APPENDIX B

STUDY REPORTS

AMERICAN EEL (*ANGUILLA ROSTRATA*) ABUNDANCE STUDY REPORT

PARR HYDROELECTRIC PROJECT

(FERC NO. 1894)

Prepared for:

South Carolina Electric & Gas Company
Cayce, South Carolina

Prepared by:

Kleinschmidt

Lexington, South Carolina
www.KleinschmidtGroup.com

June 2016

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(*ANGUILLA ROSTRATA*)
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SOUTH CAROLINA ELECTRIC & GAS COMPANY

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AMERICAN EEL (*ANGUILLA ROSTRATA*) ABUNDANCE STUDY REPORT

PARR HYDROELECTRIC PROJECT
(FERC NO. 1894)

SOUTH CAROLINA ELECTRIC & GAS COMPANY

1.0 INTRODUCTION

South Carolina Electric & Gas Company (SCE&G) is the Licensee of the Parr Hydroelectric Project (FERC No. 1894) (Project). The Project consists of the Parr Shoals Development and the Fairfield Pumped Storage Development. The developments are located along the Broad River in Fairfield and Newberry Counties, South Carolina.

The Project is currently involved in a relicensing process which involves cooperation and collaboration between SCE&G, as Licensee, and a variety of stakeholders including state and federal resource agencies, state and local government, non-governmental organizations (NGO), and interested individuals. SCE&G has established several Technical Working Committees (TWC's) with members from among the interested stakeholders with the objective of achieving consensus regarding the identification and proper treatment of relicensing issues in the context of a new license.

The Fisheries TWC requested that SCE&G perform American eel (*Anguilla rostrata*) collections during 2015 to document the relative abundance of this species in the Broad River directly downstream of the Parr Shoals Dam. During a review of the 2015 study results at a Rare, Threatened and Endangered Species (RTE) TWC meeting, the TWC requested that SCE&G perform one more year of backpack electrofishing during 2016 to verify the 2015 study results.

2.0 RELEVANT LIFE HISTORY INFORMATION

The American eel, *Anguilla rostrata*, is a catadromous species known to occur within river systems in South Carolina. The present distribution of American eels in South Carolina is primarily downstream of the fall line (Rhode et al. 2009). Mature American eels spawn in the ocean and the egg and pre-larval stages mature into the leptocephalus stage, where they drift with ocean currents for approximately a year before metamorphosing into the glass eel stage. Glass eels migrate across the continental shelf, eventually entering estuaries and tidal rivers, where they mature into elvers. Elvers migrate primarily at night and are able to overcome obstacles that often times prevent passage of other aquatic species. Vertical obstacles, such as a dams, can be traversed by small eels as long as the surface of the structure is textured and remains wet. As the small eels continue to mature into yellow eels, they may gradually move upstream over many years, with the greatest movement occurring during the moderate water temperatures of spring and fall (ASMFC 2000). Upstream migrations of small eels in the southeast appear to increase as water temperatures reach 15^{o}C and continue until water temperatures reach approximately 22^{o}C (USFWS 2014 and Haro 1991).

Although the American eel currently does not have special status under state or federal regulations, it has been identified by United States Fish and Wildlife Service as an “at risk species” and the South Carolina Department of Natural Resources (SCDNR) as a priority species (SCDNR 2005).

3.0 STUDY OBJECTIVE

The objective of this study was to document the relative abundance, size, and movement patterns of the American eel in the Broad River in the immediate area downstream of Parr Shoals Dam through the use of elver traps, an elver fyke net, and backpack electrofishing. During 2016, backpack and boat electrofishing were used to verify the 2015 study findings.

4.0 METHODOLOGY

This study focused on collection of elvers in areas of the Broad River located immediately downstream of Parr Shoals Dam. Site selection for each collection method was based on attraction flows (dam leakage), safety for access and sampling, and input from the USFWS (USFWS 2014). Methodologies employed in this study were specified in the American Eel Abundance Study Plan (Appendix A).

Kleinschmidt personnel positioned two elver traps at the base of the dam in the west bank area and one trap on the east bank (directly downstream of the powerhouse). An elver fyke net was used to sample the flowing channel of water in the west channel of the Broad River.

Kleinschmidt personnel also sampled the pools and channel areas on the west side of the river and directly downstream of the dam (with a focus on areas near each of the elver traps) with a backpack electrofisher (Figure 1).

Elver traps were constructed using the design of Haro (2006) (Appendix B). Traps consisted of wooden ramps lined with landscape fabric as climbing substrate (Enkamat), an attraction flow, and a covered 44 gallon collection bucket with a flow-through water supply. Our water source for the traps on the west bank was supplied by gravity flow of leakage through the Parr Shoals Dam spillway gates (Photo 1). A reservoir height of 260.75 feet or greater was required for sufficient leakage flow to fill the collection buckets and water the traps. One of the elver traps was fitted with double ramps that sampled in different directions to increase the chances of elvers finding and using the ramps (Photo 2) and one trap was fitted with a single ramp (Photo 3). Flow for the east bank trap was provided by an electric water pump. This trap was also fitted with double ramps that sampled in opposite directions to increase the chances of elvers using the ramps.

Flow was delivered onto each of the ramps at a 45 degree angle over metal sheeting (Photo 4), so that any elvers that followed the flow up the ramp would then slide down the metal sheeting into the collection bucket. Hoses that provided attraction flow were secured at the bottom of the ramps using zip ties (Photo 5). Fine mesh screens were placed over the holes at the outlets of the collection buckets, to ensure that any elvers collected could not pass out of the traps.

Elver ramp traps were deployed and monitored from March 2, 2015 through June 12, 2015. Monitoring was also performed in the fall from October 9 to November 16, 2015. However, high flows during the month of October reduced the amount of time that the ramps effectively sampled during the fall sampling period. Traps were typically checked three times per week (Monday, Wednesday, and Friday), but only once or twice during high flow periods. Ramp flows and attraction flows were checked and repositioned as needed during each trap check event.

An elver fyke net was used to collect eels moving upstream through the west channel area (Photo 6). Kleinschmidt personnel identified an area of laminar flow and level bottom, with depths of approximately 2 to 3 feet that were ideal for use of a fyke net. The fyke net was initially placed in the main flow of the west channel. However, debris knocked the net over multiple times when it was set in this location, therefore the fyke net was moved to an area with moderate water velocity that was downstream and on the edge of the main west channel flow.

The fyke net was deployed and monitored from March 2, 2015 through June 12, 2015. Monitoring was also performed in the fall from October 9 to November 16, 2015. However, high flows during the month of October reduced the amount of time that the net sampled during the fall sampling period. The net was optimally checked three times a week (Monday, Wednesday, and Friday) and at least once or twice a week during high flow periods.

Backpack electrofishing sampling was conducted on April 1, May 1, and May 13, 2015. One electrofishing effort was also conducted during the fall period on November 16, 2015. Each electrofishing effort was conducted for 600-800 seconds. One person operated the backpack shocker, and either one or two additional people assisted in netting fish during sampling. Backpack shocking was conducted in the pools and runs located in the west channel side of the dam, with a focus on areas close to the traps.

Path: G:_Client_Data\SCE&G\ParrFairfield_MXD\Eel Trap Map.mxd
Source: ESRI, Kleinschmidt

FIGURE 1　　PARR PROJECT AMERICAN EEL - ELVER TRAP AND FYKE NET LOCATIONS

PHOTO 1 **LEAKAGE FLOW AND COLLECTION BUCKETS USED TO PROVIDE WATER TO WEST CHANNEL ELVER TRAPS**

PHOTO 2 **DOUBLE RAMP ELVER TRAP USED IN WEST CHANNEL**

PHOTO 3 SINGLE RAMP ELVER TRAP USED IN WEST CHANNEL

PHOTO 4 NOZZLE SETUP FOR PROVIDING FLOWS ONTO RAMPS

PHOTO 5 EXAMPLES OF ATTRACTION FLOW AT THE BASE OF RAMPS

PHOTO 6 EXAMPLE OF FYKE NET USED DURING STUDY

5.0 RESULTS

ELVER TRAP SAMPLING

Each of the three traps were in place for a total of 2,448 hours during the spring sampling event. The two west bank traps each sampled effectively (water flowing on ramp and attraction flow flowing at the base of the ramp) for a total of 1,499 hours. Downtime periods when the traps were not fishing were associated with low reservoir levels (< 260.75 ft.) that didn't provide enough leakage flow to supply attraction flows to the ramps. Downtime periods were also associated with instances of flooding that completely submerged and/or damaged the traps, and instances where debris clogged up nozzles, blocking flow from reaching the ramps. The east bank trap sampled effectively for a total of 1,900 hours during the spring sampling event (Table 1). Downtime was caused by flooding that completely submerged the trap, and by the electric water pump being damaged during the sampling periods. Within several days of being set in the fall, all three traps were flooded out. A single ramp trap was reset in the west channel on October 16, 2015. However this trap and the east bank trap spent the majority of October underwater due to high flows, and therefore did not spend much time sampling (Table 1). No eels were collected with the elver traps.

FYKE NET SAMPLING

The fyke net sampled effectively for a total of 2,304 hours during spring sampling (Table 1). Vandals pulled the net onto the bank on two occasions during the study. The fyke net caught approximately two hundred fish and approximately thirteen crayfish, including longnose gar, piedmont darter, redbreast sunfish, bluegill, young of year smallmouth bass, bullhead species, and shiner/minnow species. No eels were collected in the fyke net. The fyke net sampled effectively for one week during the fall sampling period, catching minnow/shiner species and a piedmont darter (Table 1). No eels were collected with the fyke net.

BACKPACK ELECTROFISHING SAMPLING

Fish collected during backpack electrofishing efforts include American eel, shorthead redhorse, gizzard shad, bluegill, redbreast sunfish, white crappie, smallmouth bass, and piedmont darter. One 250 mm American eel was collected on the May 1, 2015 electrofishing effort (Table 2). This fish was in the "yellow eel" lifestage, and was collected approximately 40 meters from the west channel double ramp trap. A visual inspection of the eel showed no elastomer tags. No elvers were collected during this study. The combined catch per unit of effort (CPUE) for all three springtime electrofishing efforts was 1.7 eels/hour. No eels were collected during the fall electrofishing effort. The total CPUE over all four electrofishing efforts was 1.3 eels/hour.

TABLE 1 TIME THAT ELVER RAMPS AND FYKE NET SPENT FISHING IN THE BROAD RIVER

	TIME EFFECTIVELY SAMPLED (HOURS)	
	SPRING SAMPLING	FALL SAMPLING
Double Ramp Trap – West Bank	1,499	44
Single Ramp Trap – West Bank	1,499	271
Double Ramp Trap – East Bank	1,900	155
Fyke – Net West Channel	2,304	170

TABLE 2 DATES, SAMPLING TIME, AND NUMBER OF EELS COLLECTED DURING FOUR BACKPACK ELECTROFISHING EVENTS IN THE BROAD RIVER

DATE	**SAMPLING TIME (SECONDS)**	**NUMBER OF EELS COLLECTED**
4/1/2015	800	0
5/1/2015	608	1
5/13/2015	710	0
11/16/2015	600	0

6.0 ADDITIONAL COLLECTIONS DURING 2016

During a meeting on March 1, 2016, the RTE TWC (specifically NOAA Fisheries) requested that SCE&G perform additional American eel backpack electrofishing collections during 2016 to verify the relative abundance of eels in the study area downstream of the Parr Shoals Dam (see Appendix C). The backpack electrofishing collections in 2016 replicated methodologies from 2015 (see Section 4.0 of this report). In addition, boat electrofishing was also used to collect additional samples in the deeper portions of the tailrace along the downstream face of the powerhouse tailrace area. During collections, one person operated the boat, while one netter stood on the bow of the boat. Collection locations for each methodology are depicted in Figure 2.

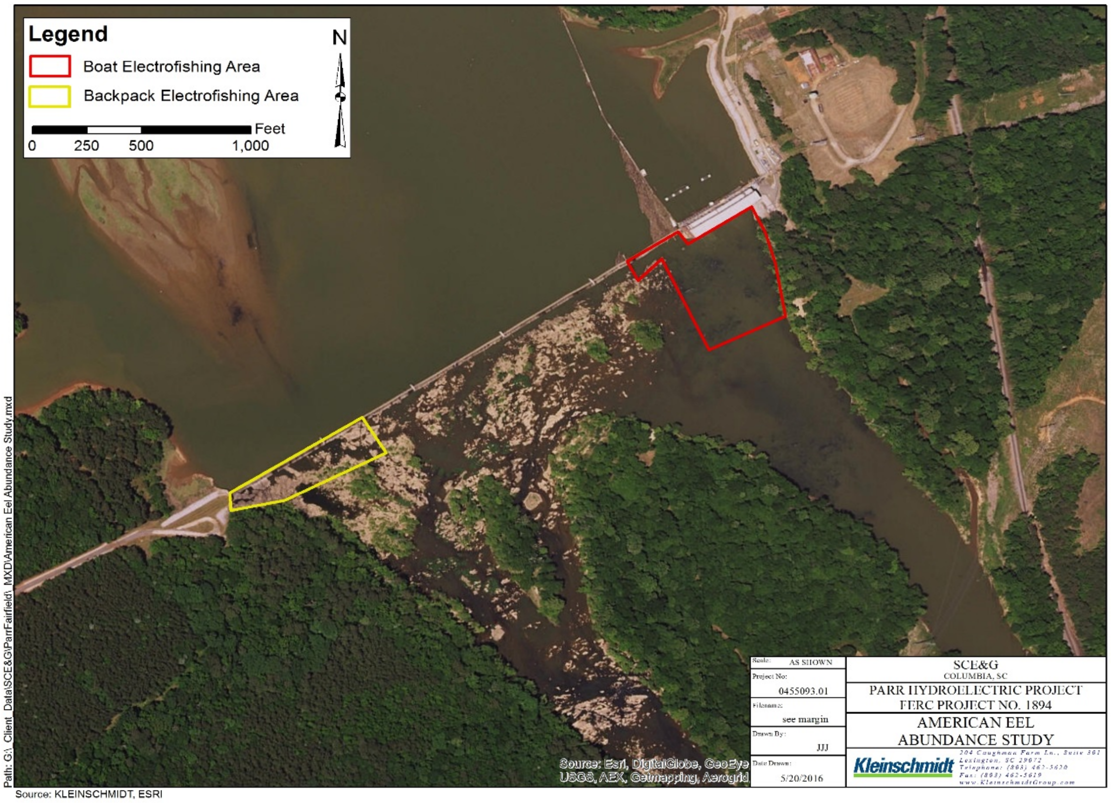

FIGURE 2 PARR PROJECT AMERICAN EEL - 2016 SAMPLING LOCATIONS

RESULTS

Fish collected during 2016 backpack electrofishing included similar species as the 2015 collections. One American eel was shocked but not netted during the April collections. Boat electrofishing detected one eel during the April collection also (Table 3). The eels observed were shocked but due to sampling conditions could not be netted. Both observed eels were yellow eels and appeared to be comparable in size to the yellow eel collected during 2015 sampling.

The combined catch per unit of effort (CPUE) for all three backpack electrofishing efforts was 1.4 eels/hour. The combined CPUE for all three boat electrofishing efforts was 0.9 eels/hour. Based on the total of 6,675 seconds of shock time, the total CPUE was 1.1 eels/hour.

TABLE 3 SUMMARY OF AMERICAN EEL COLLECTIONS DOWNSTREAM OF THE PARR SHOALS DAM DURING 2016

DATE	BACKPACK SHOCK TIME (SEC)	EELS OBSERVED	CPUE (EELS/HR)	BOAT SHOCK TIME (SEC)	EELS OBSERVED	CPUE (EELS/HR)
3/21	854	0	0.0	1,100	0	0
4/28	880	1	4.1	1,263	1	2.8
5/12	821	0	0.0	1,757	0	0
TOTALS	2,555	1	1.4	4,120	1	0.9

7.0 DISCUSSION

A one-year study was conducted in 2015 to determine the relative abundance, size and movement patterns of American eel in the Broad River immediately downstream from the Parr Shoals Dam. Despite using a variety of sampling methods , and sampling when water temperatures ranged from 7-24 ^{o}C during the spring sampling period, only one American eel was collected. The results of this study suggest that while American eels are present in the area downstream of Parr Shoals Dam, they do not appear to be abundant. The low numbers of eels collected could have resulted for several reasons, including low numbers of American eels in the vicinity of the project or inefficient sampling methods.

Low numbers of American eels collected could be related to the actual abundance of eels near the Project. There are a number of downstream blockages that hinder eels from reaching Parr Shoals Dam (i.e. multiple downstream dams). During 2010-2012, the SCDNR collected 13 eels downstream of the Columbia Hydroelectric Project dam (located on the Broad River 23.5 miles downstream of Parr Shoals Dam) by eel ramps (2), electrofishing (10), and Fukui trap (1) (SCDNR 2013). The mean annual backpack electrofishing CPUE at the Columbia Dam was 1.28 eels/hour (range of 0.61 – 2.35), which is comparable to the CPUE of 1.3 eels/hour experienced during our current study in the Parr tailrace. In separate studies during 2009-2014, the SCDNR collected a total of 21 yellow eels in the Broad River with 12 of those eels collected immediately downstream of Parr Shoals Dam via boat electrofishing. The 12 eels were collected over a total sampling time of 9600 seconds (CPUE=4.5 eels/hour), which is somewhat higher than the CPUE experienced during this study.

Three backpack and three boat electrofishing efforts were conducted in the spring of 2016 to provide an additional assessment of the abundance of American eels downstream of Parr Shoals Dam. A total of two yellow eels were observed during the collections. Combined springtime CPUE from the 2015 backpack electrofishing efforts (1.7 eels/hr) are comparable to the combined springtime CPUE for the 2016 backpack electrofishing efforts (1.4 eels/hr). The results of the 2016 study corroborate the findings of the previous 2015 eel sampling effort, that while American eels are present in the area downstream of Parr Shoals Dam, they do not appear to be abundant.

Low numbers of American eels collected could also be a result of the difficulty of catching eels with eel traps, fyke nets, and by boat or backpack electrofishing. Much of our study sampling effort targeted elvers or smaller yellow eels. Eels greater than 90 mm in length and over 14 months old are likely to have transitioned from the elver lifestage into yellow eels (Machut 2006, as cited in Pitman and Schmidt 2012). Therefore, it is possible that in the time it takes for most eels to reach the Parr project, they have matured into yellow eels. The Columbia Dam collections during 2010-2012 reinforce this theory in that all thirteen eels collected downstream of the Columbia Dam were greater than 128 mm in length (128 – 314 mm total length).

According to Rhode et al. (2009), “American eel are widespread and common in the Coastal Plain and the Piedmont up to the first migration barrier” and the SCDNR describes American eels as rare in the piedmont of the State (http://www.dnr.sc.gov/fish/species/americaneel.html). Regardless of the reasons for the low catch rates of American eel in this study, the results and conclusions of this study appear to be consistent with the current understanding of American eel distributions in South Carolina.

8.0 REFERENCES

Atlantic States Marine Fisheries Commission (ASMFC). April 2000. Fishery Management Report No. 36. Interstate Fishery Management Plan for American Eel.

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APPENDIX A

AMERICAN EEL ABUNDANCE STUDY PLAN

AMERICAN EEL (*ANGUILLA ROSTRATA*) ABUNDANCE STUDY PLAN

PARR HYDROELECTRIC PROJECT (FERC NO. 1894)

Prepared for:

South Carolina Electric & Gas Company
Cayce, South Carolina

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AMERICAN EEL (*ANGUILLA ROSTRATA*) ABUNDANCE STUDY PLAN

PARR HYDROELECTRIC PROJECT
(FERC NO. 1894)

SOUTH CAROLINA ELECTRIC & GAS COMPANY

1.0 INTRODUCTION

South Carolina Electric & Gas Company (SCE&G) is the Licensee of the Parr Hydroelectric Project (FERC No. 1894) (Project). The Project consists of the Parr Hydro Development and the Fairfield Pumped Storage Development. The developments are located along the Broad River in Fairfield and Newberry Counties, South Carolina.

The Project is currently involved in a relicensing process which involves cooperation and collaboration between SCE&G, as licensee, and a variety of stakeholders including state and federal resource agencies, state and local government, non-governmental organizations (NGO), and interested individuals. Collaboration and cooperation is essential for the identification of and treatment of operational, economic, and environmental issues associated with a new operating license for the Project. SCE&G has established several Technical Working Committees (TWC's) with members from among the interested stakeholders with the objective of achieving consensus regarding the identification and proper treatment of these issues in the context of a new license.

The Fisheries TWC has requested that American eel (*Anguilla rostrata*) studies be performed in 2015 to document the relative abundance of this species in the Broad River, directly downstream of the Parr Shoals Dam.

2.0 RELEVANT LIFE HISTORY INFORMATION

The American eel, *Anguilla rostrata,* is a catadromous species known to occur within river systems in South Carolina. Mature American eels spawn in the ocean and the egg and pre-larval stages mature into the leptocephalus stage, where they drift with ocean currents for approximately a year before metamorphosing into the glass eel stage. Glass eels migrate across the continental shelf, eventually entering estuaries and tidal rivers, where they mature into elvers.

Elvers migrate primarily at night and are able to overcome obstacles that often times prevent passage of other aquatic species. Vertical obstacles, such as a dam, can be traversed by small eels as long as the surface of the structure is textured and remains wet. As the small eels continue to mature into yellow eels, they may gradually move upstream over many years, with the greatest movement occurring during the moderate water temperatures of spring and fall (ASMFC 2000). Upstream migrations of small eels in the southeast appear to increase as water temperatures reach 15^{o}C and continue until water temperatures reach approximately 22 ^{o}C (USFWS 2014 and Haro 1991).

Although the American eel currently does not have special status under state or federal regulations, it has been identified by the South Carolina Department of Natural Resources (SCDNR) as a priority species (SCDNR 2005). The federal status of this species is currently under review by the U.S. Fish and Wildlife Service(USFWS) and has been reviewed by the USFWS and National Marine Fisheries Service (NMFS) several times over the past decade.

3.0 STUDY OBJECTIVE

The objective of this study is to document the relative abundance, size, and movement patterns of the American eel in the Broad River in the immediate area downstream of Parr Dam through the use of elver traps, elver fyke net, and electrofishing methods.

4.0 GEOGRAPHIC SCOPE

The study will focus on the Broad River immediately downstream of Parr Shoals Dam. Three to five elver traps of standard design will be positioned at two sites along the base of the dam located near the west bank and one site on the east bank of the Broad River, directly downstream of the powerhouse. Site selection was based on dam leakage, current flow, and safety for access and sampling. One elver trap will be placed in each area at the start of sampling and two additional traps (for a total of 5 traps) may be added to these areas during the sampling period based on the collection or observations of elvers (in the traps or during electrofishing) in those areas. An elver fyke net will be positioned in the west channel that drains a large portion of the leakage from the Parr Dam. Backpack electrofishing efforts will be performed in the pools and channel areas on the west side of the river and directly downstream of the dam with a focus on areas near each of the elver traps (Figure 1).

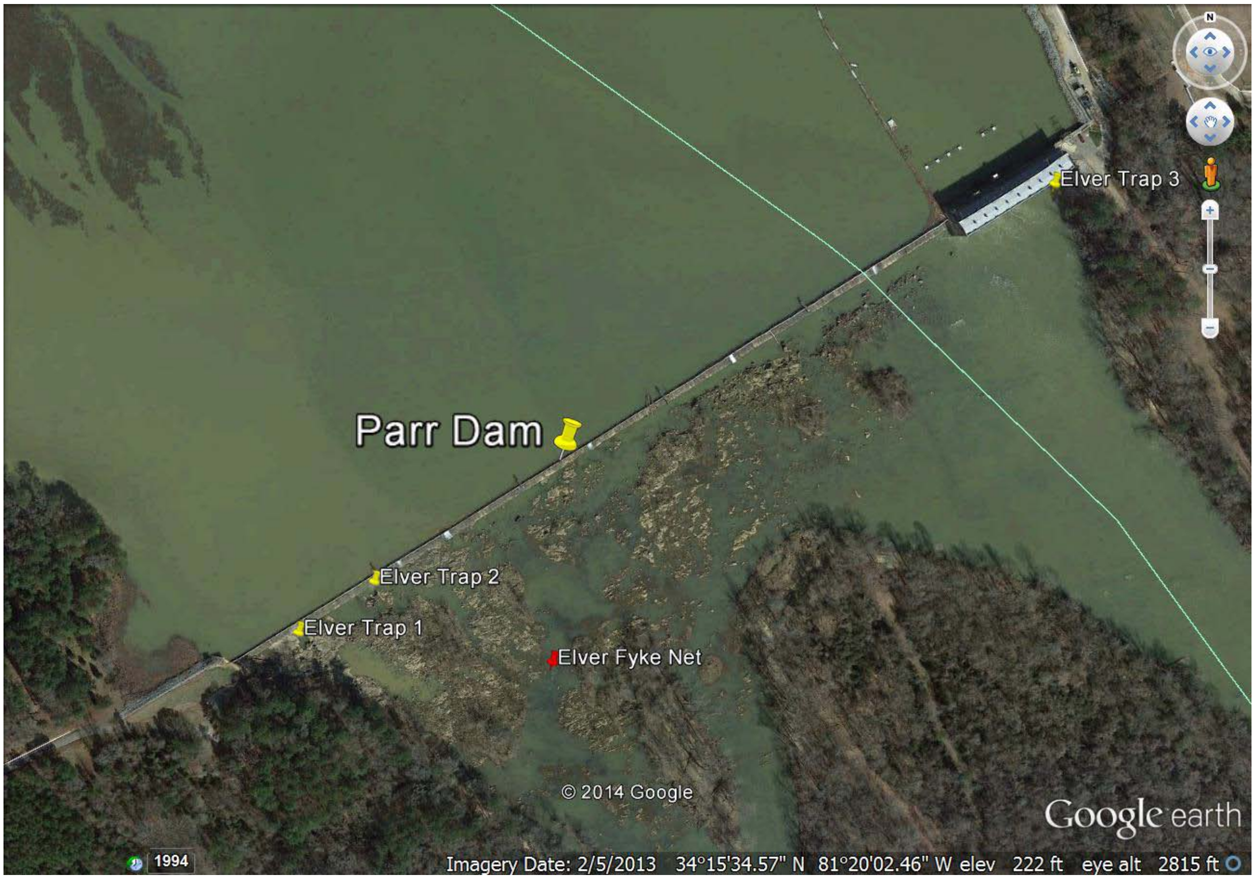

FIGURE 1. PARR PROJECT AMERICAN EEL – ELVER TRAP AND FYKE NET LOCATIONS

5.0 METHODOLOGY AND TEMPORAL SCOPE

Passive collection methods for elvers will consist of a metal ramp lined with landscape fabric climbing substrate (Enkamat or Akwadrain), an attraction flow, and a covered collection bucket with aeration or flow-through water supply. Ramp attraction flow will be provided by either gravity fed or pumped water supply (Figure 2). Elver traps in areas 2 and 3 will be fitted with double ramps that will sample in opposite directions to increase the chances of elvers using the ramp. The area 1 trap will only be fitted with a single ramp. An elver fyke net will also be used to collect eels moving upstream through the west channel area (Figure 3). We have identified an area of laminar flow, level bottom, and depths of approximately 2 to 3 feet that will be ideal for use of a fyke net. Spare equipment will be kept on hand in order to replace damaged or lost traps and nets to reduce “down time” and safely complete the study following subsidence of spill events.

American eel studies performed by the SCDNR on the Broad River, below the Columbia Diversion Dam, have indicated that the greatest frequency of catch occurs during April - June. However, a review of temperature data at the Parr Dam indicates water temperatures of 15^{o}C could occur as early as the beginning of March. Therefore elver ramp traps will be deployed at the end of February 2015 and will be monitored beginning on March 2, 2015 and ending on June 15, 2015. Monitoring will also be performed in the fall during October 5 to November 15, 2015 (Figure 4). Monitoring during the spring period will occur once a week until water temperature reaches 15^{o}C, then traps will be monitored three times a week (Monday, Wednesday, and Friday) until temperatures reach 22^{o}C, and then spring monitoring will be discontinued. The elver traps will be placed back in position on October 5th and monitoring of the traps will occur three times per week until November 15 or until the water temperature drops below 15^{o}C, and monitoring will be discontinued for the year. Trap entrances and attraction flows will be checked and repositioned as needed during each trap check event.

FIGURE 2. EXAMPLE OF A PORTABLE ELVER RAMP TRAP USED AT THE DOMINION PROJECT TAILRACE.

FIGURE 3. EXAMPLE OF AN ELVER FINE MESH FYKE NET PRODUCED BY FILMAR, INC.

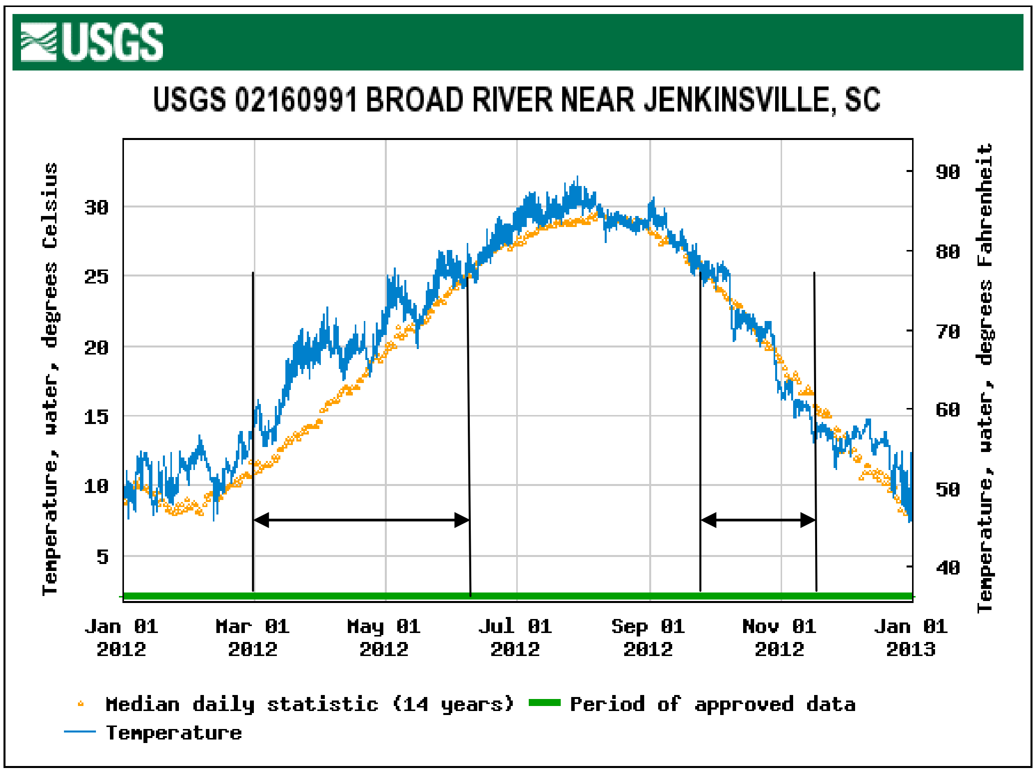

FIGURE 4. BROAD RIVER WATER TEMPERATURE AT PARR DAM – MEDIAN OVER 14 YEARS AND FOR 2012

Backpack electrofishing will be conducted once in late March, April, and May, 2015 and one sample in October during the fall period. Since American eels can be difficult to catch by electrofishing methods, one person will operate the backpack shocker and two additional people will assist in collecting eels during the effort. Backpack shocking will be conducted in the pools and runs located in the west channel side of the dam with a focus on areas close to the traps.

All eels collected will be measured, checked for visual implant elastomer (VIE) tags, recorded, and released to the Broad River upstream of Parr Dam. If the color of the VIE tag cannot be positively determined (especially pink or orange) the eels will be kept and preserved for dissection and color determination.

6.0 PRODUCTS

A final report summarizing the study findings will be issued within 120 days of completion of field work in 2015. Study methodology, timing and duration may be adjusted based on consultation with resource agencies and interested stakeholders.

7.0 USE OF STUDY RESULTS

Study results will be used as an information resource during discussion of relicensing issues and developing potential Protection, Mitigation and Enhancement measures with the South Carolina Department of Natural Resources, USFWS, Fisheries TWC, and other relicensing stakeholders.

8.0 REFERENCES

Atlantic States Marine Fisheries Commission (ASMFC). April 2000. Fishery Management Report No. 36. Interstate Fishery Management Plan for American Eel.

Haro, A. 1991. Thermal preferenda and behavior of Atlantic eels (genus *Anguilla*) in relation to their spawning migration. Environmental Biology of Fishes 31: 171-184.

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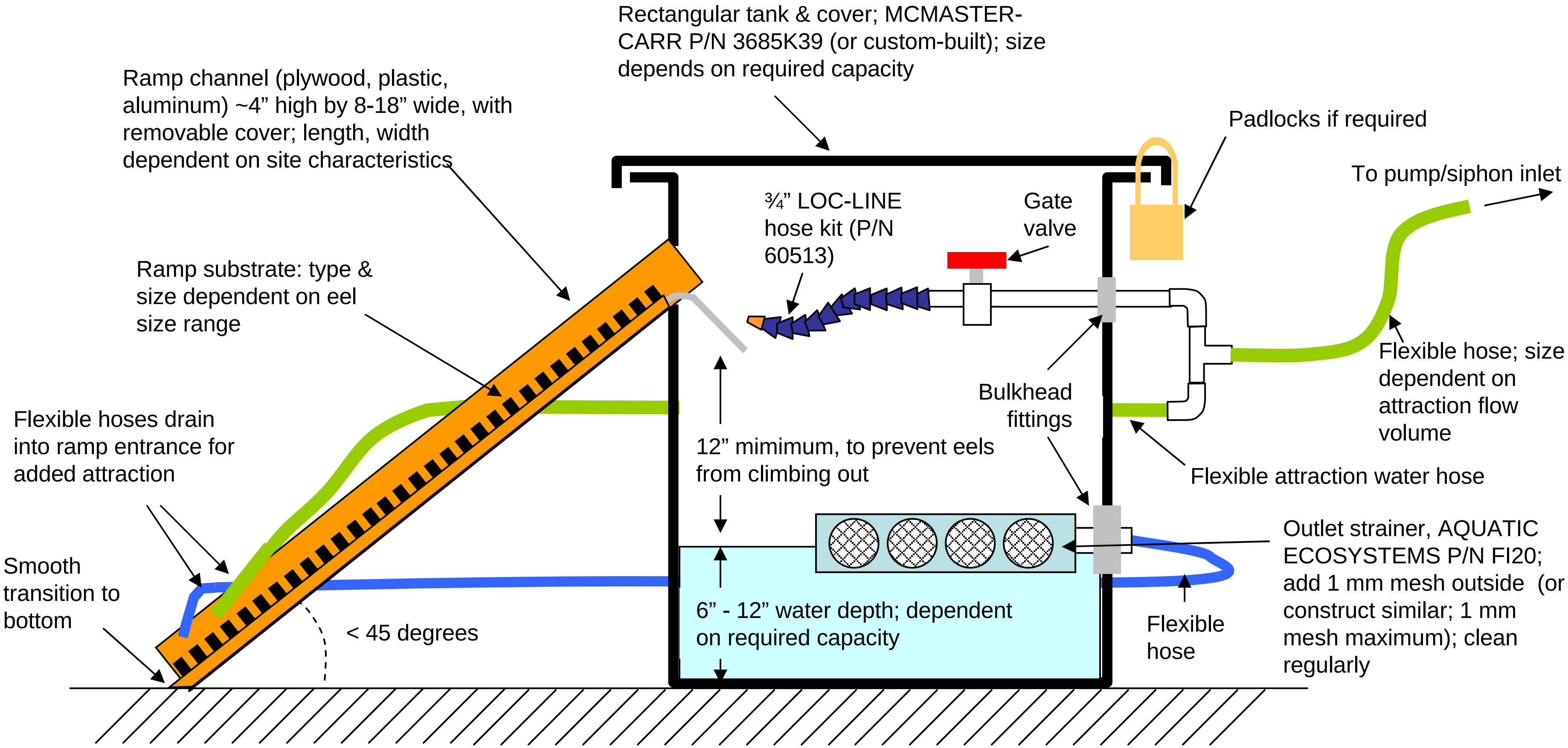
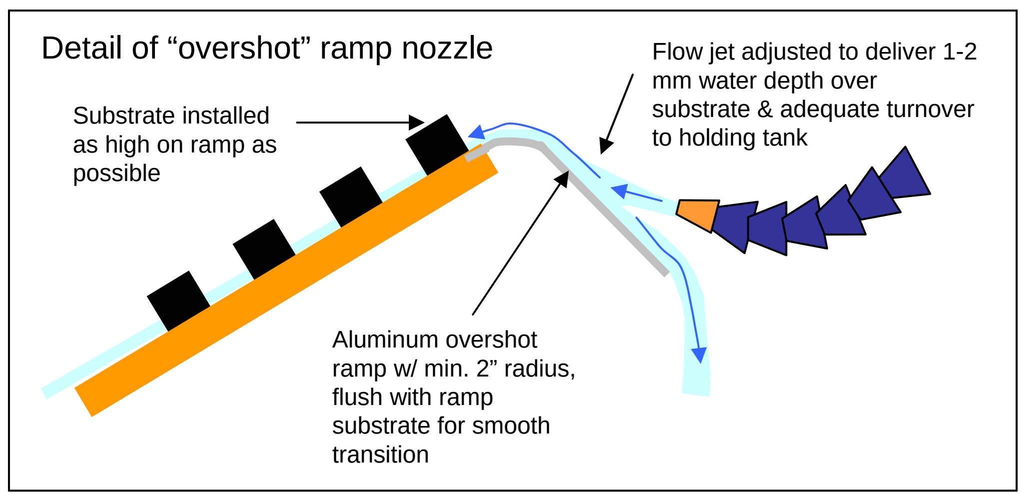
APPENDIX B

ELVER TRAP DESIGNS





"Generic" Temporary Eel Ramp Pass Trap

Design by Alex Haro
S.O. Conte Anadromous Fish Research Center,
U.S. Geological Survey, Biological Resources
Turners Falls, MA USA

March 2006

APPENDIX C

RTE TWC MEETING NOTES
MARCH 1, 2016

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
Rare, Threatened and Endangered Species TWC Meeting

March 1, 2016

Final KMK 03-28-16

ATTENDEES:

Bill Argentieri (SCE&G)	Rusty Wenerick (SCDHEC)
Ray Ammarell (SCE&G)	David Eargle (SCDHEC)
Brandon Stutts (SCE&G)	Bill Stangler (Congaree Riverkeeper)
Caleb Gaston (SCE&G)	Henry Mealing (Kleinschmidt)
Tom McCoy (USFWS)	Shane Boring (Kleinschmidt)
Fritz Rohde (NOAA)	Kelly Kirven (Kleinschmidt)
Bill Marshall (SCDNR)	Jared Porter (Kleinschmidt)

These notes serve as a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

The objective of the meeting was to review several reports that were issued to the TWC summarizing five studies that were completed during 2015, including the Rare, Threatened and Endangered Desktop Assessment, the American Eel Abundance Study, the Rocky Shoals Spider Lily Study, the Broad River Spiny Crayfish Study, and the Monticello Reservoir Mussel Survey. A brief PowerPoint presentation was prepared summarizing the methods and results of each study. This presentation is attached to the end of these notes. A second meeting objective was to identify any Protection, Mitigation, and Enhancement (PM&E) measures associated with the study issues for possible inclusion in the Settlement Agreement.

RTE Desktop Assessment

Henry said this report was originally issued in 2014, but after additional input from the USFWS, the report was revised and reissued in the late fall of 2015. The bald eagle is known to occur within the Project boundary, and SCE&G will continue to work with SCDNR on monitoring this species. There are also several fish that are known to occur within the Project boundary that will be further addressed through the IFIM study.

