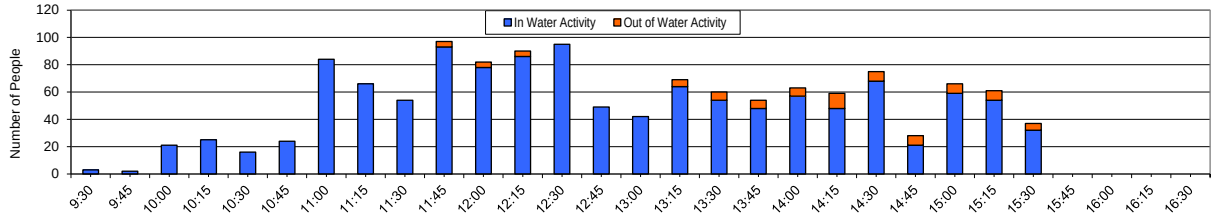
Human Use Activity Summary

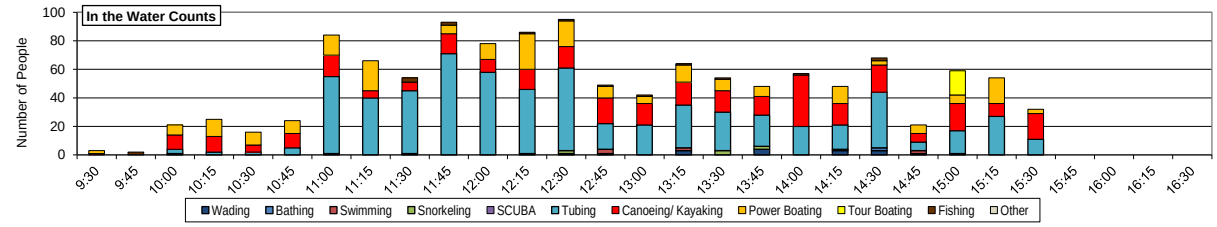
Site Rainbow River @ Dock 3 **Date** 9/6/2015 **Survey Period** 9:30 15:30

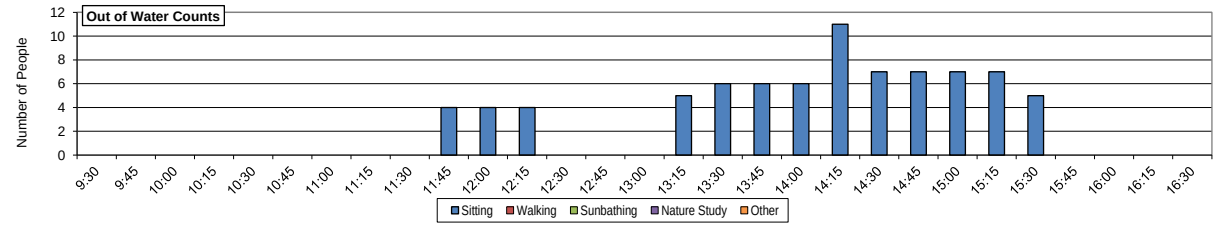
	Numbers of People																	
	In Water Activity											Out of Water Activity						
Time	Wading	Bathing	Swimming	Snorkeling	SCUBA	Tubing	Canoeing/ Kayaking	Power Boating	Tour Boating	Fishing	Other	Total	Sitting	Walking	Sunbathing	Nature Study	Other	Total
9:30							1	2				3						0
9:45										2		2						0
10:00			1			3	10	7				21						0
10:15						2	11	12				25						0
10:30						2	5	9				16						0
10:45						5	10	9				24						0
11:00				1		54	15	14				84						0
11:15						40	5	21				66						0
11:30			1			44	6			3		54						0
11:45						71	14	6		2		93	4					4
12:00						58	9	11				78	4					4
12:15			1			45	14	25		1		86	4					4
12:30		1		2		58	15	18		1		95						0
12:45		1	3			18	18	8		1		49						0
13:00						21	15	5		1		42						0
13:15	3		2			30	16	12		1		64	5					5
13:30				3		27	15	8		1		54	6					6
13:45	4			2		22	13	7				48	6					6
14:00						20	36			1		57	6					6
14:15	3			1		17	15	12				48	11					11
14:30	3	2				39	19	3		2		68	7					7
14:45	1		2			6	6	6				21	7					7
15:00				1		16	19	6	17			59	7					7
15:15						27	9	18				54	7					7
15:30						11	18	3				32	5					5
15:45												0						0
16:00												0						0
16:15												0						0
16:30												0						0
Total	14	4	10	10	0	636	314	222	17	16	0	1,243	79	0	0	0	0	79
Person-Hrs	3.50	1.00	2.50	2.50	0.00	159.00	78.50	55.50	4.25	4.00	0.00	310.75	19.75	0.00	0.00	0.00	0.00	19.75
Percentage	1.1%	0.3%	0.8%	0.8%	0.0%	51.2%	25.3%	17.9%	1.4%	1.3%	0.0%	100.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%

Note(s):
'Other' In Water Activity = Nature Study

Average Time Interval (hrs): 0.25







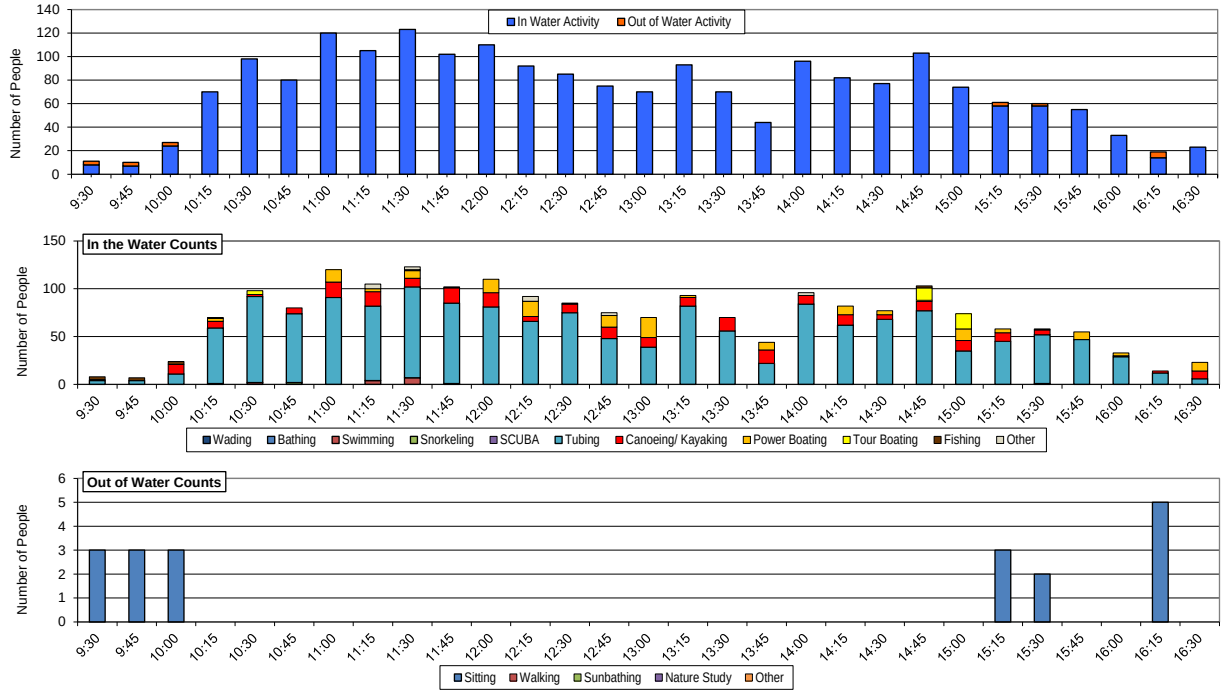
Human Use Activity Summary

Site Rainbow River @ RSR-6 **Date** 9/6/2015 **Survey Period** 9:30 16:30

	Numbers of People																	
	In Water Activity											Out of Water Activity						
Time	Wading	Bathing	Swimming	Snorkeling	SCUBA	Tubing	Canoeing/ Kayaking	Power Boating	Tour Boating	Fishing	Other	Total	Sitting	Walking	Sunbathing	Nature Study	Other	Total
9:30						4		1		3		8	3					3
9:45						4				3		7	3					3
10:00						11	10			3		24	3					3
10:15				1		58	7	3		1		70						0
10:30			2			90	2		4			98						0
10:45				2		72	6					80						0
11:00						91	16	13				120						0
11:15			4			78	15	3			5	105						0
11:30			7			95	9	8		1	3	123						0
11:45			1			84	16				1	102						0
12:00						81	15	14				110						0
12:15						66	5	16			5	92						0
12:30						75	9				1	85						0
12:45						48	12	12			3	75						0
13:00						39	10	21				70						0
13:15						82	9	2				93						0
13:30						56	14					70						0
13:45						22	14	8				44						0
14:00						84	9				3	96						0
14:15						62	11	9				82						0
14:30						68	5	4				77						0
14:45						77	10	1	13	2		103						0
15:00						35	11	12	16			74						0
15:15						45	9	4				58	3					3
15:30			1			51	5	1				58	2					2
15:45						47		8				55						0
16:00						29	1	3				33						0
16:15						12	2					14	5					5
16:30						6	8	9				23						0
Total	0	0	15	3	0	1,572	240	152	33	13	21	2,049	19	0	0	0	0	19
Person-Hrs	0.00	0.00	3.75	0.75	0.00	393.00	60.00	38.00	8.25	3.25	5.25	512.25	4.75	0.00	0.00	0.00	0.00	4.75
Percentage	0.0%	0.0%	0.7%	0.1%	0.0%	76.7%	11.7%	7.4%	1.6%	0.6%	1.0%	100.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%

Note(s):
'Other' In Water Activity = Nature Study

Average Time Interval (hrs): 0.25



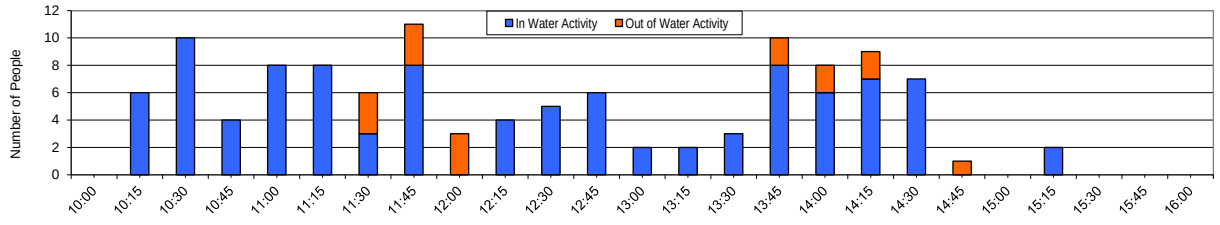
Human Use Activity Summary

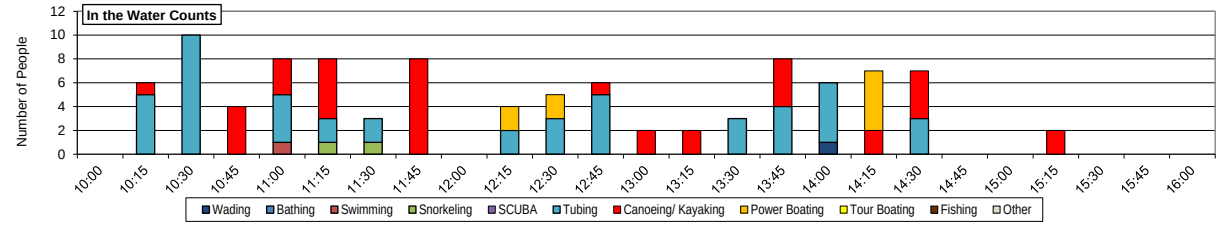
Site Rainbow River @ RSR-1 **Date** 9/10/2015 **Survey Period** 10:15 15:30

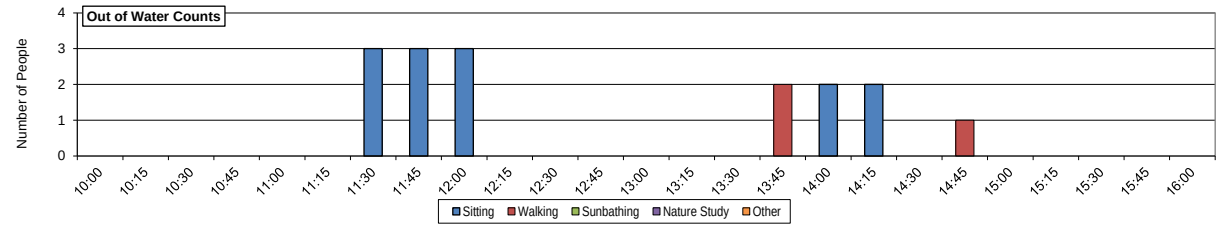
	Numbers of People																	
	In Water Activity											Out of Water Activity						
Time	Wading	Bathing	Swimming	Snorkeling	SCUBA	Tubing	Canoeing/ Kayaking	Power Boating	Tour Boating	Fishing	Other	Total	Sitting	Walking	Sunbathing	Nature Study	Other	Total
10:00												0						0
10:15						5	1					6						0
10:30						10						10						0
10:45							4					4						0
11:00			1			4	3					8						0
11:15				1		2	5					8						0
11:30				1		2						3	3					3
11:45							8					8	3					3
12:00												0	3					3
12:15						2		2				4						0
12:30						3		2				5						0
12:45						5	1					6						0
13:00							2					2						0
13:15							2					2						0
13:30						3						3						0
13:45						4	4					8		2				2
14:00	1					5						6	2					2
14:15							2	5				7	2					2
14:30						3	4					7						0
14:45												0		1				1
15:00												0						0
15:15							2					2						0
15:30												0						0
15:45												0						0
16:00												0						0
Total	1	0	1	2	0	48	38	9	0	0	0	99	13	3	0	0	0	16
Person-Hrs	0.25	0.00	0.25	0.50	0.00	12.00	9.50	2.25	0.00	0.00	0.00	24.75	3.25	0.75	0.00	0.00	0.00	4.00
Percentage	1.0%	0.0%	1.0%	2.0%	0.0%	48.5%	38.4%	9.1%	0.0%	0.0%	0.0%	100.0%	81.3%	18.8%	0.0%	0.0%	0.0%	100.0%

Note(s):
'Other' In Water Activity = Nature Study
'Other' Out of Water Activity = Yard work

Average Time Interval (hrs): 0.25







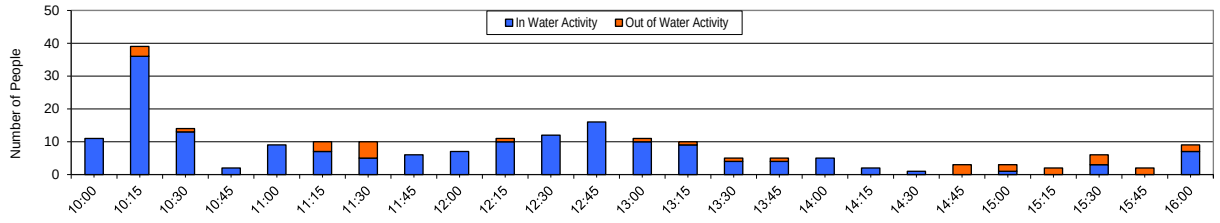
Human Use Activity Summary

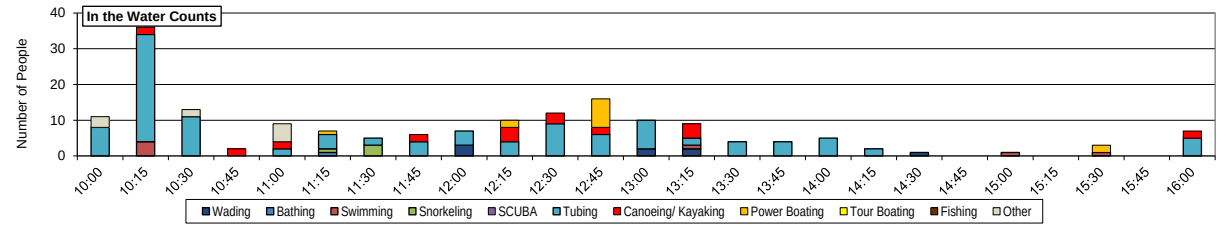
Site Rainbow River @ RSR-1 **Date** 9/11/2015 **Survey Period** 10:00 16:00

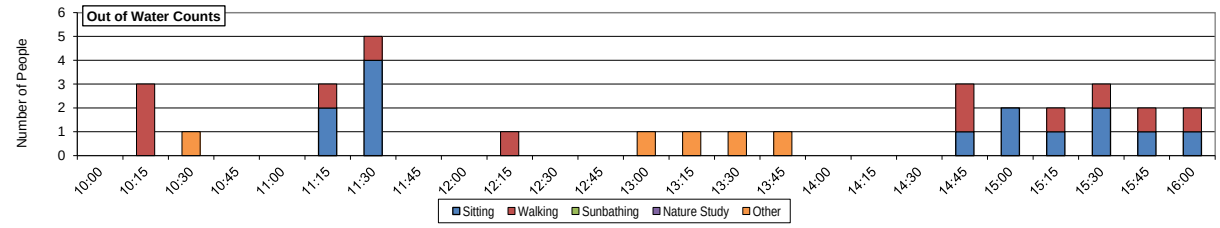
	Numbers of People																	
	In Water Activity											Out of Water Activity						
Time	Wading	Bathing	Swimming	Snorkeling	SCUBA	Tubing	Canoeing/ Kayaking	Power Boating	Tour Boating	Fishing	Other	Total	Sitting	Walking	Sunbathing	Nature Study	Other	Total
10:00						8					3	11						0
10:15			4			30	2					36		3				3
10:30						11					2	13					1	1
10:45							2					2						0
11:00						2	2				5	9						0
11:15		1		1		4		1				7	2	1				3
11:30				3		2						5	4	1				5
11:45						4	2					6						0
12:00	3					4						7						0
12:15						4	4	2				10		1				1
12:30						9	3					12						0
12:45						6	2	8				16						0
13:00	2					8						10					1	1
13:15	2		1			2	4					9					1	1
13:30						4						4					1	1
13:45						4						4					1	1
14:00						5						5						0
14:15						2						2						0
14:30	1											1						0
14:45												0	1	2				3
15:00			1									1	2					2
15:15												0	1	1				2
15:30			1					2				3	2	1				3
15:45												0	1	1				2
16:00						5	2					7	1	1				2
Total	8	1	7	4	0	114	23	13	0	0	10	180	14	12	0	0	5	31
Person-Hrs	2.00	0.25	1.75	1.00	0.00	28.50	5.75	3.25	0.00	0.00	2.50	45.00	3.50	3.00	0.00	0.00	1.25	7.75
Percentage	4.4%	0.6%	3.9%	2.2%	0.0%	63.3%	12.8%	7.2%	0.0%	0.0%	5.6%	100.0%	45.2%	38.7%	0.0%	0.0%	16.1%	100.0%

Note(s):
'Other' In Water Activity = Nature Study
'Other' Out of Water Activity = Yard work

Average Time Interval (hrs): 0.25







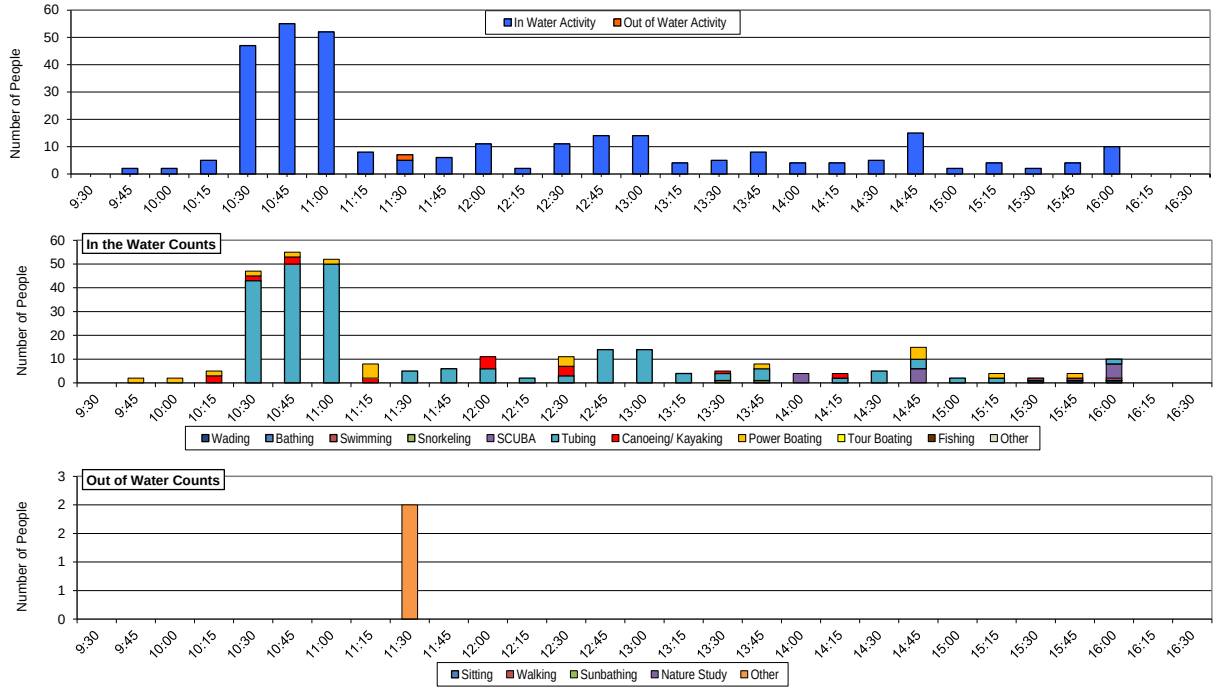
Human Use Activity Summary

Site Rainbow River @ RSR-6 **Date** 9/11/2015 **Survey Period** 9:45 16:00

	Numbers of People																	
	In Water Activity												Out of Water Activity					
Time	Wading	Bathing	Swimming	Snorkeling	SCUBA	Tubing	Canoeing/ Kayaking	Power Boating	Tour Boating	Fishing	Other	Total	Sitting	Walking	Sunbathing	Nature Study	Other	Total
9:30												0						0
9:45								2				2						0
10:00								2				2						0
10:15							3	2				5						0
10:30						43	2	2				47						0
10:45						50	3	2				55						0
11:00						50		2				52						0
11:15							2	6				8						0
11:30						5						5					2	2
11:45						6						6						0
12:00						6	5					11						0
12:15						2						2						0
12:30						3	4	4				11						0
12:45						14						14						0
13:00						14						14						0
13:15						4						4						0
13:30				1		3	1					5						0
13:45				1		5		2				8						0
14:00					4							4						0
14:15						2	2					4						0
14:30						5						5						0
14:45					6	4		5				15						0
15:00						2						2						0
15:15						2		2				4						0
15:30	1		1									2						0
15:45	1		1					2				4						0
16:00	1		1		6	2						10						0
16:15												0						0
16:30												0						0
Total	3	0	3	2	16	222	22	33	0	0	0	301	0	0	0	0	2	2
Person-Hrs	0.75	0.00	0.75	0.50	4.00	55.50	5.50	8.25	0.00	0.00	0.00	75.25	0.00	0.00	0.00	0.00	0.50	0.50
Percentage	1.0%	0.0%	1.0%	0.7%	5.3%	73.8%	7.3%	11.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	100.0%

Note(s):
'Other' Out of Water Activity = Boat Maintenance

Average Time Interval (hrs): 0.25



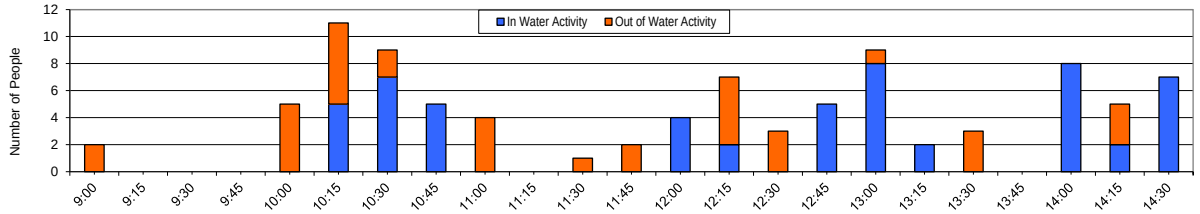
Human Use Activity Summary

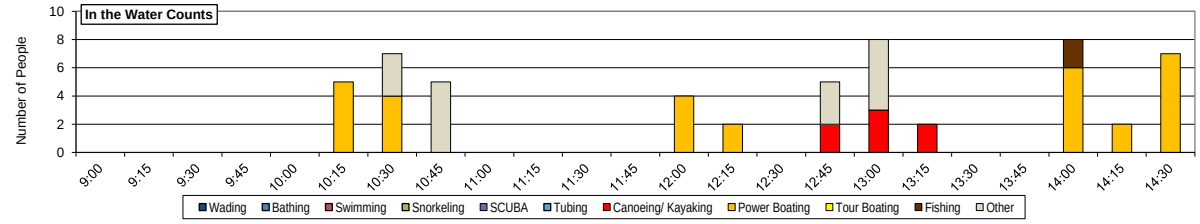
Site Rainbow River @ RSR-1 **Date** 2/8/2016 **Survey Period** 9:30 14:15

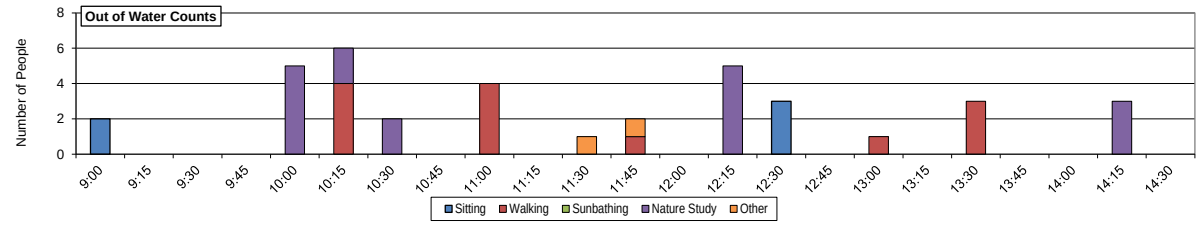
	Numbers of People																	
	In Water Activity											Out of Water Activity						
Time	Wading	Bathing	Swimming	Snorkeling	SCUBA	Tubing	Canoeing/ Kayaking	Power Boating	Tour Boating	Fishing	Other	Total	Sitting	Walking	Sunbathing	Nature Study	Other	Total
9:00												0	2					2
9:15												0						0
9:30												0						0
9:45												0						0
10:00												0				5		5
10:15								5				5		4		2		6
10:30								4			3	7				2		2
10:45											5	5						0
11:00												0		4				4
11:15												0						0
11:30												0					1	1
11:45												0		1			1	2
12:00								4				4						0
12:15								2				2				5		5
12:30												0	3					3
12:45							2				3	5						0
13:00							3				5	8		1				1
13:15							2					2						0
13:30												0		3				3
13:45												0						0
14:00								6		2		8						0
14:15								2				2				3		3
14:30								7				7						0
Total	0	0	0	0	0	0	7	30	0	2	16	55	5	13	0	17	2	37
Person-Hrs	0.00	0.00	0.00	0.00	0.00	0.00	1.75	7.50	0.00	0.50	4.00	13.75	1.25	3.25	0.00	4.25	0.50	9.25
Percentage	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	12.7%	54.5%	0.0%	3.6%	29.1%	100.0%	13.5%	35.1%	0.0%	45.9%	5.4%	100.0%

Note(s):
'Other' In Water Activity = Nature Study, fishing, yardwork, or walking dog.