Bill Stangler said that the report has wording that suggests SCE&G is “likely to consult” with agencies on blueback herring and asked if there was a reason why they would not consult. This wording will be changed to remove “likely.” He also asked if striped bass and sturgeon spawning would be addressed during any additional studies. Henry said yes, striped bass will be looked at during the IFIM study, and both species will be studied further as part of the ongoing Downstream Flow Fluctuation investigation.

Bill Marshall said that SCDNR has noted that robust redhorse are known to occur in the Monticello Reservoir. He said that the SCDNR may have some concerns about entrainment impacts if it passed into that reservoir through the pumpback operations. Henry said that it probably did get there through pumpback operations at Fairfield, and that there may be mortality, but there is also survival. This may be something that will need to be addressed further as fish passage becomes an issue in the future.

Bill M. also said that a new State Wildlife Action Plan was completed last year, so the report may need to be updated to reflect those changes. Tom McCoy said that the official status of several of the species had also changed since the report was issued. These should be updated for the Draft and Final License Application. An addendum to the report will be prepared to address these changes. Bill M. and Tom M. were asked to send their recommended updates/edits to Kleinschmidt.

American Eel Abundance Report

Jared gave the group a summary of the American eel study that was completed in the spring and fall of 2015. Henry stated that Mark Cantrell with the USFWS accompanied Kleinschmidt and SCE&G on a site visit to help pick sites for installing the eel ramps. Jared noted that the ramps did not catch any eels or any other species and the fyke net didn’t catch any eels either, although it did catch a wide variety of other species, including fish, crayfish and turtles. One backpack electrofishing effort did result in the collection of one American eel. The eel was a yellow eel; no elvers were found. These results are similar to the results of additional studies conducted by Ron Ahle with SCDNR.

Fritz asked what type of substrate was used on the eel ramps and Jared said Enkamat. Fritz pointed out that if the yellow eel life stage is what is located below the Project, Enkamat may not have been the best substrate. Henry agreed and said that during study plan development, everyone expected that elvers would be the dominant life stage of eel in the area, instead of the larger yellow eels. Henry said that based on the information collected during this study and the SCDNR study, future studies and fish passage should focus on the collection of larger eels. Fritz agreed and said he would send the group some additional information regarding eel passage.

Tom said that periodic monitoring as a PM&E measure in the new license might be a good idea. The group agreed that doing surveys on a 5-10 year basis, or when initiated by a pre-determined trigger, could be part of the Settlement Agreement. Henry said this could be tied into the fish passage requirements as described in the Accord Agreement. Tom said he would send the group some information on the triggers used for eel passage at the Wateree Project. Bill A. said that additional American eel studies could be initiated when a percentage of a trigger number is hit, similar to how fish passage study and design for American shad and blueback herring is set up in the Accord Agreement.

Fritz said that of the three methodologies used in the study, the only effective one was backpack electrofishing. He asked that the backpack electrofishing be replicated in the spring of 2016 to verify that yellow eels are the life stage of eel that are dominant below the Parr Shoals dam. This way, when additional studies are warranted, methodology can be targeted toward the collection of yellow eels. SCE&G agreed to do an additional year of backpack electrofishing downstream of the dam. Three sampling events will be scheduled during late March, mid-April and mid-May and the results will be issued as an addendum to the American Eel Abundance Report.

Rocky Shoals Spider Lily (RSSL) Report

Shane gave the group a summary of the RSSL study, and said that populations of the plant were concentrated around the top of Bookman Shoals and the top of Frost Shoals. Bill Stangler asked for clarification on the green polygons shown in the report. Shane said that the polygons were drawn around large population clusters of the plants. Henry said that transect elevation data is also being collected in some of the RSSL areas as part of the IFIM study.

Henry asked Bill S. if there was something specific that he wanted to see coming out of relicensing. Bill said that he would like to see something similar to what was done during the Columbia relicensing, such as long term monitoring and possible restoration efforts. If restoration isn't feasible in the Broad River downstream of the Project, it could be done elsewhere in the basin. Bill said that currently there is less usage in this stretch of the river, so the plant is less visible here than it is below Columbia. There is less human predation, but this could change if additional access is created downstream of Parr. Bill A stated that as part of the Saluda Project, SCE&G is a supporting member of the team that currently monitors the RSSL population below Columbia dam. SCE&G could carry this forward for consideration for the Parr Settlement Agreement – but more specific information will need to be added to the PM&E measure.

Broad River Spiny Crayfish Report

Jared gave an overview of the Broad River Spiny Crayfish study and said that Byron Hamstead (USFWS) accompanied Kleinschmidt staff to identify specific study areas for deploying crayfish traps. Jared said that ultimately, the traps did not collect any crayfish, but they did collect several fish species. He noted that the fyke net used during the American Eel Abundance Study collected many crayfish, but none of these were identified as the Broad River spiny crayfish. He noted that the traps were out during the months of September and October, and while flows were unusually high during October, which may have created unfavorable conditions for crayfish, the month of September was a typical month and provided prime conditions for crayfish.

Bill S. noted that the fyke net was deployed during spring and fall of 2015, and since crayfish were caught in the fyke net, asked if the timing was off during the crayfish study. Maybe the crayfish study should have occurred during the spring. Jared said that the study was planned for fall based on recommendations from Arnie Eversole and to make identification easier. He also noted that crayfish were also caught during the fall months in the fyke net.

Henry mentioned that during study plan development, Byron Hamstead noted that he did not believe any Broad River spiny crayfish were present in the study area, but he wanted the study to help verify this assumption.

Monticello Freshwater Mussel Survey Report

Shane gave an overview of the Monticello Freshwater Mussel survey and said that the study was conducted by Three Oaks during September and November in Monticello Reservoir and the Recreation Lake. No live mussels were found in the Recreation Lake and six species were found in Monticello Reservoir. David Eargle said that one of the species found in the reservoir, the Carolina creekshell, was unexpected, since it had never been identified in that area before. David stated that the genetic testing would be less than $1,000 based on discussions with Tim Savage (Three Oaks). He asked if genetics could be run on the samples collected, just to verify if that was the correct species, or if it was actually a similar species known to occur in the area. SCE&G agreed to contact Tim and have the additional testing completed on the samples. David said that knowing the correct identification wouldn't have any effect on Project operations, but it would be good information to know.

David said that he was curious as to why no mussels were found in the Recreation Lake. Ray said that there are racks on the intakes and fish cannot pass back and forth from the Recreation Lake and Monticello Reservoir. Upon initial filling, the Recreation Lake was treated with rotenone and stocked with fish. It is likely that mussels never had the opportunity to get established in that body of water.

David identified a few typos in the Three Oaks report and said he would send these over to Kleinschmidt to address.

Protection, Mitigation and Enhancement Measures

Several general PM&E measures were identified during the meeting, and are listed below. These should be developed with more detail through input from TWC members and will be considered as the relicensing process moves forward and a Settlement Agreement is developed.

- Periodic monitoring/studies for American eels throughout the term of the new license – possibly every 5-10 years, or based on a trigger system, similar to the triggers established in the Accord Agreement
- Establish long term monitoring of the Rocky Shoals Spider Lily populations located downstream of Parr Dam and upstream of Columbia Dam (similar to the monitoring already taking place downstream of Columbia Dam) – Possible restoration efforts for the species – Possible public outreach and education efforts (could tie into the education and outreach already established for the Columbia Project)

Action items identified during the meeting are listed below.

ACTION ITEMS:

- SCDNR and USFWS will send updates/edits for RT&E Desktop Assessment.
- Fritz will send Fish Passage Primer, which includes information on eel passage, to group.
- SCE&G and Kleinschmidt will perform 3 additional backpack electrofishing sessions during the spring of 2016 for American eels downstream of Parr Dam.
- David will send comments/edits for the Monticello Freshwater Mussel Survey Report to Kleinschmidt.
- Kleinschmidt will work with Three Oaks to get genetic testing done on mussel samples that are thought to be Carolina creekshell.

Rare Threatened and Endangered Species Desktop Assessment

Methods and Materials

- Objective- Identify RTE species potentially occurring in the Project vicinity
- Project Vicinity- Project Boundary and downstream reach of Broad River influenced by the Project
- USFWS and SCDNR county-level listings for Newberry, Fairfield, and Richland counties reviewed to find listed or at-risk species that may occur in study area
- Species on 2008 Birds of Conservation Concern list included for review
- Ten species considered priority species in the SCDNR Comprehensive Wildlife Conservation Strategy included for review

Results

- Some of the species reviewed may occur in the Project boundary
- Impacts are unlikely
- Species present in Project boundary not protected by state or federal law
- Of the 13 state and federally listed/protected species, only the bald eagle likely occurs in the study area regularly
- Fish species classified as SCDNR priority conservation species documented in study area
- Fish habitat requirements assessed further in IFIM Study

American Eel Abundance Report

Materials and Methods

- Objective- Characterize the abundance and distribution of American eels downstream of Parr Shoals Dam
- Two traps (3 ramps) set at base of dam near the west bank
- One trap (two ramps) set near powerhouse on east bank
- Fished from March 2-June 12 and October 9-November 16
- Fyke net set in west channel from March 2-June 12, and October 9-November 16
- Four backpack electrofishing efforts

Results

- One yellow eel collected over four total electrofishing efforts
- No elvers collected in traps or fyke net
- Ramp traps fished for a total of 3,428 hours
- Downtime associated with low leakage flows and flooding

Rocky Shoals Spider Lily Study Report

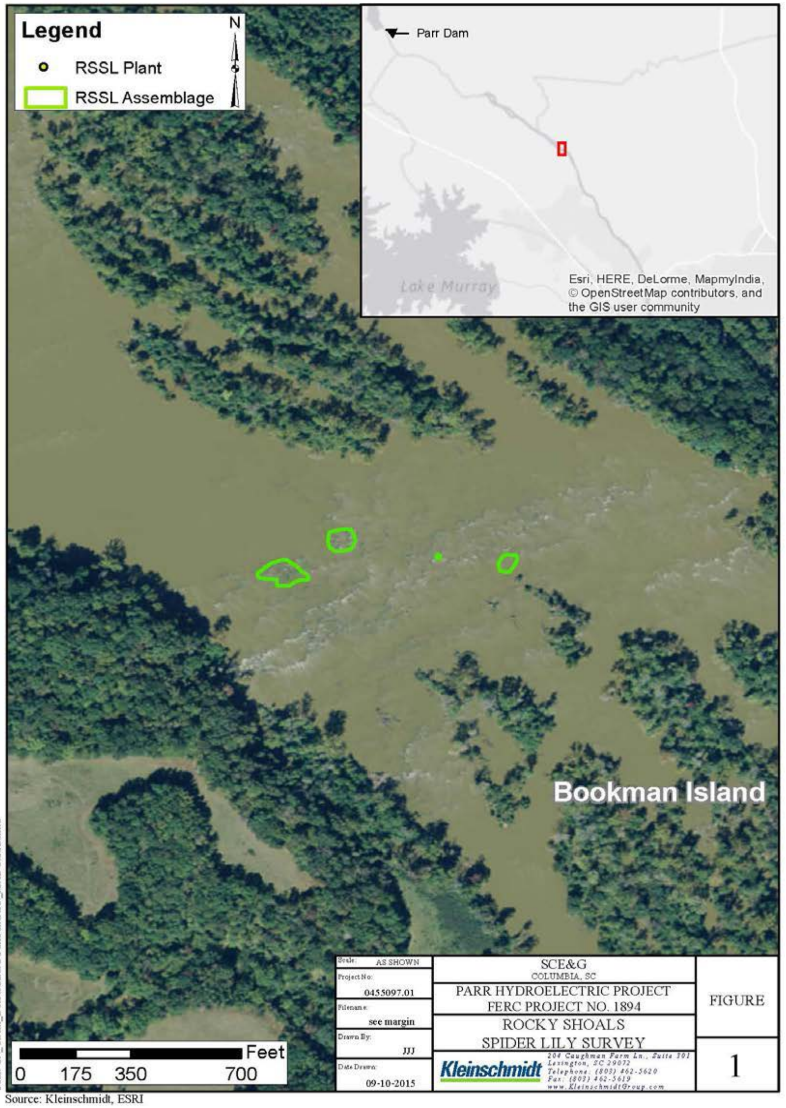
Materials and Methods

- Objective: Assess abundance and spatial distribution of RSSL between Parr Shoals Dam and Frost Shoals
- Crews floated Broad River between Parr Shoals Dam and Boatwright Island
- Study conducted during May 26-27(height of flowering season)
- Plants or clusters documented using handheld GPS
- Clusters of plants measured for length and width

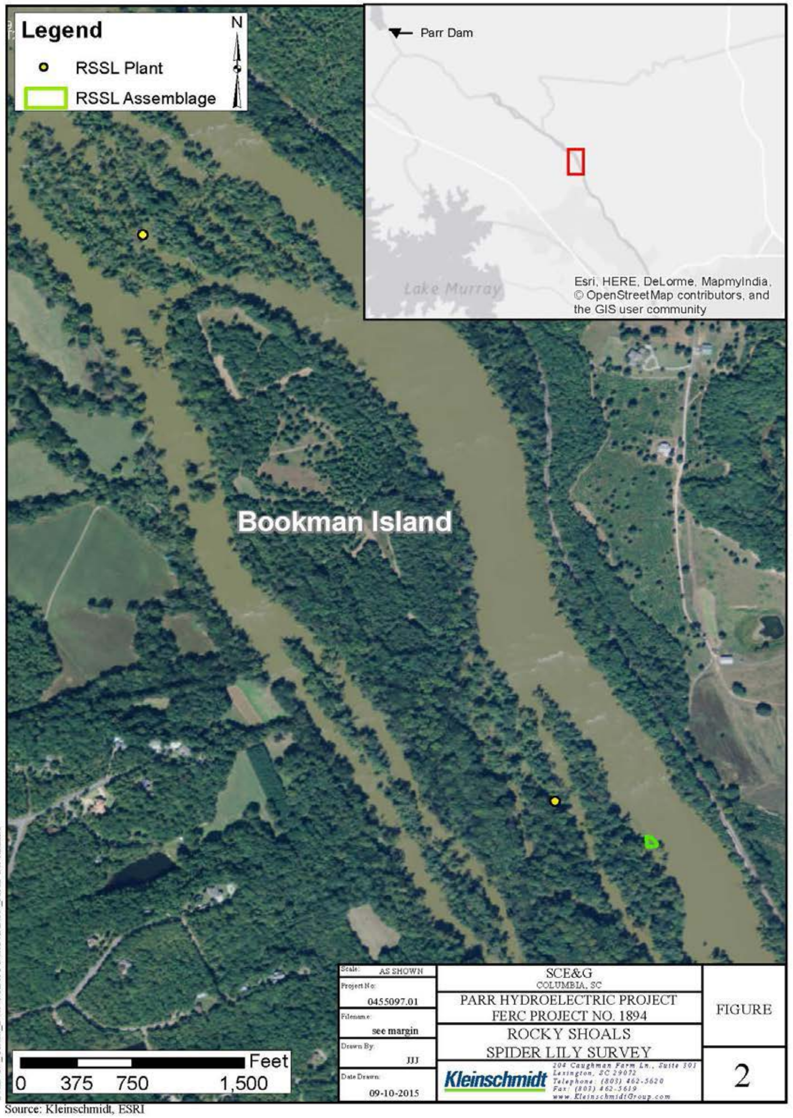
Results

- 81 plants or clumps of plants documented
- Occurrences were limited to Bookman Shoals and Frost Shoals
- Majority of plants located on bedrock ledges, in water depths of 0-30 inches
- Basal areas ranged from 0.05 m^2- 20,000 m^2

Locations of RSSL



Source: Kleinschmidt, ESRI



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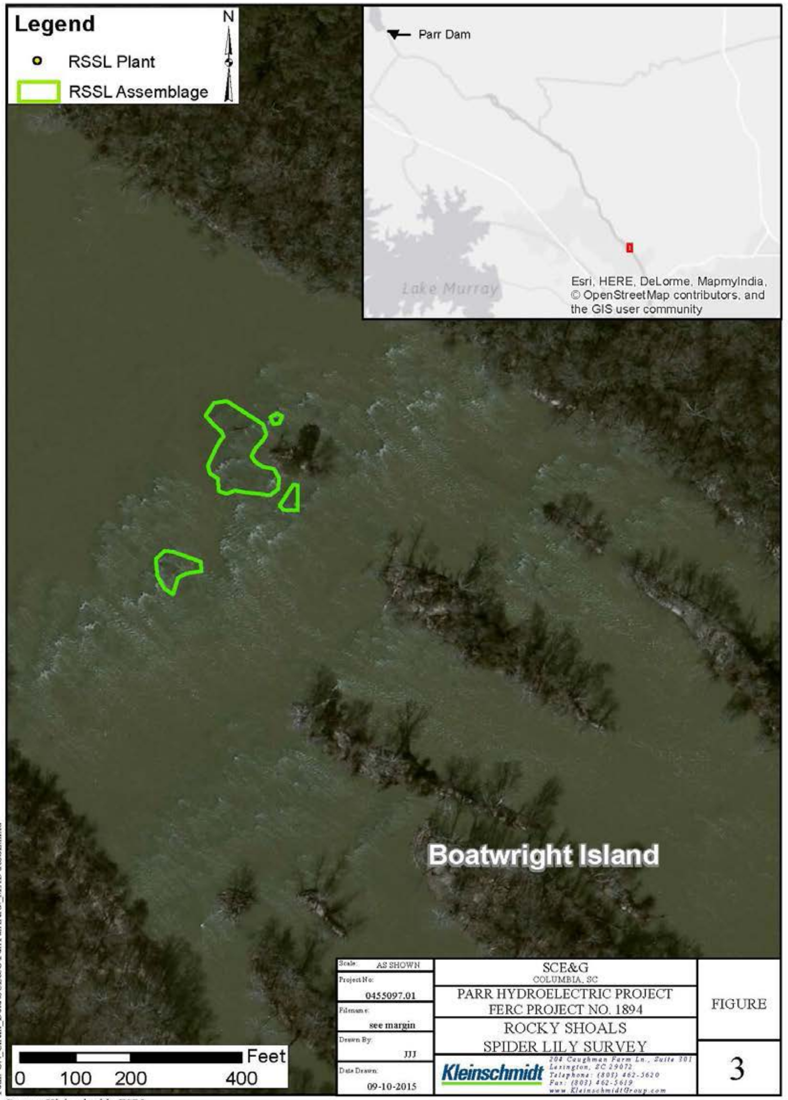


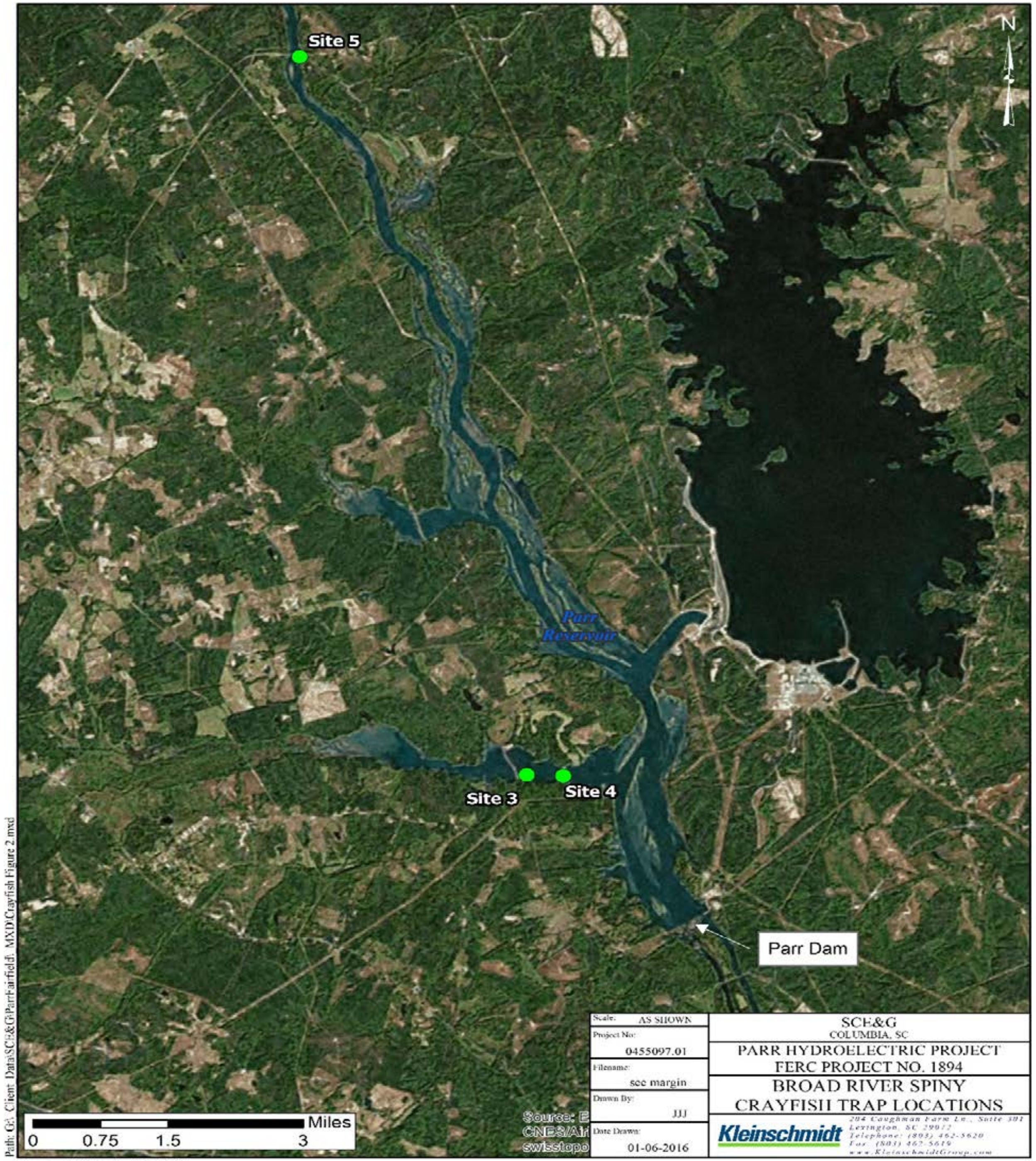
Source: Kleinschmidt, ESRI

Broad River Spiny Crayfish Study Report

Objectives, Methods, and Materials

- Study Objective- Assess the presence of the Broad River Spiny Crayfish in Parr Shoals Reservoir and in the Broad River Downstream of Parr Shoals Dam
- Study site determinations w/ USFWS
- Double entry traps wire mesh crayfish traps baited, set, and regularly checked at 3 sites (September-October 2015)

    1. Broad river at the Hwy 34 bridge
    2. Cannon's Creek arm of Parr Shoals Reservoir
    3. Confluence of Little River and Broad River, downstream of Parr Shoals Dam



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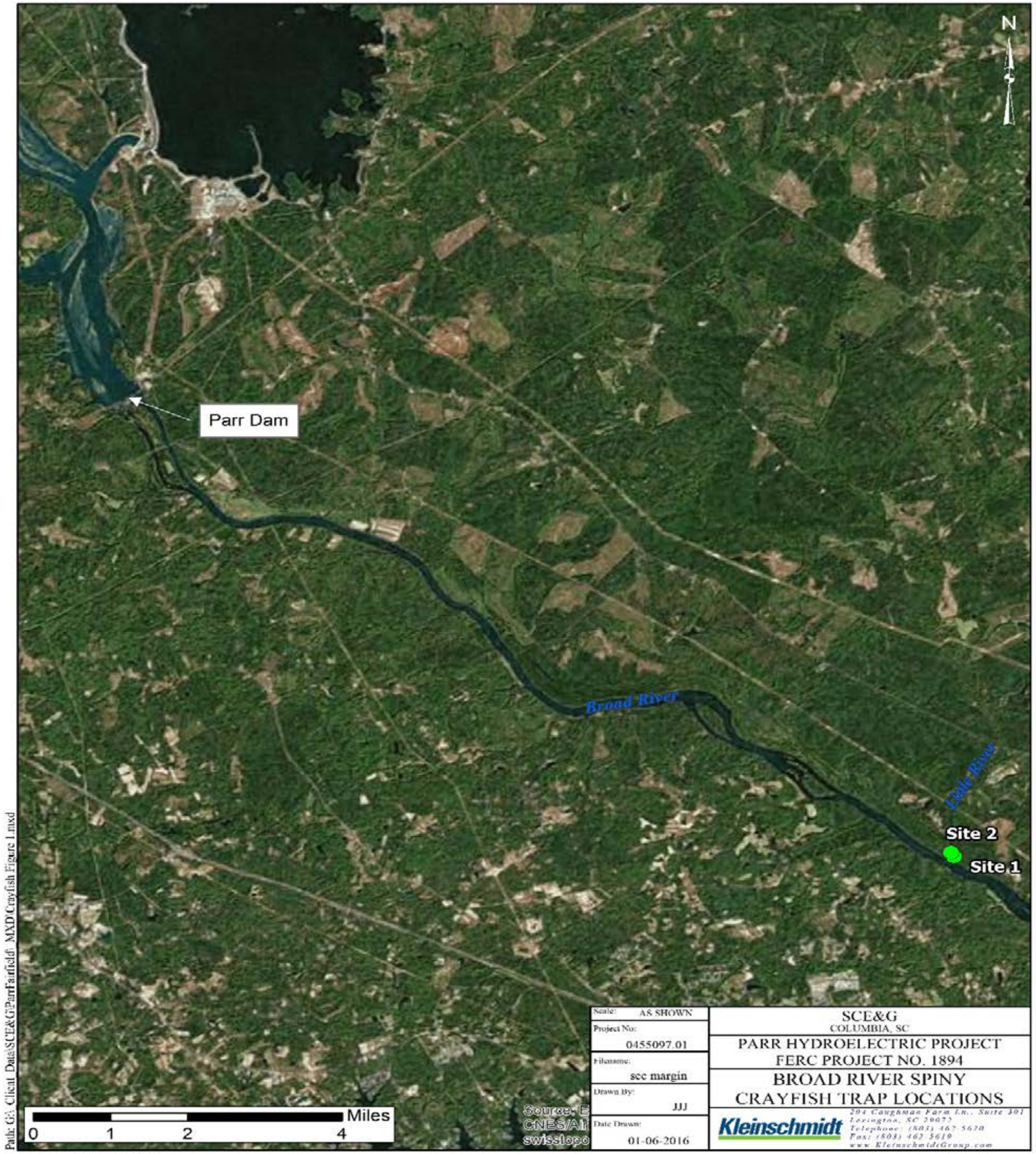

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Source: Kleinschmidt, ESRI

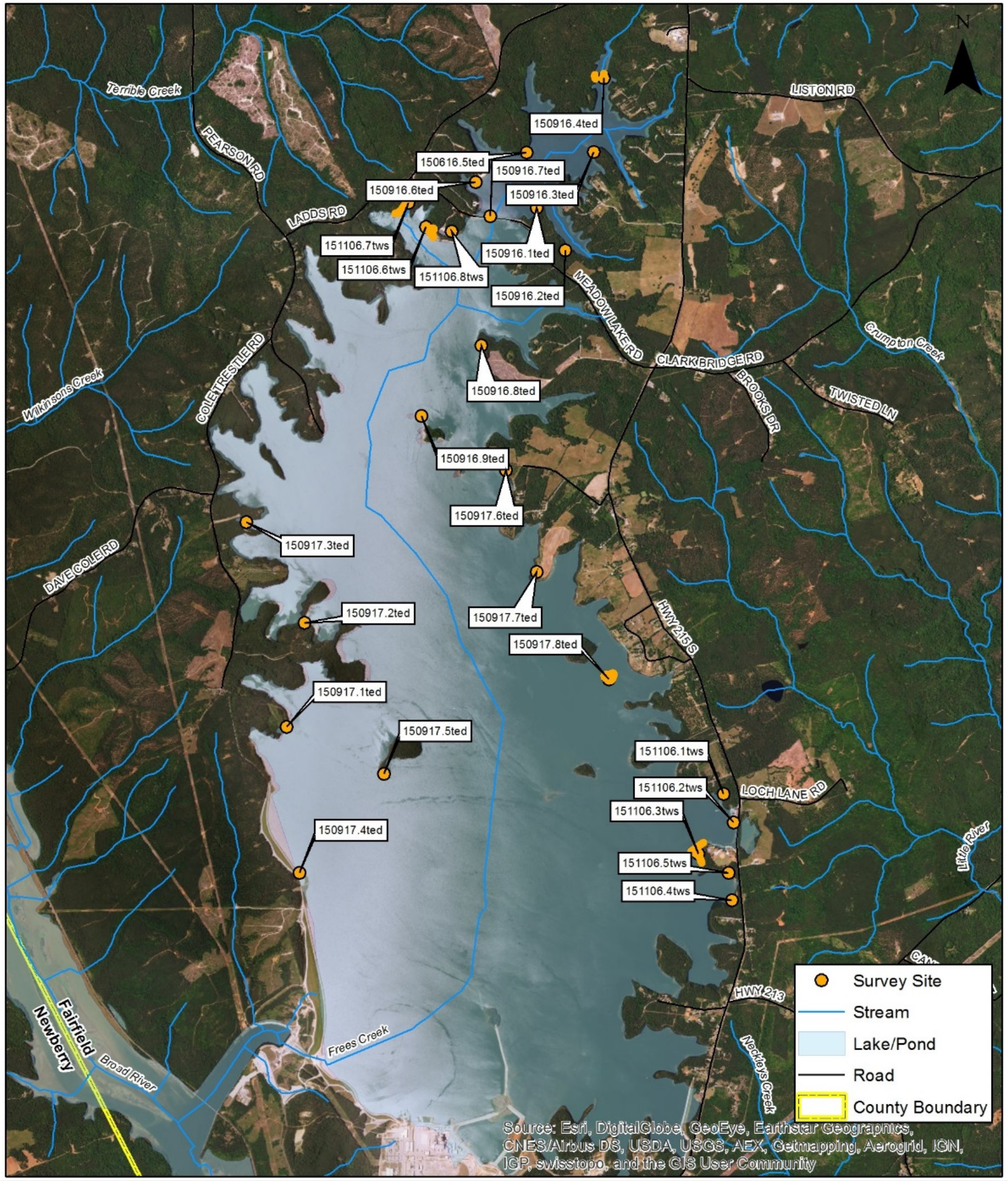
Results

- Water temperatures ranged from 12-28°C for duration of study
- Traps fished for a total of 9,996 hours
- No crayfish collected
- Traps collected small sunfish throughout study

Monticello Freshwater Mussel Survey Report

Methods and Materials

- Surveys conducted by Tim Savidge (Three Oaks/Catena) on September 16-17 and November 6, 2015
- 25 sites surveyed via SCUBA and snorkeling
- Surveyors worked from shoreline habitats towards deeper water
- All mussels identified, enumerated, and returned to substrate



Prepared For:

Kleinschmidt

Freshwater Mussel Survey
Monticello Reservoir

Fairfield County, South Carolina

Date: December 2015

Scale 0 1,000 2,000 Feet

Job No.: 3396

Drawn By: KMS

Checked By: TS

Figure 1

Results

- Six species documented: Carolina Lance (moderate priority), Eastern Floater, Florida Pondhorn, Paper Pondshell, Eastern Creekshell (moderate priority), Carolina Creekshell (highest priority)
- Relic shell material (Paper Pondshell) found in rec lake
- Reproduction appears to occur for at least 5 species
- Federally protected species (Carolina Heelsplitter and Savannah Liliput) unlikely to occur in Monticello Reservoir and are not known from the Broad River Basin.

BROAD RIVER SPINY CRAYFISH
CAMBARUS SPICATUS
STUDY REPORT

PARR HYDROELECTRIC PROJECT

(FERC NO. 1894)

Prepared for:

South Carolina Electric & Gas Company
Cayce, South Carolina

Prepared by:

Kleinschmidt

Lexington, South Carolina
www.KleinschmidtGroup.com

January 2016

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BROAD RIVER SPINY CRAYFISH
***CAMBARUS SPICATUS* STUDY REPORT**

PARR HYDROELECTRIC PROJECT
(FERC NO. 1894)

SOUTH CAROLINA ELECTRIC & GAS COMPANY

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***CAMBARUS SPICATUS* STUDY REPORT**

PARR HYDROELECTRIC PROJECT
(FERC NO. 1894)

SOUTH CAROLINA ELECTRIC & GAS COMPANY

1.0 INTRODUCTION

South Carolina Electric & Gas Company (SCE&G) is the Licensee for the Parr Hydroelectric Project (FERC No. 1894) (Project). The Project consists of the Parr Shoals Development and the Fairfield Pumped Storage Development. Both developments are located along the Broad River in Fairfield and Newberry Counties, South Carolina.

The Project is currently involved in a relicensing process which involves cooperation and collaboration between SCE&G, as licensee, and a variety of stakeholders including state and federal resource agencies, state and local government, non-governmental organizations (NGO), and interested individuals. SCE&G has established several Technical Working Committees (TWC's) comprised of members from the interested stakeholders. The TWC's objectives include the evaluation of relicensing issues and achieving consensus for addressing these issues in the new license.

The TWC identified the potential need for a crayfish survey based upon recommendations from the U.S. Fish and Wildlife Service ("USFWS"). On June 6, 2013, the USFWS noted that the Broad River Spiny Crayfish (*Cambarus spicatus*) may be located within the Project area and recommended that crayfish surveys for this species be performed in the Parr Shoals Reservoir and in the Broad River downstream of the Parr Shoals Dam. The South Carolina Department of Natural Resources currently designates this species with "special concern" status and is considering upgrading its priority rank from S3 to S2 (SC SWAP 2015). Additionally, the USFWS has been petitioned to list the Broad River Spiny Crayfish (BRSC) under the Endangered Species Act (USFWS 2011).

2.0 RELEVANT LIFE HISTORY INFORMATION

As noted, the BRSC (*Cambarus spicatus*) is a species of concern in South Carolina. Eversole (1990) identified BRSC as having a distribution limited to lotic environments in the Broad River Basin. BRSC collections in the vicinity of the Project are known from the upper portion of the Little River, a tributary to the Broad River, in Fairfield County (Figure 2-1; Eversole 2014). Although BRSC collections are limited, individuals are primarily associated with leaf litter and other organic debris located along the banks of streams. Preferred substrates are comprised primarily of sand and tend to be unstable in nature with a lack of rooted aquatic vegetation. Current information indicates that BRSC reproduce during the summer months (Eversole, 1990). BRSC was described by Hobbs (1956) as gray-green with cream, pink, purple and brown highlights. The chelae (the "claw" or "pincer") are green with orange tips and a double row of tubercles on the mesial margin of the palm. Individuals range from about 60 mm (2.4 inches) to 78 mm (3.1 inches) in length.

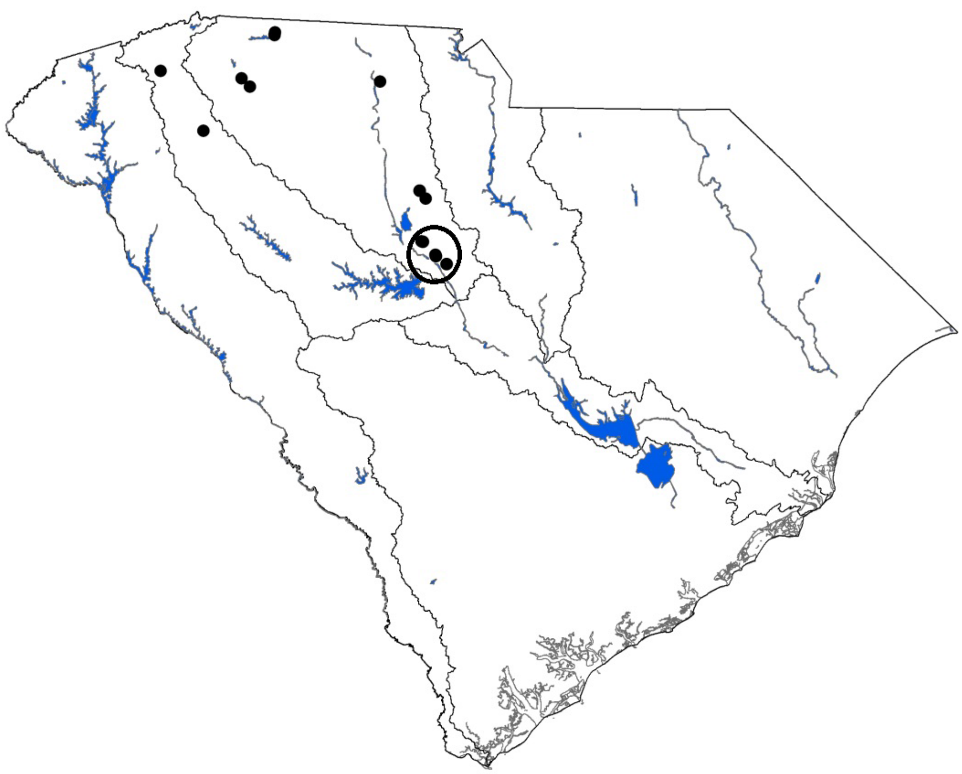


FIGURE 2-1 SPATIAL DISTRIBUTION OF *CAMBARUS SPICATUS* (EVERSOLE 2014): CIRCLE DELINEATES OCCURRENCES OF C. SPICATUS THAT OCCURRED IN THE LITTLE RIVER

3.0 STUDY OBJECTIVES

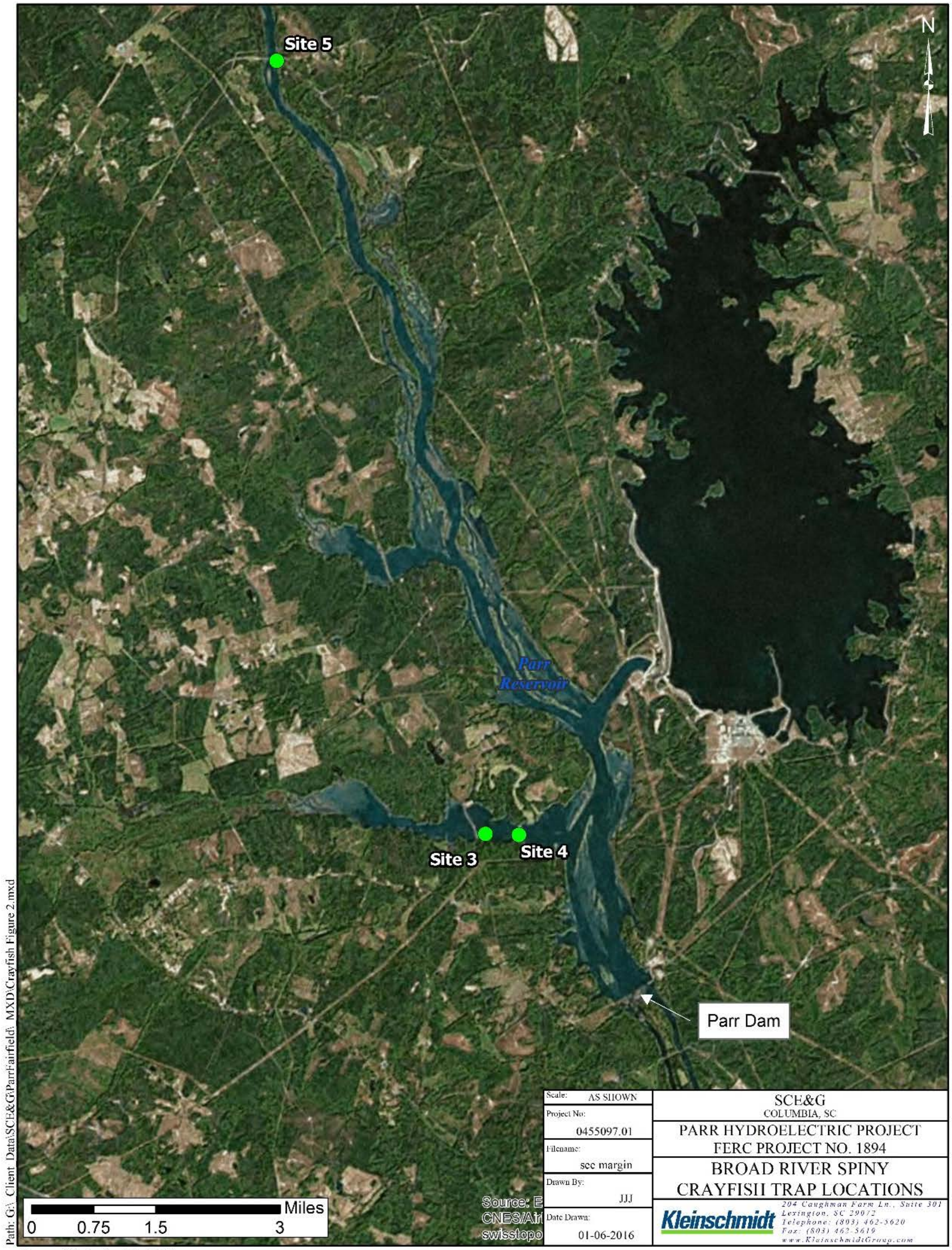
The objective of this survey was to assess the presence of BRSC in the Parr Shoals Reservoir and in the Broad River downstream of the Parr Shoals Dam.

Based upon the life history information for BRSC and input from the USFWS (Appendix A) sampling sites were selected along the margins of the Broad River and associated tributaries, in areas of leaf litter/detritus. Collection areas included the Broad River at the Highway 34 Bridge (Figure 3-1) (Photo 3-1, and Photo 3-2), the Cannon's Creek arm of Parr Reservoir (Figure 3-1) (Photo 3-3), and downstream of Parr Shoals Dam at the confluence of the Broad River and Little River (Figure 3-2).

PHOTO 3-1 TRAP LOCATION ON THE BROAD RIVER NEAR THE HIGHWAY 34 BRIDGE

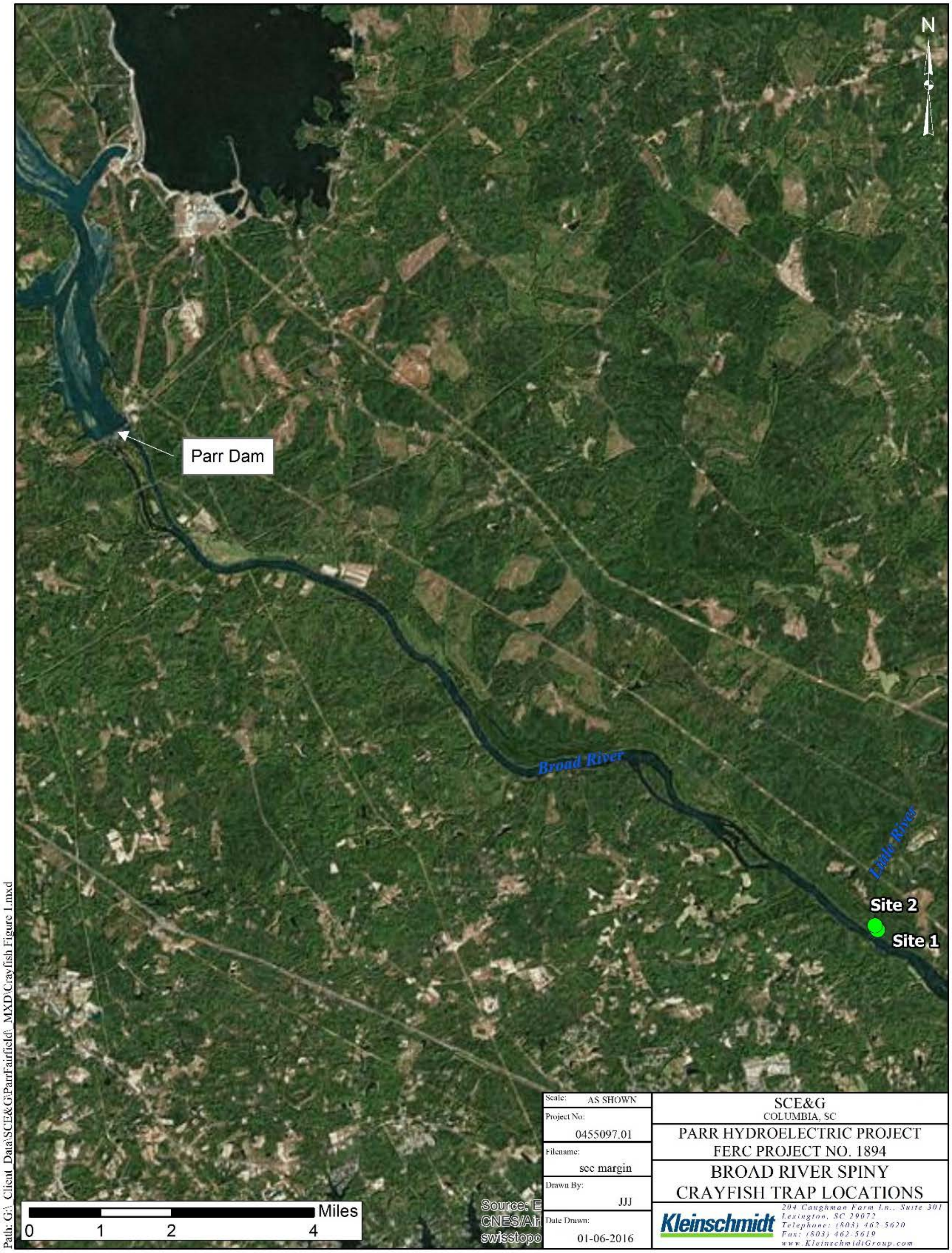
PHOTO 3-2 TRAP LOCATION ON THE BROAD RIVER NEAR THE HIGHWAY 34 BRIDGE

PHOTO 3-3 TRAP LOCATION ON THE CANNON'S CREEK ARM OF PARR RESERVOIR



Source: Kleinschmidt, ESRI

FIGURE 3-1 CRAYFISH SAMPLING AREAS AT HIGHWAY 34 AND CANNON'S CREEK



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Source: Kleinschmidt, ESRI

FIGURE 3-2 CRAYFISH SAMPLING AREAS DOWNSTREAM OF PARR DAM

4.0 COLLECTION METHODS

Sampling at all locations occurred from early September to late October, 2015 (Table 1). Passive trap methods were utilized for this study. Traps consisted of double-entry, galvanized wire mesh crayfish traps with 1.5 inch opercula (Photo 4-1). Traps were baited with canned fish and canned cat food, and were re-baited during biweekly (every 3 to 4 days) trap checks. A one-pound weight was originally placed in the traps to ensure that they remained submerged. However, after loss of gear due to flooding, traps were anchored to structures along the shoreline. Traps were deployed along shoreline habitats, in areas of detritus and/or leaf litter at all sampling sites. Traps were also placed in locations where water depth was sufficient to ensure that they remained inundated. Water quality parameters (temperature, DO, and conductivity) were periodically collected when traps were checked for crayfish.

PHOTO 4-1 EXAMPLE OF CRAYFISH TRAP USED IN THE STUDY

5.0 RESULTS

Traps at sites 1 and 2 fished for a total of 5,136 hours during this study (Table 1). Over the study period, water temperatures at the confluence of the Broad River and Little River ranged from 12-26°C, dissolved oxygen ranged from 8.5-10.6 mg/L, and conductivity ranged from 80-151 µS. No crayfish were collected, although traps at this site did collect several small sunfish throughout the study.

Traps at sites 3 and 4 were fished for a total of 4,860 hours during this study (Table 5-1). Over the study period, water temperatures at Cannon's Creek ranged from 19-28°C, dissolved oxygen ranged from 6.6-7.9 mg/L, and conductivity ranged from 60-117 µS. No crayfish were collected.

Traps at site 5 were fished for a total of 2,760 hours during this study (Table 1). Over the study period, water temperatures at the Highway 34 Bridge ranged from 16-25°C, dissolved oxygen ranged from 7.1-8.9 mg/L, and conductivity ranged from 65-159 µS. No crayfish were collected, although traps at this site did collect numerous small sunfish throughout the study.

TABLE 5-1 LOCATIONS AND DATES OF SAMPLING EFFORTS

	Location	Number of Traps and Dates Sampled			Notes
Confluence of Little River and Broad River	Site 1 (34°10'32.73"N, 81°10'41.80"W)	3 – traps 9/3/2015-10/4/2015	2 – traps 10/20/2015-10/27/2015		Traps were replaced due to 10/4/2015 flood event
	Site 2 (34°10'35.45"N, 81°10'43.74"W)	3 – traps 9/3/2015-10/4/2015	2 – traps 10/20/2015-10/27/2015		
Cannon's Creek Arm of Parr Reservoir	Site 3 (34°16'56.08"N, 81°21'35.26"W)	3 – traps 9/3/2015-10/4/2015	2 – traps 10/13/2015-11/2/2015		Traps were replaced due to 10/4/2015 flood event
	Site 4 (34°16'54.56"N, 81°21'12.86"W)	2 – traps 9/3/2015-10/4/2015	1 – trap 10/13/2015-11/2/2015		
Highway 34 Bridge	Site 5 (34°23'37.39"N, 81°23'46.53"W)	3 – traps 9/3/2015-9/28/2015	2 – traps 9/29/2015-10/4/2015	2 – traps 10/13/2015-10/28/2015	Traps were replaced during study due to flooding and theft

6.0 DISCUSSION

No crayfish were collected during the BRSC study. During the American eel study performed in the Parr Shoals Dam tailrace area, approximately thirteen crayfish were collected in a large fyke net that sampled the west channel area during springtime collections. Through consultation with USFWS (Byron Hamstead), we identified these crayfish as either acuminate crayfish *Cambarus acuminatus* or Carolina needlenose crayfish *Cambarus aldermanorum* and a reference sample was kept in 70% ethanol. No BRSC were collected in the fyke net.

7.0 REFERENCES

Eversole, A. G. 1990. Status Report on *Cambarus (Puncticambarus) spicatus* Hobbs, *Distocambarus (Fitzcambarus) youngineri* Hobbs, and *Procambarus (Pennides) echinatus* Hobbs. Completion Report. 21 pp.

Eversole, A.G. 2014. Identification and distribution of crayfishes in South Carolina. Final Report. 69 pp.

Hobbs, H. H., Jr. 1956a. A new crayfish of the genus Procambarus from South Carolina (Decapoda:Astacidae). J. Wash. Acad. Sci. 46(1):117-121.

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APPENDIX A

STUDY SITE COLLECTION NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
Parr Hydroelectric Project (FERC No.1894)

MEETING NOTES

Rare, Threatened and Endangered Species TWC
Broad River Spiny Crayfish Study – Study Site Selection Notes

July 23, 2014

Final CSB 092214

ATTENDEES:

Shane Boring – Kleinschmidt
Byron Hamstead – USFWS
Milton Quattlebaum – SCANA Environmental Services

These notes serve to be a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

The group met with the purpose of selecting collection spots for the Broad River spiny crayfish (BRSC) as part of one of the proposed relicensing studies for the Parr Hydroelectric Project. The group launched from the Cannon's Creek ramp on Parr Reservoir and examined habitats from Cannon's Creek upstream to approximately 1 mile above the Highway 34 Bridge by boat. The group also examined habitat along Haltiwanger Island downstream of Parr Dam on foot. Prime collection areas included backwater areas with the presence of coarse woody debris and reasonable access for sampling.

Byron indicated that he was less impressed with habitats observed in Parr Reservoir, although some level of sampling was warranted in that area. The group determined that habitat in the vicinity of Haltiwanger Island in general lack the course woody debris and had higher velocities than are likely suitable for BRSC. Byron expressed an interest in exploring the area in the vicinity of the mouth of Little River for potential access since that is the area closest to where BRSC has been documented. The group made several attempts to examine Little River in that area, but were unable to find an access point. Shane and Milton noted that they would contact local landowners and attempt to facilitate an access point. Byron reiterated his desire to focus on the Little River mouth area.

Based on the field examinations and identifying a local landowner that would allow access to the Little River area, five sampling sites were identified, which are shown below in Figure 1 and Table 1. Two of the selected sites will be established at the Bookman Station Property to accommodate the USFWS request for additional sampling in the Vicinity of the Little River site located downstream of Parr Dam. A minimum of 3 traps will be deployed at each collection site.

Figure 1. Broad River Spiny Crayfish Sampling Sites

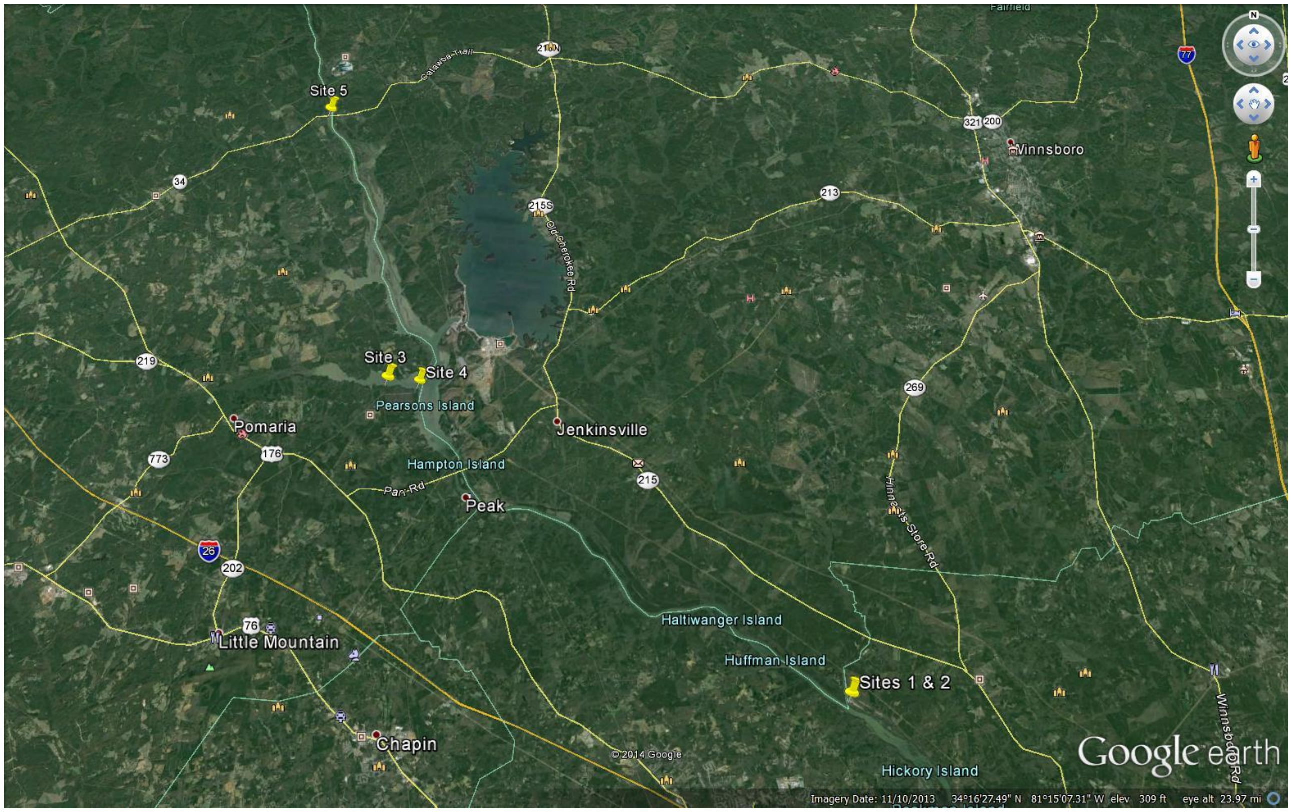

Table 1. Broad River Spiny Crayfish Sites

Site No.	Latitude/Longitude	Description/Notes
1	34°10'33.79"N, 81°10'41.48"W	Sites downstream of Parr Dam at mouth of Little River. Will be accessed from Bookman Station, LLC property. Two set of 3 traps will be positioned sufficiently apart in appropriate habitat to represent 2 sites.
2		
3	34°16'53.04"N, 81°21'35.93"W	Cove directly across from Cannon's Creek launch.
4	34°16'49.39"N, 81°20'48.05"W	Noted by USFWS as a shallow area with more overhead forest cover than other habitat in reservoir.
5	34°23'37.73"N, 81°23'55.93"W	Vicinity of Highway 34 Bridge.

ACTION ITEMS:

- Include these notes in the Final BRSC sampling plan and revise the Plan to note the listed sampling locations and number of sampling traps to be used.

DOWNSTREAM NAVIGATIONAL FLOW ASSESSMENT

AND

DOWNSTREAM RECREATIONAL FLOW USER SURVEY MEMO

PARR HYDROELECTRIC PROJECT
(FERC NO. 1894)

Prepared for:

South Carolina Electric & Gas Company
Cayce, South Carolina

Prepared by:

Kleinschmidt

Lexington, South Carolina
www.KleinschmidtGroup.com

September 2016

EXECUTIVE SUMMARY

South Carolina Electric & Gas Company (SCE&G), Licensee for the Parr Hydroelectric Project (FERC No. 1984) (Project), is currently seeking a new license from the Federal Energy Regulatory Commission (FERC), as their current license is set to expire on June 30, 2020. The Project is currently engaged in a relicensing process which involves collaboration with a variety of stakeholders including state and federal resource agencies, state and local government, non-government organizations (NGOs) and interested individuals. SCE&G has established Technical Working Committees (TWCs) which include many of the interested stakeholders. The Recreation TWC was created to identify and resolve Project-related issues regarding recreation and is composed of representatives from the South Carolina Department of Natural Resources (SCDNR), the South Carolina Department of Health and Environmental Control (SCDHEC), the National Oceanic and Atmospheric Administration (NOAA), American Rivers, and the Congaree Riverkeeper, among others. Per request of the Recreation TWC, SCE&G performed two studies that addressed recreational resource issues downstream of the Project. These were:

- the Downstream Navigational Flow Assessment, and
- the Downstream Recreational Flow Assessment.

During issues scoping, the TWC identified two areas downstream of the Parr Dam as potential areas for navigational concern. SCE&G developed a study plan in consultation with the TWC to assess one-way navigation at these sites, and the results of this study are presented in the Downstream Navigational Flows Assessment, included herein.

The Recreation TWC also requested that a study be designed and implemented that would assess flows downstream of the Parr Shoals Dam that provide quality recreational experiences, and identify preferred flows for recreational activities, specifically wade angling, canoeing and kayaking. The Downstream Recreational Flow Assessment Study Plan was developed with consultation from stakeholders and the results of this assessment are included in the attached Downstream Recreational Flow User Survey Memo.

The Recreation TWC convened a meeting on May 10, 2016 to discuss the results of these two assessments. This report is an accumulation of the original study plans, study reports, and Recreation TWC meeting notes that will be used to develop flow recommendations for SCE&G to consider in developing a new license proposal.

DOWNSTREAM NAVIGATIONAL FLOW ASSESSMENT

DOWNSTREAM NAVIGATIONAL FLOW ASSESSMENT

PARR HYDROELECTRIC PROJECT
(FERC NO. 1894)

Prepared for:

South Carolina Electric & Gas Company
Cayce, South Carolina

Prepared by:

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September 2016

DOWNSTREAM NAVIGATIONAL FLOW ASSESSMENT

PARR HYDROELECTRIC PROJECT
(FERC NO. 1894)

SOUTH CAROLINA ELECTRIC & GAS COMPANY

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PARR HYDROELECTRIC PROJECT
(FERC NO. 1894)

SOUTH CAROLINA ELECTRIC & GAS COMPANY

1.0 INTRODUCTION

South Carolina Electric & Gas Company (SCE&G) is the Licensee for the Parr Hydroelectric Project (FERC No. 1894) (Project). SCE&G is currently seeking a new license from the Federal Energy Regulatory Commission (FERC), as their current license is set to expire on June 30, 2020. The Project consists of two developments: the Parr Shoals Development and the Fairfield Pumped Storage Development.

The Parr Reservoir, located in Fairfield and Newberry counties, South Carolina, is a 4,400 acre impoundment formed by the Broad River and the Parr Shoals Dam and serves as the lower reservoir for the Fairfield Pumped Storage Development. Monticello Reservoir, a 6,800 acre impoundment is formed by a series of four earthen dams and serves as the upper reservoir for the pumped storage development. While the stretch of the Broad River downstream of the Parr Shoals Dam (Parr Dam) is not included in the Project Boundary, Project operations do influence this area. For this reason, the downstream reach of the Broad River was studied during the Instream Flow Incremental Methodology (IFIM) study to determine if downstream flows currently facilitate one-way navigation at identified points of constriction.

2.0 AGENCY CONSULTATION AND STUDY OBJECTIVES

The Project is currently engaged in a relicensing process which involves cooperation and collaboration with a variety of stakeholders including state and federal resource agencies, state and local government, non-governmental organizations (NGOs), and interested individuals. SCE&G has established Technical Working Committees (TWCs) which includes many of the interested stakeholders. The objective of each TWC is to identify, discuss, and propose options for resolution of Project-related issues, which will be evaluated for inclusion in the new Project license.

The Recreation TWC is composed of representatives from the South Carolina Department of Natural Resources (SCDNR), the South Carolina Department of Health and Environmental Control (SCDHEC), the National Oceanic and Atmospheric Administration (NOAA), American Rivers, and the Congaree Riverkeeper, among others. During issues scoping, the TWC identified two areas downstream of the Parr Dam as potential areas for navigational concern. SCE&G developed a study plan in consultation with the TWC to assess one-way navigation at these sites. The study plan is included in Appendix A.

The criteria for one-way navigation can be defined as a "minimum depth of one foot across a channel 10 feet wide or across 10 percent of the total stream width, whichever is greater. Minimum depth does not need to occur across a continuous 10 percent of the stream width, but each point of passage must be at least 10 feet wide." One-way navigation criteria are based on the passage of a 14 foot Jon-boat without a motor in the downstream direction only (SCWRC, 1988).

3.0 STUDY AREA

The navigational analyses evaluated flows within the Broad River at areas of navigational constriction downstream of the Parr Dam. Recreation TWC participants identified two areas of potential constriction. These areas, identified as "Ledge 1" and "Ledge 2" (Figure 3-1), were further investigated during preliminary field work for the IFIM study and are described in greater detail below.

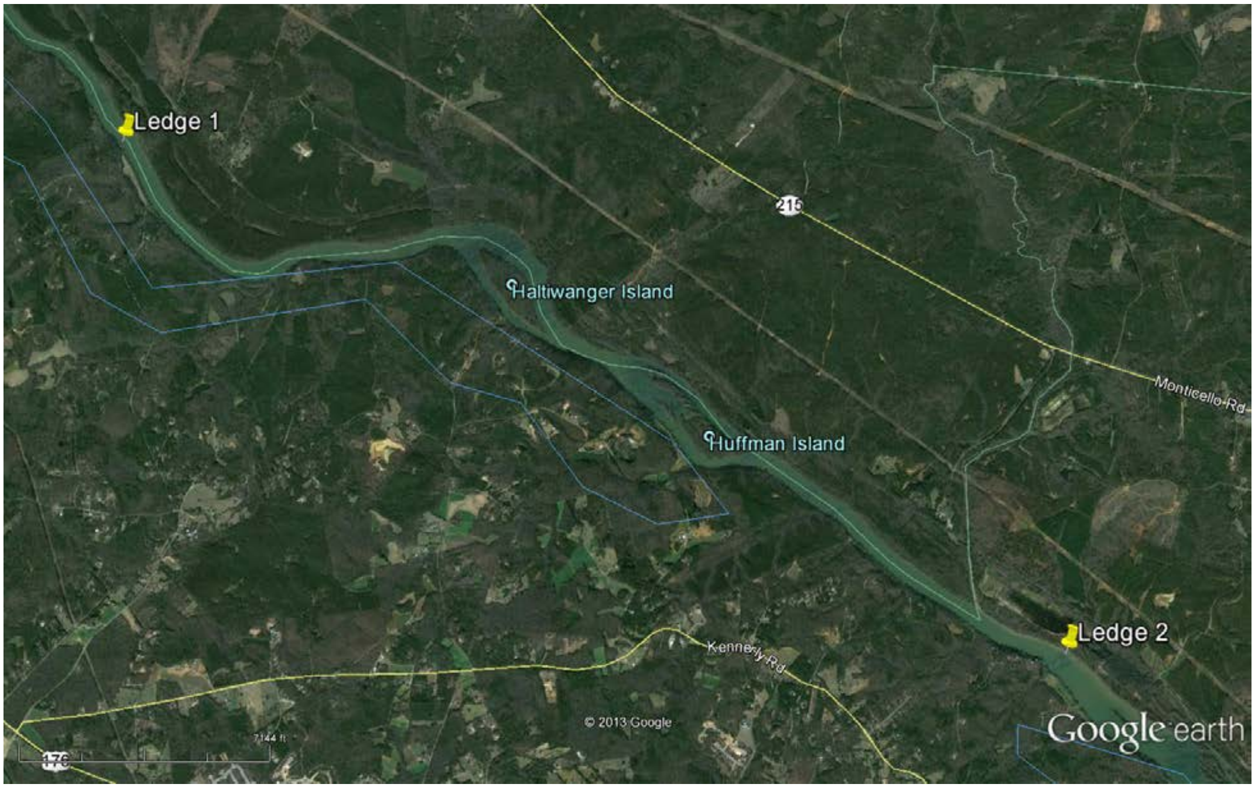

FIGURE 3-1 POTENTIAL POINTS OF NAVIGATIONAL CONSTRICTION

LEDGE 1

Ledge 1 consists of a bedrock ledge located at a lat/long of 81°15’46.507”W, 34°12’49.999”N, approximately 2.4 miles upstream of Haltiwanger Island. The study plan originally identified a primary navigational passage point on river left (looking upstream); however, a secondary passage point, located near mid-channel, was also noted during execution of the field effort (Figure 3-2).

FIGURE 3-2 LEDGE 1 IDENTIFICATION AND AREAS OF NAVIGATIONAL PASSAGE (CIRCLED IN RED)

LEDGE 2

Ledge 2 consists of a bedrock ledge located at a lat/long of 81°10’15.941”W, 34°10’18.154”N, 1.3 miles upstream of Hickory Island and approximately 0.5 miles downstream of the mouth of Little River. Field investigations identified the primary navigational passage point on river left (looking upstream) (Figure 3-3).

FIGURE 3-3 LEDGE 2 IDENTIFICATION AND AREA OF NAVIGATIONAL PASSAGE (CIRCLED IN RED)

4.0 METHODOLOGY

Bathymetric data within the navigational passage points were collecting using a Sontek M9 Acoustic Doppler Current Profiler (ADCP) and Sontek's HydroSurveyor software. Field data were collected in January 2016, with river flows at approximately 6,500 cfs to allow sufficient depth for the ADCP to map the critical ledge features. Measured ADCP water depths were converted to bed elevations utilizing water surface elevations (WSELs) measured during the bathymetry survey. WSEL profiles were collected during the bathymetric survey by Glenn Associates Surveying, Inc. (Jenkinsville, SC) using a survey-grade Topcon GR3 Global Positioning System Rover paired with Spectra Ranger External Antenna. WSEL data were collected relative to the 1988 North American Vertical Datum (NAVD88), with the surveyor estimating vertical accuracy at < 0.1 ft. Following completion of the field effort, the HydroSurveyor software was used to create three-dimensional bathymetric models of each of the passage points (Figure 4-1 through 4-3). The three-dimensional bathymetric models were then reviewed and the most limiting cross-section within each passage point was identified and exported to Microsoft Excel.

Stage-discharge relationships were developed for both ledges based on stage data obtained from Solinst Levellogger® dataloggers (level-loggers) deployed throughout the study area in support of the IFIM and Operations Modeling studies (See Kleinschmidt 2014 for additional detail regarding dataloggers). At Ledge 1, stage data were taken directly from a level-logger located at the ledge. At Ledge 2, level-loggers were located upstream and downstream of the ledge (as opposed to directly at the ledge), and as such, the HEC-RAS Model developed in support of the Operations Model was refined using the WSEL and bathymetry data collect for this study and used to interpolate between the level-loggers.

The exported cross-sectional bed profiles for each of the passage points was then overlain with WSELs corresponding to selected low-flow releases (500, 700 and 1000 cfs) and evaluated relative to navigational passage criteria.

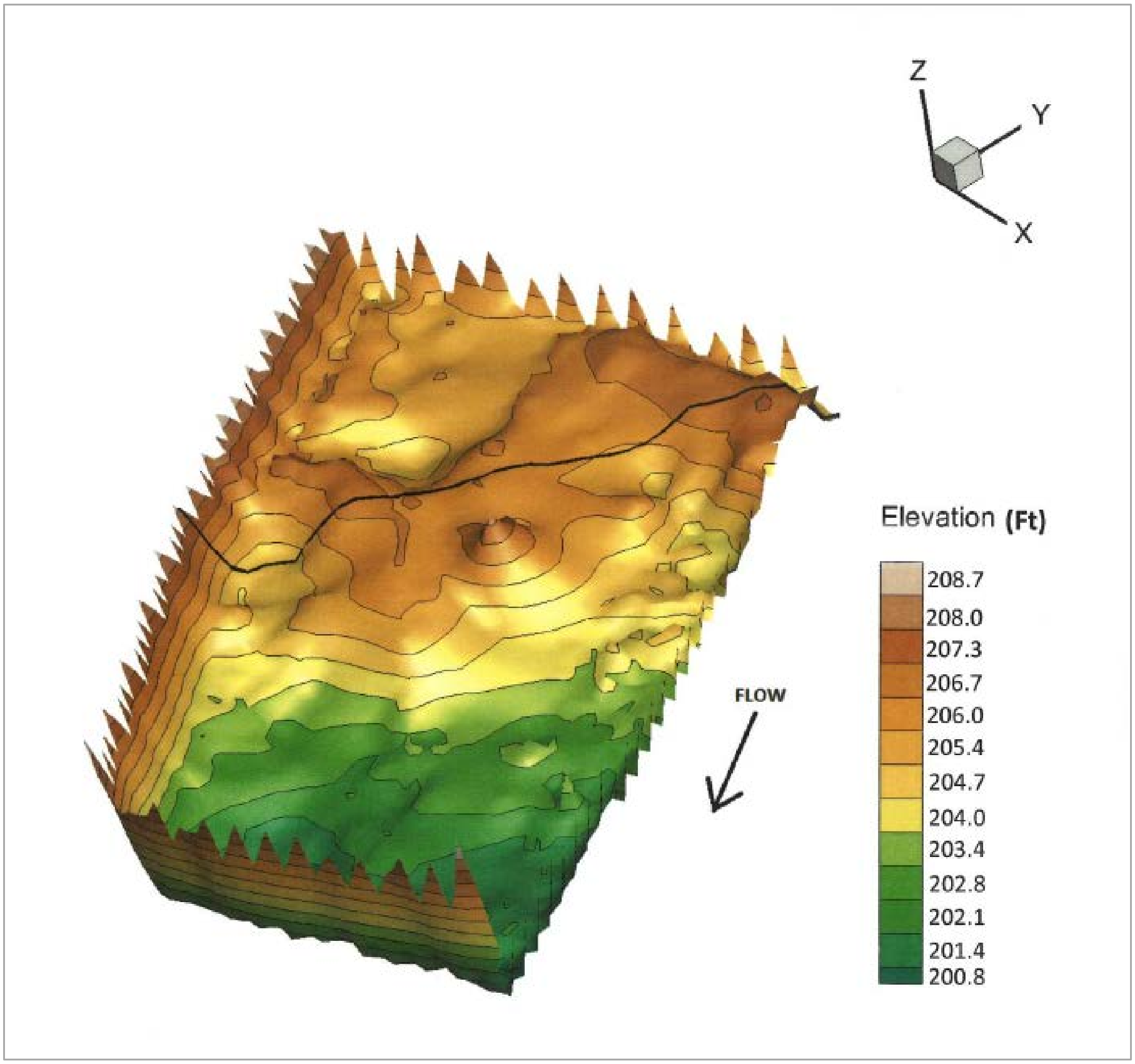

FIGURE 4-1 THREE-DIMENSIONAL UPSTREAM VIEW OF LEDGE 1 RIVER LEFT PASSAGE POINT (BLACK LINE DENOTES EXPORTED TRANSECT)

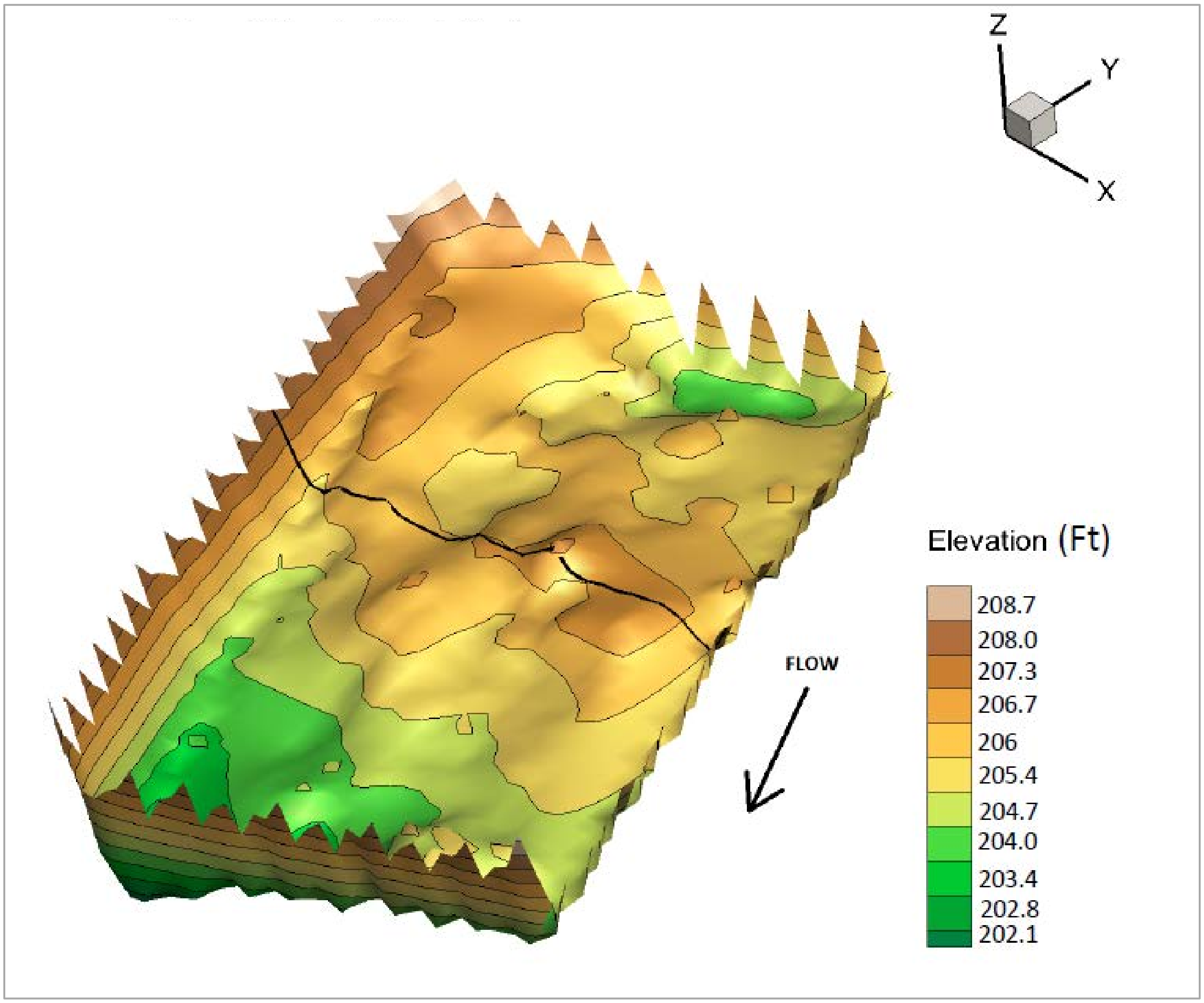

FIGURE 4-2 THREE-DIMENSIONAL UPSTREAM VIEW OF LEDGE 1 MID-CHANNEL PASSAGE POINT (BLACK LINE DENOTES EXPORTED TRANSECT)

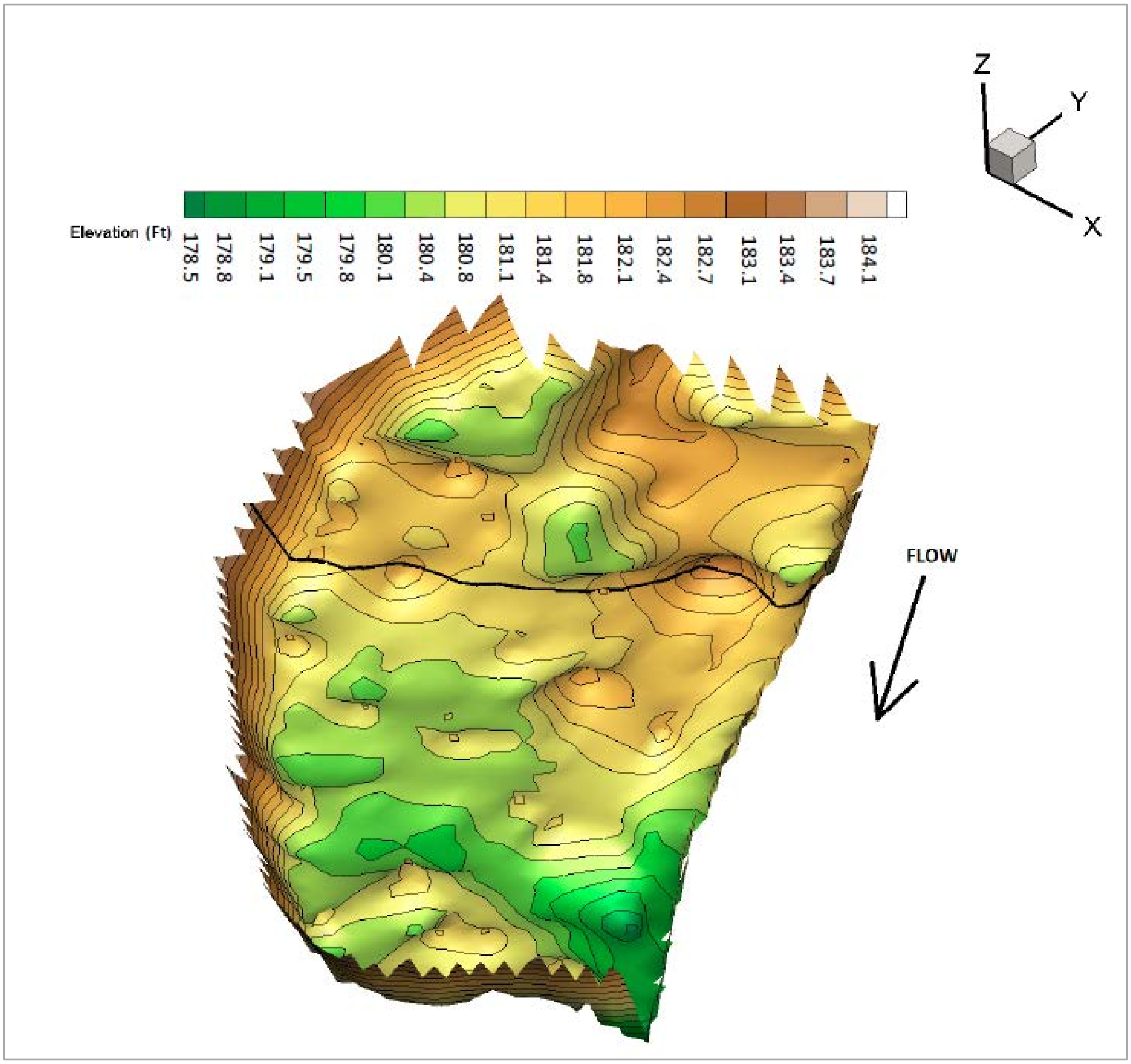

FIGURE 4-3 THREE-DIMENSIONAL UPSTREAM VIEW OF LEDGE 2 PASSAGE POINT (BLACK LINE DENOTES EXPORTED TRANSECT)

5.0 RESULTS AND DISCUSSION

The Broad River is approximately 650 ft wide at Ledge 1, meaning that a minimum depth of 1 ft is needed across a minimum cross-sectional distance of 65 ft in order to meet the navigation criteria. Data from this study indicate that a flow of 500 cfs meets the passage criteria from both the depth and width perspective, with approximately 205 ft (32 %) of cross-sectional passage provided collectively by the two passage points (Figure 5-1 and Figure 5-2). These data suggest that navigation passage is not a limiting factor at Ledge 1 for flows as low as 500 cfs.