Average Time Interval (hrs): 0.25







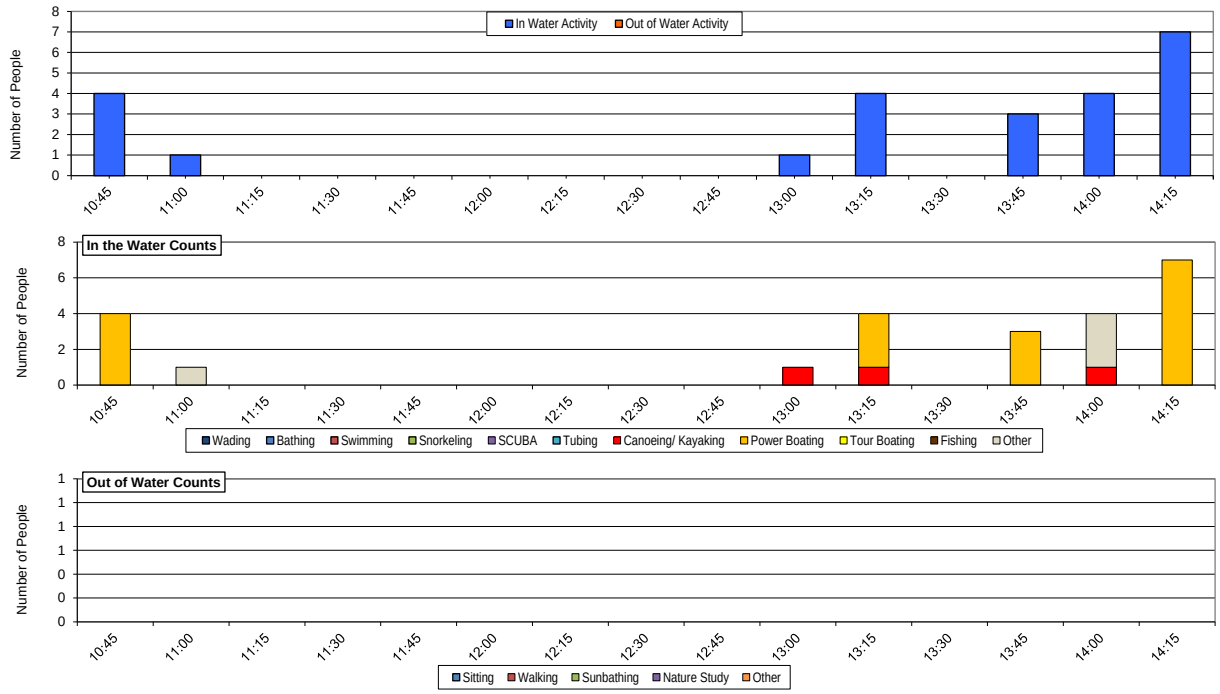
Human Use Activity Summary

Site Rainbow River @ RSR-6 **Date** 2/8/2016 **Survey Period** 10:50 14:00

	Numbers of People																	
	In Water Activity												Out of Water Activity					
Time	Wading	Bathing	Swimming	Snorkeling	SCUBA	Tubing	Canoeing/ Kayaking	Power Boating	Tour Boating	Fishing	Other	Total	Sitting	Walking	Sunbathing	Nature Study	Other	Total
10:45								4				4						0
11:00											1	1						0
11:15												0						0
11:30												0						0
11:45												0						0
12:00												0						0
12:15												0						0
12:30												0						0
12:45												0						0
13:00							1					1						0
13:15							1	3				4						0
13:30												0						0
13:45								3				3						0
14:00							1				3	4						0
14:15								7				7						0
Total	0	0	0	0	0	0	3	17	0	0	4	24	0	0	0	0	0	0
Person-Hrs	0.00	0.00	0.00	0.00	0.00	0.00	0.75	4.25	0.00	0.00	1.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00
Percentage	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	12.5%	70.8%	0.0%	0.0%	16.7%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Note(s):
'Other' In Water Activity = Nature Study

Average Time Interval (hrs): 0.25



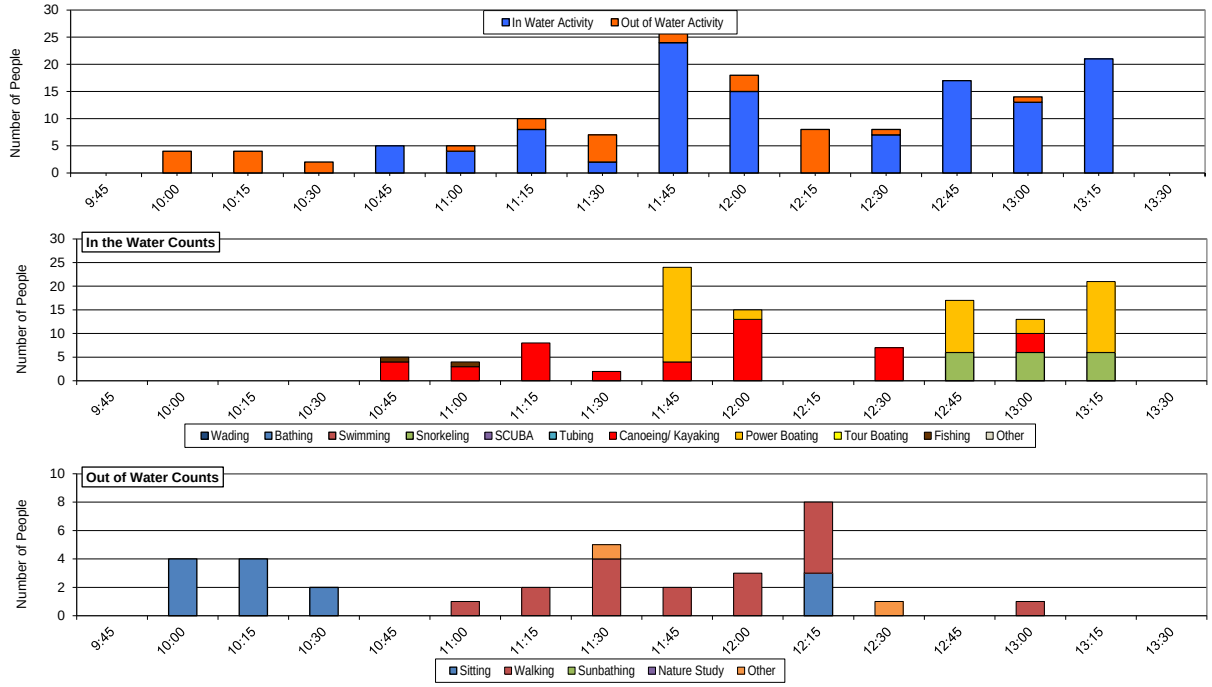
Human Use Activity Summary

Site Rainbow River @ RSR-1 **Date** 2/13/2016 **Survey Period** 10:15 13:15

	Numbers of People																	
	In Water Activity											Out of Water Activity						
Time	Wading	Bathing	Swimming	Snorkeling	SCUBA	Tubing	Canoeing/ Kayaking	Power Boating	Tour Boating	Fishing	Other	Total	Sitting	Walking	Sunbathing	Nature Study	Other	Total
9:45												0						0
10:00												0	4					4
10:15												0	4					4
10:30												0	2					2
10:45							4			1		5						0
11:00							3			1		4		1				1
11:15							8					8		2				2
11:30							2					2		4			1	5
11:45							4	20				24		2				2
12:00							13	2				15		3				3
12:15												0	3	5				8
12:30							7					7					1	1
12:45				6				11				17						0
13:00				6			4	3				13		1				1
13:15				6				15				21						0
13:30												0						0
Total	0	0	0	18	0	0	45	51	0	2	0	116	13	18	0	0	2	33
Person-Hrs	0.00	0.00	0.00	4.50	0.00	0.00	11.25	12.75	0.00	0.50	0.00	29.00	3.25	4.50	0.00	0.00	0.50	8.25
Percentage	0.0%	0.0%	0.0%	15.5%	0.0%	0.0%	38.8%	44.0%	0.0%	1.7%	0.0%	100.0%	39.4%	54.5%	0.0%	0.0%	6.1%	100.0%

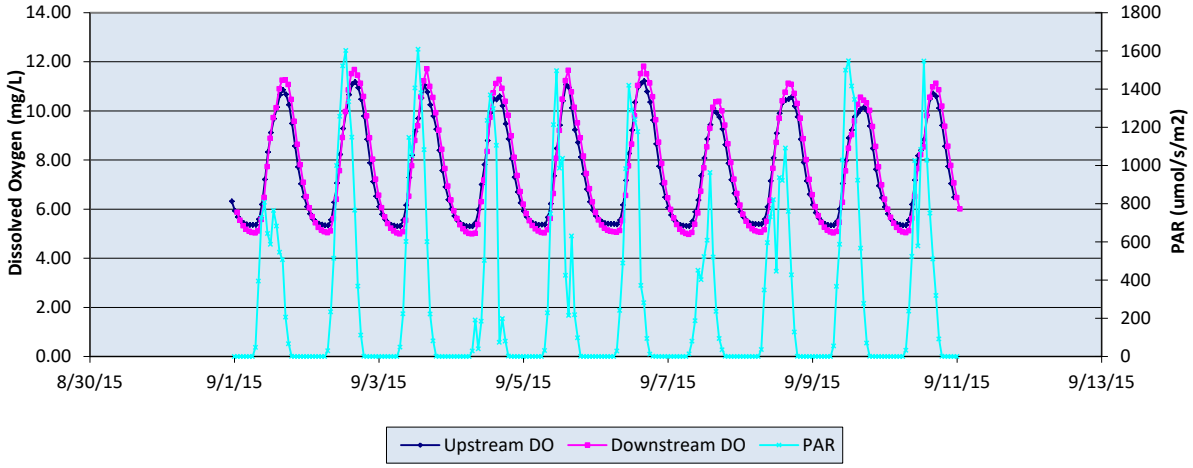
Note(s):
'Other' In Water Activity = Nature Study
'Other' Out of Water Activity: yardwork