At Ledge 2, the Broad River is approximately 800 ft wide, which means that a minimum depth of 1 ft is needed across a minimum cross-sectional distance of 80 ft in order to meet the navigation criteria. Data from this study indicate that a flow of 1000 cfs meets both the minimum depth and width aspects of the criteria, with approximately 82 ft (10 %) of cross-sectional passage provided collectively by the two passage points (Figure 5-3). However, we do note that the intent of the navigation passage criteria is to provide one-way downstream navigation of a 14 ft Jon-boat without a motor. Our study data suggest that flows as low as 500 cfs provide the "1-foot" passage criteria through a notch that is approximately 30 ft wide (Figure 5-4). Although this does not meet the exact navigation criteria, it does provide a passage point that should be more than sufficient for one-way passage of a 14 ft Jon-boat.

Results of this study may be verified in the field pending the results of the IFIM study.

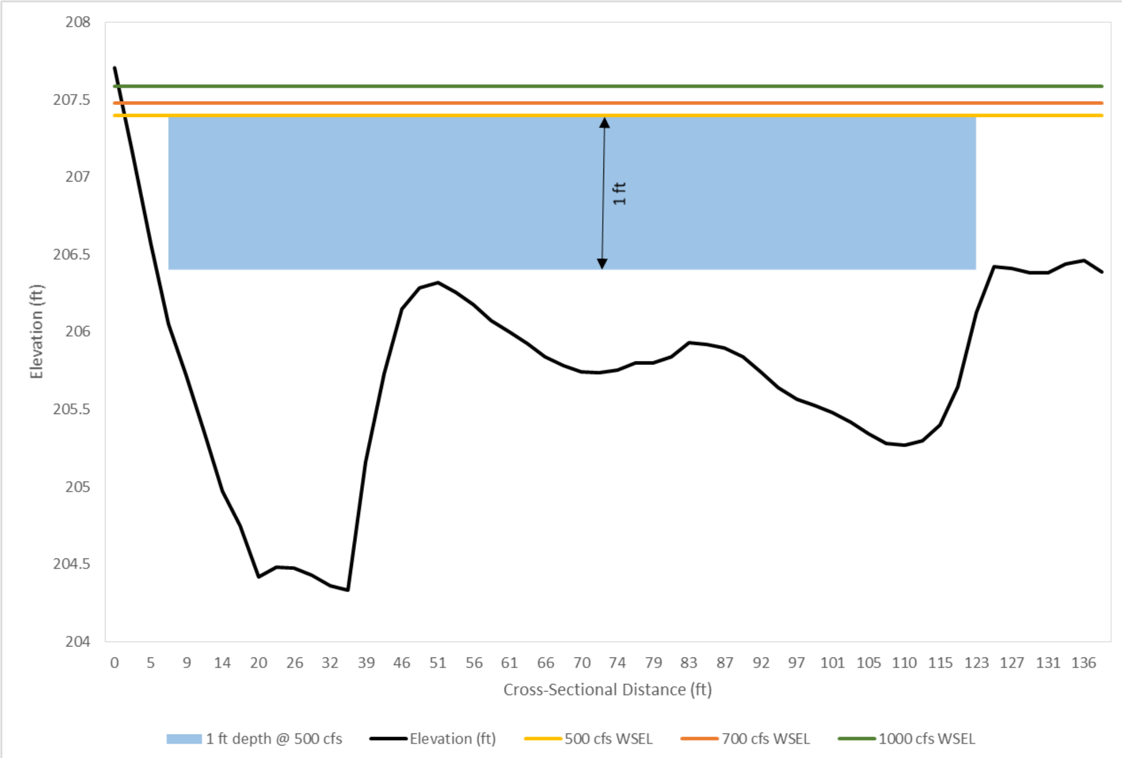

FIGURE 5-1 BED PROFILE AND WATER SURFACE ELEVATIONS AT THE RIVER LEFT PASSAGE POINT AT LEDGE 1 (UPSTREAM VIEW)

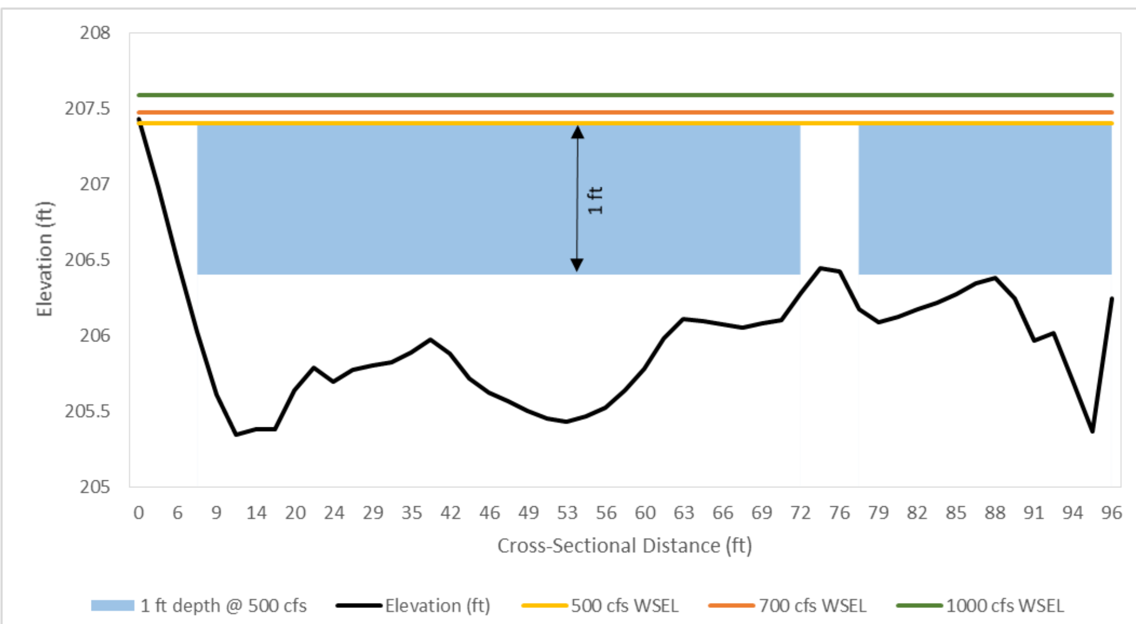

FIGURE 5-2 BED PROFILE AND WATER SURFACE ELEVATIONS AT THE MID-CHANNEL PASSAGE POINT AT LEDGE 1 (UPSTREAM VIEW)

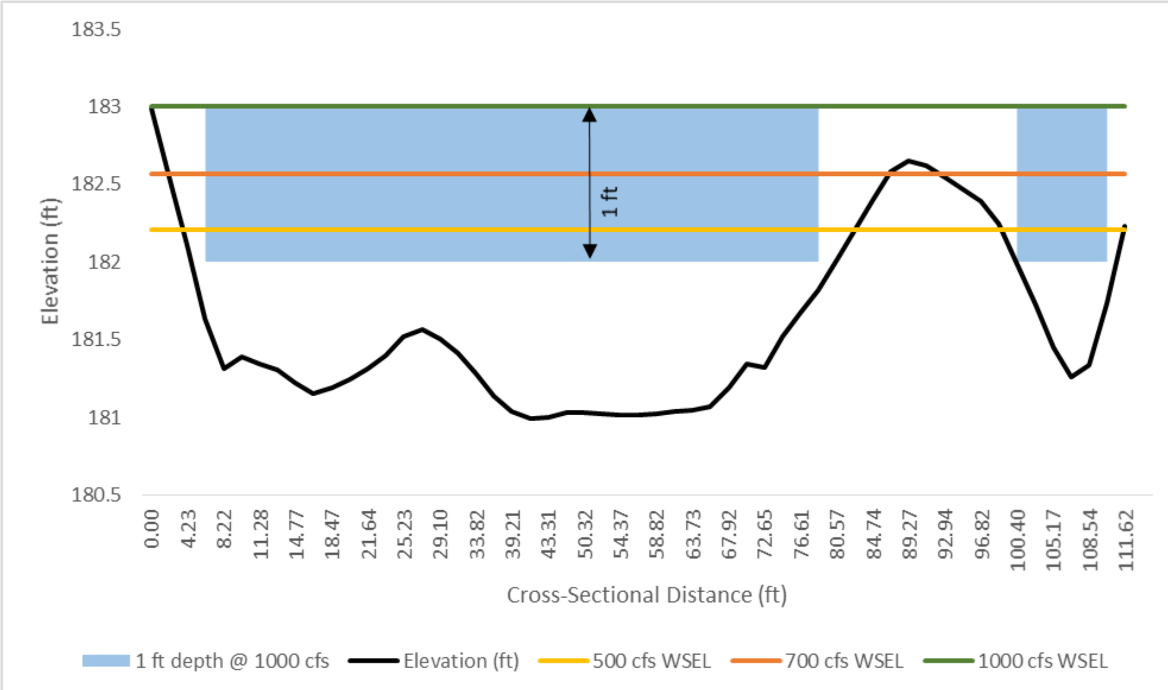

FIGURE 5-3 LEDGE 2 BED PROFILE SHOWING NAVIGATION PASSAGE AREA AT 1000 CFS (UPSTREAM VIEW)

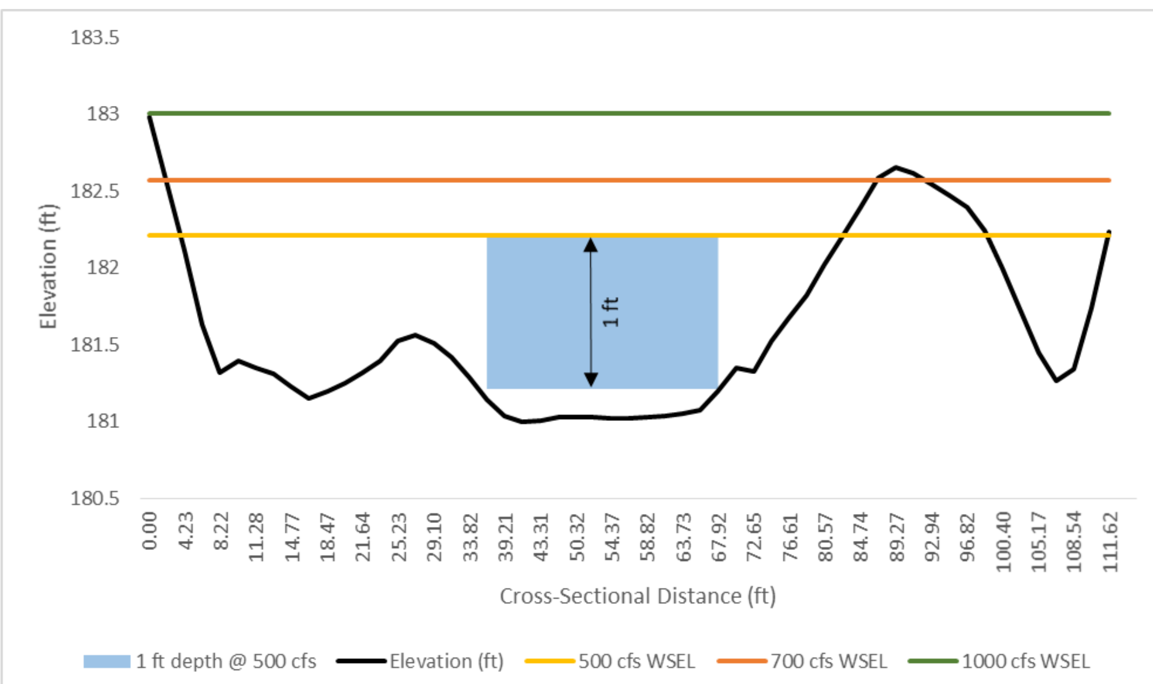

FIGURE 5-4 LEDGE 2 BED PROFILE SHOWING NAVIGATION PASSAGE AREA AT 500 CFS (UPSTREAM VIEW)

6.0 REFERENCES

South Carolina Water Resources Commission (SCWRC). 1988. Instream Flow Study Phase II: Determination of Minimum Flow Standards to Protect Instream Uses in Priority Stream Segments: A Report to the South Carolina General Assembly. Available Online. [URL]: http://scwaterlaw.sc.gov/Instream%20Flow%20Study%20ph2.pdf. Accessed August 2013.

Kleinschmidt Associates. 2014. Parr-Fairfield Operations Modeling System Final Report. Prepared for South Carolina Electric & Gas, Co. December 2014.

APPENDIX A

DOWNSTREAM NAVIGATIONAL FLOW STUDY PLAN

DRAFT

DOWNSTREAM NAVIGATIONAL FLOW ASSESSMENT STUDY PLAN

PARR HYDROELECTRIC PROJECT

(FERC NO. 1894)

Prepared for:

South Carolina Electric & Gas Company
Cayce, South Carolina

Prepared by:

Kleinschmidt

Lexington, South Carolina
www.KleinschmidtUSA.com

December 2013

DRAFT
DOWNSTREAM NAVIGATIONAL FLOW ASSESSMENT
STUDY PLAN

PARR HYDROELECTRIC PROJECT
(FERC NO. 1894)

Prepared for:

South Carolina Electric & Gas Company
Cayce, South Carolina

Prepared by:

Kleinschmidt

Lexington, South Carolina
www.KleinschmidtUSA.com

December 2013

DOWNSTREAM NAVIGATIONAL FLOW ASSESSMENT STUDY PLAN

PARR HYDROELECTRIC PROJECT
(FERC NO. 1894)

SOUTH CAROLINA ELECTRIC & GAS COMPANY

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(FERC NO. 1894)

SOUTH CAROLINA ELECTRIC & GAS COMPANY

1.0 INTRODUCTION

South Carolina Electric & Gas Company (SCE&G) is the Licensee of the Parr Hydroelectric Project (FERC No. 1894) (Project). The Project consists of the Parr Hydro Development and the Fairfield Pumped Storage Development. Both developments are located along the Broad River in Fairfield and Newberry Counties, South Carolina.

The Project is currently engaged in a relicensing process which involves cooperation and collaboration among SCE&G, as licensee, and a variety of stakeholders including state and federal resource agencies, state and local government, non-governmental organizations (NGO), and interested individuals. The collaboration and cooperation is essential to the identification of and treatment of operational, economic, and environmental issues associated with a new operating license for the Project. SCE&G has established Technical Working Committees (TWC's) with members from among the interested stakeholders with the objective of achieving consensus regarding the identification and proper treatment of these issues in the context of a new license.

The Recreation TWC has requested that flows downstream of the Parr Shoals Dam (Parr Dam) be assessed during planned Instream Flow Incremental Methodology (IFIM) studies to determine if downstream flows currently facilitate one-way navigation at an identified point of constriction in the Broad River, downstream of the Project. Although the primary purpose of the IFIM study is to develop an understanding of key habitat-flow relationships for aquatic species in the Broad River, the IFIM study also provides an appropriate means of determining consistency with navigational goals under various flow scenarios.

2.0 STUDY OBJECTIVE

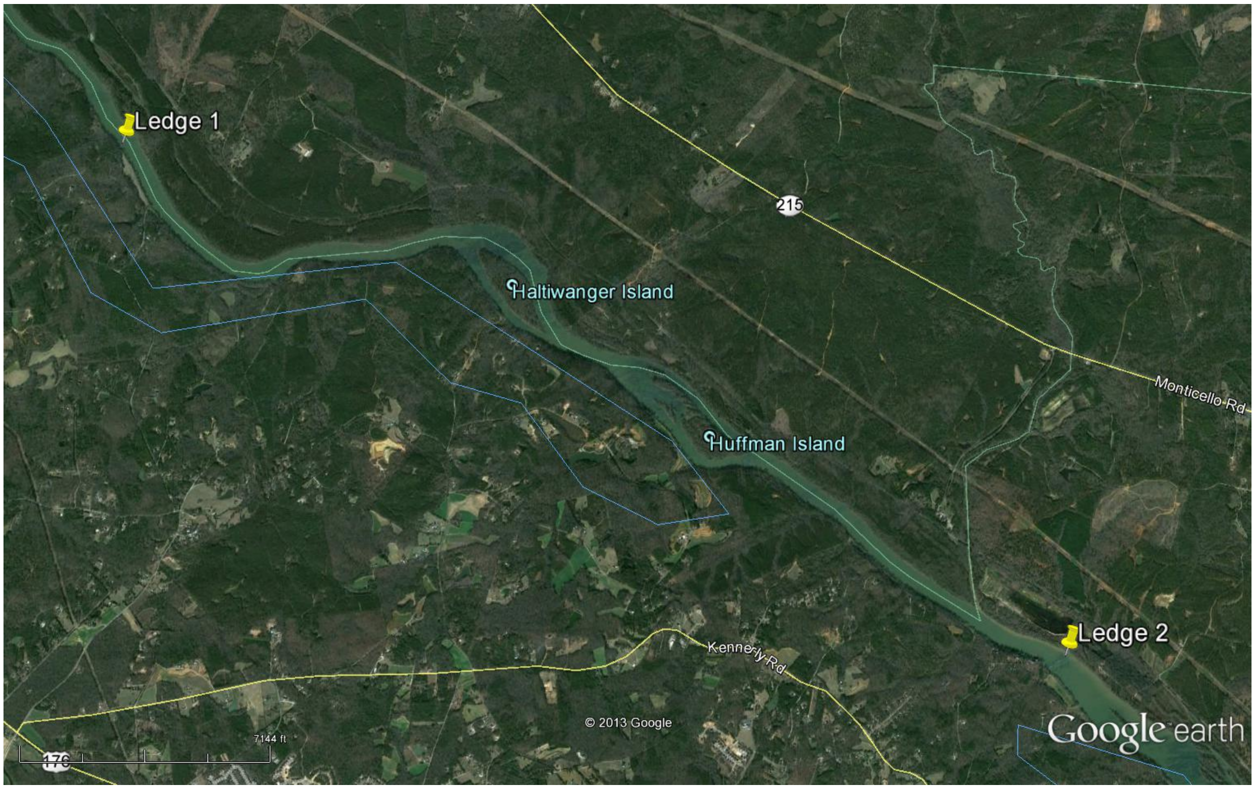
The objective of the navigational analysis is to assess the flow levels within the Broad River, at identified points of constriction, needed to facilitate one-way navigation. The criteria for one-way navigation can be defined as a "minimum depth of one foot across a channel 10 feet wide or across 10 percent of the total stream width, whichever is greater. Minimum depth does not need to occur across a continuous 10 percent of the stream width, but each point of passage must be at least 10 feet wide." One-way navigation criteria are based on the passage of a 14 foot Jon-boat without a motor in the downstream direction only (SCWRC, 1988).

Although not included within scope of this study, two-way navigation is defined as a "minimum depth of two feet across a channel 20 feet wide or across 20 percent of total stream width, whichever is greater. Minimum depth does not need to occur across a continuous 20 percent of stream width, but each point of passage must be at least 10 feet wide." Two-way navigation criteria are based on the passage of a 14 foot Jon-boat with a motor in either direction (SCWRC, 1988).

3.0 GEOGRAPHIC AND TEMPORAL SCOPE

The navigational analyses will evaluate flows within the Broad River at points of navigational constriction downstream of the Parr Dam. Recreation TWC participants initially identified two points of potential constriction. These points, identified as "Ledge 1" and "Ledge 2", were further investigated during Parr mesohabitat studies and are defined below. See Figure 1 for location of the two points of navigational constriction.

FIGURE 1 POTENTIAL POINTS OF NAVIGATIONAL CONSTRICTION



Ledge 1. Ledge 1 is located at a lat/long of 81°15'46.507"W, 34°12'49.999"N, approximately 2.4 miles upstream of Haltiwanger Island. Field investigations have identified a navigational passage point on river right (looking downstream) that is approximately 45 ft wide with an approximate elevation change of 1.5 feet. Please see Figure 2; the passage point is within the red circle.

FIGURE 2 LEDGE 1 IDENTIFICATION AND AREA OF NAVIGATIONAL PASSAGE

Ledge 2. Ledge 2 is located 1.3 miles upstream of Hickory Island and approximately 0.5 miles downstream of the mouth of Little River. Ledge 2 has a lat/long of 81°10’15.941”W, 34°10’18.154”N, and an approximate elevation change of 1.5 to 2.0 feet. Field investigations have identified a navigational passage point on river right (looking downstream) that is approximately 60 ft wide. Please see Figure 3; the passage point is within the red circle.

FIGURE 3 LEDGE 2 IDENTIFICATION AND AREA OF NAVIGATIONAL PASSAGE

The navigational analyses will be conducted during the summer of 2015 concurrent with IFIM study efforts.

4.0 METHODOLOGY

IFIM study transects will include the representative locations of navigational constriction identified in Section 3.0, to allow the characterization of hydraulics (wetted depth and width) during a range of flows. The transect locations will be field blazed with flagging, recorded via GPS, or other appropriate means. The study sites will be mapped sufficiently to quantify the areas represented by the transects. Consistent with IFIM survey protocol, transect headpin and tailpin ends will be located at or above the top-of-bank elevation, and secured by steel rebar or other similar means. A measuring tape accurate to 0.1-foot will be secured at each transect to enable repeat field measurements, if necessary. Stream bed and water elevations tied to a local datum will be surveyed to the nearest 0.1-foot using standard optical surveying instrumentation and methods. If USGS gage data is not available, a staff gage may be placed at the study site to confirm stable flow during measurements. Survey activities are anticipated to take place at a flow of 400 cfs. A water level logger will also be placed at the transect locations to gather water surface elevation data under various flow events. Water surface elevations will be used to develop stage-discharge relationships for the site and the stage-discharge relationships will be assessed on whether one-way navigation is achieved.

Information obtained during survey activities will be included within the draft IFIM report that will be submitted to the study team for review and comment. The report will document the methods and results as encountered in the field. Supporting data will be presented in graphic and tabular form and appendices will include cross-sectional survey data and reference photographs of study sites.

The methodology for this analysis may be revised or supplemented based on consultation with the Instream Flow TWC and other interested stakeholders, or if field efforts so dictate.

5.0 SCHEDULE AND REPORTING

Data will be gathered during the IFIM study, anticipated to occur in 2015. A final report summarizing IFIM study findings, including an analysis of impediments to one-way navigation under various flow conditions, will be issued subsequent to the completion of field work.

6.0 USE OF STUDY RESULTS

Study results will be used as an information resource during discussion of relicensing issues and developing potential Protection, Mitigation and Enhancement measures with the South Carolina Department of Natural Resources, USFWS, the Instream Flows TWC, and other relicensing stakeholders.

7.0 REFERENCES

South Carolina Water Resources Commission (SCWRC). 1988. Instream Flow Study Phase II: Determination of Minimum Flow Standards to Protect Instream Uses in Priority Stream Segments: A Report to the South Carolina General Assembly. Available Online. [URL]: http://scwaterlaw.sc.gov/Instream%20Flow%20Study%20ph2.pdf. Accessed August 2013.

APPENDIX B

COMMENTS FROM STAKEHOLDERS

American Rivers
Rivers Connect Us®

April 8, 2016

Mr. William R. Argentieri
South Carolina Electric and Gas Company
Mail Code A221
220 Operations Way
Cayce, SC 29033-3701

Subject: Comments and Recommendations: Downstream Navigational Flow Assessment
Parr-Fairfield Hydroelectric Project (FERC No. 1894)

Dear Mr. Argentieri:

Ensuring downstream navigation and recreation needs are met through a new license for the Parr-Fairfield Hydroelectric Project is fundamental to American Rivers' interests in this relicensing and for the future of the Broad River which is directly affected by project operations. We are a member of the Recreation Technical Working Committee, and participated in numerous meetings and the development of the study plan for assessing downstream flows to meet the state's minimum standards for recreational navigation. American Rivers has reviewed the April 2016 Downstream Navigational Flow Assessment report and offer the following comments and recommendations.

The flow assessment report clearly indicates that a flow of 1,000 cfs is needed to satisfy the State of South Carolina's navigation requirements as a determined by state guidance (South Carolina Water Resources Commission 1988: Instream Flow Study Phase II: Determination of Minimum Flow Standards to Protect Instream Uses in Priority Stream Segments: A Report to the South Carolina General Assembly. The Water Resources Commission is now part of the South Carolina Department of Natural Resources which has adopted this method for determining navigation flow requirements.)

Despite the findings of the navigation assessment, the report recommends a flow of 500 cfs for navigation requirements. A flow of 500 cfs clearly does not meet the state's criteria for determining minimum navigation flows. We are baffled why the report recommends a flow which is clearly in conflict with the state's method and study results.

American Rivers recognizes that based on the findings of the Downstream Navigation Flow Assessment a flow of at least 1,000 cfs is needed to meet navigation requirements. We recommend that the report be changed to conclude that a 1,000 cfs flow, not a 500 cfs flow, is needed to meet navigation requirements.

Sincerely,

Southeast Region
215 Pickens Street p 803.771.7114
Columbia, S.C. 29205 f 803.771.7580
www.AmericanRivers.org

Gerrit Jöbsis
Senior Director, Southeast Conservation

cc: SC Department of Health and Environmental Control
SC Department of Natural Resources
Recreation Technical Working Committee

From:	Bill Marshall
To:	Kelly Kirven; Alex Pellett; Alison Jakupca; ARGENTIERI, WILLIAM R; Bill Stangler (CRK@congareeriverkeeper.org); BRESNAHAN, AMY; btrump@scana.com; Caleb Gaston (caleb.gaston@scana.com); Charlene Coleman (cheetahtrk@yahoo.com); Chuck Hightower (hightocw@dhec.sc.gov); Dick Christie (dchristie@comporium.net); Edye Joyner; Erich Miarka (erich.miarka@gillscreekwatershed.org); Frank_Henning@nps.gov; Gerrit Jobsis (gjobsis@americanrivers.org); Greg Mixon; Henry Mealing; J. Hagood Hamilton Jr. (jhamilton@scana.com); Jaclyn Daly (Jaclyn.Daly@noaa.gov); Jay Maher; Jeff Carter (jmcarter00@sc.rr.com); Joe Wojcicki; John Fantry (jfantry@bellsouth.net); Jon Durham (jondurham@bellsouth.net); Karen Swank Kustafik (kakustafik@columbiasc.net); Lorianne Riggin; Malcolm Leaphart (mwleapjr@att.net); Mark Davis; Merrill McGregor (merrillm@scccl.org); Pace Wilber (Pace.Wilber@noaa.gov); rammarell@scana.com; Randy Mahan (randolph.mahan@scana.com); randy mahan (rmahan@sc.rr.com); Robert Stroud; Rusty Wenerick (weneriwr@dhec.sc.gov); Scott Collins (secollins@scana.com); Steve Summer; STUTTS, BRANDON G; tboozer@scana.com; Wayne and Ginny Boland (wayneboland@bellsouth.net); William Hendrix (HendrixWB@dot.state.sc.us)
Subject:	RE: draft Downstream Navigational Flow Assessment
Date:	Thursday, April 14, 2016 3:15:37 PM

Hi Kelly, I have a few comments to offer.

I think the Navigational Flow Assessment provides useful information, and DNR staff will want to consider these results in combination with the Instream Flow Study findings as we further evaluate future flow needs below Parr hydro.

In addition, I think this navigational flow assessment at the two ledges may not capture the more complicated navigational obstruction presented in shoal complexes such as those in the upper Bookman Island complex, particularly the shoals just upstream of Hickory Island (see attached image). I'd be interested in seeing how the Instream Flow Study data collected for Study Site 10 (Bookman Island Complex, 2D data collection) might help us to evaluate navigational flow conditions for that area. Please let us know if those other data might be useful to further evaluating the navigation issues.

Thank you,

Bill Marshall
SCDNR
803-734-9096

From: Kelly Kirven [mailto:Kelly.Kirven@KleinschmidtGroup.com]
Sent: Friday, April 01, 2016 10:37 AM
To: Alex Pellett ; Alison Jakupca ; ARGENTIERI, WILLIAM R ; Bill Marshall ; Bill Stangler (CRK@congareeriverkeeper.org) ; BRESNAHAN, AMY ; btrump@scana.com; Caleb Gaston (caleb.gaston@scana.com) ; Charlene Coleman (cheetahtrk@yahoo.com) ; Chuck Hightower (hightocw@dhec.sc.gov) ; Dick Christie (dchristie@comporium.net) ; Edye Joyner ; Erich Miarka (erich.miarka@gillscreekwatershed.org) ; Frank_Henning@nps.gov; Gerrit Jobsis (gjobsis@americanrivers.org) ; Greg Mixon ; Henry Mealing ; J. Hagood Hamilton Jr. (jhamilton@scana.com) ; Jaclyn Daly (Jaclyn.Daly@noaa.gov) ; Jay Maher ; Jeff Carter (jmcarter00@sc.rr.com) ; Joe Wojcicki ; John Fantry (jfantry@bellsouth.net) ; Jon Durham (jondurham@bellsouth.net) ; Karen Swank Kustafik (kakustafik@columbiasc.net) ; Kelly Kirven ; Lorianne Riggin ; Malcolm Leaphart (mwleapjr@att.net) ; Mark Davis ; Merrill McGregor (merrillm@scccl.org) ; Pace Wilber (Pace.Wilber@noaa.gov) ; rammarell@scana.com; Randy Mahan (randolph.mahan@scana.com) ; randy mahan (rmahan@sc.rr.com) ; Robert Stroud ; Rusty Wenerick (weneriwr@dhec.sc.gov) ; Scott Collins (secollins@scana.com) ; Steve Summer ; STUTTS, BRANDON G ; tboozer@scana.com; Wayne and Ginny Boland (wayneboland@bellsouth.net) ; William Hendrix (HendrixWB@dot.state.sc.us)
Subject: draft Downstream Navigational Flow Assessment

Good morning,
Attached is the draft Downstream Navigational Flow Assessment. Please review and submit any comments or edits by Friday, April 15th. We will discuss this document at the upcoming Recreation TWC meeting, to be scheduled for some time in May.
Thanks,
Kelly

Kelly Miller Kirven
Regulatory Coordinator
Kleinschmidt
Office: 803.462.5633
Cell: 803.917.4528
www.KleinschmidtGroup.com

April 15, 2016

Attn: Bill Argentieri
South Carolina Electric & Gas Company

Re: Downstream Navigational Flow Assessment – Parr Hydroelectric Project

Mr. Argentieri,

The following comments are in response to the Downstream Navigational Flow Assessment that was prepared as part of the relicensing of the Parr/Fairfield hydroelectric projects and was sent to members of the Recreation Technical Working Committee on April 1st.

- The transects used to determine navigability of a shoal should not follow a straight line, but rather should follow the top of the shoal (the shallowest area) to better reflect the possible blockages to navigation. We suggest the committee make an effort to verify the results by attempting to actually navigate the shoals at the recommended flows.

- The assessment states that a flow of 1,000 cfs meets the established criteria for navigation at ledge two, but goes on to recommend a navigational minimum flow of 500 cfs which the assessment clearly states does not meet the criteria. The assessment should not include a recommendation the author feels "should be more than sufficient" when we have clearly defined criteria to determine navigability.

- Additionally, as there should be supplementary data available from the IFIM study we recommend navigational flows be assessed at other sites including the Bookman Shoals area suggested by the DNR.

As we continue to review the assessment and the stage-discharge rating curves used in the analysis we may have additional questions or comments.

Thank you.

Sincerely,

Bill Stangler

Bill Stangler
Congaree Riverkeeper

Post Office Box 5294 • Columbia, South Carolina 29250
(803) 760-3357 • www.congareeriverkeeper.org

WATERKEEPER® ALLIANCE MEMBER

Downstream Recreational Flow User Survey Memo

MEMORANDUM

TO: Recreation TWC and Downstream Recreational Flow Focus Group

FROM: Alison Jakupca – Kleinschmidt Associates

DATE: January 20, 2016

RE: Downstream Recreational Flow User Survey

During relicensing issue identification meetings, the Recreation Technical Working Committee (TWC) requested that a study be designed and implemented that would do the following: 1) assess flows downstream of the Parr Shoals Dam (Parr Dam) that provide quality recreational experiences, and; 2) identify preferred flows for recreational activities, primarily as they relate to wade angling, canoeing and kayaking. In accordance with the Downstream Recreational Flow Assessment Study Plan designed to fulfill this request, a panel of stakeholders that are knowledgeable about the Project area was identified and convened as a focus group. The focus group provided information regarding quality recreation opportunities (to fulfill objective 1), potential flow effects on recreation on the Broad River, downstream of the Parr Dam (Area of Interest [AOI]), and preferred flows for recreational activities (to fulfill objective 2). The focus group meeting was held on December 11, 2014.

As a follow-up to the focus group meeting, an on-line survey was distributed to focus group members via SurveyMonkey on November 9, 2015 (see Appendix A for a copy of survey questions). The primary purpose of this survey was to gather user opinions on recreational use and preferred river flows for the AOI in 2015. Four focus group members responded to the on-line survey. This memorandum summarizes the contents and results of this survey which will be discussed further in the Recreation TWC, assessed in conjunction with navigational and environmental flows, and may be used in Settlement Agreement negotiations.

METHODS

The focus group meeting provided a good baseline of information regarding type of recreation activity, time of recreation activity, preferred flows for recreation activity, and access issues for the AOI. A summary of discussions from the focus group meeting is available at the following link: Recreation Focus Group Discussions Summary. The 2015 on-line survey was intended to gather additional information regarding potential quality recreation opportunities and preferred flows based on specific user experiences during 2015. Data gathered through this activity is intended to provide guidance in addressing recreational flow needs in the AOI, as recommended by the Recreation TWC and through Settlement Agreement negotiations.

As shown in Appendix A, survey Questions 1 through 4 and Question 6 focus on the frequency and timing of recreation activities. These questions were designed to help determine the timing of recreational use for the development of potential recreational flow recommendations for the Settlement Agreement. Question 5 and Question 7 focus on the type of recreational activity and preferred flows associated with that activity. The goal of the study is to focus on preferred flows for wade-angling, canoeing and kayaking. In addition to these activities, boat fishing, bank fishing, and hunting were also provided as choices in the survey. These options were provided in the survey because boat fishing, bank fishing and hunting were identified as popular activities during the 2014 focus group meeting. Questions 8 and 9 focus on additional comments and contact information, which was optional information.

RESULTS

The survey was sent to the thirteen members of the Downstream Recreational Flow Focus Group of which four responded to the survey. Three of the four respondents indicated that they recreated in the AOI during 2015 (Figure 1). The fourth respondent indicated that they had not recreated in the AOI during 2015 and did not provide responses to the subsequent survey questions.

FREQUENCY, TYPE AND TIMING OF USE

Two of the three respondents indicated that they recreated in the AOI one to five times during 2015. One respondent indicated that they had recreated in the survey area 6-10 times in 2015 (Figure 2).

When asked about the time of day and day of the week (Questions 3 and 4) in which recreation in the AOI took place, respondents indicated that they recreated all day during daylight hours (Figure 3) and generally on the weekends (Figure 4). Respondents indicated that they participated in all five activities listed under Question 5 (canoeing/kayaking; boat fishing; hunting; wade fishing, and; bank fishing) (Figure 5). One participant added swimming under "other activity". Canoeing/kayaking and fishing (boat, wade and bank) were the most popular activities in 2015 among the respondents who answered this question.

Question 6 of the survey focused on the months in which the selected activities took place in 2015. The intent of this question was to narrow the time of year when the primary recreation activities take place. Respondents noted that canoeing/kayaking took place during the months of May through September, with May and June having the greatest response rate (Figure 6). Boat fishing activities occurred during the months of April through September with May and June receiving the highest response rate (Figure 7). Hunting was noted for the months of January and April (Figure 7). Respondents indicated that wade fishing occurred during May through October, with May, June and July receiving the highest response rate (Figure 8). Bank Fishing was noted as occurring during May through September, also with May, June and July receiving the highest response rate (Figure 8). One respondent noted that swimming took place May through August (Figure 9).

PREFERRED FLOW RANGES

Three respondents provided answers for Question 7, which served to identify preferred flow ranges for recreation activities. Preferred flow ranges for canoeing/kayaking were indicated as ranging from 3,000 – 4,999 cfs by one respondent and a stage of 3.5 to 5 feet by a second respondent (Figure 10). For reference purposes, stage ranges from 3.5 to 5 feet on the USGS Gage located on the Broad River at Alston, SC (02161000) are equal to approximately 1,450 to 4,000 cfs.

All three respondents provided preferred flow ranges for boat fishing. One of the respondents indicated that preferred flows ranged from 2,000-2,999 cfs; 3,000 – 4,999 cfs, and; 5,000 cfs and above (Figure 11). A second respondent indicated that preferred flows for boat fishing were lower, ranging from 500 to 1,499. The third respondent noted that a stage of 3.5 to 5 feet (1,450 to 4,000 cfs) was preferred for boat fishing.

One respondent indicated that flow ranges preferred for hunting ranged from 500 cfs to 2,999 cfs (Figure 11). Two respondents provided preferred flows for wade fishing. One respondent noted that wade fishing could take place in flows from 500 to 1,999 cfs. The second respondent noted that flows from 500 to 999 cfs were preferred for this activity (Figure 11).

Preferred flows for bank fishing were indicated as being fairly inclusive by one respondent, ranging from 0 to 4,999 cfs. The second responded noted that bank fishing was preferred from 500 to 999 cfs (Figure 12). One respondent noted that acceptable flow ranges for "other activity" (swimming) ranged from 0 to 1,999 cfs (Figure 12).

RESPONDENT COMMENTS

Question 8 and Question 9 served to gather general comments about recreation in the AOI and the contact information of the respondents (optional). Personal contact information is not being published in this memo; however, general comments regarding recreation are provided in Figure 14. A general theme among respondents' comments is that additional access downstream of the Project is needed. This was also a key topic of conversation during 2014 focus group discussions. Focus group attendees indicated that recreational opportunities would increase with improved access. One respondent suggested limits on motorized boat usage. Another respondent indicated that flows below a stage of 3.5 (1,450 cfs) are too shallow for paddling in some areas of the river.

DISCUSSION

Although more survey responses would be preferred, the survey information and the 2014 focus group input led to several general conclusions. As indicated through Question 4 responses and 2014 focus group discussions, recreation in the AOI primarily takes place on the weekends. Furthermore, the months of May, June and July were the most popular recreation months for the activities targeted in the study plan (canoeing, kayaking, and wade fishing). Bank fishing and boat fishing have similar temporal use patterns, with boat fishing beginning earlier in the spring (April). Hunting occurs in the winter/early spring (January and April). This is supported by 2014 focus group discussions where attendees noted that they "generally utilized the AOI during weekends and warmer seasonal temperatures. However, attendees indicated that the AOI was utilized by duck hunters and fishermen during colder seasons."