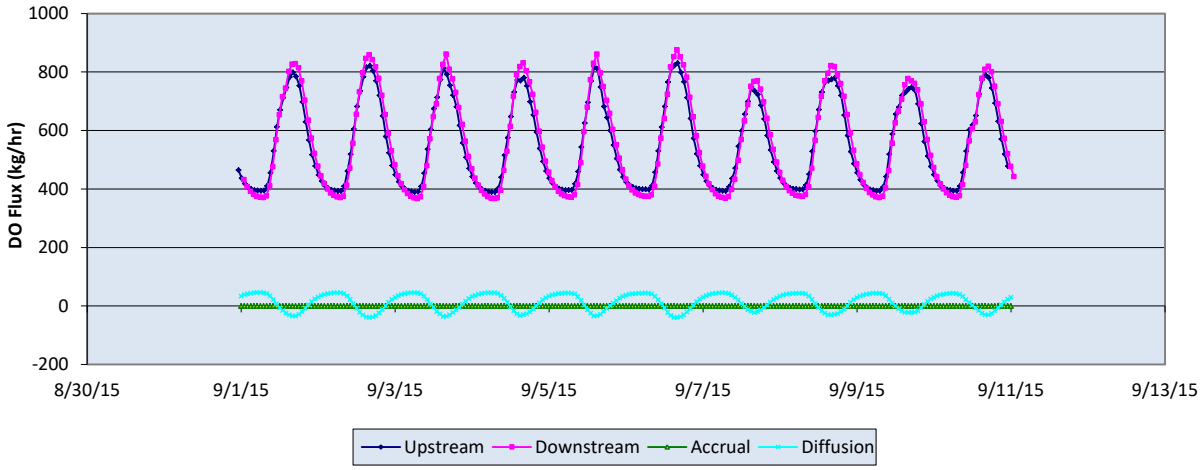
Average Time Interval (hrs): 0.25

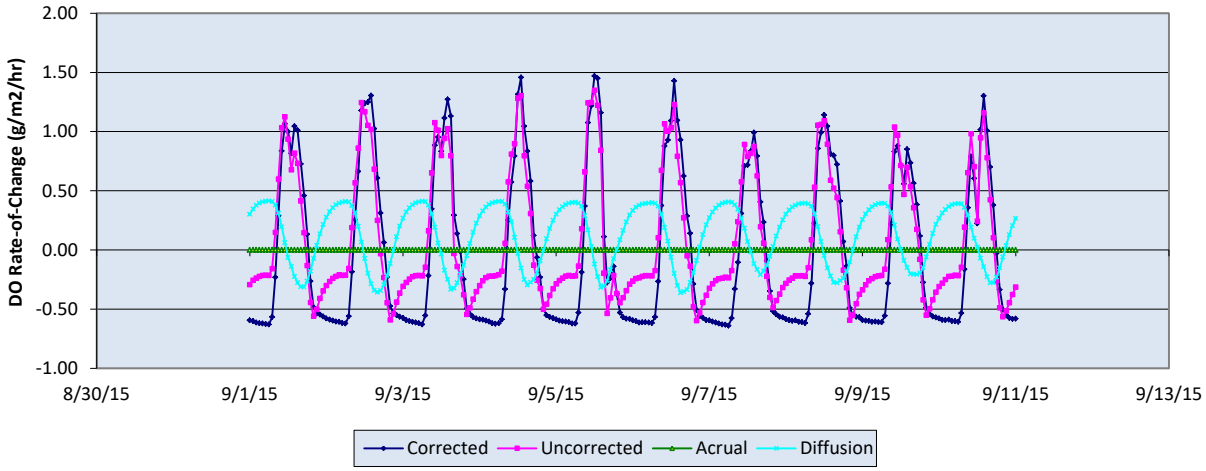


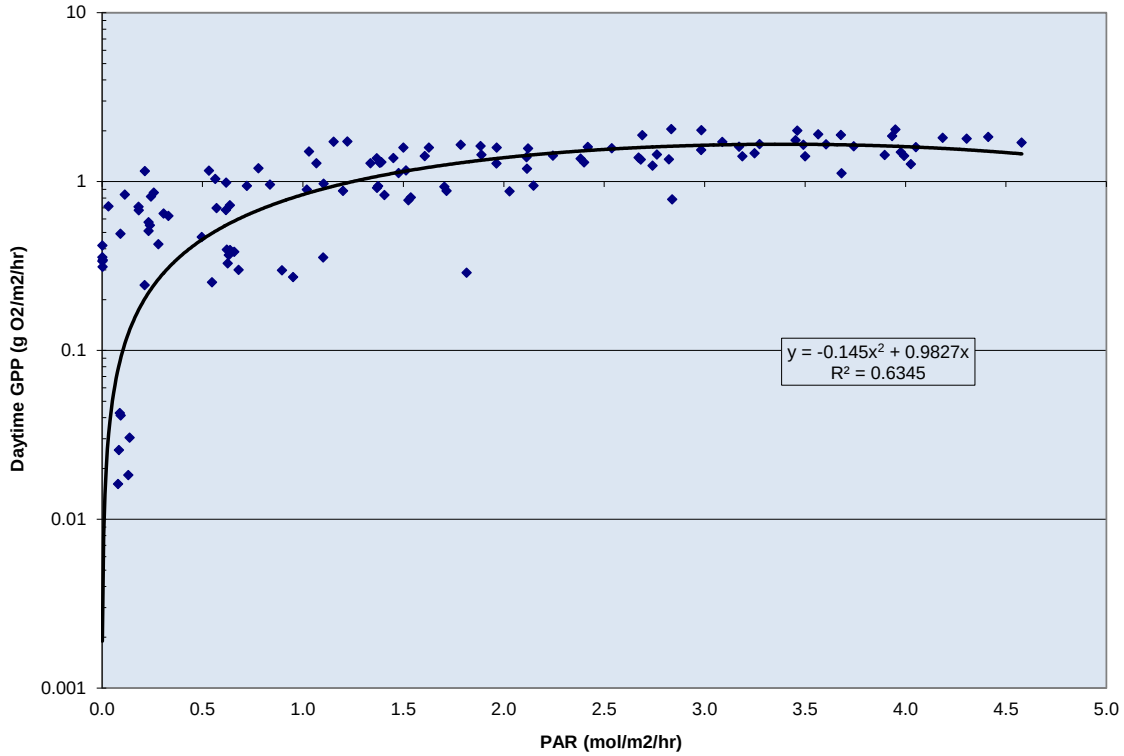
Appendix I

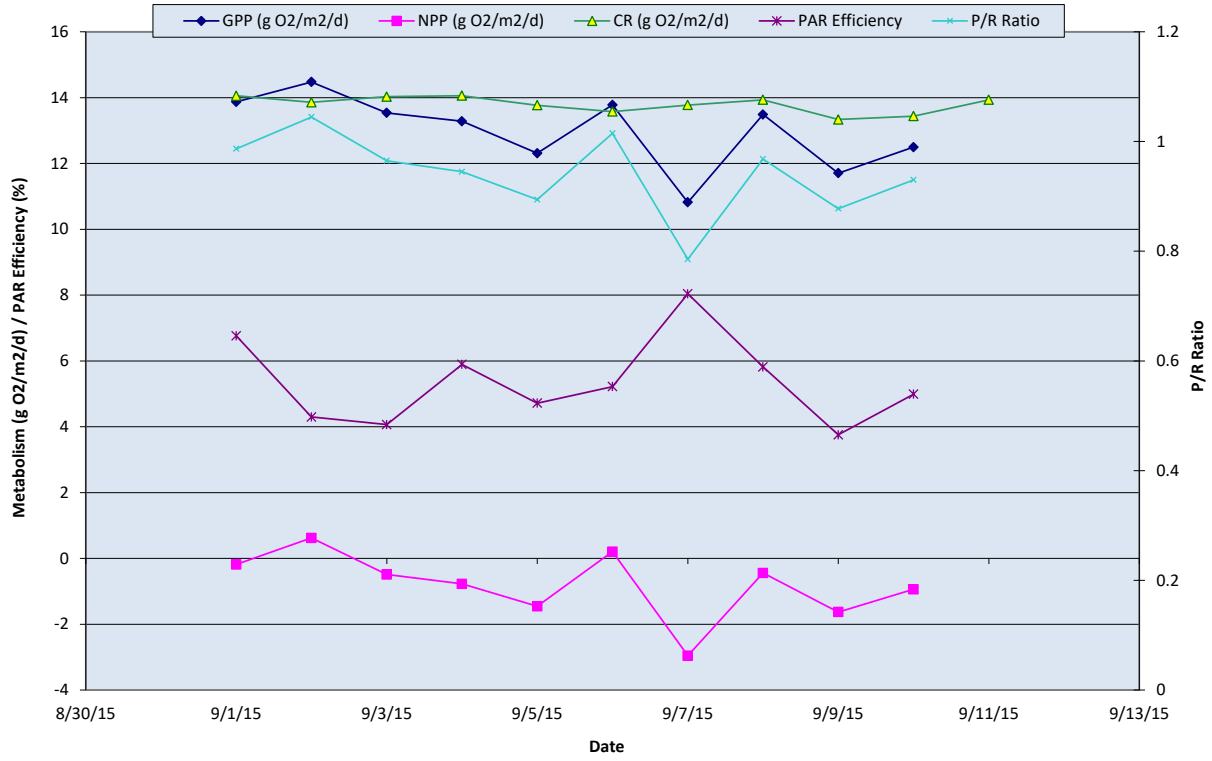
Ecosystem Metabolism Summary

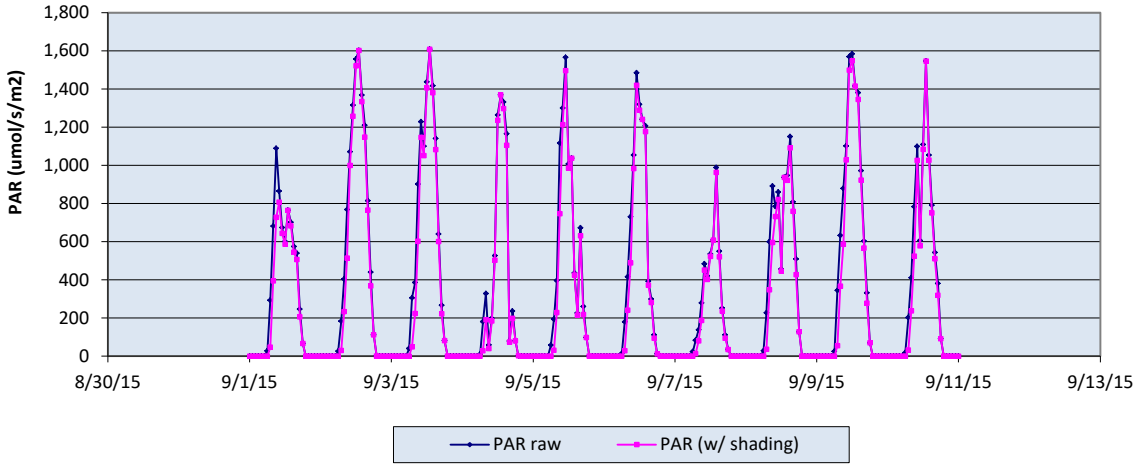

Dissolved Oxygen (mg/L)
PAR (umol/s/m2)
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
1800
1600
1400
1200
1000
800
600
400
200
0
8/30/15
9/1/15
9/3/15
9/5/15
9/7/15
9/9/15
9/11/15
9/13/15
Upstream DO
Downstream DO
PAR

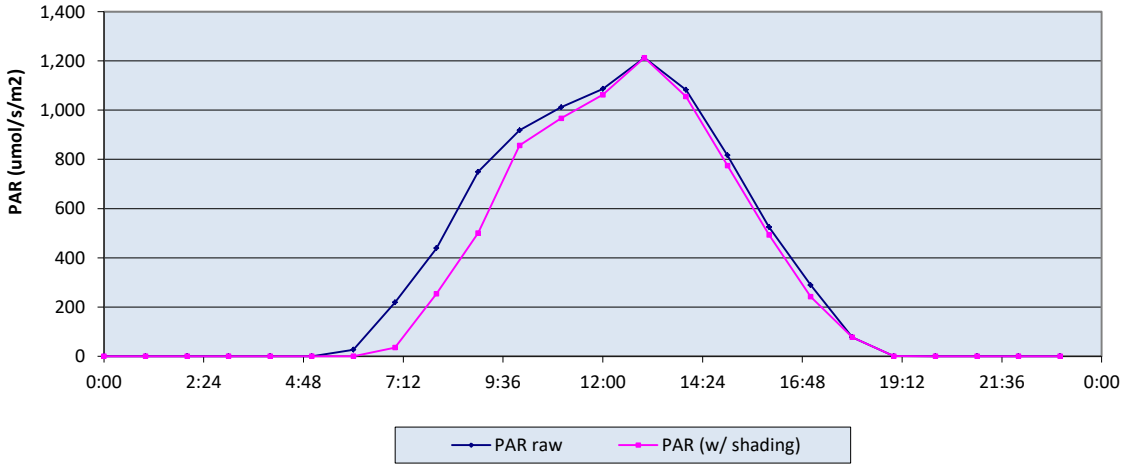

DO Flux (kg/hr)
1000
800
600
400
200
0
-200
8/30/15
9/1/15
9/3/15
9/5/15
9/7/15
9/9/15
9/11/15
9/13/15
Upstream
Downstream
Accrual
Diffusion

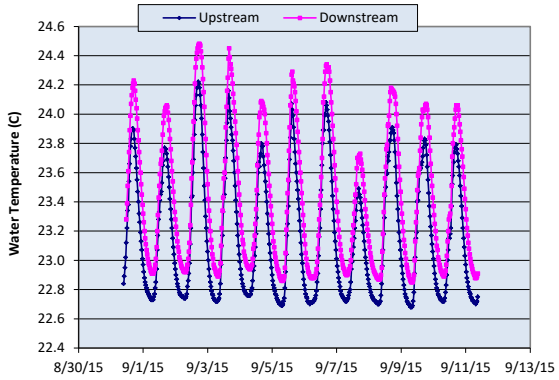

DO Rate-of-Change (g/m2/hr)
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
8/30/15
9/1/15
9/3/15
9/5/15
9/7/15
9/9/15
9/11/15
9/13/15
Corrected
Uncorrected
Acrual
Diffusion

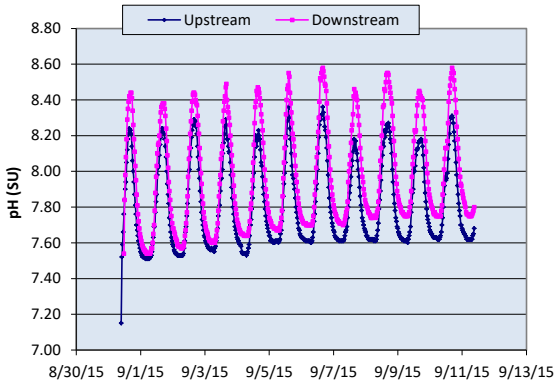

Daytime GPP (g O2/m2/hr)
PAR (mol/m2/hr)
y = -0.145x² + 0.9827x
R² = 0.6345
10
1
0.1
0.01
0.001
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0