To fulfill study plan objectives, user preferences have been summarized into preferred flow ranges that provide the greatest recreational opportunity. These ranges, when combined with the temporal use patterns discussed above, may be considered in the context of a Settlement Agreement. Focus group input indicates that higher flows necessary for canoeing, kayaking and boat fishing are not always compatible with the generally lower flows needed for wade angling, bank fishing, hunting and swimming. Therefore, two preferred recreational flow ranges have resulted from focus group discussions and the 2015 survey results:

1. Responses indicate that a flow between **2,000 and 5,000 cfs** during the months of May and/or June would generally support canoeing, kayaking and those individuals that prefer a higher flow for boat fishing.

2. Responses indicate that a flow between **500 and 999 cfs** would generally support lower boat fishing flows, hunting, wade fishing and swimming. Although the preferred time period for these activities varies, May, June and July were the most popular months for these activities with the exception of hunting, which is generally confined by hunting seasons (September and January).

NEXT STEPS

Preferred flow ranges will be discussed with the Recreation TWC and focus group. They will also be considered in the context of other flows evaluated through the relicensing process (e.g. navigational flows and environmental flows). If recreational flows are included as part of the Settlement Agreement, the specific timing and duration of those flows will be determined during settlement negotiations and evaluated with the Parr Hydroelectric Project Operations Model. The Operations Model will be used to determine if the requested flows are available under current operations, how often the requested flows are typically available (hydrologic year), and if the requested flows will result in lost revenues for the Project. These two recommendations will be forwarded for evaluation and the Operations Model results will be discussed with TWC members and summarized in a final report that will be used in development of a Settlement Agreement.

APPENDIX A

SURVEY QUESTIONNAIRE

Parr Hydroelectric Project Relicensing
Downstream Recreational Flow User Survey

South Carolina Electric & Gas Company (SCE&G) is currently relicensing the Parr Hydroelectric Project, located on the Broad River in Fairfield and Newberry counties, South Carolina. As part of the relicensing process, stakeholders identified the need for information that characterizes non-motorized boating use and preferred river flows associated with reasonable and safe recreational use on the Broad River downstream of the Parr Shoals Dam, primarily as they relate to wade-angling, canoeing and/or kayaking. In 2014, SCE&G held a Focus Group meeting for selected recreational users to help identify these needs and preferences. This survey is a follow-up to the Focus Group meeting to help gather additional user opinions regarding use and flow preferences, subsequent to the 2015 recreation season.

1. Did you recreate on the Broad River, downstream of Parr Shoals Dam, during 2015?

   ☐ Yes
   ☐ No (*If no, skip to Question 8*).

2. About how many times did you recreate on the Broad River, downstream of Parr Shoals Dam, during 2015?

   ☐ 1-5 times
   ☐ 6-10 times
   ☐ More than 10 times

3. About what time of day did you typically recreate on the Broad River, downstream of Parr Shoals dam, during 2015.

   ☐ Morning
   ☐ Noon/early afternoon
   ☐ Late afternoon/evening
   ☐ All day

4. Did you typically recreate on the Broad River, downstream of Parr Shoals dam, during the weekdays or on weekends?

   ☐ Weekdays
   ☐ Weekends
   ☐ Recreated on both weekdays and weekends equally

5. What activities did you participate in on the Broad River, downstream of Parr Shoals Dam, in 2015 (*Check all that apply*).

☐ canoeing/kayaking	☐ boat fishing	☐ hunting
☐ wade fishing	☐ bank fishing	
☐ other activity (please specify): ________________________________)		

6. For each activity that you checked in Question 5, please indicate the month, or months, during which you engaged in this activity (Circle all the months that apply for each activity that you identified in Question 5).

Canoeing/kayaking –

(JAN FEB MAR APR MAY JUN JULY AUG SEP OCT)

Boat fishing –

(JAN FEB MAR APR MAY JUN JULY AUG SEP OCT)

Hunting–

(JAN FEB MAR APR MAY JUN JULY AUG SEP OCT)

Wade fishing–

(JAN FEB MAR APR MAY JUN JULY AUG SEP OCT)

Bank fishing–

(JAN FEB MAR APR MAY JUN JULY AUG SEP OCT)

Other activity–

(JAN FEB MAR APR MAY JUN JULY AUG SEP OCT)

7. For each activity that you identified in Question 5, please indicate what flow level (in cubic feet per second ["cfs"]) you would consider "preferred" for that activity. If a wider range of flows is acceptable for that activity, please check all flow ranges that apply. If you only know river stage, please identify the river stage under "Other flow or river stage". If you do not know flow in cfs or river stage, please skip to Question 8.

Canoeing/kayaking –

- ☐ 0-499 cfs
- ☐ 500-999 cfs
- ☐ 1,000-1,499 cfs
- ☐ 1,500-1,999 cfs
- ☐ 2,000-2,999 cfs
- ☐ 3,000 – 4,999 cfs
- ☐ 5,000 cfs and above
- ☐ Other flow or river stage (please list) ____________________

Boat fishing –

- ☐ 0-499 cfs
- ☐ 500-999 cfs
- ☐ 1,000-1,499 cfs
- ☐ 1,500-1,999 cfs
- ☐ 2,000-2,999 cfs
- ☐ 3,000 – 4,999 cfs
- ☐ 5,000 cfs and above
- ☐ Other flow or river stage (please list) ____________________

(Question 7 continued on next page)

Hunting–

- ☐ 0-499 cfs
- ☐ 500-999 cfs
- ☐ 1,000-1,499 cfs
- ☐ 1,500-1,999 cfs
- ☐ 2,000-2,999 cfs
- ☐ 3,000 – 4,999 cfs
- ☐ 5,000 cfs and above
- ☐ Other flow or river stage (please list) ______________________

Wade fishing–

- ☐ 0-499 cfs
- ☐ 500-999 cfs
- ☐ 1,000-1,499 cfs
- ☐ 1,500-1,999 cfs
- ☐ 2,000-2,999 cfs
- ☐ 3,000 – 4,999 cfs
- ☐ 5,000 cfs and above
- ☐ Other flow or river stage (please list) ______________________

(Question 7 continued on next page)

Bank fishing–

- ☐ 0-499 cfs
- ☐ 500-999 cfs
- ☐ 1,000-1,499 cfs
- ☐ 1,500-1,999 cfs
- ☐ 2,000-2,999 cfs
- ☐ 3,000 – 4,999 cfs
- ☐ 5,000 cfs and above
- ☐ Other flow or river stage (please list) ______________________

Other Activity– (please list activity) ________________________

- ☐ 0-499 cfs
- ☐ 500-999 cfs
- ☐ 1,000-1,499 cfs
- ☐ 1,500-1,999 cfs
- ☐ 2,000-2,999 cfs
- ☐ 3,000 – 4,999 cfs
- ☐ 5,000 cfs and above
- ☐ Other flow or river stage (please list) ______________________

8. Do you have any comments about recreational use on the Broad River, below Parr Shoals Dam? (*Please fill in blank and be as specific as possible.*)

____

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9. Contact Information (*optional*):

Name: ____

Organization: ____

Phone Number or Email address: ____

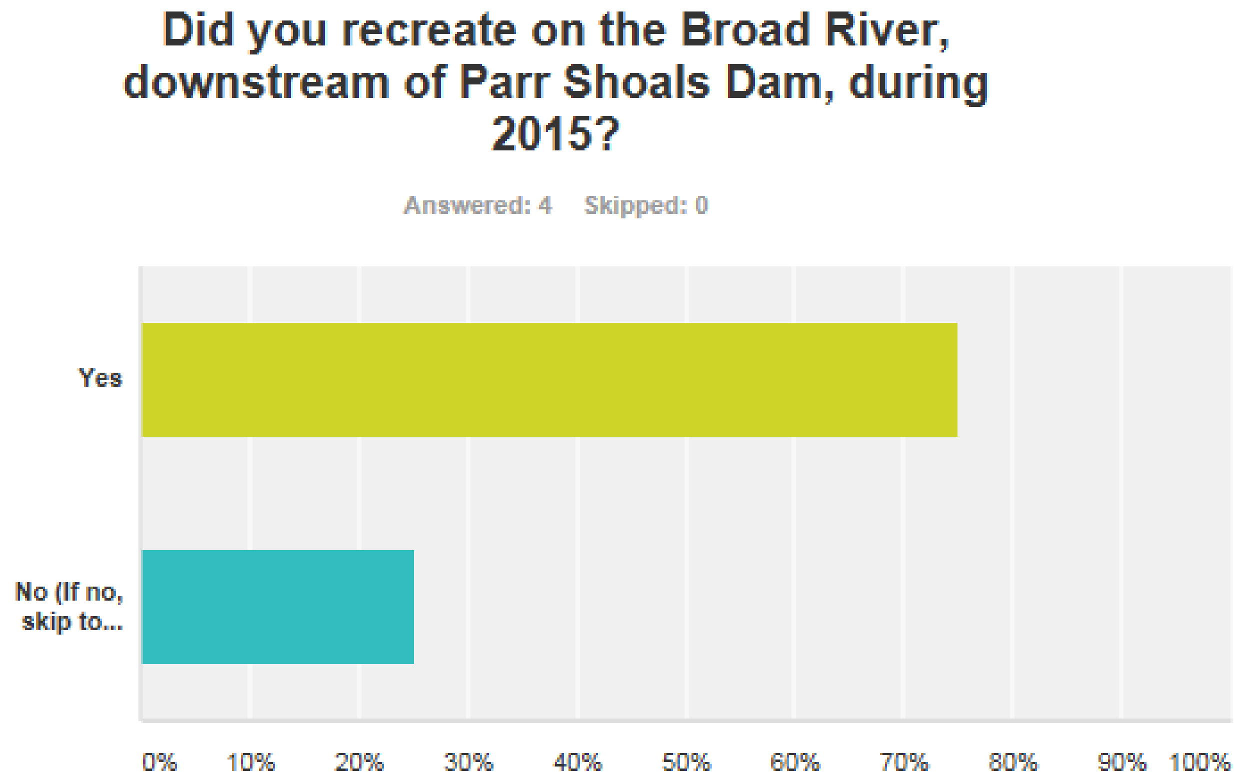
____

THANK YOU FOR YOUR HELP!

APPENDIX B

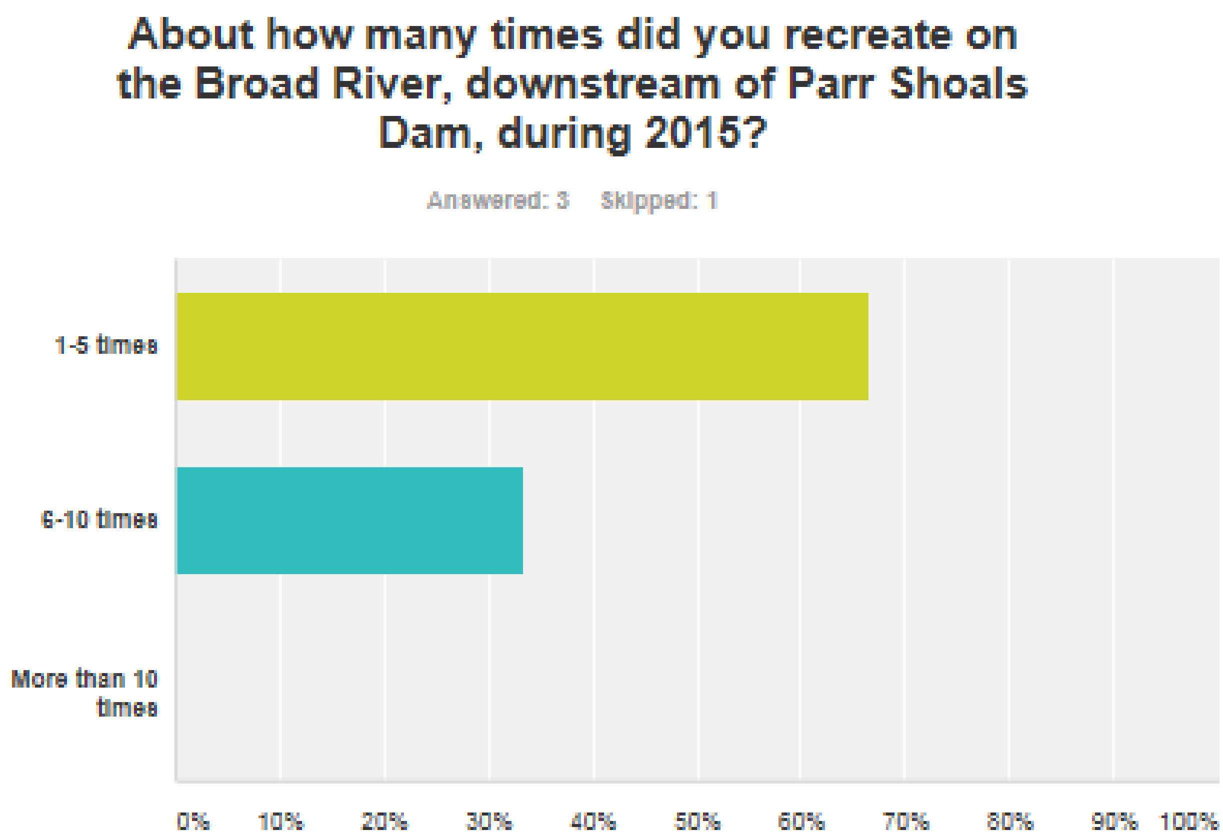
SURVEY RESPONSE FIGURES

FIGURE 1 – SURVEY RESPONSE FOR QUESTION 1



Answer Choices	Responses	
Yes	75.00%	3
No (If no, skip to Question 8)	25.00%	1
Total		4

FIGURE 2 – SURVEY RESPONSE FOR QUESTION 2

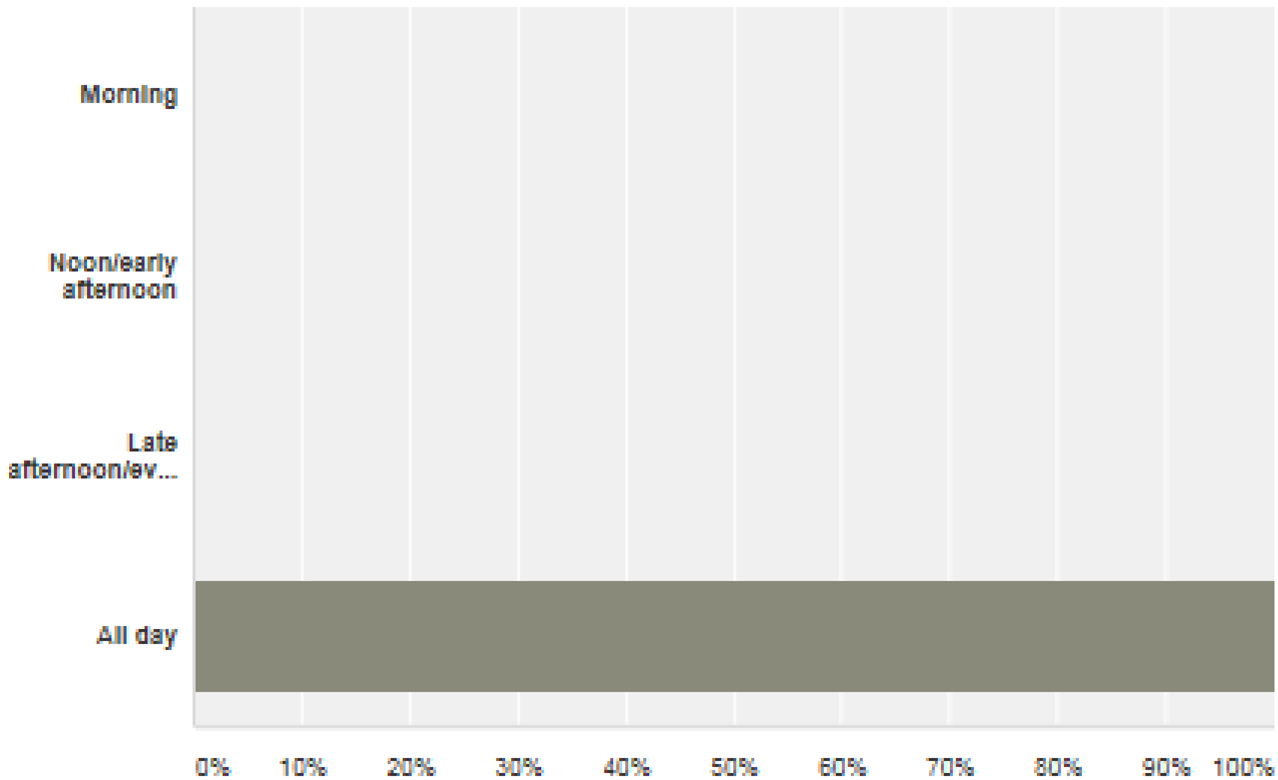


Answer Choices	Responses	
1-5 times	66.67%	2
6-10 times	33.33%	1
More than 10 times	0.00%	0
Total		3

FIGURE 3 – SURVEY RESPONSE FOR QUESTION 3

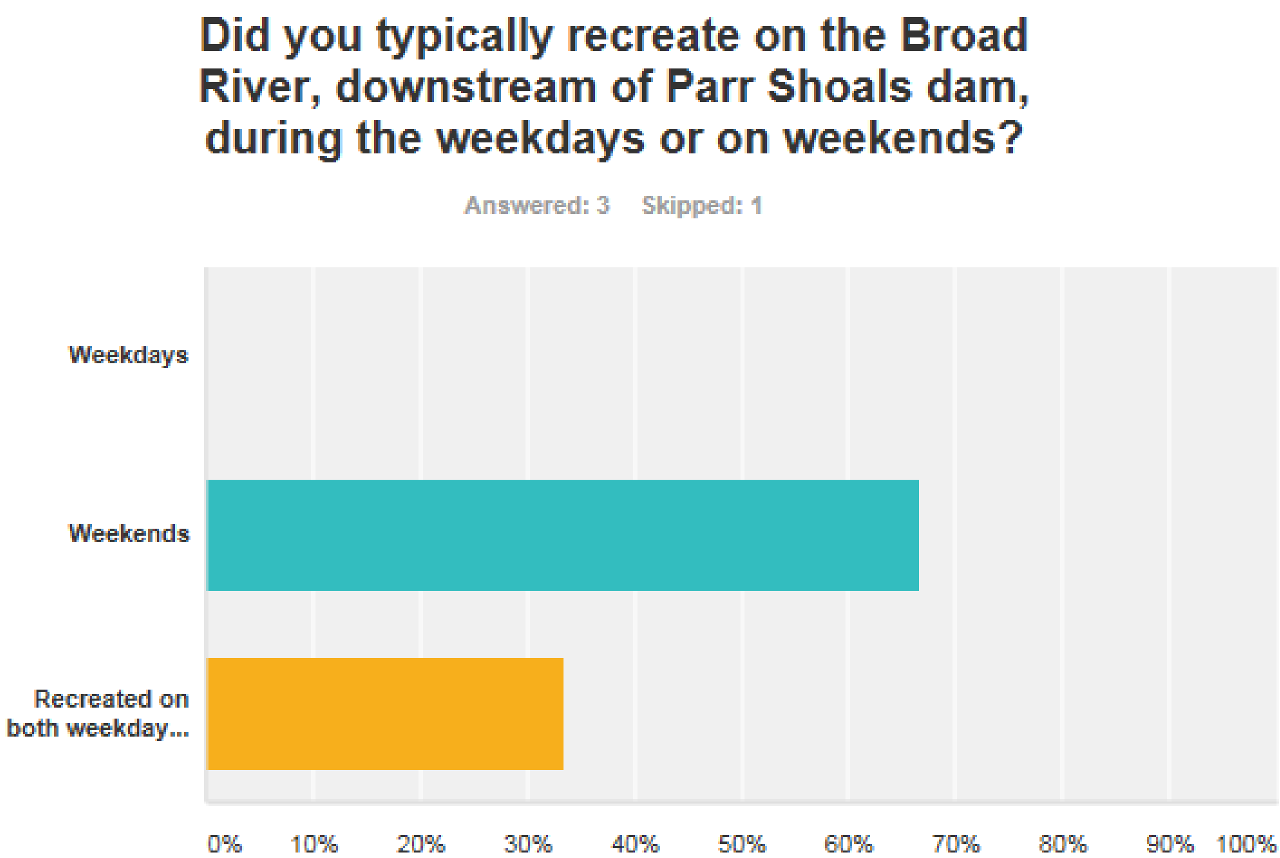
About what time of day did you typically recreate on the Broad River, downstream of Parr Shoals dam, during 2015.

Answered: 3 Skipped: 1



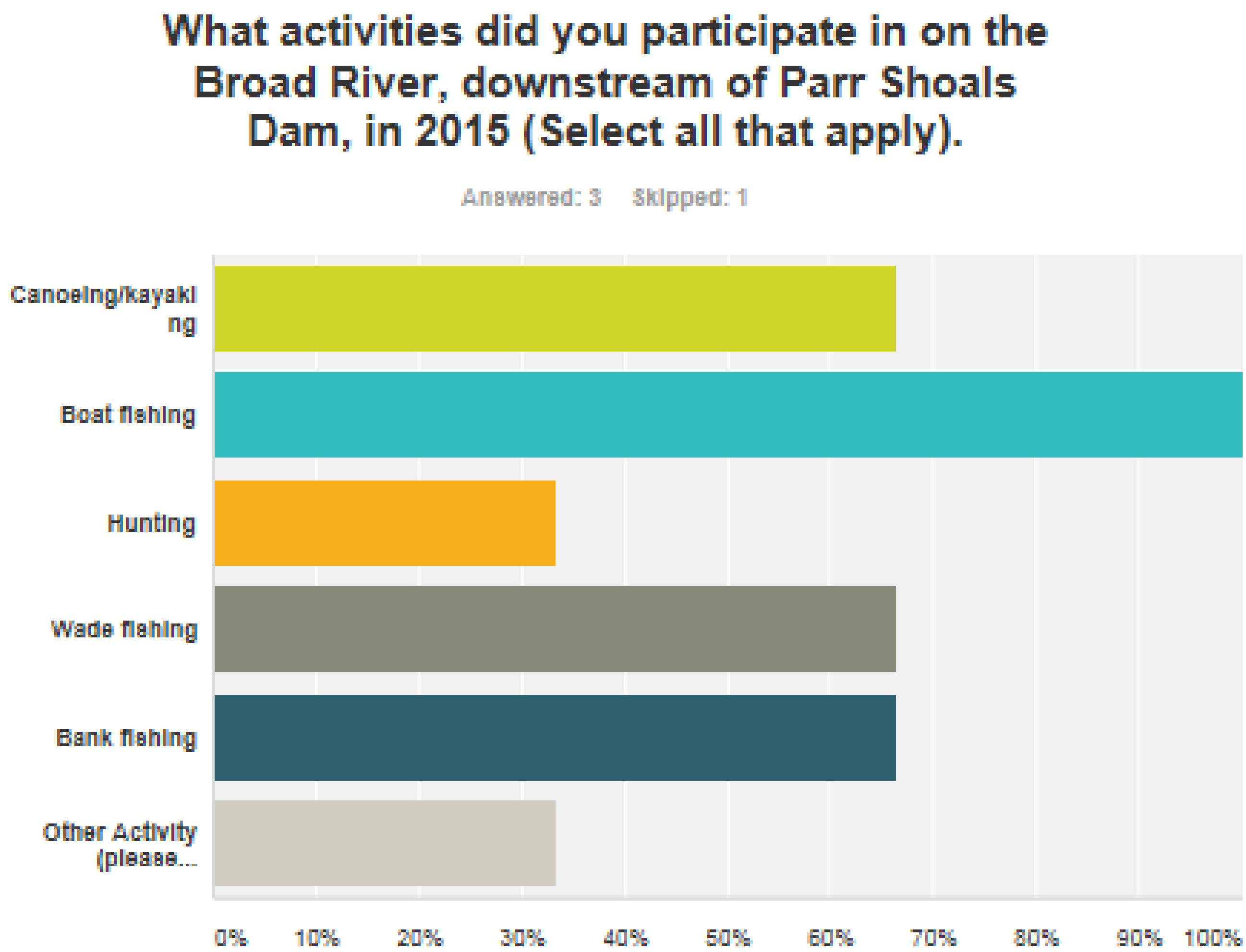
Answer Choices	Responses	
Morning	0.00%	0
Noon/early afternoon	0.00%	0
Late afternoon/evening	0.00%	0
All day	100.00%	3
Total		3

FIGURE 4 – SURVEY RESPONSE FOR QUESTION 4



Answer Choices	Responses	
Weekdays	0.00%	0
Weekends	66.67%	2
Recreated on both weekdays and weekends equally	33.33%	1
Total		3

FIGURE 5 – SURVEY RESPONSE FOR QUESTION 5



Answer Choices		Responses	
Canoeing/kayaking		66.67%	2
Boat fishing		100.00%	3
Hunting		33.33%	1
Wade fishing		66.67%	2
Bank fishing		66.67%	2
Other Activity (please specify)	Responses	33.33%	1
Total Respondents: 3			

FIGURE 6 – SURVEY RESPONSE FOR QUESTION 6

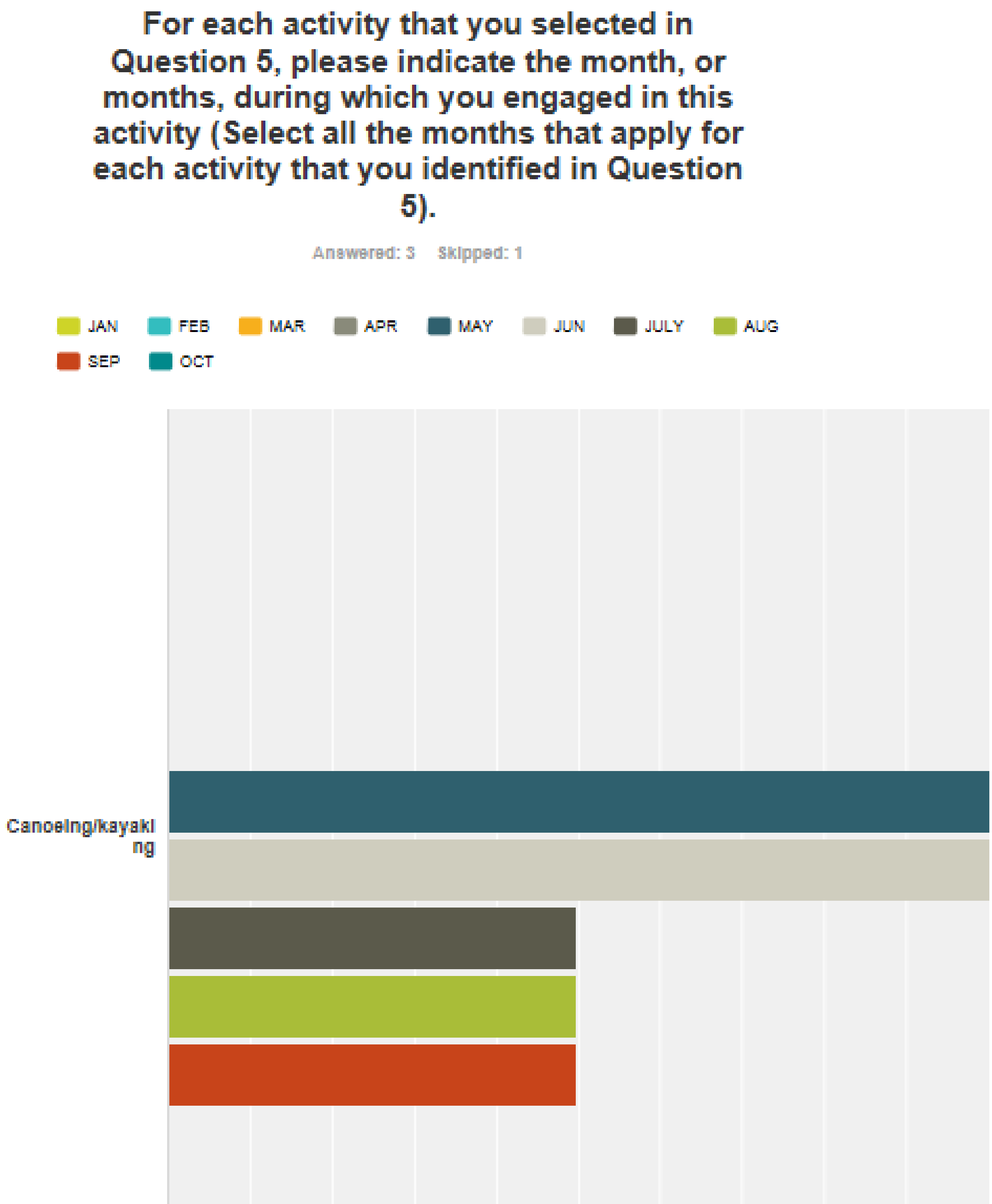


FIGURE 7 – SURVEY RESPONSE FOR QUESTION 6 (CONT.)

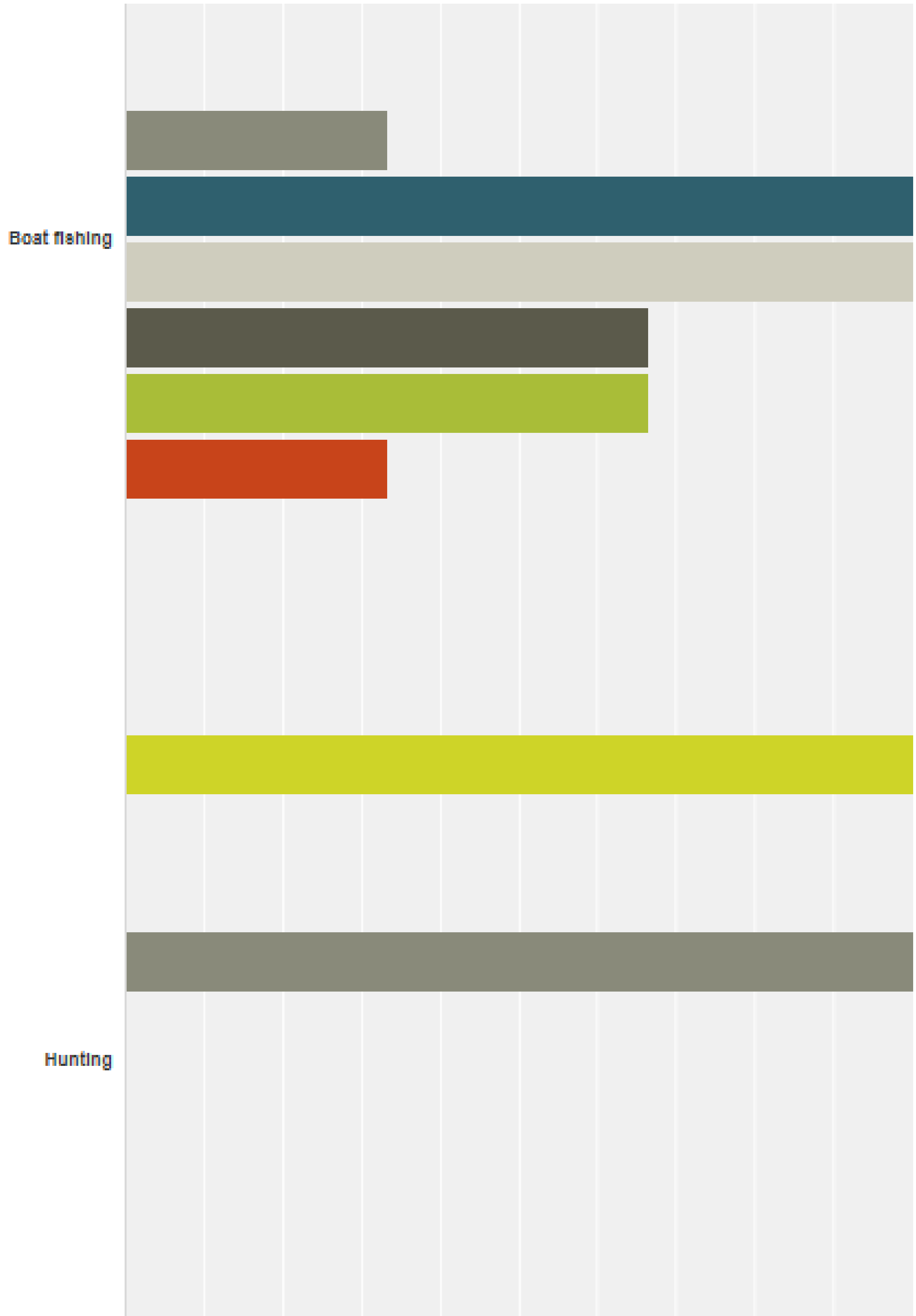


FIGURE 8 – SURVEY RESPONSE FOR QUESTION 6 (CONT.)

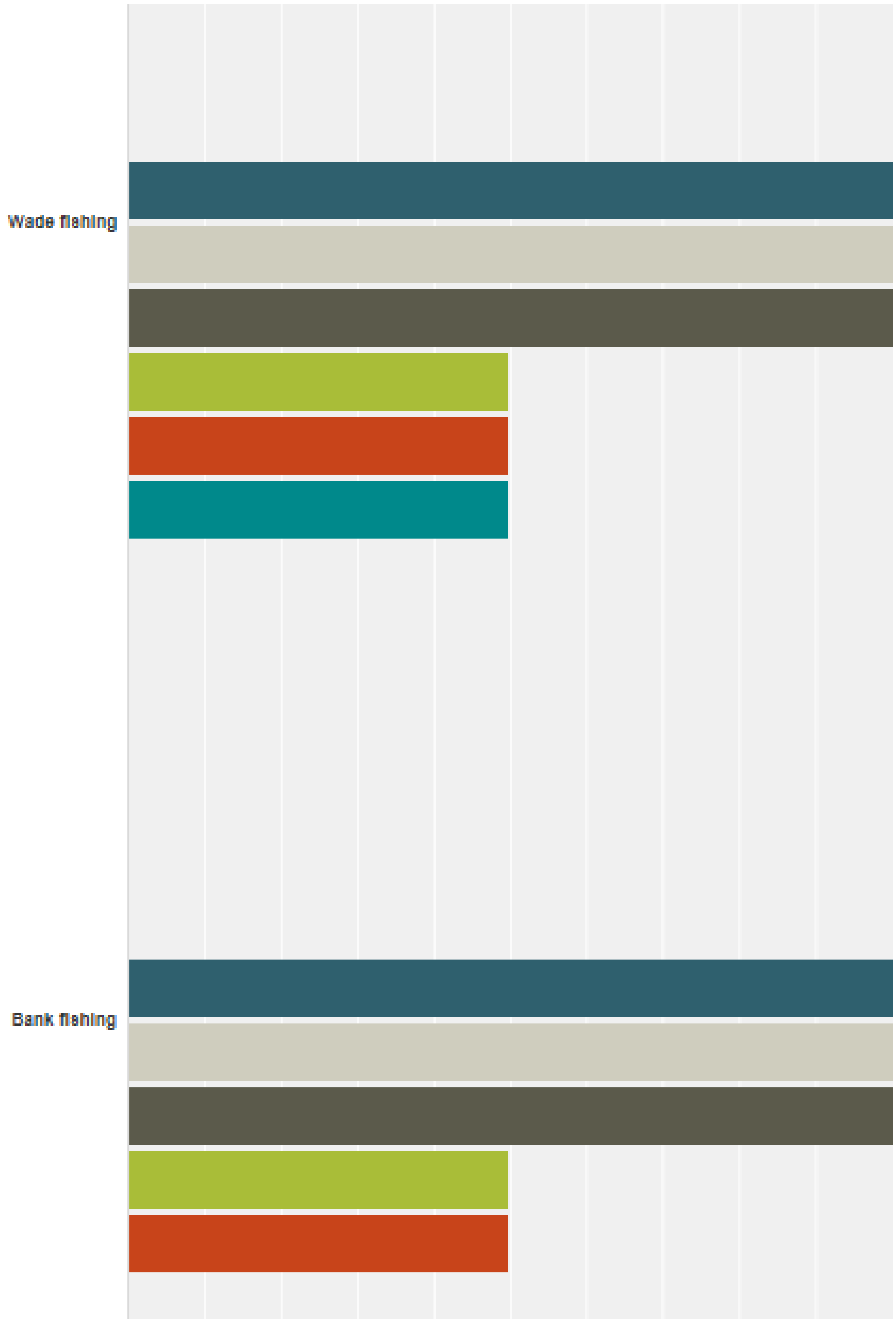
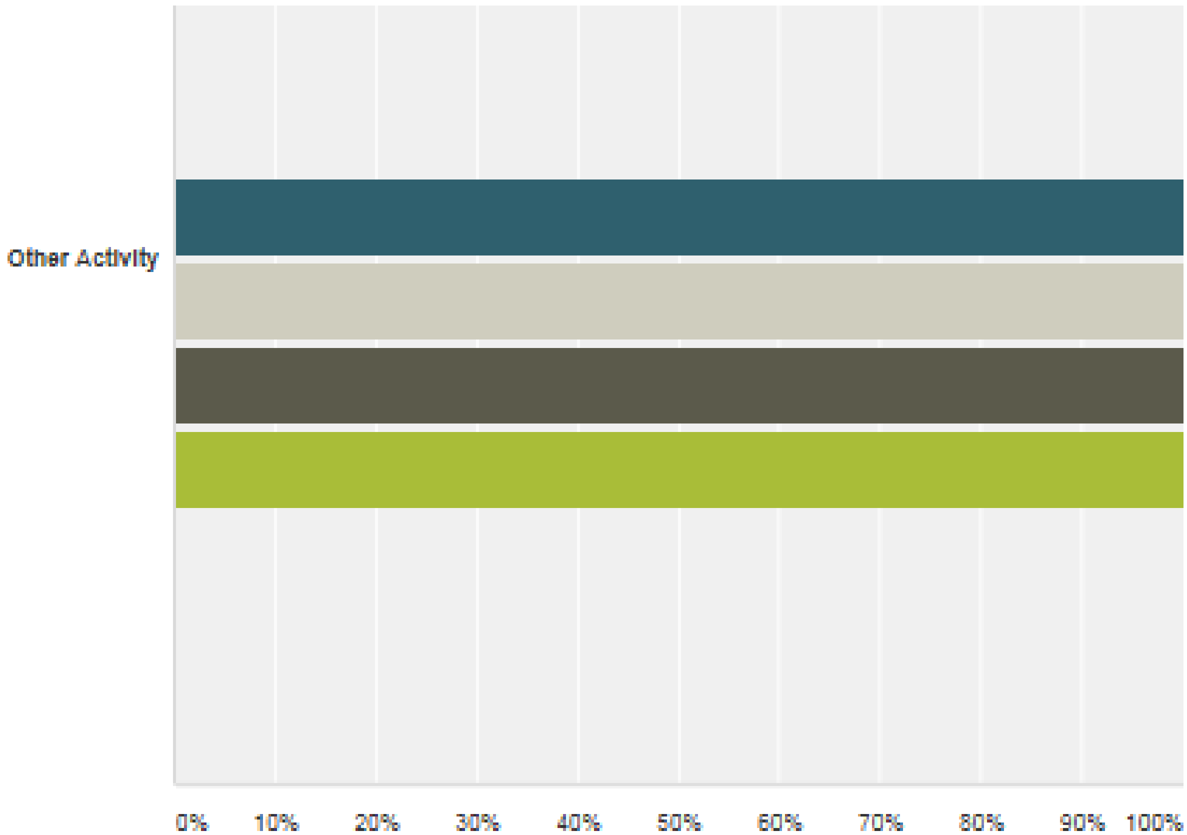


FIGURE 9 – SURVEY RESPONSE FOR QUESTION 6 (CONT.)