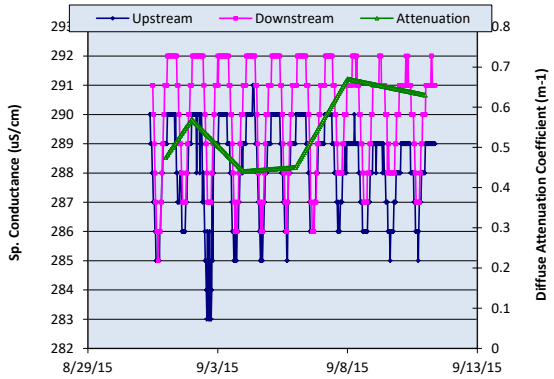

GPP (g O2/m2/d)
NPP (g O2/m2/d)
CR (g O2/m2/d)
PAR Efficiency
P/R Ratio
Metabolism (g O2/m2/d) / PAR Efficiency (%)
P/R Ratio
Date
16
14
12
10
8
6
4
2
0
-2
-4
1.2
1
0.8
0.6
0.4
0.2
0
8/30/15
9/1/15
9/3/15
9/5/15
9/7/15
9/9/15
9/11/15
9/13/15

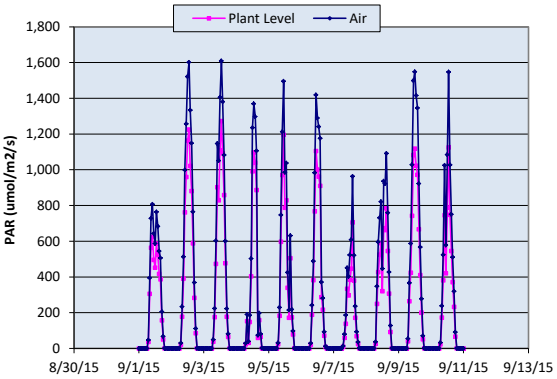

PAR (umol/s/m2)
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
8/30/15
9/1/15
9/3/15
9/5/15
9/7/15
9/9/15
9/11/15
9/13/15
PAR raw
PAR (w/ shading)

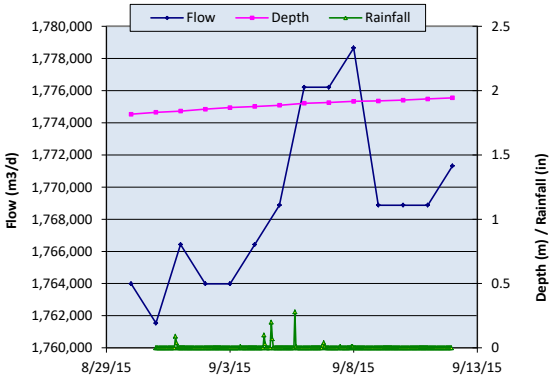

PAR (umol/s/m2)
1,400
1,200
1,000
800
600
400
200
0
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
PAR raw
PAR (w/ shading)



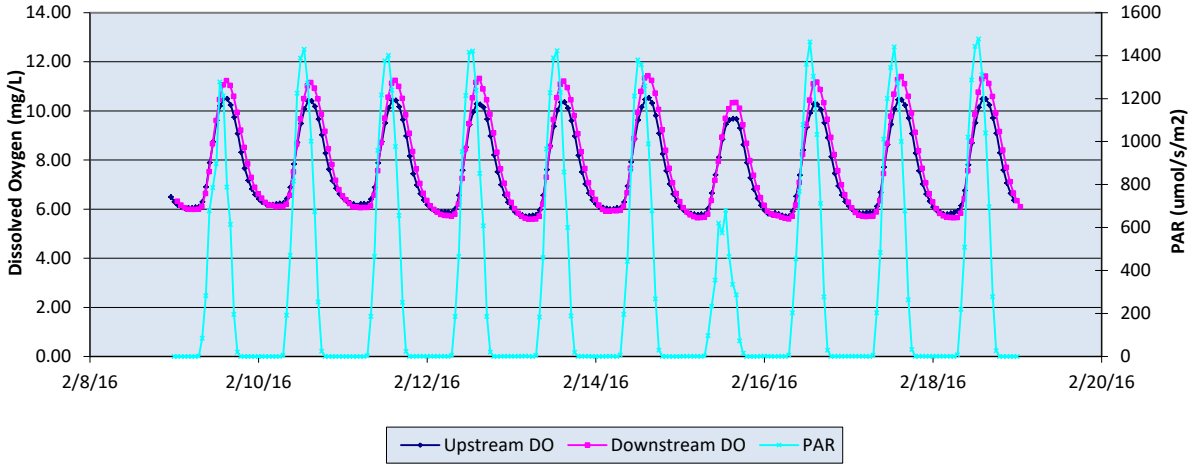


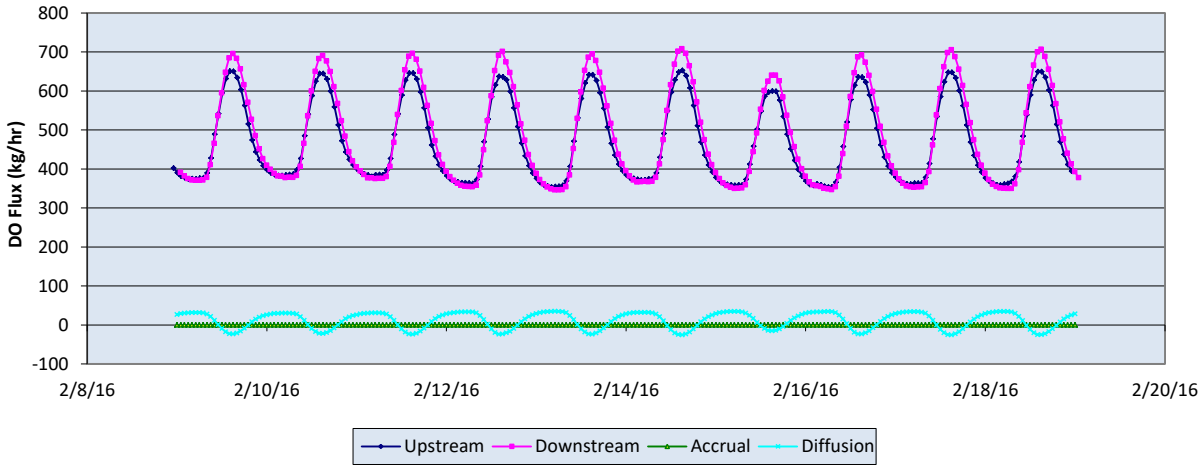


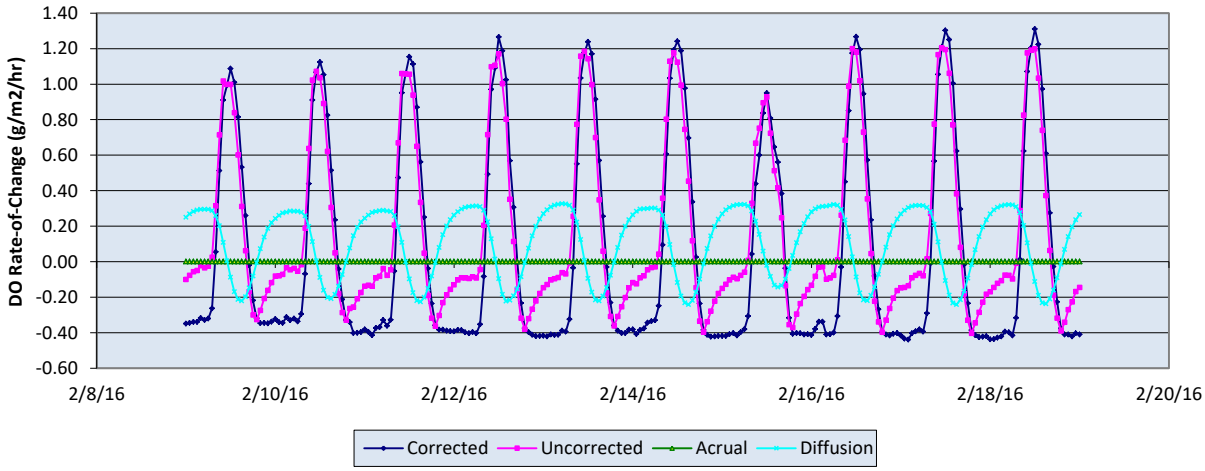


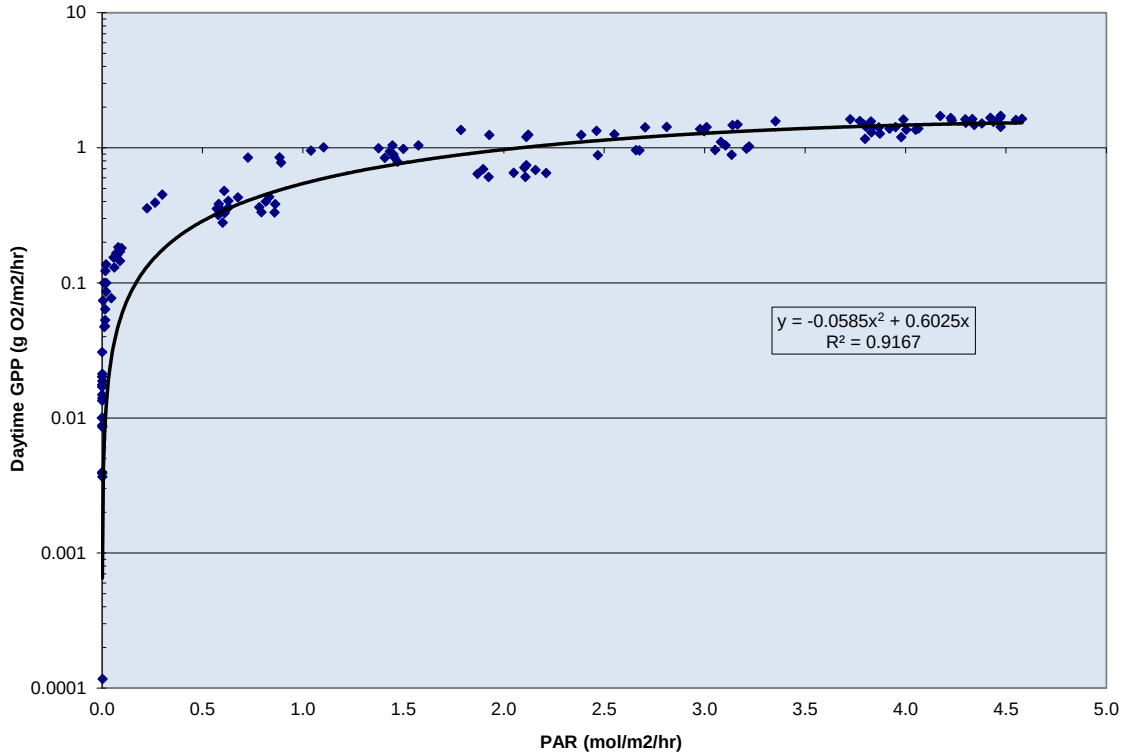


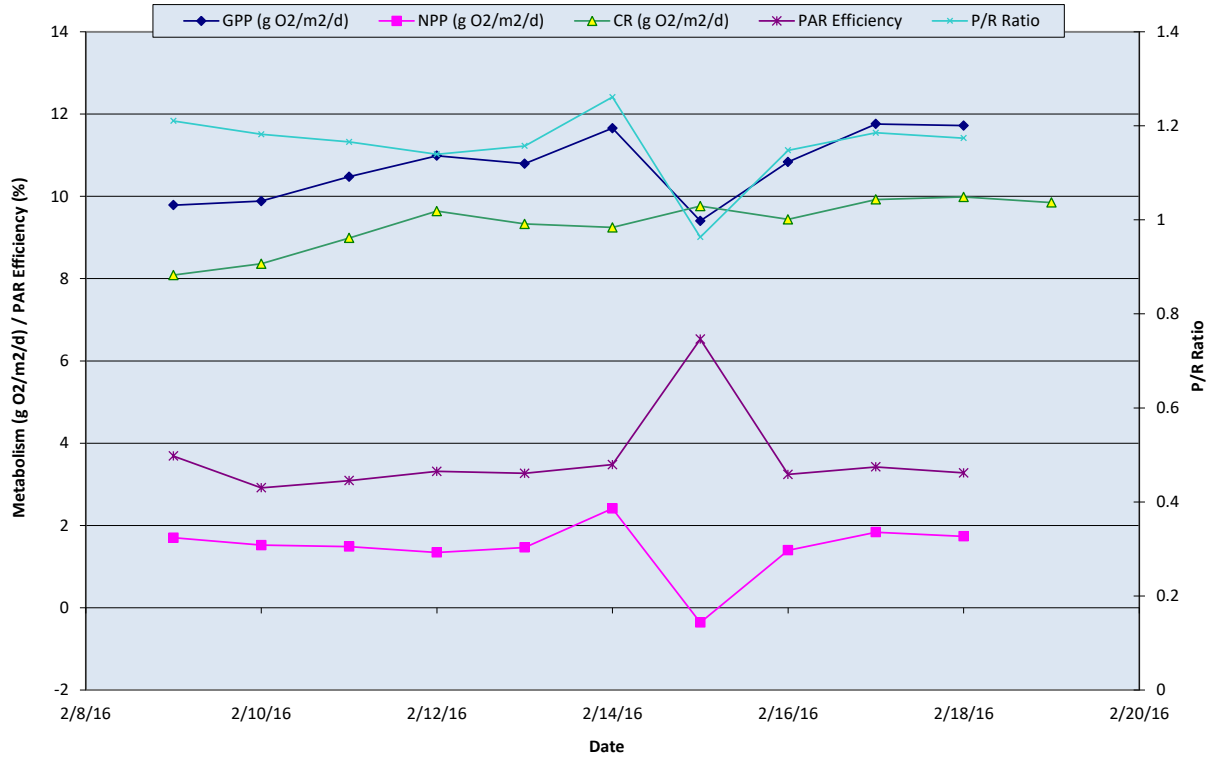
Parameter	Units	Avg	Min	Max	N
DO - up	mg/L	7.49	5.29	11.34	528
down		7.63	4.97	11.84	524
Wtr Temp - up	C	23.2	22.7	24.2	528
down		23.4	22.9	24.5	524
pH - up	SU	7.82	7.15	8.36	528
down		7.97	7.54	8.58	524
SpCond - up	uS/cm	288	283	291	528
down		290	285	292	524
Flow - up	m^3/d	1,768,874	1,761,535	1,778,661	14
Depth	m	1.89	1.82	1.94	14
Rainfall Total	in		0.9		
PAR - air	$umol/m^2/s$	356	0.0	1,724	288
plant		238	0.0	1272	241
DO rate chng	$g/m^2/hr$				
corr		-0.036	-0.641	1.469	241
uncorr		0.079	-0.598	1.350	241

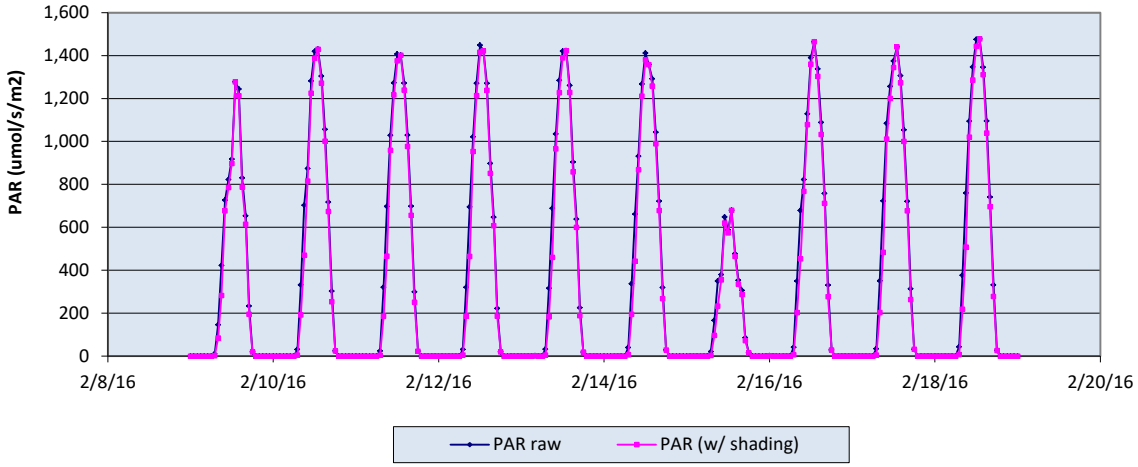

Dissolved Oxygen (mg/L)
PAR (umol/s/m2)
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
1600
1400
1200
1000
800
600
400
200
0
2/8/16
2/10/16
2/12/16
2/14/16
2/16/16
2/18/16
2/20/16
Upstream DO
Downstream DO
PAR

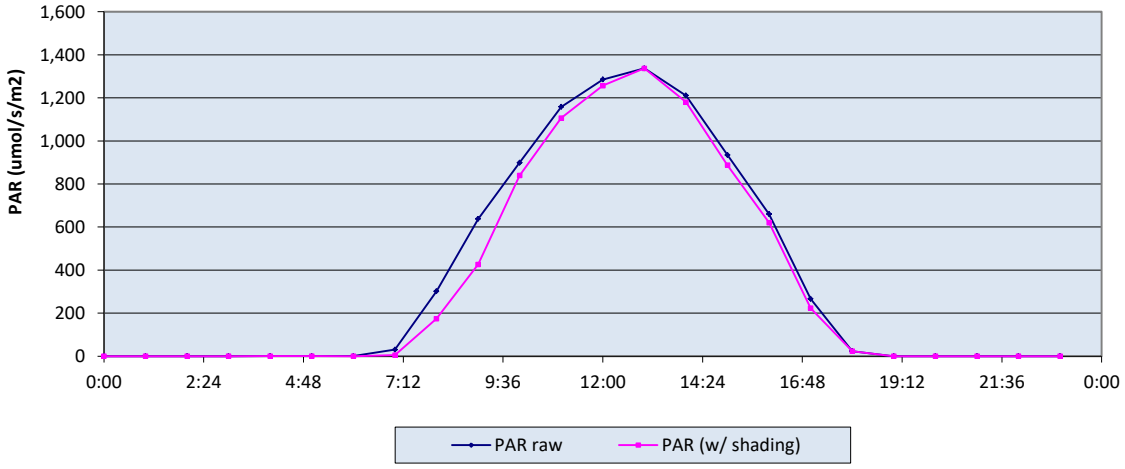

DO Flux (kg/hr)
800
700
600
500
400
300
200
100
0
-100
2/8/16
2/10/16
2/12/16
2/14/16
2/16/16
2/18/16
2/20/16
Upstream
Downstream
Accrual
Diffusion

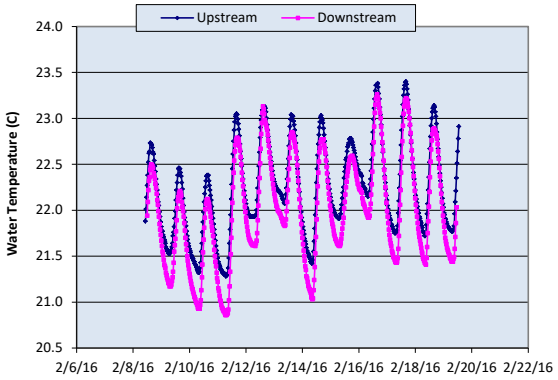

DO Rate-of-Change (g/m2/hr)
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
2/8/16
2/10/16
2/12/16
2/14/16
2/16/16
2/18/16
2/20/16
Corrected
Uncorrected
Acrual
Diffusion

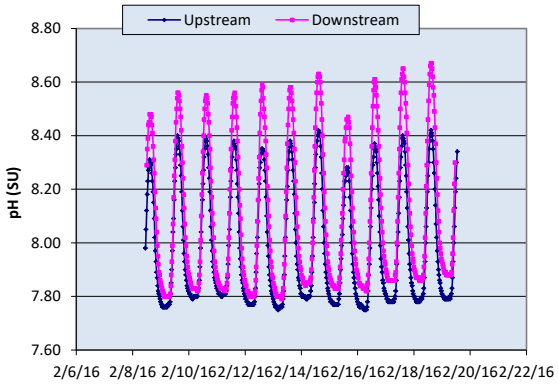

Daytime GPP (g O2/m2/hr)
PAR (mol/m2/hr)
y = -0.0585x² + 0.6025x
R² = 0.9167
10
1
0.1
0.01
0.001
0.0001
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0

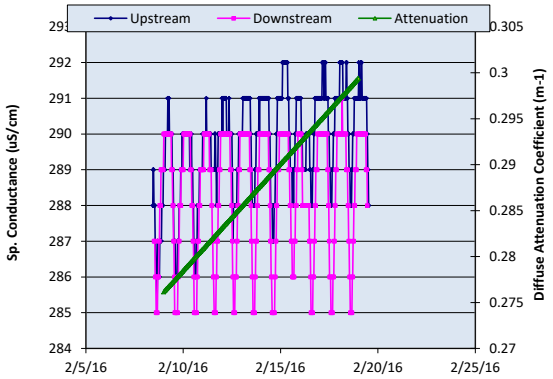

GPP (g O2/m2/d)
NPP (g O2/m2/d)
CR (g O2/m2/d)
PAR Efficiency
P/R Ratio
Metabolism (g O2/m2/d) / PAR Efficiency (%)
P/R Ratio
Date
14
12
10
8
6
4
2
0
-2
1.4
1.2
1
0.8
0.6
0.4
0.2
0
2/8/16
2/10/16
2/12/16
2/14/16
2/16/16
2/18/16
2/20/16

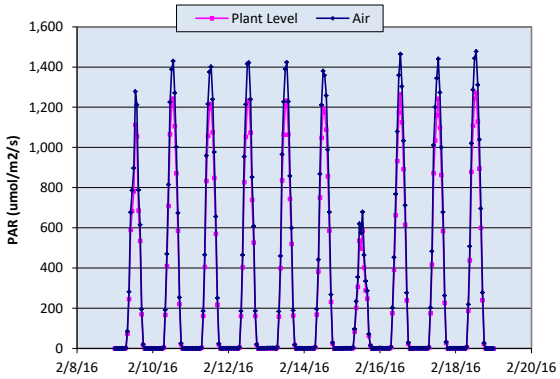

1,600
1,400
1,200
1,000
800
600
400
200
0
PAR (umol/s/m2)
2/8/16
2/10/16
2/12/16
2/14/16
2/16/16
2/18/16
2/20/16
PAR raw
PAR (w/ shading)

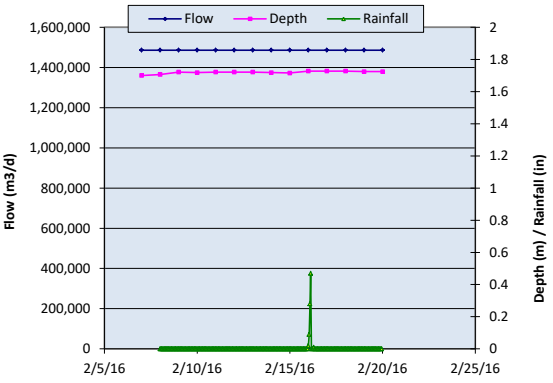

1,600
1,400
1,200
1,000
800
600
400
200
0
PAR (umol/s/m2)
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
PAR raw
PAR (w/ shading)











Parameter	Units	Avg	Min	Max	N
DO - up	mg/L	7.58	5.69	10.60	534
down		7.84	5.59	11.47	527
Wtr Temp - up	C	22.2	21.3	23.4	534
down		22.0	20.9	23.3	527
pH - up	SU	7.98	7.75	8.42	533
down		8.10	7.79	8.67	527
SpCond - up	uS/cm	290	285	292	534
down		288	285	291	527
Flow - up	m^3/d	1,486,784	1,486,784	1,486,784	14
Depth	m	1.72	1.70	1.73	14
Rainfall Total	in		0.9		
PAR - air	umol/m^2/s	364	0.0	1,483	288
plant		290	0.0	1272	241
DO rate chng	g/m^2/hr				
corr		0.057	-0.439	1.310	241
uncorr		0.162	-0.403	1.204	241

Appendix J

Nutrient Assimilation Detail

Rainbow River estimated nutrient mass removals

			Inflow (RSR-1)				Outflow (RSR-10)				Removal				
			Segment - Up				Segment - Down								
			Conc	Flow	Mass	Mass	Conc	Flow	Mass	Mass	Conc		Mass		
Parameter	Units	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)	(%)
NH4-N	mg/L	Sep-15	0.025	1,768,874	44.2	4.0	0.040	1,768,874	70.8	6.4	-0.015	-60.0	-26.5	-2.41	-60.0
		Feb-16	0.008	1,486,784	11.9	1.1	0.008	1,486,784	11.9	1.1	0.000	0.0	0.0	0.00	0.0
		POR	0.017	1,627,829	28.1	2.5	0.025	1,627,829	41.3	3.7	-0.008	-47.3	-13.3	-1.20	-47.3
NOx-N	mg/L	Sep-15	1.75	1,768,874	3,096	280.9	1.70	1,768,874	3,007	272.8	0.050	2.9	88.4	8.02	2.9
		Feb-16	1.70	1,486,784	2,528	229.3	1.70	1,486,784	2,528	229.3	0.000	0.0	0.0	0.00	0.0
		POR	1.73	1,627,829	2,812	255.1	1.70	1,627,829	2,767	251.1	0.027	1.6	44.2	4.01	1.6
Org N	mg/L	Sep-15	0.09	1,768,874	159.2	14.4	0.01	1,768,874	17.7	1.6	0.080	88.9	141.5	12.84	88.9
		Feb-16	0.13	1,486,784	193.3	17.5	0.04	1,486,784	59.5	5.4	0.090	69.2	133.8	12.14	69.2
		POR	0.11	1,627,829	176.2	16.0	0.02	1,627,829	38.6	3.5	0.085	78.1	137.7	12.49	78.1
TKN	mg/L	Sep-15	0.10	1,768,874	176.9	16.0	0.03	1,768,874	53.1	4.8	0.070	70.0	123.8	11.23	70.0
		Feb-16	0.13	1,486,784	193.3	17.5	0.03	1,486,784	44.6	4.0	0.100	76.9	148.7	13.49	76.9
		POR	0.11	1,627,829	185.1	16.8	0.03	1,627,829	48.8	4.4	0.084	73.6	136.2	12.36	73.6
TN	mg/L	Sep-15	1.86	1,768,874	3,290	298.5	1.75	1,768,874	3,096	280.9	0.110	5.9	194.6	17.65	5.9
		Feb-16	1.84	1,486,784	2,736	248.2	1.75	1,486,784	2,602	236.1	0.090	4.9	133.8	12.14	4.9
		POR	1.85	1,627,829	3,013	273.4	1.75	1,627,829	2,849	258.5	0.101	5.4	164.2	14.90	5.4