	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	Total Respondents
Canoeing/kayaking	0.00% 0	0.00% 0	0.00% 0	0.00% 0	100.00% 2	100.00% 2	50.00% 1	50.00% 1	50.00% 1	0.00% 0	2
Boat fishing	0.00% 0	0.00% 0	0.00% 0	33.33% 1	100.00% 3	100.00% 3	66.67% 2	66.67% 2	33.33% 1	0.00% 0	3
Hunting	100.00% 1	0.00% 0	0.00% 0	100.00% 1	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	1
Wade fishing	0.00% 0	0.00% 0	0.00% 0	0.00% 0	100.00% 2	100.00% 2	100.00% 2	50.00% 1	50.00% 1	50.00% 1	2
Bank fishing	0.00% 0	0.00% 0	0.00% 0	0.00% 0	100.00% 2	100.00% 2	100.00% 2	50.00% 1	50.00% 1	0.00% 0	2
Other Activity	0.00% 0	0.00% 0	0.00% 0	0.00% 0	100.00% 1	100.00% 1	100.00% 1	100.00% 1	0.00% 0	0.00% 0	1

FIGURE 10 – SURVEY RESPONSE FOR QUESTION 7

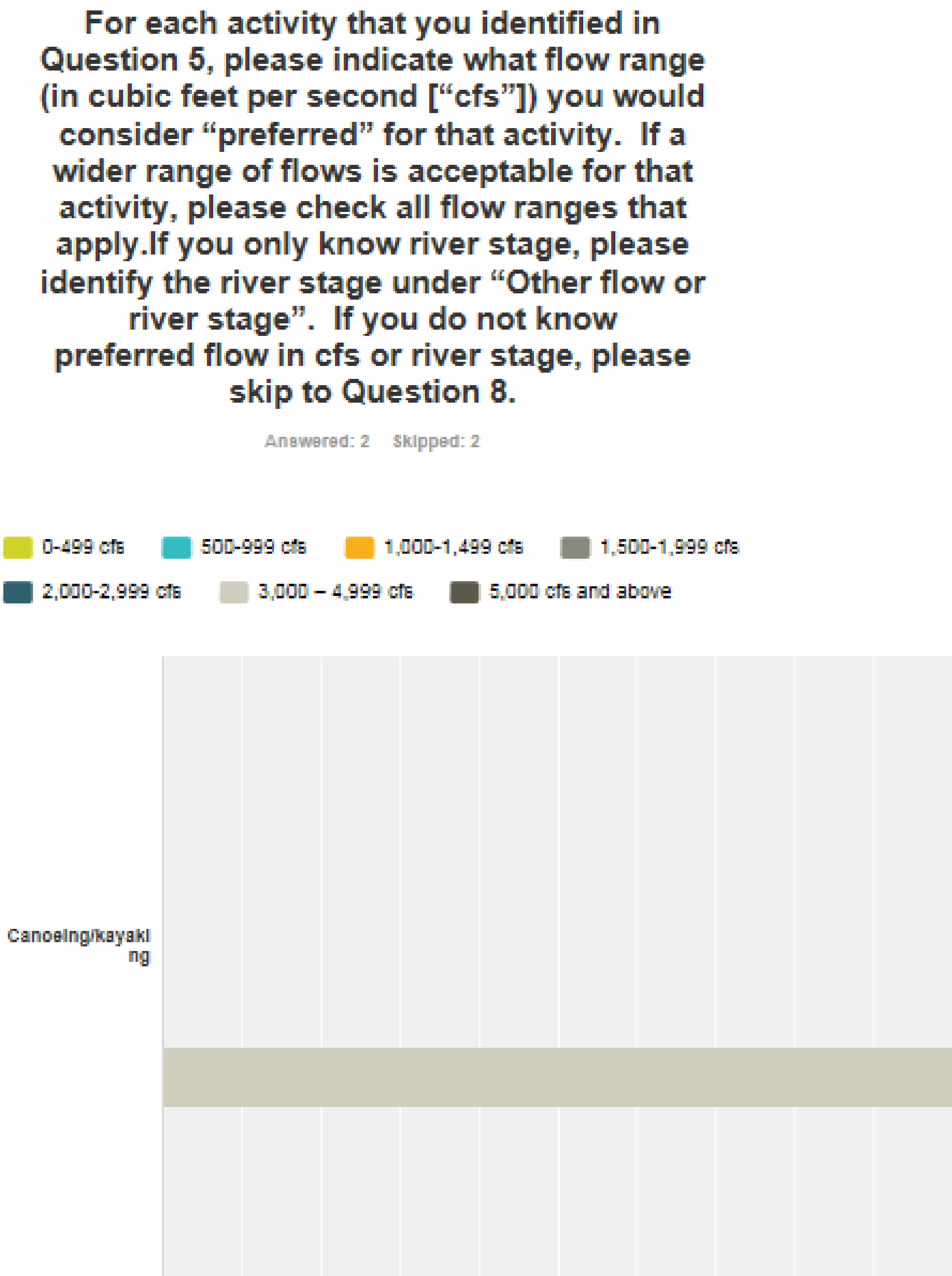


FIGURE 11 – SURVEY RESPONSE FOR QUESTION 7 (CONT.)

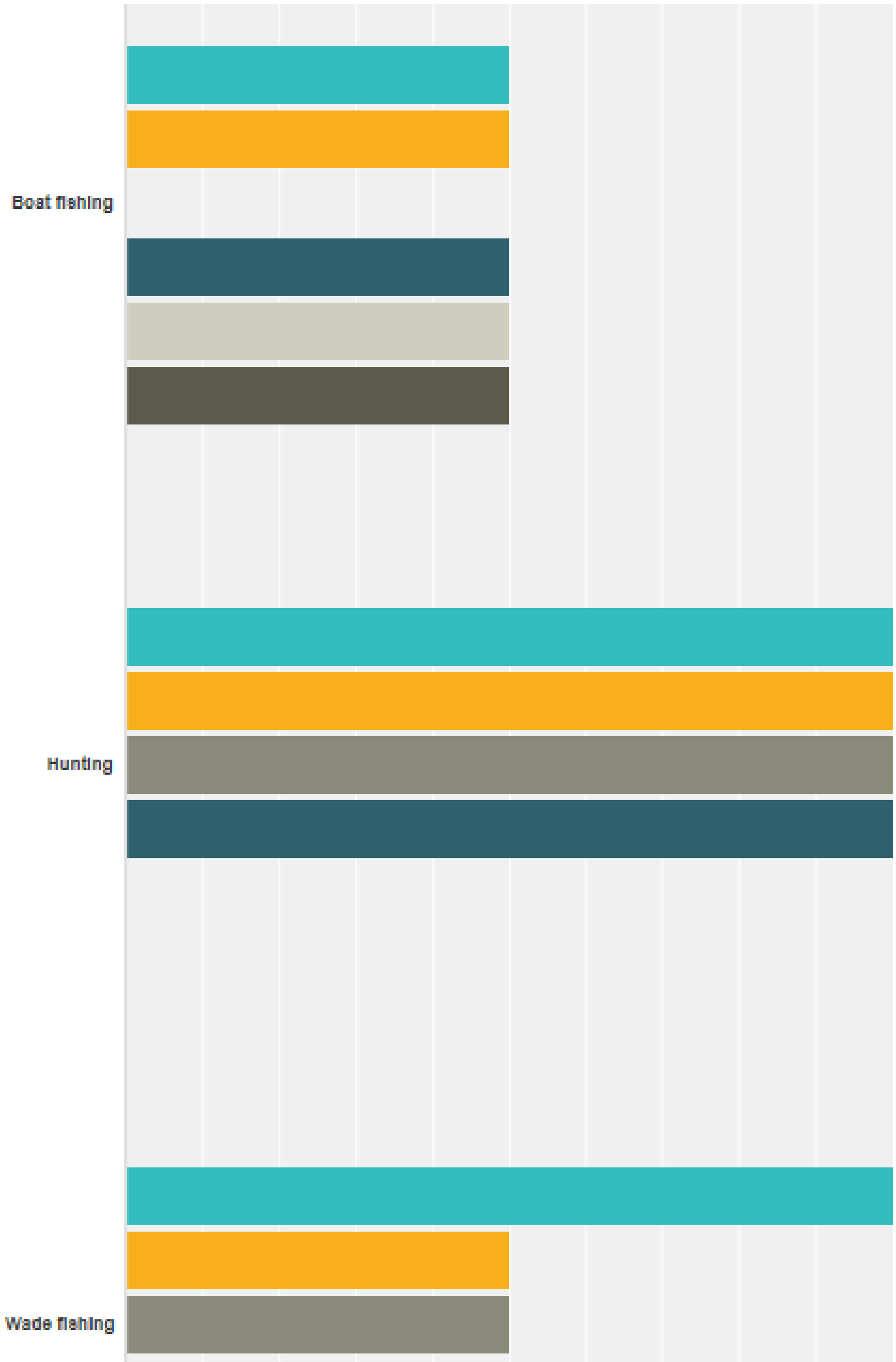


FIGURE 12 – SURVEY RESPONSE FOR QUESTION 7 (CONT.)

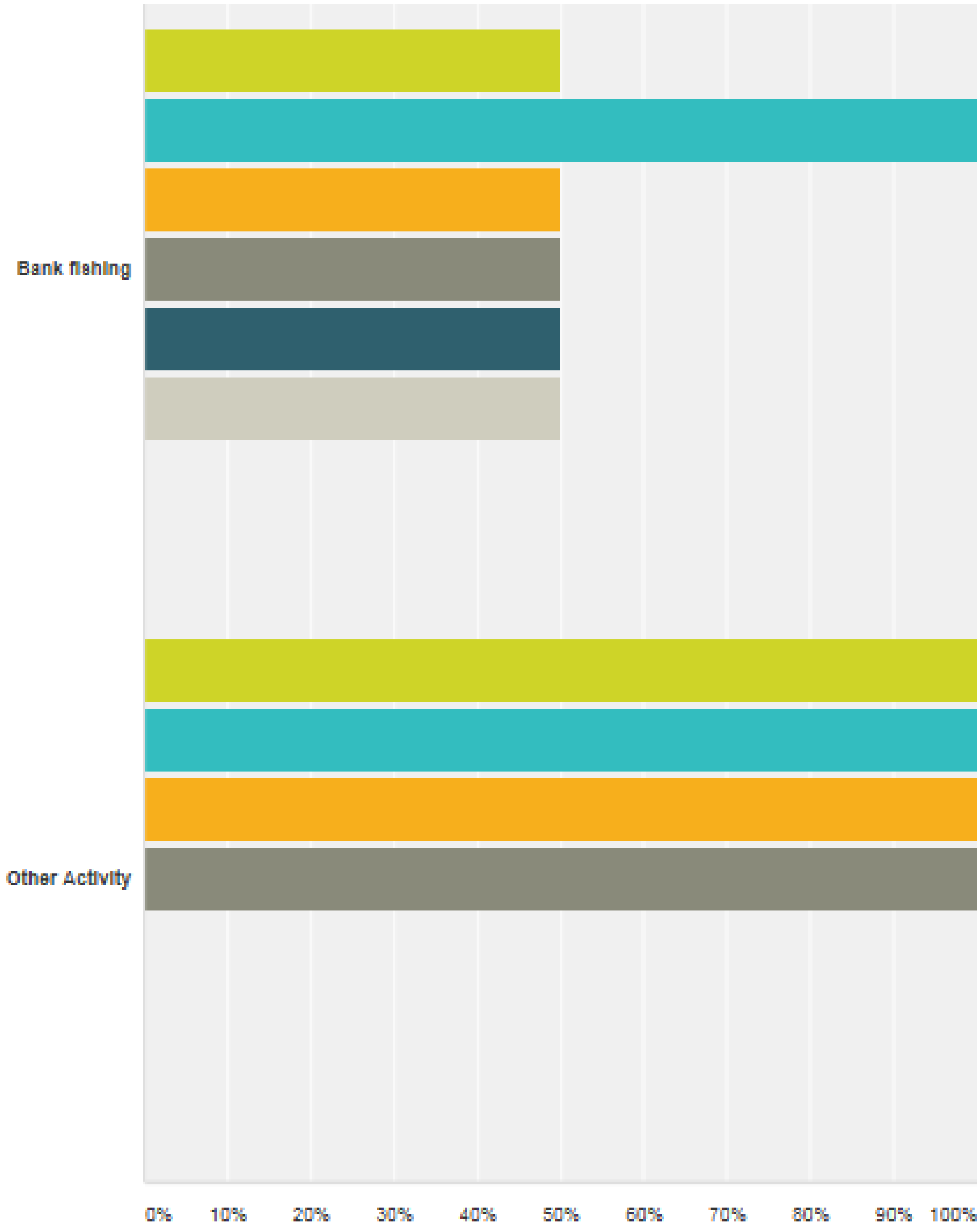


FIGURE 13 – SURVEY RESPONSE FOR QUESTION 7 (CONT.)

	0-499 cfs	500-999 cfs	1,000-1,499 cfs	1,500-1,999 cfs	2,000-2,999 cfs	3,000 – 4,999 cfs	5,000 cfs and above	Total Respondents
Canoeing/kayaking	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	100.00% 1	0.00% 0	1
Boat fishing	0.00% 0	50.00% 1	50.00% 1	0.00% 0	50.00% 1	50.00% 1	50.00% 1	2
Hunting	0.00% 0	100.00% 1	100.00% 1	100.00% 1	100.00% 1	0.00% 0	0.00% 0	1
Wade fishing	0.00% 0	100.00% 2	50.00% 1	50.00% 1	0.00% 0	0.00% 0	0.00% 0	2
Bank fishing	50.00% 1	100.00% 2	50.00% 1	50.00% 1	50.00% 1	50.00% 1	0.00% 0	2
Other Activity	100.00% 1	100.00% 1	100.00% 1	100.00% 1	0.00% 0	0.00% 0	0.00% 0	1

Comments (2)

Categorize as... Filter by Category Search responses

Showing 2 responses

Swimming

11/22/2015 8:22 AM View respondent's answers

3.5 to 5 ft stage for both

11/9/2015 1:59 PM View respondent's answers

FIGURE 14 – SURVEY RESPONSE FOR QUESTION 8

Do you have any comments about recreational use on the Broad River, below Parr Shoals Dam? (Please fill in blank and be as specific as possible.)

Answered: 3   Skipped: 1

Categorize as... ▾ | Filter by Category ▾ | Search responses

Showing 3 responses

One, or preferably two primitive throw in/ takeout sites would make this a fantastic family recreational area. If a little camping was available on the islands it would be wonderful.
11/22/2015 8:26 AM   View respondent's answers

I believe there needs to be more access for boaters. Mainly kayakers and non mote riled boats. This would mean at least two more accesses between parr and the irmo area. I think there could also be regulations set to limit motorized boats in the river such as a motor size restriction or no gas powered boats.
11/17/2015 7:14 AM   View respondent's answers

High quality paddling and fishing in the right flow range. Flows much below 3.5 ft stage too shallow for paddling in island complex areas
11/9/2015 2:04 PM   View respondent's answers

FIGURE 15 – SURVEY RESPONSE FOR QUESTION 9

Contact Information (optional)

Answered: 3 Skipped: 1

Answer Choices		Responses	
Name	Responses	100.00%	3
Organization	Responses	100.00%	3
Address	Responses	0.00%	0
Address 2	Responses	0.00%	0
City/Town	Responses	0.00%	0
State/Province	Responses	0.00%	0
ZIP/Postal Code	Responses	0.00%	0
Country	Responses	0.00%	0
Email Address	Responses	100.00%	3
Phone Number	Responses	100.00%	3

RECREATION TWC MEETING NOTES

MAY 10, 2016

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
Recreation TWC Meeting

May 10, 2016

Final KMK 06-03-16

ATTENDEES:

Bill Argentieri (SCE&G)	Fritz Rohde (NOAA) via conference call
Ray Ammarell (SCE&G)	Gerrit Jobsis (American Rivers)
Steve Summer (SCANA)	Bill Stangler (Congaree Riverkeeper)
Brandon Stutts (SCANA)	Charlene Coleman (American Whitewater)
Caleb Gaston (SCANA)	Stuart Greeter
Beth Trump (SCE&G)	Henry Mealing (Kleinschmidt)
Randy Mahan (SCE&G)	Alison Jakupca (Kleinschmidt)
Bill Marshall (SCDNR)	Shane Boring (Kleinschmidt)
Dick Christie (SCDNR)	Kelly Kirven (Kleinschmidt)

These notes are a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

Alison opened the meeting with introductions and then reviewed the two objectives of the meeting: (1) to discuss the final Downstream Navigational Flows Assessment Report and determine if any additional follow-up is needed; and (2) to discuss the Downstream Recreation Flow User Survey Memo and identify recreation flow recommendations for the operations model. Alison reminded the group that the TWCs and RCGs will need to work together to balance the flow recommendations for the various resources (e.g., aquatic, recreation, navigation).

Downstream Navigational Flows Assessment Report

Shane reviewed the Downstream Navigational Flows Assessment Study Plan with the group, and discussed the two ledges that were identified as potential areas where navigation could be an issue. He explained that Ledge 1 was originally identified during scoping of the IFIM study plan and Ledge 2 was added to the Navigational Flows study plan during the mesohabitat assessment. The criteria for one-way navigation is defined as a "minimum depth of one foot across a channel 10 feet wide or across 10 percent of the total stream width, whichever is greater. Minimum depth does not need to occur across a continuous 10 percent of the stream width, but each point of passage must be at least 10 feet wide." One-way navigation criteria are based on the passage of a 14 foot Jon-boat without a motor in the downstream direction only.

An Acoustic Doppler Current Profiler (ADCP) was used to collect bathymetry data at the two ledges when flows were at approximately 6,000 cfs. Shane showed the group a series of images that were included in the report. These images are attached to the end of these notes. Shane explained that the black line drawn across the first image of Ledge 1 maps out the most restrictive

Kleinschmidt

portion of the ledge. ADCP data shows that Ledge 1 provides navigation passage that meets the SCDNR recommended criteria for one-way navigation at flows as low as 500 cfs. Shane stated that a 500 cfs flow provided a passage point that was 32% of the stream width.

According to the navigation criteria, Ledge 2 is navigable at flows as low as 1000 cfs. However, Shane pointed out that the ledge comes very close to meeting the criteria at a flow of 700 cfs and even 500 cfs. Although the criteria isn't met for providing navigation across 10 percent of the stream width, there are passage points that provide enough width for a 14 foot Jon-boat to pass through. Gerrit asked if there was a minimum width as part of the criteria and Shane said that it's either 10 feet or 10 percent of the stream width. So in the case of Ledge 2, there is a notch at 500 cfs that is wider than 10 feet, but it's not 10 percent of the stream width. Shane stated that at 1000 cfs the passage width is 82 ft (10% of the stream width); at 700 cfs the passage width is 67 ft (8% of the stream width); and at 500 cfs the passage width is 30 ft wide (4% of the stream width)

Bill Marshall mentioned that the Bookman Shoals complex is another area in the river where navigation can be difficult for paddlers at lower flows. Shane said that Bookman Shoals was considered for inclusion when the Navigational Flows study plan was being developed. However, this area will be studied in much greater detail during the IFIM study, so additional information will be coming with that report. Shane also mentioned that since Bookman Shoals is a very braided area of the river, although it is rocky, there are more navigation points than might be obvious at first glance.

Gerrit mentioned that the study plan allows for the possibility of a field assessment to verify the report results. He is interested in completing that component of the study. Alison said that the one-way navigation criteria also mentions that it shouldn't be necessary to get out and drag your boat in order to navigate an area of the river, and a field verification exercise would demonstrate if this is necessary at the recommended flows. Henry suggested that the field verification be scheduled after IFIM results are out. We will likely perform field observations for IFIM results and navigation passage at the same time later in August/September.

Steve asked how flows will be balanced if 1,000 cfs is agreed on as necessary for navigation but the 7Q10 is different flow. He mentioned that Parr Reservoir is not a storage reservoir that might allow for greater flexibility in downstream flows. Henry said that we will use the Operations Model to assist in balancing between flows and water availability. The TWC will use the Operations Model results to develop a recommendation for consideration by SCE&G. Henry agreed that this project does not have a storage reservoir, which means that recreation flows will be extremely difficult to schedule, unlike at Lake Murray. We also will likely have a caveat for downstream flows being linked to inflows as well.

Charlene asked how many Jon-boats are actually on the Broad River downstream of the Project. She believes that mostly kayaks and canoes are used on this area of the river, since access is not great for Jon-boats. Gerrit said there are actually quite a few Jon-boats that get out there, utilizing private access. Charlene said she would be interested in knowing navigation issues from people who actually use this area of the river versus what the navigational flows assessment showed. Alison said this is another reason for doing a field verification. The information collected during the field verification will be included in an addendum to the navigation study report.

Bill S. said that after talking with Steve de Kozlowski, he was concerned that in the report, a straight line of navigation was used, thus excluding the most restrictive navigation points in the ledges. Shane said that a straight line was not modeled, instead the ADCP was run back and forth over each ledge approximately 10-20 times. This captured a 3D image of each entire ledge. The one-way navigation criteria was then applied to the ledge, which is a linear criteria. The idea was to pick the most restrictive area within each ledge. The black line depicted in the 3D figures included in the report are then used as the bed profile in the second set of report figures and compared to the linear criteria.

Gerrit said that using this ADCP technology, in addition to finding the most restrictive point, you could also map out the best course for navigation at each ledge. Shane agreed, and said that a grid showing the entire ledge can be exported from the data collected and the navigation course could be depicted there. This would give a good representation of what the shoal actually looks like. The group agreed that it would be helpful to have maps of this information for the two ledges and for the Bookman Shoals complex (if possible) to use during the field verification.

The report will be modified to mention that a field verification will be completed. Comments received on the report from SCDNR, American Rivers and Congaree Riverkeeper will be added to the report in an appendix. Once the field verification is completed, an addendum will also be added to the report discussing the results.

Downstream Recreation Flow User Survey Memo

Alison began the discussion by giving some background information on the memo. The Downstream Recreation Flows Study Plan was developed and a Focus Group meeting was held in 2014 to discuss what experiences recreators were having on the river downstream of the Project and to identify preferred flows for various activities. During that meeting, flows were narrowed down to a few preferred ranges. The Operations Model needs more specific flows at a specific time for input, so the ranges need to be narrowed down.

A second Focus Group meeting was originally planned for 2015 to again gather information on recreation experiences, however a survey was developed and distributed as a way to capture additional information instead. Alison mentioned that only four people responded to the survey, with only three respondents indicating that they had recreated in the study area the previous recreation season. However, the results of the survey were similar to the Focus Group discussion from 2014. Flow recommendations coming out of the survey were 2,000-5,000 cfs during May and/or June for canoeing, kayaking and higher flow boat fishing, and 500-999 cfs during May, June and July for lower flow boat fishing, hunting, wade fishing and swimming. Alison asked the TWC if they agreed with these recommendations and said the goal is to narrow down the ranges to specific flows for the Operations Model. Henry mentioned that the lower flow recommendation of 500-999 cfs is very close to what the Navigational Flow Assessment recommended. He suggested the group focus on picking flows from the higher range to run through the Operations Model.

Ray mentioned that the flow duration curves in the PAD show historically what flows are available at specific times. For example, a flow of 5,000 cfs may only be available for 30 percent of the time in May. Bill A. also mentioned that the wording of the settlement agreement will need to have flexibility since these flows will only be available when inflows allow. Gerrit said the goal is to include something that allows for a specific flow on weekends during the recreation season during a specific timeframe, such as 8 AM until 1 PM. Gerrit said the benefit of recreation flows is to have something that people can depend on and schedule around. Gerrit indicated that he would like to see an attempt by SCE&G to provide a scheduled recreation flow if the water is available. Bill A. said that having a window of 6 hours would be much more doable than a 12 hour window, or an entire weekend, if the water is available.

Henry suggested to the group that flows of 2,000, 3,500, and 5,000 cfs during a 6 hour window on the weekends of May, June and July be run through the model. After some discussion, the group excluded 5,000 cfs since this high flow is also unlikely to occur often and expanded the timeframe to include the recreation season (May through September). The group agreed on the following recommendation for recreation flows to be run through the Operations Model:

- Flows of 2,000 cfs and 3,500 cfs
- Focus on weekends and holidays during the recreation season (May through September)
- 6 hour window (approximately 8 AM until 2 PM)

The group agreed that IFIM recommendations will likely cover the lower ranges of flows which would be ideal for activities such as wade fishing.

The meeting adjourned and action items are listed below.

ACTION ITEMS:

- Kleinschmidt will make maps for navigation through the two ledges and Bookman Shoals (if possible with the current data)
- SCE&G will schedule a field verification for navigation and fish habitat after the IFIM results are presented to the TWC for review.
- Kleinschmidt will add an appendix to the navigational flow report which will include the comments from SCDNR, American Rivers and Congaree Riverkeeper.
- Kleinschmidt will add an addendum to the Navigational Flows report which will include a report discussing the field verification results.

Waterfowl Aerial Surveys of Monticello and Parr Reservoirs,

South Carolina: Final Report

A Final Report of Activities under Contract Agreement between
The University of Georgia Research Foundation, Inc.
Savannah River Ecology Laboratory and
Kleinschmidt Associates

Prepared and edited by:

R. A. Kennamer, C. S. Eldridge, and J. C. Beasley

The Savannah River Ecology Laboratory

P.O. Drawer E, Aiken, SC 29802

April 2017

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Executive Summary

As a part of the Federal Energy Regulatory Commission (FERC) relicensing process for the Parr Hydroelectric Project (FERC No. 1894) by the South Carolina Electric & Gas Company (SCE&G), SCE&G formed a Fish and Wildlife and Water Quality Resource Conservation Group (RCG) of interested stakeholders. The RCG submitted a study request asking for an evaluation of wintering waterfowl usage at Monticello and Parr Reservoirs, South Carolina. Kleinschmidt Associates, a consulting firm specializing in engineering, regulatory management and environmental services, is coordinating the relicensing process for SCE&G. In October 2015, the University of Georgia's Savannah River Ecology Laboratory (SREL) of Aiken, South Carolina, was contracted to provide aerial survey data from two consecutive years describing wintering waterfowl use of Monticello and Parr Reservoirs, which are located in Newberry and Fairfield Counties, South Carolina.

In year one, nine fixed-wing aerial surveys of the entire Monticello Reservoir basin and Parr Shoals Reservoir from the Parr Shoals Dam to Henderson Island (including adjacent Enoree and Broad River Waterfowl Management Areas (WMAs) were conducted between 17 November, 2015 and 15 March, 2016, during which nearly 2,200 waterfowl (representing 9 species) were documented using the Monticello Reservoir and over 4,900 waterfowl (representing 11 species) were recorded using Parr Reservoir. In year two, nine additional fixed-wing aerial surveys of the Monticello and Parr Reservoirs were conducted between 15 November, 2016 and 21 March, 2017, during which just over 1,250 waterfowl (representing 10 species) were documented using the Monticello Reservoir and over 3,000 waterfowl (representing 11 species) were recorded using Parr Reservoir.

Greater diversity and numbers of dabbling ducks were seen at Parr Reservoir than at Monticello Reservoir; this was the case in both years. Diving duck diversity and numbers did not differ between reservoirs, but greater numbers of diving ducks were observed in the first year of the study than in the second year. In both years, Canada geese (*Branta canadensis*) were seen at Monticello Reservoir more consistently and in higher numbers than at Parr Reservoir. Snow geese (*Chen caerulescens*) however, were only seen at Parr Reservoir and on only three surveys in the first year. Most waterfowl seen at Parr Reservoir were found at Broad River WMA and/or Enoree WMA, where active management for waterfowl by SCDNR has created favorable conditions (e.g., food, cover, limited human disturbance) preferred by waterfowl. Concentrations of 50+ waterfowl observed at Parr Reservoir included primarily the Broad River and Enoree WMAs. For the Monticello Reservoir, waterfowl concentration locations were spread widely around the reservoir, but flocks appeared to favor the western half of the reservoir, and coves and islands elsewhere, that provided protection from the prevailing winds.

We evaluated the effects of fluctuating reservoir water levels on waterfowl numbers. There was greater variation observed for water levels during the waterfowl aerial surveys at Parr Reservoir (range > 7 ft) than at Monticello Reservoir (range < 3 ft). We were unable to find any indications of relationships (linear or non-linear) between water levels at the time of aerial surveys and numbers of dabbling ducks, diving ducks, or total waterfowl for either reservoir. We noted however, as Broad River WMA impoundments were drawn down for management purposes in February and March, following the hunting season, that waterfowl naturally moved

out of those impoundments. Substantial waterfowl numbers persisted at the Enoree WMA during some late-season aerial surveys because water remained in impoundments there later into the year than for the Broad River WMA impoundments.

During the fall and winter waterfowl aerial surveys of Monticello and Parr Reservoirs, we also recorded boats observed at both locations, so we assessed the effect of recreational boating activity on waterfowl counts. Boat numbers noted on the reservoirs ranged from none to 20 on individual surveys, with more boating activity typically seen on Monticello Reservoir than on Parr Reservoir. Warmer temperatures during the fall and winter waterfowl surveys were associated with higher numbers of boaters using Monticello Reservoir; there was no similar relationship for Parr Reservoir. We expected that, if boating activity at these reservoirs was sufficient to cause any major impacts to waterfowl, increased boating would be accompanied with lower waterfowl numbers. We found no evidence for increasing boat activity being associated with lower total duck or goose numbers for either reservoir.

In addition to the waterfowl observed during the aerial surveys, we also noted other avian species (non-game species) on both reservoirs as they were encountered during the aerial surveys, including mostly piscivorous birds. Among these additional species, most frequently recorded were non-specific gulls/terns and double-crested cormorants (*Phalacrocorax auritus*), which were seen on both reservoirs on most surveys. Bald eagles (*Haliaeetus leucocephalus*) were seen on 13 of 18 (72%) surveys of Parr Reservoir and 6 of 18 (33%) surveys of Monticello Reservoir. These bald eagle sightings included birds identified as both adults (16) and immatures (16).

Introduction

South Carolina Electric & Gas Company (SCE&G) is the Licensee of the Parr Hydroelectric Project (hereafter Project; FERC No. 1894). The Project consists of the Parr Shoals Development and the Fairfield Development. Both developments are located along the Broad River in Newberry and Fairfield Counties, South Carolina. The Project is currently involved in a relicensing process which involves cooperation between SCE&G as licensee and a variety of stakeholders including state and federal resource agencies, state and local government, non-governmental organizations (NGOs), and interested individuals.

In preparation for relicensing, SCE&G formed a Fish and Wildlife and Water Quality Resource Conservation Group (RCG) which is comprised of interested stakeholders who are working with SCE&G to identify potential issues, make biological study recommendations, and provide technical and experience-based input related to wildlife resources in the Project area. During an initial scoping meeting to identify issues of importance, the RCG identified the need for a waterfowl survey to better understand waterfowl utilization of Project waters. Further, this information will be useful in evaluating potential Project effects (including water level fluctuation effects) on wintering waterfowl utilizing Monticello and Parr reservoirs.

In October 2015, the University of Georgia's Savannah River Ecology Laboratory (SREL) of Aiken, South Carolina, was contracted to provide aerial survey data from two consecutive years describing wintering waterfowl use of Monticello and Parr Reservoirs. The primary objective of this study was to evaluate the current abundance and distribution of wintering waterfowl (ducks, geese, swans, and coots) using Monticello and Parr Reservoirs. Herein, we summarize data collected by SREL during eighteen (18) aerial surveys of waterfowl conducted during the fall/winter study periods (2015–2016 and 2016–2017), with surveys running each fall and winter from mid-November through March.

Study Area

The Project is located in Newberry and Fairfield Counties, South Carolina, on the Broad River, approximately 26 river miles upstream from the City of Columbia, South Carolina. The Project includes the existing Parr Shoals Dam, which creates the 4,400 acre Parr Shoals Reservoir (Figure 1). The Project also includes the existing Fairfield Development, which utilizes the 6,800 acre Monticello Reservoir (Figure 2). The two developments are operated together as a single hydroelectric generating facility which utilizes pumped storage of water to efficiently provide energy as needed based on customer demand. The facilities can generate as much as 544,000 kilowatts during periods of high electricity demand. Functionally, water in Monticello Reservoir flows through turbine generators and continues into Parr Reservoir where it is held. When energy demands are low, electricity from base-load fossil and nuclear generating plants is used to pump water back into Monticello Reservoir. Monticello Reservoir has little natural inflow other than negligible rainfall in the immediate area of the reservoir, so pumping of water from Parr Reservoir back into Monticello Reservoir is necessary to maintain the needed water resource.

The Project's alternate cycles of generation and pumping cause daily fluctuations in the water levels of both Monticello and Parr Reservoirs. Monticello Reservoir drops as much as 4.5 ft over a 10- to 12-hour period during the generating phase. At the same time, the water is flowing into Parr Reservoir, causing it to fluctuate as much as 10 ft. During the pumping cycle the reverse occurs, with water level rises in Monticello Reservoir and drops in Parr Reservoir.

Both Monticello and Parr Reservoirs offer a variety of recreational opportunities to the public. In particular, portions of Project lands are under management jurisdiction of the South Carolina Department of Natural Resources (SCDNR). Waterfowl management areas located on the Broad River and Enoree River are available for public use and are managed by the SCDNR under its Game Management Program. The Broad River and Enoree River Waterfowl Management Areas (WMAs) provide important habitat for overwintering waterfowl, as well as recreational waterfowl hunting opportunities that are important to the local economy. Both areas were established in the late 1970s as mitigation when Parr Reservoir was expanded during construction of the Fairfield Development. The Broad River WMA includes five impoundments totaling approximately 130 acres of waterfowl habitat. The area includes one green-tree impoundment with an oak canopy; the remaining four impoundments are planted in corn or millet and flooded seasonally. Over 500 acres of the remaining area are either upland or uncontrolled backwater. Although a wide variety of duck species may be present, the primary species harvested are ring-necked ducks (*Aythya collaris*), wood ducks (*Aix sponsa*), mallards

(*Anas platyrhynchos*), and green-winged teal (*Anas crecca*). Mallard numbers have reportedly decreased in harvests from recent years.

Aerial Surveys Methods

On days when aerial surveys were conducted, SREL personnel traveled by UGA vehicle to Daniel Field Airport, on Highland Avenue in Augusta, GA where the services of Augusta Aviation, Inc. (http://www.augustaaviation.com) were engaged to provide fixed-wing aircraft (Cessna Skyhawk) and pilot services for the aerial waterfowl surveys over Monticello and Parr reservoirs. These aerial surveys were conducted in close coordination with V.C. Summer Nuclear Station's security organization (Mr. Greg Douglass) and local air-traffic controllers to assure safety of all aircraft operating in the vicinity of Monticello and Parr reservoirs during the execution of these surveys. Both reservoirs, in their entirety, were surveyed for waterfowl use. Specifically, with respect to Parr Reservoir, aerial surveys were conducted from Parr Shoals Dam to the base of Henderson Island and included the Enoree River and Broad River WMAs, managed by SCDNR (Figure 1).

Because of potential bias associated with multiple observers, all aerial surveys were conducted by a single observer. The SREL observer, C. S. Eldridge, accompanied the pilot in the aircraft; the pilot was instructed to fly at an altitude of approximately 200–300 ft and airspeed of about 80–105 mph, consistent with Federal Aviation Administration (FAA) regulations. Surveys consisted of complete coverages of the lake basins, thus providing what were considered true count data as opposed to randomized line-transect surveys which would yield calculated estimates of bird abundance (this latter technique is often used when study areas are much larger geographic regions). The pilot was instructed to circle above larger flocks of birds while species were identified and counts were made. The ability to observe and identify waterfowl using green-tree impoundments using aerial survey methods can be limited because of tree canopy. The SREL observer identified species and counted all waterfowl (ducks, geese, swans, and coots) observed during aerial surveys. Bird species and numbers of individuals were recorded directly onto field maps of the two reservoirs; after survey completion, observed birds were tallied by reservoir and species and recorded on a summary data sheet. Boats observed during the aerial surveys were noted as well. Additional data provided on each summary data sheet included: date, start/end times of survey, and general weather conditions at the time of the aerial survey (i.e., visibility, wind, temperature, rainfall). Meteorological information from a weather station near Peak, SC (KSCLITTL12) was also gathered for each flight period. Aerial surveys were conducted during the mid-late morning hours, with all surveys being started by 1125hrs. Actual duration of each aerial survey was approximately 1.5 hours, plus additional flight time of about 40 minutes each for travel time to and from Daniel Field Airport in Augusta, GA.

Data were stored on a networked PC-workstation operating in a Microsoft-Windows environment. The JMP Analysis System (SAS Institute, Inc., Cary, NC) was used to summarize and analyze the aerial survey data. Data were summarized in both graphical and tabular format. Summaries below include location graphics of waterfowl numbers, as well as tabular summaries and descriptions of temporal changes in waterfowl distributions (species- and/or subfamily-specific). Waterfowl surveys were conducted during the fall-winter months (mid-November through late-March) of 2015-2016 and 2016-17. As previously noted, for each of the two years, nine (9) aerial surveys were conducted over a period of five (5) months, executed as follows: 1 in late November, 2 in December, 2 in January, 2 in February, and 2 in March.

Aerial Survey Results and Discussion

Year one (2015–2016)

During year one, nine fixed-wing aerial surveys of the Monticello and Parr Reservoirs were conducted between 17 November, 2015 and 15 March, 2016. Dates of the nine individual aerial surveys and prevailing conditions during the 2015–2016 flights are provided in Table 1.

Nine waterfowl species (includes American Coots [*Fulica americana*]) were identified using Monticello Reservoir during the 2015–2016 aerial surveys (Table 2) and 11 waterfowl species (including coots) were identified using Parr Reservoir during the 2015–2016 aerial surveys (Table 2). A greater diversity of dabbling ducks was seen on Parr Reservoir (5) than on Monticello Reservoir (3; Table 2). However, the same three diving duck species, including ring-necked ducks, lesser scaup (*Aythya affinis*), and buffleheads (*Bucephala albeola*), were seen on both reservoirs (Table 2). Canada geese (*Branta canadensis*), mallards, and ring-necked ducks were seen on Monticello Reservoir during all nine aerial surveys (Table 2); ring-necked ducks (88.9% of surveys) and mallards (77.8% of surveys) were the most-often observed species on Parr Reservoir (Table 2). Most waterfowl seen on Parr Reservoir were found at Broad River WMA and/or Enoree WMA, where active management for waterfowl by SCDNR has created favorable conditions (e.g., food, cover, limited human disturbance) preferred by waterfowl. For the Broad River and Enoree WMAs at Parr Reservoir, the same eight waterfowl species were identified at both WMAs (Table 3), with ring-necked ducks most frequently seen at Broad River WMA (88.9% of surveys), and ring-necked ducks and blue-winged teal (*Anas discors*) most frequently seen at Enoree WMA (44.4% of surveys for each of the two species; Table 3). There was more late-season (particularly late February and March) waterfowl use of the Enoree WMA than had been the case earlier in the fall/winter while the waterfowl hunting season was active.

During these aerial surveys, about 2,200 waterfowl were documented using Monticello Reservoir (Table 4) and more than 4,900 waterfowl were documented using the Parr Reservoir (Table 5). Dabbling duck numbers on Monticello Reservoir never exceeded 78 birds on an individual flight ($\bar{x}$ = 41.2; Table 4), but in contrast, dabbling duck numbers on Parr Reservoir exceeded 100 individuals on five of nine surveys (maximum = 238; $\bar{x}$ = 104.8; Table 5). Diving duck numbers on Monticello Reservoir exceeded 100 individuals on only one survey (330 on 5 January 2016; $\bar{x}$ = 79.2;), but again in contrast, diving duck numbers on Parr Reservoir exceeded 100 individuals on all but one flight, the last one in March of 2016 (maximum = 665; $\bar{x}$ = 385.6; Table 5). In contrast to higher duck use of Parr Reservoir (including Broad River and Enoree WMAs) than Monticello Reservoir, Canada geese were seen on Monticello more consistently and in higher numbers than on Parr Reservoir (Monticello $\bar{x}$ = 99.0, Parr $\bar{x}$ = 26.4; Tables 4 and 5). Snow geese (*Chen caerulescens*) however, were only seen on Parr Reservoir and on only three surveys (maximum = 62; Table 5). American coots were seen on Monticello Reservoir on three aerial surveys (maximum = 100; Table 4), while seen on only a single flight over Parr Reservoir (245 on 21 December, 2015).