Segment Area (ha): 11.02

Appendix K

Particulate Export Detail

Station	Date	Start Time	Sample #	Upstream 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)	Laboratory Analysis					Total Sample		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 ($g/m^2/d$)
											Vol. Dried (mL)	Dry Wt. (g)	Ash Wt. (g)	% Ash	Ash-Free Dry Wt. (g)	Dry Wt. (g)	Ash-Free Dry Wt. (g)						
RSR-1	9/2/2015	15:22	57	189,785	183	20.42	0.1886	0.44	15.25	120	60	0.47	0.30	63.75	0.1700	0.938	0.3400	0.06150	0.02229	108,488	39,324	0.572	0.207
RSR-1	9/2/2015	15:22	58	189,785	149	20.42	0.1886	0.43	11.99	65	60	0.33	0.20	59.09	0.1350	0.357	0.1462	0.02982	0.01220	52,597	21,517	0.277	0.113
RSR-1	9/2/2015	15:22	78	189,785	159	20.42	0.1886	0.43	12.79	100	58	0.36	0.24	65.93	0.1230	0.622	0.2121	0.04865	0.01658	85,813	29,238	0.452	0.154
RSR-10	9/2/2015	14:29	84	299,999	300	20.42	0.1886	0.27	15.52	168	62	0.85	0.55	64.87	0.3000	2.314	0.8129	0.14911	0.05238	263,032	92,400	0.877	0.308
RSR-10	9/2/2015	14:29	23	299,999	157	20.42	0.1886	0.27	8.12	106	58	0.71	0.45	63.47	0.2590	1.296	0.4733	0.15955	0.05828	281,435	102,809	0.938	0.343
RSR-10	9/2/2015	14:29	95	299,999	218	20.42	0.1886	0.27	11.28	135	65	0.61	0.41	66.72	0.2040	1.273	0.4237	0.11290	0.03757	199,149	66,275	0.664	0.221
RSR-1	9/9/2015	12:11	18	189,785	135	20.47	0.1886	0.34	8.69	104	59	0.39	0.28	70.05	0.1180	0.695	0.2080	0.07992	0.02393	141,360	42,336	0.745	0.223
RSR-1	9/9/2015	12:24	74	189,785	133	20.47	0.1886	0.30	7.49	168	64	0.43	0.29	68.78	0.1330	1.118	0.3491	0.14927	0.04660	264,035	82,433	1.391	0.434
RSR-1	9/9/2015	12:31	21	189,785	153	20.47	0.1886	0.34	9.67	202	57	0.32	0.23	72.50	0.0880	1.134	0.3119	0.11723	0.03224	207,368	57,026	1.093	0.300
RSR-10	9/9/2015	12:55	76	299,999	141	20.47	0.1886	0.32	8.59	143	61	0.52	0.35	67.37	0.1690	1.214	0.3962	0.14136	0.04612	250,041	81,577	0.833	0.272
RSR-10	9/9/2015	13:01	38	299,999	162	20.47	0.1886	0.31	9.40	146	66	0.53	0.35	65.10	0.1860	1.179	0.4115	0.12537	0.04375	221,768	77,390	0.739	0.258
RSR-10	9/9/2015	13:07	42	299,999	181	20.47	0.1886	0.28	9.57	89	58	0.37	0.23	62.43	0.1390	0.568	0.2133	0.05932	0.02229	104,929	39,419	0.350	0.131

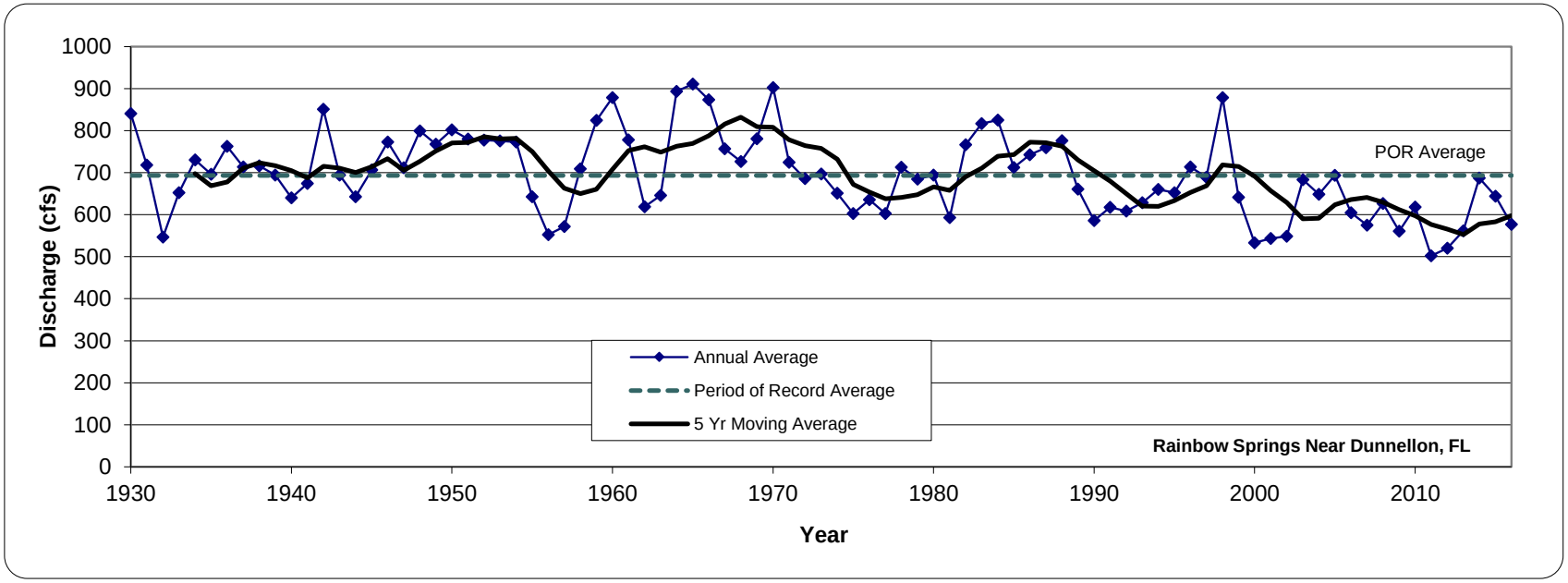
Station	Date	Start Time	Sample #	Upstream Area (m^2)	Time of Tow (s)	Flow Rate (m^3/s)	Net Area (m^2)	Water Velocity (m/s)	Volume Filtered (m^3)	Total Sample Volume (mL)	Laboratory Analysis					Total Sample		Dry Matter (g/m^3)	Organic Matter (g/m^3)	Dry Matter (g/d)	Organic Matter (g/d)	Dry Matter ($g/m^2/d$)	Organic Matter ($g/m^2/d$)
											Vol. Dried (mL)	Dry Wt. (g)	Ash Wt. (g)	% Ash	Ash-Free Dry Wt. (g)	Dry Wt. (g)	Ash-Free Dry Wt. (g)						
RSR - 1	2/8/16	12:45	24	189,785	234	17.21	0.1886	0.09	3.77	92	61	0.27	0.15	55.27	0.1230	0.415	0.1855	0.11013	0.04926	163,745	73,239	0.863	0.386
RSR - 1	2/8/16	12:45	26	189,785	236	17.21	0.1886	0.10	4.34	94	57	0.31	0.18	60.00	0.1220	0.503	0.2012	0.11588	0.04635	172,283	68,913	0.908	0.363
RSR - 1	2/8/16	12:45	88	189,785	236	17.21	0.1886	0.11	4.75	102	57	0.30	0.18	59.21	0.1240	0.544	0.2219	0.11458	0.04674	170,361	69,489	0.898	0.366
RSR - 10	2/8/16	13:20	35	299,999	236	17.21	0.1886	0.09	3.80	110	61	0.38	0.23	61.17	0.1460	0.678	0.2633	0.17852	0.06932	265,419	103,062	0.885	0.344
RSR - 10	2/8/16	13:20	43	299,999	235	17.21	0.1886	0.10	4.32	105	60	0.33	0.20	61.09	0.1280	0.576	0.2240	0.13320	0.05182	198,046	77,051	0.660	0.257
RSR - 10	2/8/16	13:20	86	299,999	204	17.21	0.1886	0.11	4.10	98	59	0.38	0.22	59.20	0.1530	0.623	0.2541	0.15178	0.06193	225,662	92,070	0.752	0.307
RSR - 1	2/19/16	13:00	25	189,785	120	17.21	0.1886	0.09	1.93	100	58	0.30	0.20	68.00	0.0960	0.517	0.1655	0.26783	0.08571	398,203	127,425	2.098	0.671
RSR - 1	2/19/16	13:05	63	189,785	120	17.21	0.1886	0.10	2.21	106	58	0.41	0.30	72.09	0.1150	0.753	0.2102	0.34115	0.09522	507,218	141,578	2.673	0.746
RSR - 1	2/19/16	13:10	85	189,785	120	17.21	0.1886	0.11	2.41	75	62	0.42	0.27	64.61	0.1490	0.509	0.1802	0.21096	0.07466	313,656	111,009	1.653	0.585
RSR - 10	2/19/16	11:20	75	299,999	240	17.21	0.1886	0.09	3.86	107	61	0.63	0.45	71.56	0.1800	1.110	0.3157	0.28747	0.08174	427,405	121,537	1.425	0.405
RSR - 10	2/19/16	11:25	31	299,999	180	17.21	0.1886	0.10	3.31	113	61	0.55	0.39	71.01	0.1600	1.023	0.2964	0.30886	0.08953	459,215	133,106	1.531	0.444
RSR - 10	2/19/16	11:30	87	299,999	120	17.21	0.1886	0.11	2.41	108	62	0.41	0.30	72.51	0.1130	0.716	0.1968	0.29657	0.08154	440,936	121,231	1.470	0.404

2/19/16 - USGS flow data not available

Appendix L

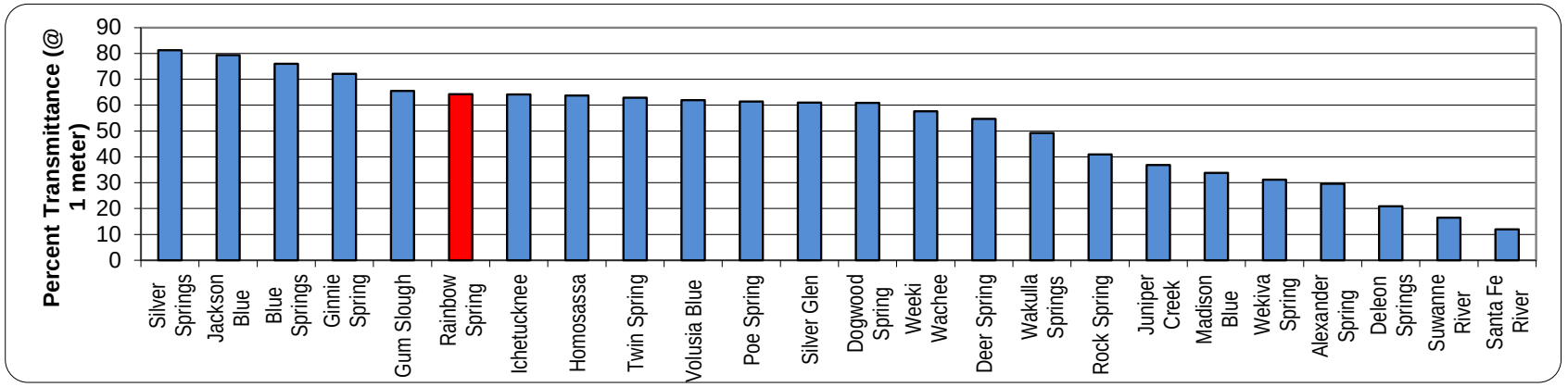
Rainbow Springs 2016 Report Card

RAINBOW SPRINGS AND RIVER



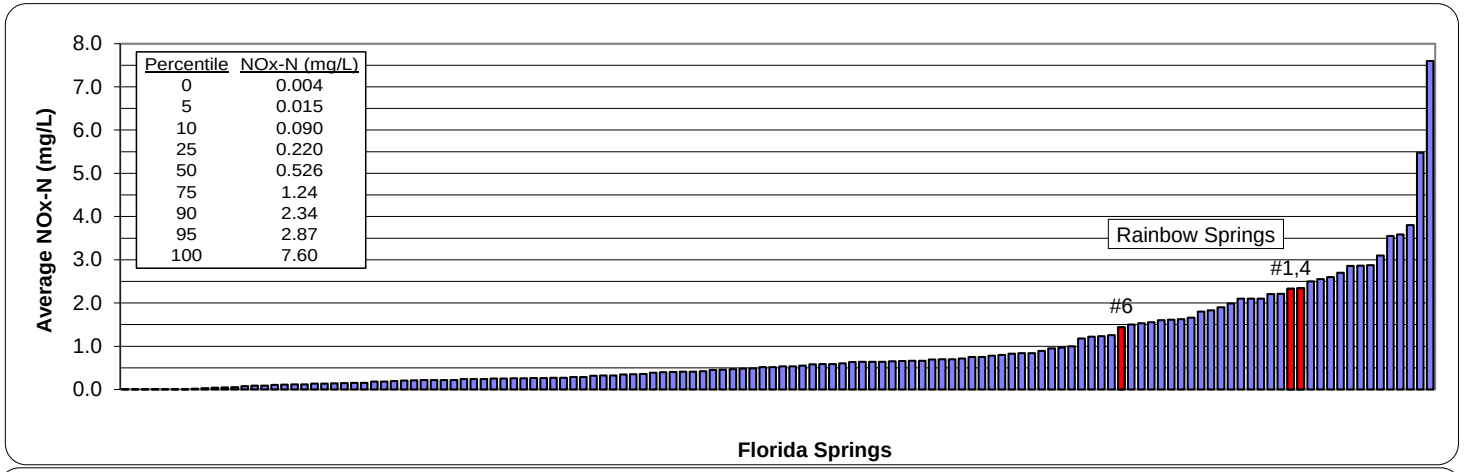
Spring Discharge @ US 484	Grade	Average (2012-2016)	A: > 776 cfs B: 713 - 775 cfs C: 660 - 712 cfs D: 610 - 659 cfs F: < 609 cfs
	F	**598 cfs**	

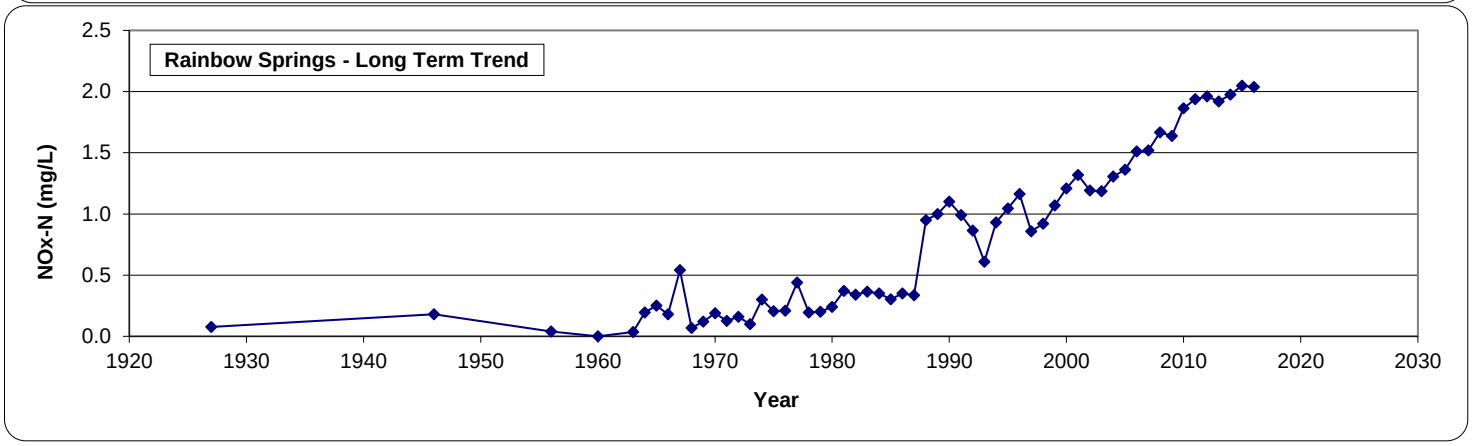
RAINBOW SPRINGS AND RIVER



Water Clarity @ Spring Run	Grade	Average (2015-2016)	A: > 70 % B: 60 - 69 % C: 50 - 59 % D: 40 - 49 % F: < 40 %
	B	**64%** **Light Transmittance @ 1 meter**	

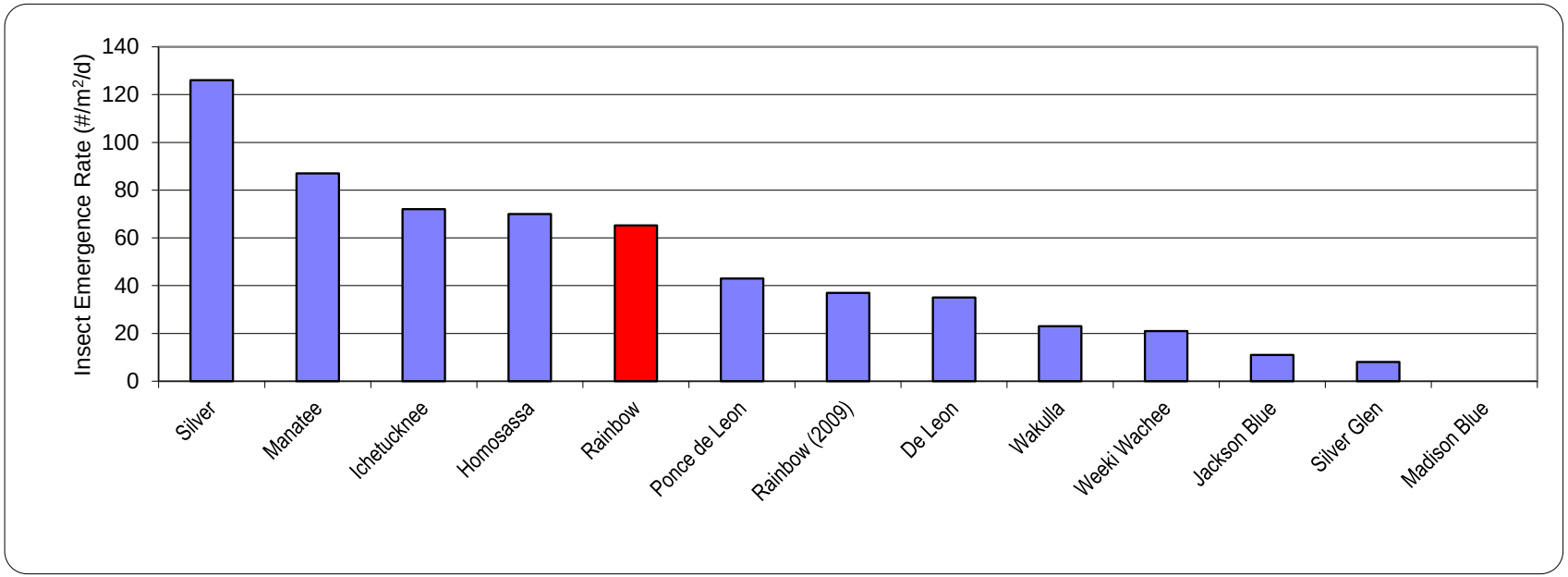
RAINBOW SPRINGS AND RIVER





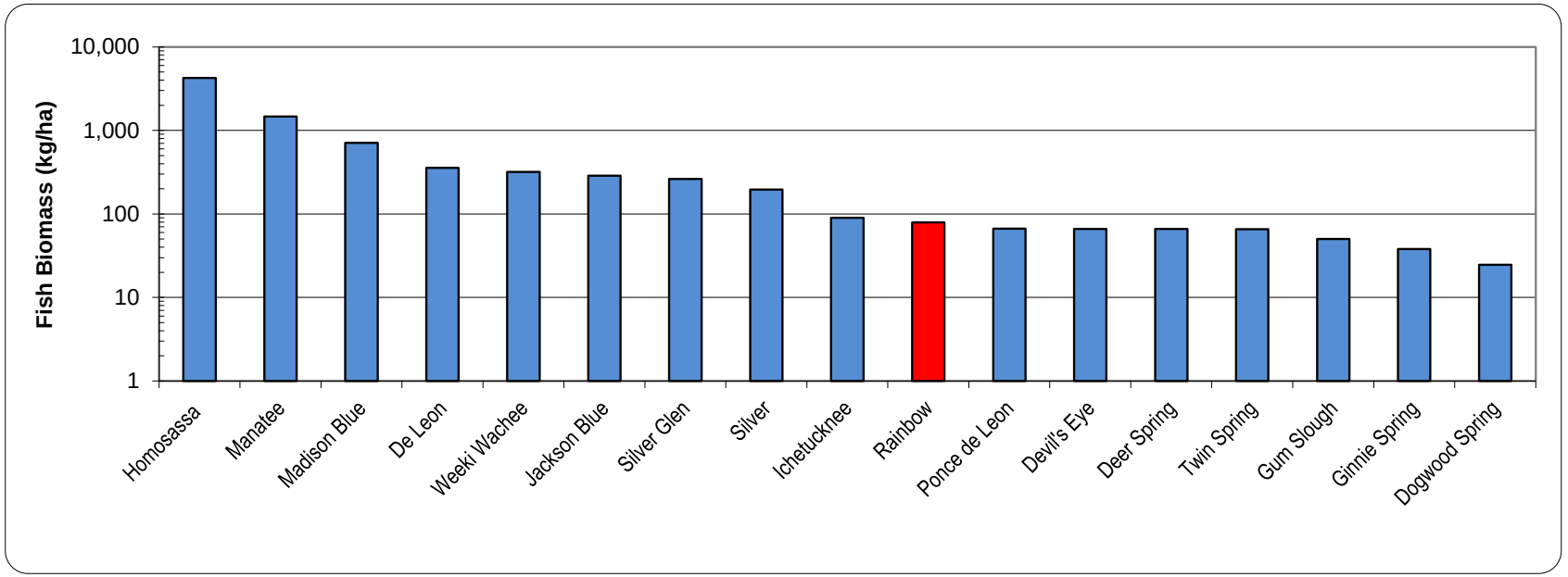
Nitrate Concentration @ Spring Boil	Grade	Average (2016)	A: < 0.15 mg/L B: 0.15 - 0.35 mg/L C: 0.36 - 0.60 mg/L D: 0.61 - 0.90 mg/L F: > 0.90 mg/L
	F	**2.04 mg/L**	

RAINBOW SPRINGS AND RIVER



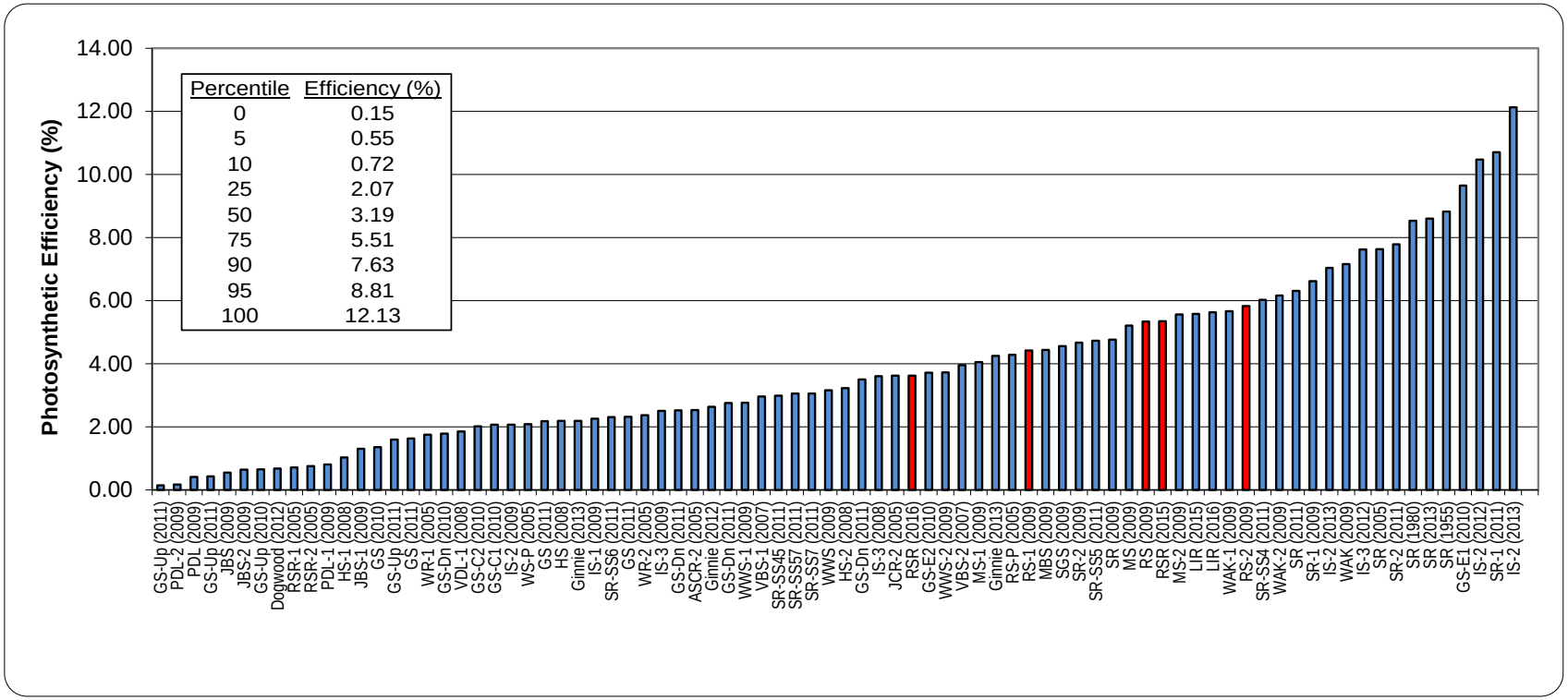
Adult Aquatic Emergence @ Spring Run	Grade	Average (2015-2016)	A: > 100 B: 75 - 99 C: 50 - 74 D: 25 - 49 F: < 24
	C	**65** insects/m²/day	

RAINBOW SPRINGS AND RIVER



Fish Biomass	Grade	Average (2016)	A: > 300 B: 200 - 299 C: 100 - 199 D: 50 - 99 F: < 50
	D	79 Biomass kg/ha	

RAINBOW SPRINGS AND RIVER



Photosynthetic Efficiency	Grade	Average (2015-2016)	A: > 7.0 B: 5.0 - 6.99 C: 3.0 - 4.99 D: 1.0 - 2.99 F: <1.0
	C+	**4.49 %**	