Figures 3 and 4 show the respective Parr Reservoir and Monticello Reservoir locations of waterfowl concentrations of 50+ individuals observed during aerial surveys in the winter of 2015–2016. For Parr Reservoir, these locations included primarily the Broad River and Enoree WMAs (Figure 3). For the Monticello Reservoir, these locations were spread widely around the reservoir (Figure 4), but flocks appeared to favor the western half of the reservoir, and coves and islands elsewhere that provided protection from the prevailing winds.

In addition to the waterfowl observed during the aerial surveys, which were of primary concern for the purposes of this study, we also noted other avian species (non-game species) on both reservoirs as they were encountered during the aerial surveys (Table 2). Most of these species were piscivorous birds, foraging largely or exclusively on fish. Among these additional species, most frequently recorded were non-specific gulls/terns and double-crested cormorants (*Phalacrocorax auritus*; Table 2), which were seen on both reservoirs on almost all surveys. On Monticello Reservoir, we also recorded two species of grebes, including the pied-billed grebe (*Podilymbus podiceps*) and the horned grebe (*Podiceps auritus*), as well as the common loon (*Gavia immer*; Table 2). On Parr Reservoir, we also recorded Anhingas (*Anhinga anhinga*), and flocks of non-specific shorebirds using shoreline areas exposed by receding water levels. Perhaps of more interest was the bald eagle (*Haliaeetus leucocephalus*) sightings made during the waterfowl surveys. Bald eagles were seen on eight of nine surveys of Parr Reservoir and three of nine surveys of Monticello Reservoir (Table 2). Bald eagle sightings included both adult (8) and immature (11) birds.

Year two (2016–2017)

During year two, nine fixed-wing aerial surveys of the Monticello and Parr Reservoirs were conducted between 15 November, 2016 and 21 March, 2017. Dates of the nine individual aerial surveys and prevailing conditions during the 2016–2017 flights are provided in Table 6.

Ten waterfowl species (including coots) were identified using Monticello Reservoir during the 2016–2017 aerial surveys (Table 7) and 11 waterfowl species (including coots) were identified using Parr Reservoir during the 2016–2017 aerial surveys (Table 7). Consistent with the previous fall and winter period, a greater diversity of dabbling ducks was seen on Parr Reservoir (7) than on Monticello Reservoir (3 species; Table 7). No more than three diving duck species, including ring-necked ducks, lesser scaup, and buffleheads, were seen on either reservoir in both years (Table 7). Canada geese were the only waterfowl seen on Monticello Reservoir during all nine 2016–2017 aerial surveys (Table 7), but mallards (88.9%) and wood ducks (66.7%) were often seen on Monticello as well. Mallards (100% of surveys) and ring-necked ducks (66.7% of surveys) were the most-often observed species on Parr Reservoir (Table 7). As in the previous year, most waterfowl seen on Parr Reservoir were found at Broad River WMA and/or Enoree WMA. In 2016–2017, eight waterfowl species were identified at Broad River WMA and nine waterfowl species were identified at Enoree WMA (Table 8), with ring-necked ducks most frequently seen at Broad River WMA (77.8% of surveys), and mallards and wood ducks most frequently seen at Enoree WMA (44.4% of surveys for each of the two species; Table 8). There was more late-season (particularly late February and March) waterfowl use of the Enoree WMA than Broad River WMA, likely due to an earlier post hunting-season drawdown schedule for Broad River WMA than for Enoree WMA (further discussion below).

During the 2016–2017 aerial surveys, about 1,250 waterfowl were documented using Monticello Reservoir (Table 9) and more than 3,000 waterfowl were documented using the Parr Reservoir (Table 10), amounting to about 1,000 and 1,900 fewer waterfowl than during the previous year, respectively. Dabbling duck numbers on Monticello Reservoir in 2016–2017 never exceeded 58 birds on an individual flight ($\bar{x}$ = 19.9; Table 9), but in contrast, dabbling duck numbers on Parr Reservoir exceeded 100 individuals on six of nine surveys (maximum = 543; $\bar{x}$ = 219.3; Table 10). In 2016–2017, diving duck numbers on Monticello Reservoir exceeded 100 individuals on only one survey (211 on 10 January 2017; $\bar{x}$ = 36.3;), but again in contrast, diving duck numbers on Parr Reservoir exceeded 100 individuals on three flights, with a maximum of 340 observed on 22 December 2016 ($\bar{x}$ = 88.6; Table 10). In contrast to higher duck use of Parr Reservoir (including Broad River and Enoree WMAs) than Monticello Reservoir, Canada geese were seen on Monticello more consistently and in higher numbers than on Parr Reservoir (Monticello $\bar{x}$ = 77.3, Parr $\bar{x}$ = 24.7; Tables 9 and 10). Snow geese were not seen on Monticello or Parr reservoirs in 2016–2017 (Tables 9 and 10). American coots were seen on Monticello Reservoir on only a single aerial survey, 10 January 2017 (30; Table 9); likewise, coots were seen on only a single flight over Parr Reservoir, 22 December 2016 (40; Table 10).

Figures 5 and 6 show the respective Parr Reservoir and Monticello Reservoir locations of waterfowl concentrations of 50+ individuals observed during aerial surveys in the winter of 2016–2017. As in the previous year, for Parr Reservoir, these locations included primarily the Broad River and Enoree WMAs (Figure 5), and for the Monticello Reservoir, these locations were spread widely around the reservoir (Figure 6).

In 2016–2017, we also noted other avian species (non-game species) on both reservoirs as they were encountered during the aerial surveys (Table 7). Among these additional species, most frequently recorded were again non-specific gulls/terns and double-crested cormorants, which were seen on both reservoirs on most surveys. On Monticello Reservoir, we also recorded two species of grebes, including the pied-billed grebe and the horned grebe, as well as the common loon (Table 7). On Parr Reservoir, we also recorded non-specific shorebirds using shoreline areas exposed by receding water levels. Bald eagles were seen on five of nine surveys of Parr Reservoir and three of nine surveys of Monticello Reservoir (Table 7). These bald eagle sightings included both adult (8) and immature (5) birds.

Examination of Pooled Data

<u>Reservoir and year effects</u>—Using data pooled for the two years of study, we examined potential statistical differences by reservoir and year for dabbling ducks, diving ducks, and geese. Tests for normality of the count data indicated a need for transformations of the data. Natural log-transformations tended to improve normality of the data, so we used log-transformed count data (scaled by the addition of 1 to prevent attempted log-transformations of zero values) as response variables in analysis of variance (ANOVA) models that tested effects of reservoir, year, and their interaction (using JMP, SAS Institute, Cary, NC). We accepted effect significance when $P <$ 0.05 and least-squares estimates from the analyses were back-transformed, with the removal of the scaling value, to produce geometric mean estimates and their associated 95% confidence intervals (CI).

For the analysis of dabbling duck numbers, the overall model was significant ($F_{3,32}$ = 4.53, P < 0.01, adjusted R^2 = 0.23). Reservoirs differed significantly in numbers of dabbling ducks ($F_{1,32}$ = 9.70, P < 0.004), with Parr Reservoir (geometric $\bar{x}$ = 82.0, 95% CI = 61.1–149.0) used to a greater degree by dabbling ducks than Monticello Reservoir (geometric $\bar{x}$ = 20.9, 95% CI = 11.1–38.7). Dabbling duck counts did not differ by year ($F_{1,32}$ = 0.068, P > 0.5) or its interaction with reservoir ($F_{1,32}$ = 3.81, P > 0.05).

For the analysis of diving duck numbers, the overall model was significant ($F_{3,32}$ = 4.82, P < 0.008, R^2 = 0.25). Reservoirs did not differ significantly in numbers of diving ducks ($F_{1,32}$ = 3.26, P > 0.08), nor its interaction with year ($F_{1,32}$ = 0.119, P > 0.7). However, diving duck counts differed significantly by year ($F_{1,32}$ = 11.07, P < 0.003), with more diving ducks seen in 2015–2016 (geometric $\bar{x}$ = 99.7, 95% CI = 39.8–247.6) than in 2016–2017 (geometric $\bar{x}$ = 10.5, 95% CI = 3.7–27.4).

For the analysis of goose numbers, the overall model was significant ($F_{3,32}$ = 9.27, P < 0.009, adjusted R^2 = 0.41). Reservoirs differed significantly in numbers of geese ($F_{1,32}$ = 26.0, P < 0.0001), with Monticello Reservoir (geometric $\bar{x}$ = 66.4, 95% CI = 33.0–132.9) used to a greater degree by geese than Parr Reservoir (geometric $\bar{x}$ = 4.4, 95% CI = 1.7–9.7). Goose counts did not differ by year ($F_{1,32}$ = 1.64, P > 0.2) or its interaction with reservoir ($F_{1,32}$ = 0.197, P > 0.6).

<u>Fluctuating water level effects</u>—In 2015–2016, water levels at Monticello Reservoir at the times of the nine fall and winter aerial surveys averaged 423.8 ft and varied by only 2.7 ft from highest to lowest levels during the surveys. There was more variability in water levels during aerial surveys at Parr Reservoir (Figure 7), varying by more than 7 ft during the surveys, while averaging 260.9 ft there. Simple scatter plots showed no indications of relationships (linear or non-linear) between water level at the time of aerial surveys (Table 1) and numbers of dabbling ducks, diving ducks, or total waterfowl for either reservoir (Tables 4 and 5). In 2016–2017, water levels at Monticello Reservoir at the times of the nine fall and winter aerial surveys averaged 422.9 ft and varied by only 2.5 ft from highest to lowest levels during the surveys. As in the previous year, there was more variability in water levels during aerial surveys at Parr Reservoir (Figure 8), varying by almost 5 ft during the surveys, while averaging 262.8 ft. Again, scatter plots elucidated no significant relationships between water level at the time of aerial surveys (Table 6) and numbers of observed dabbling ducks, diving ducks, or total waterfowl for either reservoir (Tables 9 and 10).

Given that greater variation in water levels occurred at Parr Reservoir than at Monticello Reservoir, we expected that the greatest opportunity to demonstrate a water level effect on waterfowl abundance or distributions would be found at Parr. However, most waterfowl associated with Parr Reservoir were found at Enoree and Broad River WMAs, where control of water levels was managed by SCDNR personnel and was generally not impacted by water level fluctuations occurring in the main body of Parr Reservoir. However, the Enoree WMA is situated near the northern limits of the Parr Reservoir dam's influence, and factors affecting water levels there are perhaps somewhat different than at Broad River WMA, particularly in that Enoree WMA is subjected to water conditions (e.g., bottlenecking) of the Enoree river as it enters the upper Parr Reservoir. Despite these potential limitations, we noted that as Broad River WMA impoundments were actively drawn down for management purposes in March 2016, following the hunting season, waterfowl naturally moved out of those impoundments. Similar to the previous year, in 2017, as Broad River WMA impoundments were dewatered in mid-February and on into March, waterfowl again moved out of the managed impoundments at that WMA. On some late-season occasions in both years, substantial waterfowl numbers persisted at the Enoree WMA impoundments because water remained in impoundments there later into the year than for the Broad River WMA impoundments.

Recreational boating effects—During the waterfowl aerial surveys of Monticello and Parr reservoirs, we also recorded boats observed on both reservoirs. Human disturbance is often a factor affecting abundance and distribution of waterfowl, so we included an assessment of recreational boating activity on waterfowl counts. During 2015–2016 surveys, numbers of boats on Monticello Reservoir averaged 4.1, ranging from 0 to 14 boats, and on Parr Reservoir averaged 2.3, ranging from 0 to 4 boats (Table 1). During 2016–2017 surveys, numbers of boats on Monticello Reservoir averaged 6.9, ranging from 2 to 20 boats, and on Parr Reservoir averaged 3.7, ranging from 0 to 13 boats (Table 6).

As might be expected, warmer temperatures during fall and winter waterfowl surveys were associated with higher numbers of boaters using Monticello Reservoir (Figure 9); there was no similar relationship for Parr Reservoir. We did not find evidence that increasing boat activity was associated with lower total duck or goose numbers for either reservoir. These results suggest no major impacts to waterfowl at current boating activity levels on Monticello and Parr reservoirs during the fall and winter periods. Furthermore, the two SCDNR waterfowl management areas likely contribute substantially as sanctuaries, buffering migratory waterfowl from disturbance, particularly in the post-hunting season period. Maintaining watered impoundments at these WMAs through March annually, before initiating drawdowns, may provide additional benefits to spring migrant waterfowl.

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Table 1. Prevailing conditions during waterfowl aerial surveys of Monticello Reservoir and Parr Reservoir in 2015–2016.

Survey Date:	11/17/2015	12/9/2015	12/21/2015	1/5/2016	1/19/2016	2/4/2016	2/16/2016	3/2/2016	3/15/2016
Observer	C.S. Eldridge	C.S. Eldridge	C.S. Eldridge	C.S. Eldridge	C.S. Eldridge	C.S. Eldridge	C.S. Eldridge	C.S. Eldridge	C.S. Eldridge
Start Time	9:51	10:45	10:39	10:47	11:25	11:06	11:00	11:01	10:00
Stop Time	11:15	12:23	12:20	12:20	12:56	12:39	12:37	12:36	11:30
Noted General Conditions	PC	SNY/CLM	OVC/CLM	SNY/WNDY	SNY/WNDY	CLDY	SNY/WNDY	SNY/WNDY	SNY/CLM
Peak, SC Temp Range (C)*	15-17ºC	14-16ºC	8-10ºC	2-3ºC	0-1ºC	12-13ºC	10-14ºC	12ºC	18-22ºC
Peak, SC Wind (mph)*	NE@3.5-E@6.9	SW@4.6-SW@8.1	CLM-N@5.8	ENE@6.9-NE@8.1	NNW@4.6-NW@5.8	W@3.5	W@6.9-NNW@8.1	NW@10.4-NNW@9.2	CLM-NNW@5.8
Peak, SC Rainfall Rate (mm/hr)*	None	None	None	None	None	None	None	None	None
Peak, SC Sky Conditions*	CLR/BKN	CLR	BKN/OVC	CLR	CLR	SCT	CLR	SCT/BKN	CLR
Monticello Reservoir Water Level (ft)	422.0	424.1	424.4	424.5	423.4	424.0	422.8	423.9	424.7
Parr Shoals Reservoir Water Level (ft)	264.4	257.2	260.4	260.1	262.0	260.4	262.9	261.3	259.5
Monticello reservoir Boats Seen	N/A	6	7	2	0	2	0	2	14
Parr Reservoir Boats Seen	N/A	2	4	2	2	1	4	0	3

*Central School Road (KSCLITTL12), near Peak, SC Lat: N 34.23 °; Lon: W -81.42 °; Elevation: 462 ft; **Abbreviations**: PC=Partly Cloudy, OVC=Overcast, CLDY = Cloudy, FEW=Few Clouds, SCT=Scattered Clouds, CLR=Clear Skies, BKN=Broken Skies, RN = Rain, SNY = Sunny, CLM = Calm, WNDY = Windy.

Table 2. Species list compiled from waterfowl aerial surveys of Monticello Reservoir and Parr Reservoir (including Broad River and Enoree Waterfowl Management Areas) in 2015–2016. Shown in parentheses are percentages of the 9 aerial surveys when a given species was observed.

Guild	Common Name	Scientific Name	Monticello	Parr
Waterfowl:				
Geese				
	Canada Goose	*Branta canadensis*	**X** (100%)	**X** (44.4%)
	Snow Goose	*Chen caerulescens*	NONE	**X** (33.3%)
Dabbling Ducks				
	Mallard	*Anas platyrhynchos*	**X** (100%)	**X** (77.8%)
	Gadwall	*Anas strepera*	NONE	**X** (66.7%)
	American Wigeon	*Anas americana*	NONE	**X** (33.3%)
	Green-winged Teal	*Anas crecca*	NONE	NONE
	Blue-winged Teal	*Anas discors*	**X** (66.7%)	**X** (66.7%)
	Northern Shoveler	*Anas clypeata*	NONE	**X** (44.4%)
	Wood Duck	*Aix sponsa*	**X** (77.8%)	NONE
Diving Ducks				
	Ring-necked Duck	*Aythya collaris*	**X** (100%)	**X** (88.9%)
	Lesser Scaup	*Aythya affinis*	**X** (44.4%)	**X** (33.3%)
	Bufflehead	*Bucephala albeola*	**X** (55.6%)	**X** (11.1%)
Mergansers				
	Hooded Merganser	*Lophodytes cucullatus*	**X** (22.2%)	NONE
	Other Merganser	*Mergus sp.*	NONE	NONE
Rails				
	American Coot	*Fulica americana*	**X** (33.3%)	**X** (11.1%)
Other Birds:				
	Common Loon	*Gavia immer*	**X** (55.6%)	NONE
	Anhinga	*Anhinga anhinga*	NONE	**X** (22.2%)
	Double-crested Cormorant	*Phalacrocorax auritus*	**X** (100%)	**X** (100%)
	Pied-billed Grebe	*Podilymbus podiceps*	**X** (88.9%)	NONE
	Horned Grebe	*Podiceps auritus*	**X** (44.4%)	NONE
	Gulls/Terns		**X** (100%)	**X** (88.9%)
	Shorebirds		NONE	**X** (22.2%)
	Bald Eagle	*Haliaeetus leucocephalus*	**X** (33.3%)	**X** (88.9%)

Table 3. Species list compiled from waterfowl aerial surveys of Broad River and Enoree Waterfowl Management Areas in 2015–2016. Shown in parentheses are percentages of the 9 aerial surveys when a given species was observed.

Guild	**Common Name**	**Scientific Name**	**Broad River**	**Enoree**
<u>Waterfowl:</u>				
Geese				
	Canada Goose	*Branta canadensis*	**X** (22.2%)	**X** (11.1%)
	Snow Goose	*Chen caerulescens*	NONE	NONE
Dabbling Ducks				
	Mallard	*Anas platyrhynchos*	**X** (33.3%)	**X** (11.1%)
	Gadwall	*Anas strepera*	**X** (22.2%)	**X** (22.2%)
	American Wigeon	*Anas americana*	**X** (11.1%)	**X** (11.1%)
	Green-winged teal	*Anas crecca*	NONE	NONE
	Blue-winged Teal	*Anas discors*	**X** (33.3%)	**X** (44.4%)
	Northern Shoveler	*Anas clypeata*	**X** (33.3%)	**X** (11.1%)
	Wood Duck	*Aix sponsa*	NONE	NONE
Diving Ducks				
	Ring-necked Duck	*Aythya collaris*	**X** (88.9%)	**X** (44.4%)
	Lesser Scaup	*Aythya affinis*	**X** (33.3%)	**X** (11.1%)
	Bufflehead	*Bucephala albeola*	NONE	NONE
Mergansers				
	Hooded Merganser	*Lophodytes cucullatus*	NONE	NONE
	Other Merganser	*Mergus sp.*	NONE	NONE
Rails				
	American Coot	*Fulica americana*	NONE	NONE

Table 4. Counts of waterfowl identified during aerial surveys of Monticello Reservoir in 2015–2016.

Survey Date:	11/17/15	12/9/15	12/21/15	1/5/16	1/19/16	2/4/16	2/16/16	3/2/16	3/15/16	All Surveys
Mallard	31	52	41	29	10	6	13	18	11	211
Gadwall										0
American Wigeon										0
Green-winged Teal										0
Blue-winged Teal			35	35	45	5	23	2		145
Northern Shoveler										0
Wood Duck	3	3	2		4	1		1	1	15
Total Dabblers:	**34**	**55**	**78**	**64**	**59**	**12**	**36**	**21**	**12**	**371**
Lesser Scaup	10	6		115					15	146
Ring-necked Duck	39	77	85	210	30	25	20	5	55	546
Bufflehead			1	5	2	10		3		21
Total Divers:	**49**	**83**	**86**	**330**	**32**	**35**	**20**	**8**	**70**	**713**
Hooded Merganser				7	1					8
Other Merganser										0
Unidentified Ducks										0
Total Ducks:	**83**	**138**	**164**	**401**	**92**	**47**	**56**	**29**	**82**	**1092**
Snow Goose										0
Canada Goose	281	126	74	80	68	59	122	35	46	891
Total Geese:	**281**	**126**	**74**	**80**	**68**	**59**	**122**	**35**	**46**	**891**
American Coot		100			45				70	215
Grand Total:	**364**	**364**	**238**	**481**	**205**	**106**	**178**	**64**	**198**	**2,198**

Table 5. Counts of waterfowl identified during aerial surveys of Parr Reservoir (including Broad River and Enoree Waterfowl Management Areas) in 2015–2016.

Survey Date:	11/17/15	12/9/15	12/21/15	1/5/16	1/19/16	2/4/16	2/16/16	3/2/16	3/15/16	All Surveys
Mallard		6		35	45	10	10	4	12	122
Gadwall		2		8	10	60	8		5	93
American Wigeon			40	15				50		105
Green-winged Teal										0
Blue-winged Teal		230	10	45		120		60	8	473
Northern Shoveler			50	25			35	40		150
Wood Duck										0
Total Dabblers:	**0**	**238**	**100**	**128**	**55**	**190**	**53**	**154**	**25**	**943**
Lesser Scaup			19				65	40		124
Ring-necked Duck	600	665	285	420	230	570	100	470		3,340
Bufflehead			6							0
Total Divers:	**600**	**665**	**310**	**420**	**230**	**570**	**165**	**510**	**0**	**3,470**
Hooded Merganser										0
Other Merganser										0
Unidentified Ducks					10					10
Total Ducks:	**600**	**903**	**410**	**548**	**295**	**760**	**218**	**664**	**25**	**4,423**
Snow Goose				62	39	1				102
Canada Goose		20	47	4		65				136
Total Geese:	**0**	**20**	**47**	**66**	**39**	**66**	**0**	**0**	**0**	**238**
American Coot			245							245
Grand Total:	**600**	**923**	**702**	**614**	**334**	**826**	**218**	**664**	**25**	**4,906**

Table 6. Prevailing conditions during waterfowl aerial surveys of Monticello Reservoir and Parr Reservoir in 2016–2017.

Survey Date:	11/15/2016	12/9/2016	12/22/2016	1/10/2017	1/24/2017	2/7/2017	2/16/2017	3/7/2017	3/21/2017
Observer	C.S. Eldridge	C.S. Eldridge	C.S. Eldridge	C.S. Eldridge	C.S. Eldridge	C.S. Eldridge	C.S. Eldridge	C.S. Eldridge	C.S. Eldridge
Start Time	11:11	10:54	11:07	10:51	10:53	10:45	10:53	10:52	10:53
Stop Time	12:37	12:28	12:42	12:25	12:18	12:10	12:15	12:17	11:15
Noted General Conditions	CLR/HAZE	SNY	SNY/WNDY	PC	SNY/WNDY	CLDY/WNDY	SNY	PC/WNDY	SNY/HAZE
Peak, SC Temp Range (C)*	13-16ºC	3-5ºC	14-17ºC	5-8ºC	13-16ºC	20-22ºC	10-12ºC	20-21ºC	22-26ºC
Peak, SC Wind (mph)*	CLM-N@6.9	N@5.8-NW@4.6	W@10.4-SW@10.4	CLM-SW@4.6	W@8.1-W@10.4	SW@12.7-SW@16	WNW@4.3	SW@12.7-SW@16	W@9.2-W@8.1
Peak, SC Rainfall Rate (mm/hr)*	None	None	None	None	None	None	None	None	None
Peak, SC Sky Conditions*	CLR	CLR	CLR	CLR	CLR	CLR/SCT	CLR	SCT	CLR
Monticello Reservoir Water Level (ft)	423.8	424.5	422.2	422.8	422.5	422.0	423.1	422.4	422.8
Parr Shoals Reservoir Water Level (ft)	260.9	259.4	264.1	263.6	261.5	264.1	263.9	263.9	263.4
Monticello Reservoir Boats Seen	6	2	7	4	4	5	5	9	20
Parr Reservoir Boats Seen	13	2	4	0	1	3	1	4	5

*Central School Road (KSCLITTL12), near Peak, SC   Lat: N 34.23 °; Lon: W -81.42 °; Elevation: 462 ft; **Abbreviations**: PC=Partly Cloudy, OVC=Overcast, CLDY = Cloudy, FEW=Few Clouds, SCT=Scattered Clouds, CLR=Clear Skies, BKN=Broken Skies, RN = Rain, SNY = Sunny, CLM = Calm, WNDY = Windy.

Table 7. Species list compiled from waterfowl aerial surveys of Monticello Reservoir and Parr Reservoir (including Broad River and Enoree Waterfowl Management Areas) in 2016–2017. Shown in parentheses are percentages of the 9 aerial surveys when a given species was observed.

Guild	Common Name	Scientific Name	Monticello	Parr
<u>Waterfowl:</u>				
Geese				
	Canada Goose	*Branta canadensis*	**X** (100%)	**X** (44.4%)
	Snow Goose	*Chen caerulescens*	NONE	NONE
Dabbling Ducks				
	Mallard	*Anas platyrhynchos*	**X** (88.9%)	**X** (100%)
	Gadwall	*Anas strepera*	NONE	**X** (44.4%)
	American Wigeon	*Anas americana*	NONE	**X** (11.1%)
	Green-winged Teal	*Anas crecca*	NONE	**X** (11.1%)
	Blue-winged Teal	*Anas discors*	**X** (44.4%)	**X** (44.4%)
	Northern Shoveler	*Anas clypeata*	NONE	**X** (33.3%)
	Wood Duck	*Aix sponsa*	**X** (66.7%)	**X** (44.4%)
Diving Ducks				
	Ring-necked Duck	*Aythya collaris*	**X** (55.6%)	**X** (66.7%)
	Lesser Scaup	*Aythya affinis*	**X** (22.2%)	**X** (11.1%)
	Bufflehead	*Bucephala albeola*	**X** (11.1%)	NONE
Mergansers				
	Hooded Merganser	*Lophodytes cucullatus*	**X** (22.2%)	NONE
	Other Merganser	*Mergus sp.*	**X** (11.1%)	NONE
Rails				
	American Coot	*Fulica americana*	**X** (11.1%)	**X** (11.1%)
<u>Other Birds:</u>				
	Common Loon	*Gavia immer*	**X** (100%)	**X** (11.1%)
	Anhinga	*Anhinga anhinga*	NONE	NONE
	Double-crested Cormorant	*Phalacrocorax auritus*	**X** (100%)	**X** (100%)
	Pied-billed Grebe	*Podilymbus podiceps*	**X** (100%)	**X** (11.1%)
	Horned Grebe	*Podiceps auritus*	**X** (77.8%)	NONE
	Gulls/Terns		**X** (100%)	**X** (77.8%)
	Shorebirds		NONE	**X** (11.1%)
	Bald Eagle	*Haliaeetus leucocephalus*	**X** (33.3%)	**X** (55.6%)

Table 8. Species list compiled from waterfowl aerial surveys of Broad River and Enoree Waterfowl Management Areas in 2016–2017. Shown in parentheses are percentages of the 9 aerial surveys when a given species was observed.

Guild	Common Name	Scientific Name	Broad River	Enoree
<u>Waterfowl:</u>				
Geese				
	Canada Goose	*Branta canadensis*	**X** (11.1%)	**X** (11.1%)
	Snow Goose	*Chen caerulescens*	NONE	NONE
Dabbling Ducks				
	Mallard	*Anas platyrhynchos*	**X** (77.8%)	**X** (44.4%)
	Gadwall	*Anas strepera*	**X** (22.2%)	**X** (22.2%)
	American Wigeon	*Anas americana*	NONE	**X** (11.1%)
	Green-winged Teal	*Anas crecca*	NONE	**X** (11.1%)
	Blue-winged Teal	*Anas discors*	**X** (33.3%)	**X** (33.3%)
	Northern Shoveler	*Anas clypeata*	**X** (11.1%)	**X** (11.1%)
	Wood Duck	*Aix sponsa*	**X** (22.2%)	**X** (44.4%)
Diving Ducks				
	Ring-necked Duck	*Aythya collaris*	**X** (44.4%)	**X** (11.1%)
	Lesser Scaup	*Aythya affinis*	**X** (11.1%)	NONE
	Bufflehead	*Bucephala albeola*	NONE	NONE
Mergansers				
	Hooded Merganser	*Lophodytes cucullatus*	NONE	NONE
	Other Merganser	*Mergus sp.*	NONE	NONE
Rails				
	American Coot	*Fulica americana*	NONE	NONE

Table 9. Counts of waterfowl identified during aerial surveys of Monticello Reservoir in 2016–2017.

Survey Date:	11/15/16	12/9/16	12/22/16	1/10/17	1/24/17	2/7/17	2/16/17	3/7/17	3/21/17	All Surveys
Mallard	4	50	8	9	8	19	10		13	121
Gadwall										0
American Wigeon										0
Green-winged Teal										0
Blue-winged Teal		5		10	5	20				40
Northern Shoveler										0
Wood Duck		3		5	2	5		1	2	18
Total Dabblers:	**4**	**58**	**8**	**24**	**15**	**44**	**10**	**1**	**15**	**179**
Lesser Scaup				175					12	187
Ring-necked Duck	18	5	30	30					51	134
Bufflehead				6						6
Total Divers:	**18**	**5**	**30**	**211**	**0**	**0**	**0**	**0**	**63**	**327**
Hooded Merganser				5	8					13
Other Merganser							7			7
Unidentified Ducks										0
Total Ducks:	**22**	**63**	**38**	**240**	**23**	**44**	**17**	**1**	**78**	**526**
Snow Goose										0
Canada Goose	150	119	16	61	202	23	55	14	56	696
Total Geese:	**150**	**119**	**16**	**61**	**202**	**23**	**55**	**14**	**56**	**696**
American Coot				30						30
Grand Total:	**172**	**182**	**54**	**331**	**225**	**67**	**72**	**15**	**134**	**1252**

Table 10. Counts of waterfowl identified during aerial surveys of Parr Reservoir (including Broad River and Enoree Waterfowl Management Areas) in 2016–2017.

Survey Date:	11/15/16	12/9/16	12/22/16	1/10/17	1/24/17	2/7/17	2/16/17	3/7/17	3/21/17	All Surveys
Mallard	6	55	311	360	160	110	20	115	15	1152
Gadwall			65	165	40	45				315
American Wigeon					30					30
Green-winged Teal									20	20
Blue-winged Teal			35			55		100	90	280
Northern Shoveler			40		50				40	130
Wood Duck				18	20			7	2	47
Total Dabblers:	**6**	**55**	**451**	**543**	**300**	**210**	**20**	**222**	**167**	**1974**
Lesser Scaup		60								60
Ring-necked Duck	12	60	340	35	235				55	737
Bufflehead										0
Total Divers:	**12**	**120**	**340**	**35**	**235**	**0**	**0**	**0**	**55**	**797**
Hooded Merganser										0
Other Merganser										0
Unidentified Ducks										0
Total Ducks:	**18**	**175**	**791**	**578**	**535**	**210**	**20**	**222**	**222**	**2771**
Snow Goose										0
Canada Goose	195	6		2	19					222
Total Geese:	**195**	**6**	**0**	**2**	**19**	**0**	**0**	**0**	**0**	**222**
American Coot			40							40
Grand Total:	**213**	**181**	**831**	**580**	**554**	**210**	**20**	**222**	**222**	**3033**

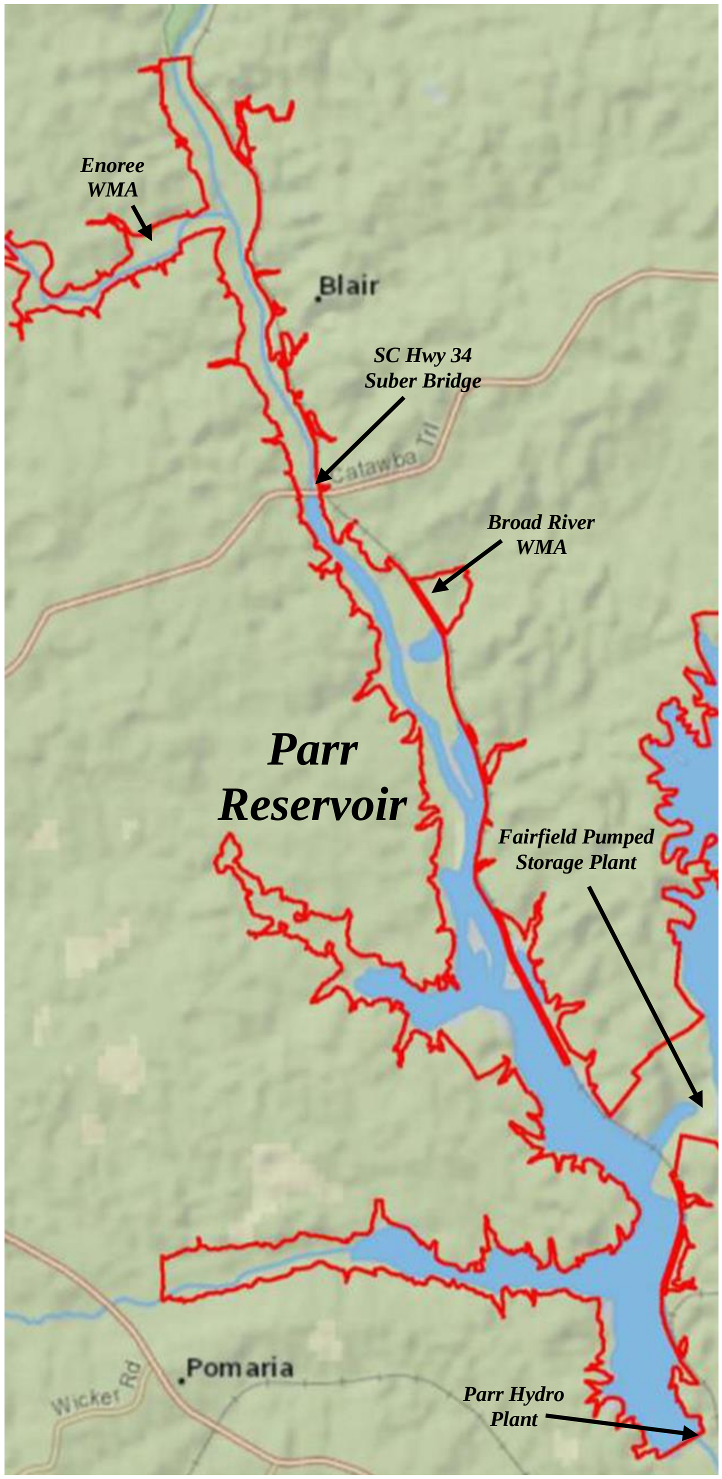

Figure 1. Map of Parr Shoals Reservoir showing locations referred to in the report. The Project boundary is outlined in red.

Figure 2. Map of Monticello Reservoir showing locations referred to in the report. The Project boundary is outlined in red.

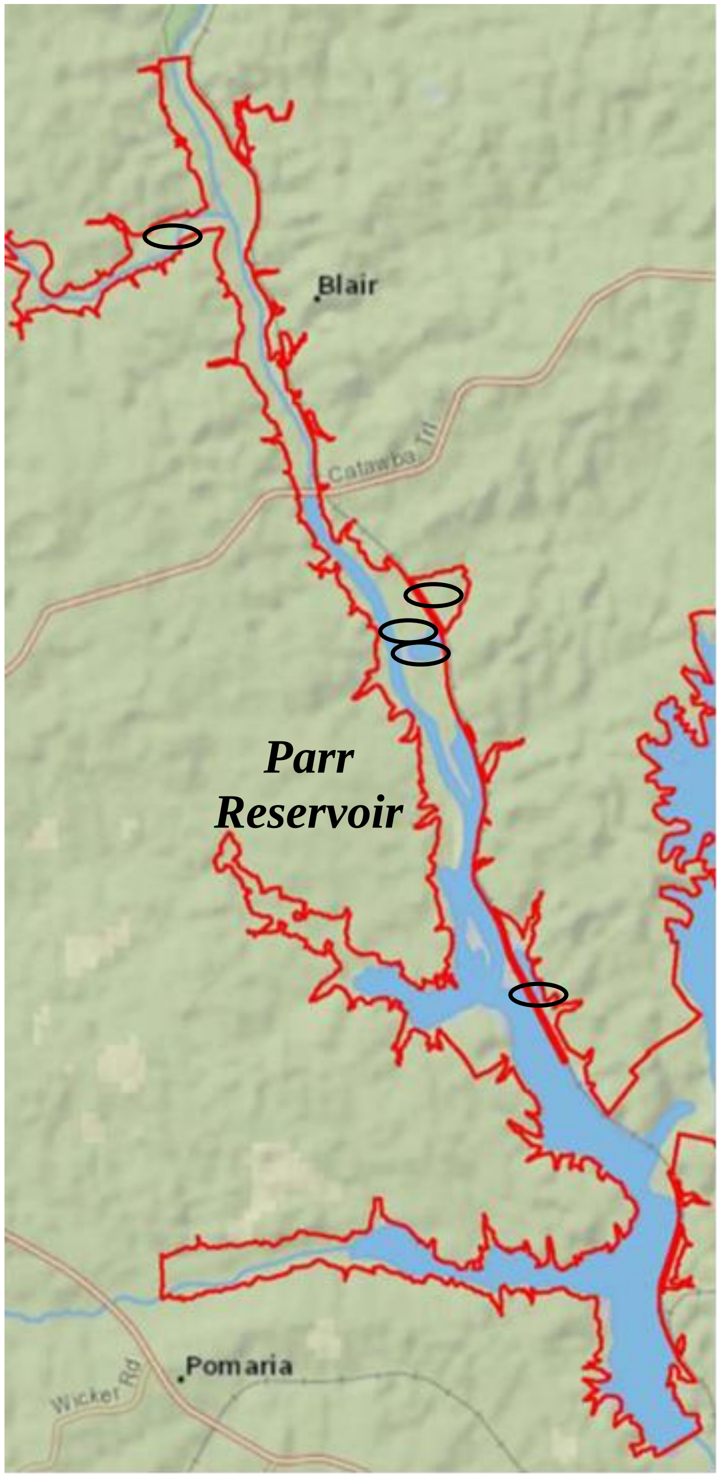

Figure 3. Map of Parr Reservoir showing locations of waterfowl concentrations of 50+ individuals observed during aerial surveys in 2015–2016. The Project boundary is outlined in red.

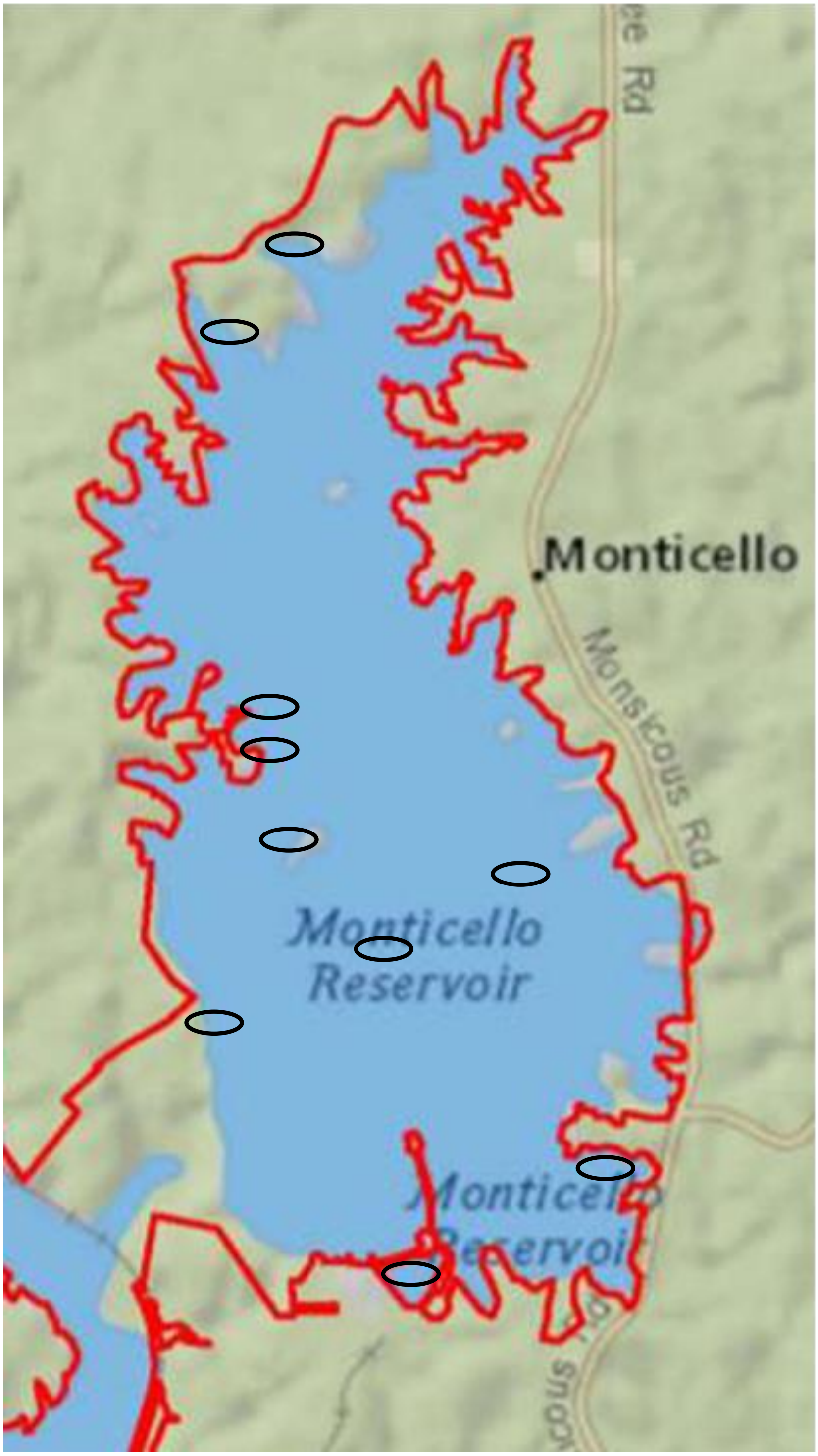

Figure 4. Map of Monticello Reservoir showing locations of waterfowl concentrations of 50+ individuals observed during aerial surveys in 2015–2016. The Project boundary is outlined in red.

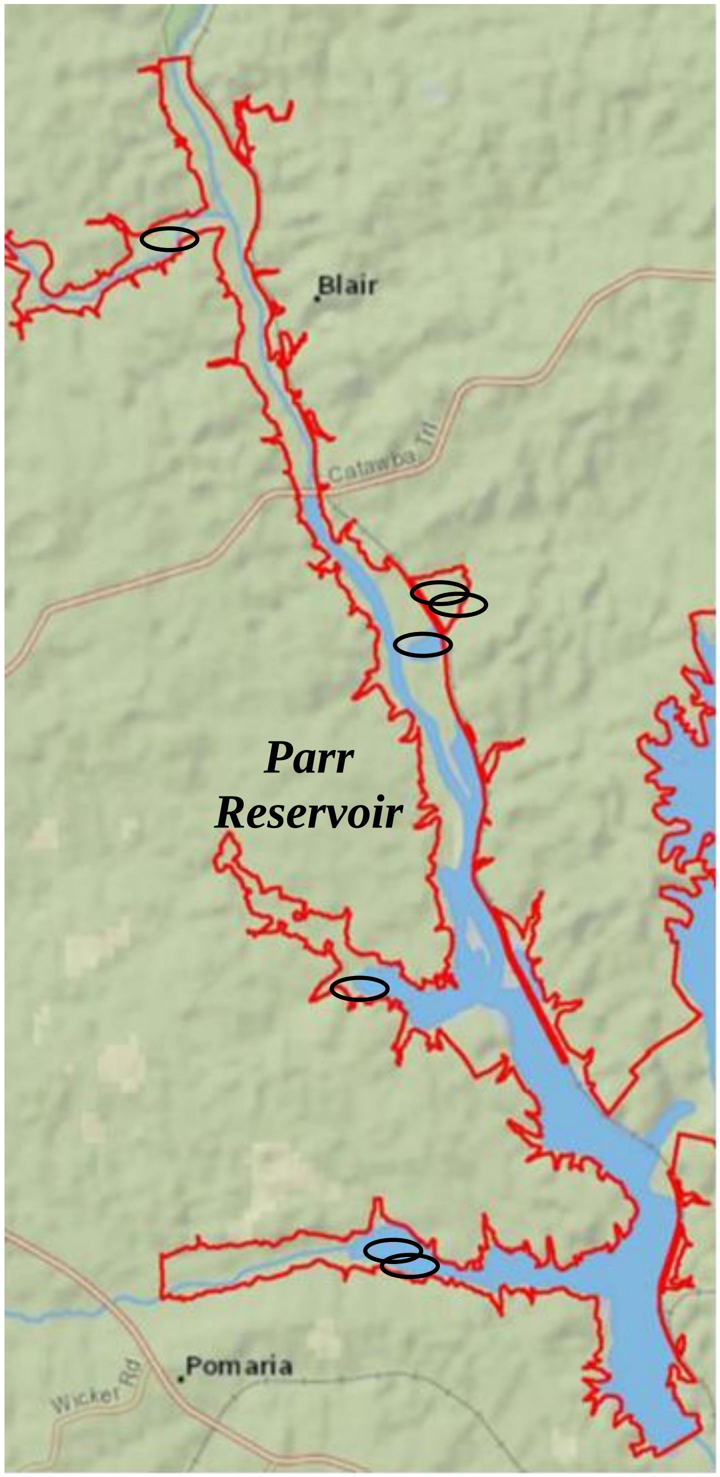

Figure 5. Map of Parr Reservoir showing locations of waterfowl concentrations of 50+ individuals observed during aerial surveys in 2016–2017. The Project boundary is outlined in red.

Figure 6. Map of Monticello Reservoir showing locations of waterfowl concentrations of 50+ individuals observed during aerial surveys in 2016–2017. The Project boundary is outlined in red.

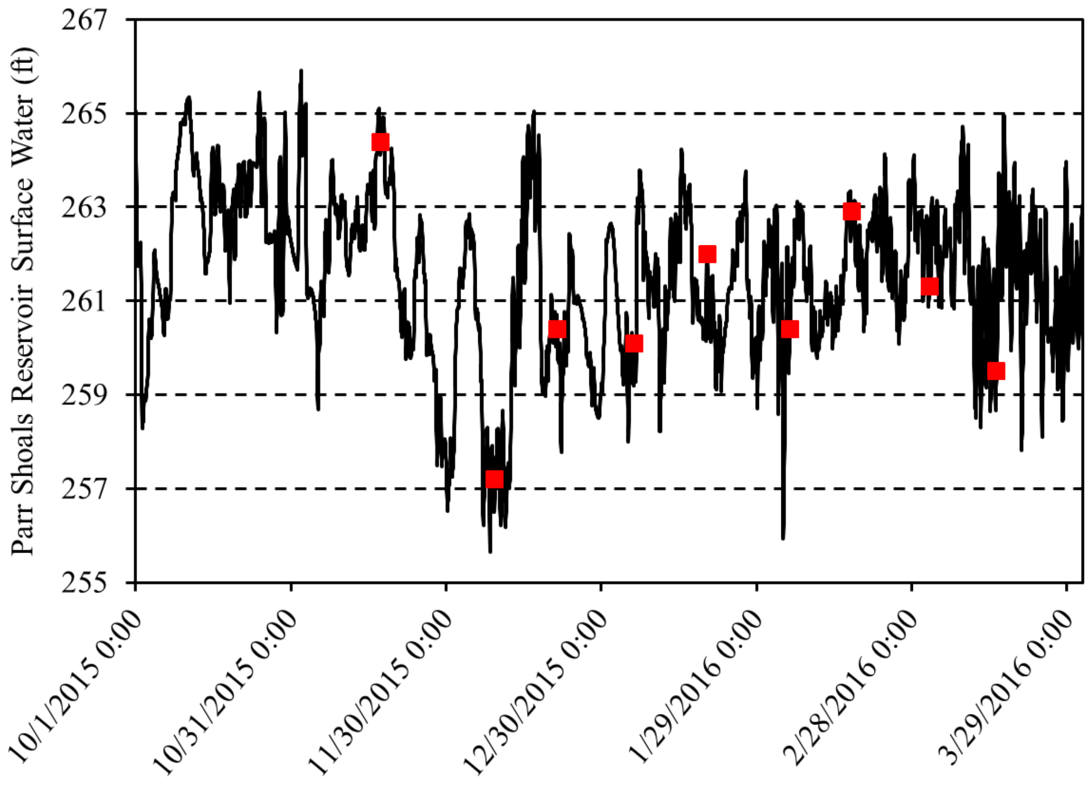

Figure 7. Parr Shoals Reservoir daily gage height (feet; full pool = 266ft [top of crest gates]) during October 1, 2015–March 31, 2016; Location: Latitude 34°15'40", Longitude 81°19'55" (NAD27), Fairfield Co., SC, Hydrologic Unit 03050106; Description: Drainage area: 4,750.00 square miles; Datum of gage: 000 feet above NGVD29. Source: U.S. Geological Survey National Water Information System. Parr Shoals Reservoir water levels at the time of the waterfowl aerial surveys are shown in by the red symbols.

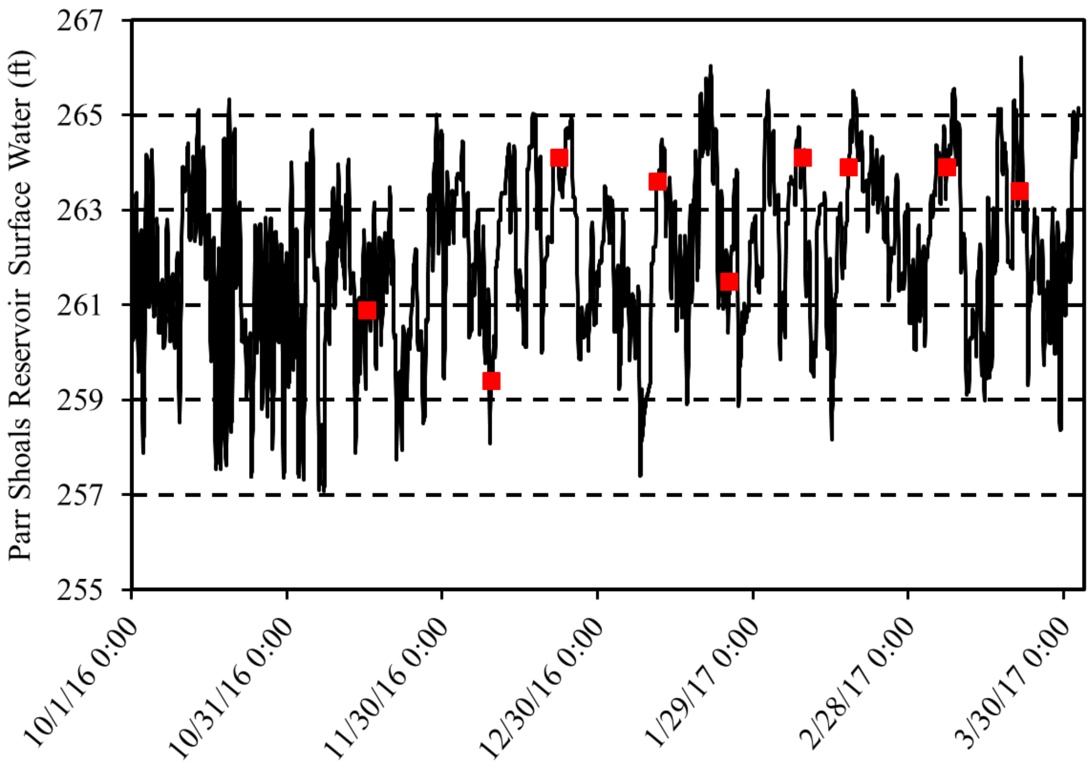

Figure 8. Parr Shoals Reservoir daily gage height (feet; full pool = 266ft [top of crest gates]) during October 1, 2016–March 31, 2017; Location: Latitude 34°15'40", Longitude 81°19'55" (NAD27), Fairfield Co., SC, Hydrologic Unit 03050106; Description: Drainage area: 4,750.00 square miles; Datum of gage: 000 feet above NGVD29. Source: U.S. Geological Survey National Water Information System. Parr Shoals Reservoir water levels at the time of the waterfowl aerial surveys are shown in by the red symbols.

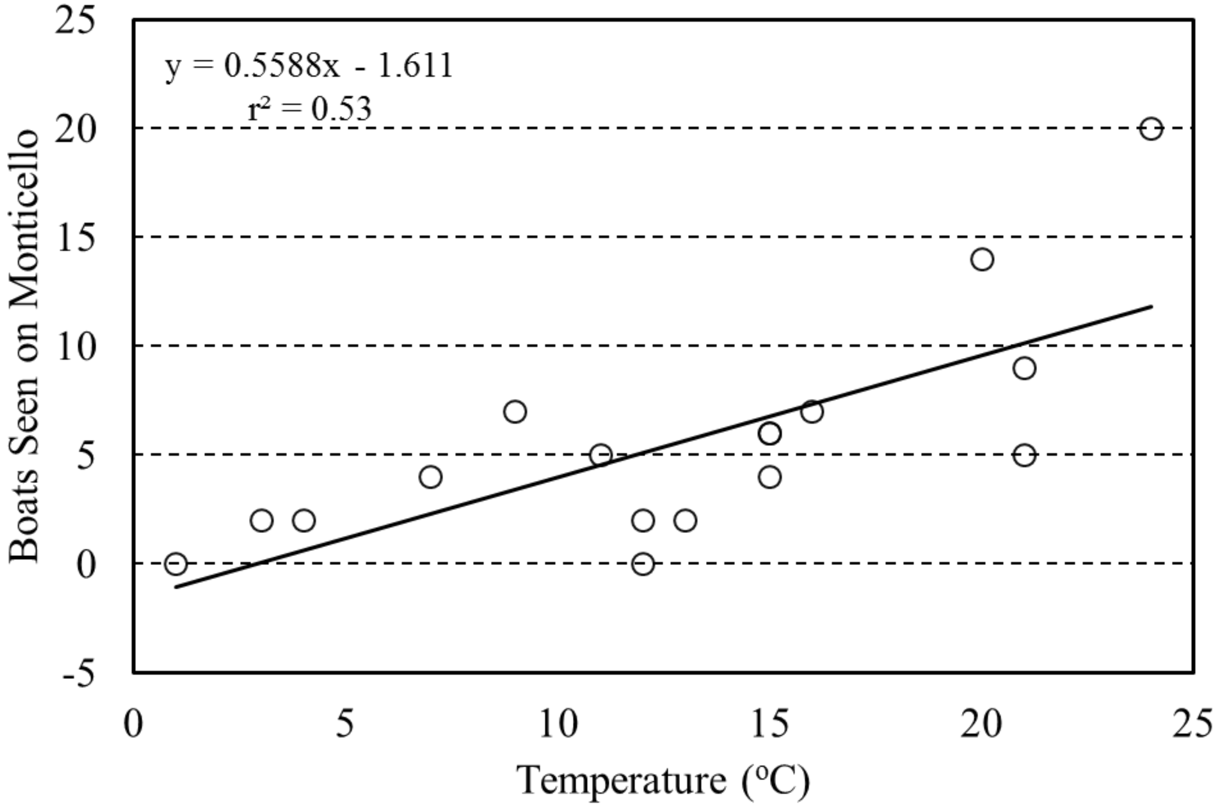

Figure 9. Relationship between temperature (ºC) and numbers of boats seen on Monticello Reservoir at the time of waterfowl aerial surveys during the fall and winters of 2015–2016 and 2016–2017. Temperature data were from Central School Road (KSCLITTL12) weather station, near Peak, SC.

Freshwater Mussel Survey Report

In Monticello Reservoir
Parr Hydroelectric Project
(FERC No. 1894)

Fairfield and Newberry Counties, South Carolina

Monticello Reservoir Shoreline Habitat

Prepared For:

South Carolina Electric & Gas Company &

Kleinschmidt

Kleinschmidt Associates
204 Caughman Farm Lane, Suite 301
Lexington, SC 29072

April 14, 2016

Prepared by:

Three Oaks Engineering
1000 Corporate Drive, Suite 101
Hillsborough, NC 27278

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1.0 INTRODUCTION

The Parr Hydro Project (FERC No. 1894) consists of the Parr Shoals Development and the Fairfield Pumped Storage Development; both are located along the Broad River in Fairfield and Newberry Counties, South Carolina. The Parr Shoals Development forms the lower reservoir, Parr Reservoir, along the Broad River. The Fairfield Pumped Storage Development is located directly off of the Broad River and forms the 6,800-acre upper reservoir, Monticello Reservoir, with four earthen dams. The Fairfield Development has a licensed capacity of 511.2 MW and is used for peaking operations, reserve generation, and power usage.

As part of the Federal Energy Regulatory Commission (FERC) re-licensing coordination, the Rare, Threatened and Endangered Species (RT&E) Technical Working Group made up of stakeholders including state and federal resource agencies requested information describing the status of freshwater mussels in Parr and Monticello reservoirs, as well as in the downstream reach of the Broad River influenced by Project operations. Review of existing freshwater mussel data for the Project vicinity determined that recent survey data existed and were adequate for characterizing the mussel fauna of Parr Reservoir and the downstream reach of the Broad River; thus, new survey information was only needed within Monticello Reservoir, and the Monticello Subimpoundment (herein referred to as the recreational lake) adjacent to the reservoir.

Three Oaks Engineering, Inc. (3Oaks) was retained to develop and implement a mussel survey plan for the Monticello Reservoir portion of the project area.

2.0 TARGET FEDERALLY PROTECTED SPECIES DESCRIPTION: Carolina Heelsplitter (*Lasmigona decorata*)

*2.1 Species Characteristic*s

The Carolina Heelsplitter, originally described as *Unio decoratus* by (Lea 1852), synonymized with *Lasmigona subviridis* (Conrad 1835, Johnson 1970), and later separated as a distinct species (Clarke 1985), is a federally Endangered freshwater mussel, historically known from several locations within the Catawba and Pee Dee River systems in North Carolina and the Pee Dee, Savannah, and possibly the Saluda River systems in South Carolina.

The Carolina Heelsplitter can reach a length of 118 mm, with a height of 68 mm and a width of 39 mm. Based on specimens collected by Keferl and Shelley (1988) from three different streams and rivers, the mean length is 78 mm, the mean height is 43 mm and the mean width is 27 mm. The shell is an ovate trapezoid. The dorsal margin is straight and may end with a slight wing. The umbo is flattened. The beaks are depressed and project a little above the hinge line. The beak sculpture is double looped. The unsculptured shell can have a yellowish, greenish or brownish periostracum. The Carolina Heelsplitter can have greenish or blackish rays. The lateral teeth may or may not be well developed; in most cases they are thin. The pseudo-cardinal teeth are lamellar and parallel to the dorsal margin, and there is a slight interdentum. The nacre varies from an iridescent white to a mottled pale orange. The shell's nacre is often pearly white to bluish white, grading to orange in the area of the umbo (Keferl 1991). The hinge teeth are well developed and heavy and the beak sculpture is double looped (Keferl and Shelly 1988). Morphologically, the shell of the Carolina Heelsplitter is very similar to the shell of the Green Floater (Clarke 1985), with the exception of a much larger size and thickness in the Carolina Heelsplitter (Keferl and Shelly 1988).

Prior to collections in 1987 and 1990 by Keferl (1991), the Carolina Heelsplitter had not been collected in the 20th century and was known only from shell characteristics. Because of its rarity, very little information of this species' biology, life history, and habitat requirements was known until very recently. Feeding strategy and reproductive cycle of the Carolina Heelsplitter have not been fully documented, but are likely similar to other native freshwater mussels (USFWS 1996).

The feeding processes of freshwater mussels are specialized for the removal (filtering) of suspended microscopic food particles from the water column (Pennak 1989). Documented food sources for freshwater mussels include detritus, diatoms, phytoplankton, and zooplankton (USFWS 1996).

Freshwater mussels have complex reproductive cycles, which include a larval stage (glochidium) that is an obligatory parasite on a fish. The glochidia develop into juvenile mussels and detach from the "fish host" and sink to the stream bottom where they continue to develop, provided suitable substrate and water conditions are available (USFWS 1996). For more details regarding general freshwater mussel reproductive biology, McMahon and Bogan (2001) and Pennak (1989) should be consulted.

At the time of listing, nothing was known about the host species(s) for the Carolina Heelsplitter (USFWS 1996, Bogan 2002). Starnes and Hogue (2005) identified the most likely fish host candidates (15 species) based on fish community surveys in occupied streams throughout the range of the Carolina Heelsplitter. Captive propagation efforts for this species had not been attempted in the past; however, due to the critical level of imperilment of the North Carolina populations, acting on recommendations from the NC Scientific Council on Mollusks, the NC Wildlife Resources Commission (NCWRC) funded a life history/captive propagation study, which allowed for salvage of individuals from the Goose/Duck and Sixmile Creek populations to be used in the study. A total of nine minnow species (Cyprinidae) were identified as suitable, and two sunfish species (*Lepomis* spp.) were identified as marginally suitable host species (Eads and Levine 2008, Eads et al. 2010). All of these species may occur in habitat types known to be occupied by the Carolina Heelsplitter; however, "it is always possible that it may use a combination of fish host species and some may not be native to all streams inhabited by this mussel" (Starnes and Hogue 2005). Another member of the genus *Lasmigona*, the Green Floater (*L. subviridis*), perhaps a close relative to the Carolina Heelsplitter, has been documented to be capable of in situ early development with glochidia developing within the marsupium of the female (Barfield and Watters 1998), thus it is possible that the Carolina Heelsplitter may also be able to propagate by direct transformation.

2.2 Distribution and Habitat Requirements

Currently, the Carolina Heelsplitter has a very fragmented, relict distribution. Until recently, it was known to be surviving in only six streams and one small river (USFWS 1996); however, recent discoveries have increased the number of known populations to eleven:

Pee Dee River Basin:
1. Duck Creek/Goose Creek - Mecklenburg/Union counties, NC
2. Flat Creek/Lynches River - Lancaster/Chesterfield/Kershaw counties, SC
Catawba River Basin:
3. Sixmile Creek (Twelvemile Creek Subbasin) - Lancaster County, SC
4. Waxhaw Creek - Union County, NC and Lancaster County, SC
5. Cane Creek/Gills Creek - Lancaster County, SC
6. Fishing Creek Subbasin - Chester County, SC
7. Rocky Creek Subbasin (Bull Run Creek/UT Bull Run Creek/Beaverdam Creek - Chester County, SC
Saluda River Basin:
8. Redbank Creek - Saluda County, SC
9. Halfway Swamp Creek- Greenwood/Saluda County, SC
Savannah River Basin:
10. Little Stevens Creek/Mountain Creek/Sleepy Creek /Turkey Creek (Stevens Creek Subbasin) - Edgefield/McCormick counties, SC.
11. Cuffytown Creek (Stevens Creek Subbasin) - Greenwood/McCormick counties, SC

All of these populations occur in stream reaches within the Piedmont Physiographic Province, particularly within two northeast trending lithostratigraphic belts of the Carolina Terrane, the Carolina Slate Belt and the Charlotte Belt. The Carolina Slate Belt is a band of greenschist faces metavolcanic rock formations positioned in the central and lower Piedmont province extending from south-central Virginia to extreme eastern Georgia (Howell 2005, Butler and Secor 1991). The Charlotte Belt extends from north central North Carolina to eastern Georgia and is comprised of amphibolite faces metavolcanic and metaplutonic rock (Howell 2005, Butler and Secor 1991). These hard formations strongly dictate the channel morphology and character of stream substrates where they intersect. Starnes and Hogue (2005) describe such reaches as "generally characterized by dark, often tilted, bedrock stream bottom with associated large and small rock rubble interspersed with pockets of sand, silt, and gravel." Habitat for this species has been reported from small to large streams and rivers as well as ponds. The ponds are believed to be millponds on some of the smaller streams within the species' historic range (Keferl 1991). Keferl and Shelly (1988) and Keferl (1991) reported that most individuals have been found along well-shaded streambanks with mud, muddy sand, or muddy gravel substrates; however, numerous individuals in several of the populations have been found in cobble and gravel dominated substrate in stream reaches intersecting the hard rock formations described above (T. W. Savidge personal observations). The stability of stream banks appears to be very important to this species (Keferl 1991).

2.3 Threats to Species

The cumulative effects of several factors, including sedimentation, point and non-point discharge, and stream modification (impoundments, channelization, etc.) have contributed to low numbers and restricted range of surviving populations; therefore, they are extremely vulnerable to extirpation from a single catastrophic event or activity (USFWS 1996).

Siltation resulting from improper sedimentation control of various land usage practices, including agriculture, forestry, and development activities, has been recognized as a major contributing factor to the degradation of mussel populations (USFWS 1996). Siltation has been documented to be extremely detrimental to mussel populations by degrading substrate and water quality, increasing potential exposure to other pollutants, and by direct smothering of mussels (Ellis 1936, Markings and Bills 1979). Sediment accumulations of less than one inch have been shown to cause high mortality in most mussel species (Ellis 1936). Feral hog (*Sus scrofa*) activity has been observed to be another source of siltation in a number of Carolina Heelsplitter populations (Tim Savidge, personal observations).

Loss of riparian buffers can lead to degradation of adjacent aquatic habitats. The role of forested riparian buffers in protecting aquatic habitats is well documented (NCWRC 2002). The Recovery Plan for the Carolina Heelsplitter (USFWS 1996) identifies the establishment of stream buffer zones as a major Recovery Objective (Task 1.4). Riparian buffers provide many functions including pollutant reduction and filtration, a primary source of carbon for aquatic food web, stream channel stability, and maintenance of water and air temperatures. Numerous studies have recommended a range of buffer widths needed to maintain these functions. Recommended widths vary greatly depending on the parameter or function evaluated. Wide contiguous buffers of 100-300 feet (30-91 meters) are recommended to adequately perform all functions (NCWRC 2002). The NCWRC recommends a minimum of 200 foot (61 meter) native, forested buffer on perennial streams and a 100 foot (30 meter) forested buffer on intermittent streams in watersheds that support federally endangered and threatened aquatic species (NCWRC 2002). Although not officially adopted, the USFWS uses the NCWRC recommendations as guidance when addressing federally protected aquatic species in North Carolina and South Carolina.

Other factors threatening mussel species include sewage treatment effluent (Goudreau et al. 1988), dams, and other impoundments (USFWS 1992a, Neves 1993, USFWS 1996, USFWS 1992b), and the introduction of exotic species such as the Asian Clam (*Corbicula fluminea*) and Zebra Mussel (*Dreissena polymorpha*) (Fuller and Powell 1973, USFWS 1996, Neves and Widlack 1987, Alderman 1995).

2.4 Designated Critical Habitat

In accordance of Section 4 of the ESA, Critical Habitat for listed species consists of:

(1) The specific areas within the geographical area occupied by the species at the time it is listed in which are found those physical or biological features (constituent elements) that are:

a. essential to the conservation of the species, and
b. which may require special management considerations or protection

(2) Specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of Section 4 of the Act, upon a determination by the Secretary that such areas are "essential for the conservation of the species."

When designating Critical Habitat, the USFWS identifies physical and biological features (primary constituent elements) that are essential to the conservation of the species and that may require special management considerations or protection. The primary constituent elements essential for the conservation of the Carolina Heelsplitter (USFWS 2002) include:

1. permanent flowing, cool, clean water
2. geomorphically stable stream and river channels and banks
3. pool, riffle, and run sequences within the channel
4. stable substrates with no more than low amounts of fine sediment
5. moderate stream gradient
6. periodic natural flooding
7. fish hosts, with adequate living, foraging, and spawning areas for them.

Critical habitat for the Carolina Heelsplitter was designated in 2002 (USFWS 2002). The designated area totals approximately 92 miles (148 kilometers) of nine creeks and one river in North and South Carolina. These areas are considered essential to the conservation of the Carolina Heelsplitter. Six areas (Units) have been designated as critical habitat and a description of each follows.

Unit 1: Goose Creek and Duck Creek (Pee Dee River System), Union County, NC

Unit 1 encompasses approximately 4.5 miles (7.2 km) of the main stem of Goose Creek, Union County, NC, from the N.C. Highway 218 Bridge, downstream to its confluence with the Rocky River, and approximately 6.4 mi (10.3 km) of the main stem of Duck Creek, Union County, NC, from the Mecklenburg/Union County line downstream to its confluence with Goose Creek. The Carolina heelsplitter was first discovered in Goose Creek in 1987 (Keferl 1991) and in Duck Creek in 2000 (NCWRC Database). Between 1993 and 1999, a total of 15 live individuals had been recorded in Goose Creek. NCWRC surveys in early 2002, found 16 live individuals in Duck Creek (NCWRC Database); however, following extreme drought conditions in late 2002, where much of the streambed in both creeks was dry, status surveys in Duck Creek yielded only four live and more than 40 fresh dead. One fresh-dead shell was also found in Goose Creek during the 2002 drought surveys just below US 601. Pools and wet streambeds were much more common in lower Goose Creek, apparently providing refuge from desiccation during the drought. Between 2004 and 2005, four live individuals were found at two locations within Goose Creek, and 12 live individuals were found at six locations within Duck Creek. Prolonged severe drought conditions persisted in the Goose Creek watershed in 2006 through 2007. A total of nine individuals have been found in Duck Creek between 2006 and 2009. Three of the individuals were found on more than one occasion. Four of these individuals were taken into captivity, as much of the stream channel was dry when they were found. A survey conducted in

2011 of the critical habitat portion of Goose Creek, from the Rocky River confluence to the NC 218 crossing, located a total of 12 live individuals and one fresh dead shell (Catena 2012a). All of the live individuals were taken into captivity for a joint propagation effort between North Carolina State University and the North Carolina Wildlife Resources Commission. The majority of the individuals were estimated to be <5 years of age based on shell condition and growth rests, indicating relatively recent reproduction. Repeated survey efforts in Duck Creek in 2011 and 2012 have not located any live individuals post drought.

Unit 2: Waxhaw Creek (Catawba River System), Union County, NC

Unit 2 encompasses approximately 12.2 mi (19.6 km) of the main stem of Waxhaw Creek, Union County, NC, from the N.C. Highway 200 Bridge, downstream to the North Carolina/South Carolina state line. Very few Carolina Heelsplitter individuals have been found in Waxhaw Creek since they were first discovered in 1987. Keferl (1991) found one live individual in 1987 and two in 1990. Subsequent surveys failed to find any individuals until one weathered shell was found in 1996, followed by one live individual in 1998, one weathered shell in 2005, and three live individuals at three separate sites in 2006 (NCWRC Database). Surveys of Waxhaw Creek in South Carolina, conducted in 2004, documented only two live individuals at a single site – one of only a couple of sites in the stream below the North Carolina/South Carolina state line that appeared to provide suitable substrate for the Heelsplitter (USFWS 2007). On-going surveys conducted in 2015 have yielded ten individuals to date (Tim Savidge, personal observations).

Unit 3: Gills Creek (Catawba River System), Lancaster County, SC

Unit 3 encompasses approximately 6.0 mi (9.6 km) of the main stem of Gills Creek, Lancaster County, SC, from the County Route S-29-875, downstream to the SC Route 51 Bridge, east of the City of Lancaster. One 88.0 mm fresh shell and one 67.0 mm live individual discovered in 1998, represent this population (Alderman 1998). No additional surveys have been completed in this section of Gills Creek since 1998. In 2006, Catena discovered the species (two live and one shell) at three sites in Cane Creek, a tributary to Gills Creek (USFWS 2007). One weathered shell was found in 2015 (Tim Savidge, personal observations). While Cane Creek is not within the boundaries of Unit 3, Gills Creek and Cane Creek are considered a single population from a management perspective, as there are no physical barriers that would isolate the two areas. The discovery of the Carolina Heelsplitter in Cane Creek demonstrates that this population has been reduced to small pockets of habitat in the watershed.

Unit 4: Flat Creek (Pee Dee River System), Lancaster County, SC, and the Lynches River (Pee Dee River System), Lancaster, Chesterfield, and Kershaw Counties, SC

Unit 4 encompasses approximately 11.4 mi (18.4 km) of the main stem of Flat Creek, Lancaster County, SC, from the SC Route 204 Bridge, downstream to its confluence with the Lynches River, and approximately 14.6 mi (23.6 km) of the main stem of the Lynches River, Lancaster and Chesterfield Counties, SC, from the confluence of Belk Branch, Lancaster County, northeast (upstream) of the U.S. Highway 601 Bridge, downstream to the SC Highway 903 Bridge in Kershaw County, SC. Within this unit, the Lynches River local population is represented most recently (2005 to 2007) by 14 live and two fresh dead shells (54-87mm) found above SC 265 Chesterfield/Lancaster Co. SC in 2007 (USFWS 2007, USFWS 2012). Between 1994 and 1997, the Flat Creek local population was represented by 28 live individuals ranging in length from 54.15 to 94.1 mm and by four shells ranging in length from 41.0 to 86.1 mm (Alderman 1998). In 2007, Alderman conducted surveys of two reaches of Flat Creek, one in upper Flat Creek and one in middle-lower Flat Creek, and documented 16 live Carolina Heelsplitter individuals, including several age classes, some likely less than five years of age based on shell measurements (USFWS 2007). In 2010, Alderman found 42 live and one weathered shell in Flat Creek, with a large number of size classes represented (Alderman 2010, pers. comm.).

Multiple survey efforts have been conducted in 2014 and 2015 in this unit and numerous individuals were found in both Flat Creek and the Lynches River. This data is not readily available at the time of writing this report (Tim Savidge, John Fridell, personal communication).

Unit 5: Mountain and Beaverdam Creeks (Savannah River System), Edgefield County, SC, and Turkey Creek (Savannah River System), Edgefield and McCormick Counties, SC

Unit 5 encompasses approximately 7.0 mi (11.2 km) of the main stem of Mountain Creek, Edgefield County, SC, from the SC Route 36 Bridge, downstream to its confluence with Turkey Creek; approximately 6.7 mi (10.8 km) of Beaverdam Creek, Edgefield County, from the SC Route 51 Bridge, downstream to its confluence with Turkey Creek; and approximately 11.4 mi (18.4 km) of Turkey Creek, from the SC. Route 36 Bridge, Edgefield County, downstream to the SC Route 68 Bridge, Edgefield and McCormick Counties, SC.

The Mountain Creek local population is represented by 15 live individuals ranging in length from 38.7 to 84.9 mm and by 15 shells ranging in length from 53.0 to 98.0 mm (Alderman 1998, 2002). During 2002, two additional local populations of Carolina Heelsplitter were discovered within the Turkey Creek Subbasin, one in Little Stevens Creek represented by a shell fragment, and one in Sleepy Creek represented by seven live individuals ranging in length from 51.1 to 73.0 mm and by three shells ranging in length from 61.4 to 71.0 mm (Alderman 2002). Seven live and one moribund individuals were documented in Little Stevens Creek in 2007 (USFWS 2007).

The Turkey Creek local population is represented by a few shells discovered in 1995, and by one live individual discovered in 1997 (Mcdougal 1997). Ten 10 individuals were found at eight locations in 2012-2013 (Catena 2013), and one individual was found just above the SC 68 bridge in December 2015 (Tim Savidge, personal observation). Within this unit, only a single shell of the Carolina Heelsplitter has been found in Beaverdam Creek (Alderman 1995) and additional surveys of the stream have failed to locate any individuals (USFWS 2007). This portion of the population may be extirpated or exist only in very low numbers (USFWS 2007).

A single shell of the Carolina Heelsplitter was found in Beaverdam Creek (Alderman 1995) and additional surveys of the stream failed to locate any individuals, and it was suggested that this portion of the population may have extirpated or exist only in very low numbers (USFWS 2007). However, two live individuals and three fresh shells were found in 2015 (Three Oaks 2015).

Unit 6: Cuffytown Creek (Savannah River System), Greenwood and McCormick Counties, SC

Unit 6 encompasses approximately 12.9 mi (20.8 km) of the main stem of Cuffytown Creek, from the confluence of Horsepen Creek, northeast (upstream) of the SC Route 62 Bridge in Greenwood County, SC, downstream to the U.S. Highway 378 Bridge in McCormick County. Within this unit, the population is represented by five live individuals (three discovered in 1998 and two discovered in 2001) with lengths ranging from 53.5 to 71.5 mm and by one shell discovered in 1998 with a length of 63.0 mm (Alderman 1998, 2002).

Five of the eleven Carolina Heelsplitter populations listed in Section 2.2: Sixmile Creek, Fishing Creek, Rocky Creek, Redbank Creek, and Halfway Swamp Creek, were discovered after Critical Habitat was designated. Like most of the other Carolina Heelsplitter populations, these populations are also limited in size and distribution. Live individuals have been found in 2015 in the Sixmile Creek (Tom Dickinson, personal observations), Fishing Creek and Rocky Creek populations (Tim Savidge, personal observations).

3.0 TARGET PETITIONED FEDERALLY PROTECTED SPECIES DESCRIPTION: Savannah Lilliput (*Toxolasma pullus*)

3.1 Species Characteristics

Savannah Lilliput was described by Conrad (1838) from the Wateree River in South Carolina, this species ranges from the Altamaha River basin in Georgia north to the Neuse River basin in North Carolina (Johnson 1970). The Savannah Lilliput is a small mussel with an oval or elliptical shell. The color of the shell is usually blackish but can also be brownish, greenish or olive with fine, green rays. A large individual's metrics would range from 30-35 mm long with a height of 19-20 mm and a width of 15-16 mm. Shells are usually inflated with a broadly rounded to angular double posterior ridge. Shells are sexually dimorphic. Periostracum is coarse due to numerous closely spaced growth lines and is blackish to brown-greenish with fine rays that are usually not visible. Nacre is bluish white with a pink to purplish iridescence towards the posterior. Individuals from the lower Savannah River have a slight different morphology and were once thought to be a different species (Bates 1966).

3.2 Distribution and Habitat Requirements

The historical range of the Savannah Lilliput included the Neuse River basin in North Carolina to the Altamaha basin in Georgia (Bogan and Alderman 2004). After rapid decline the range has been narrowed to select areas. In South Carolina, it has been recently found in the Pee-Dee, Santee, and Savannah River basins.

The species is found in creeks, rivers, and impounded habitats; it is rarely found in deeper lake waters. It is typically located in sand, silty-sand or mud substrates and appears to prefer near shore, still or low velocity shallow water habitats. The fish host species for the Savannah Lilliput is unknown (Bogan and Alderman 2004).

3.3 Threats to Species

Due to its distribution in shallow water, the Savannah Lilliput is susceptible to droughts, water drawdowns and off-road vehicle traffic. One particular event in January 2005, during a draw down in Lake Marion, SC, which is occupied by this species, resulted in numerous mussels stranded on near the shoreline attempting to move to lower water; many had dried up on the banks. The small size and limited distribution of many of this species populations make it vulnerable to events such as these.

4.0 SURVEY EFFORTS

In order to provide current data on the freshwater mussel fauna with regards to species composition, distribution, and relative abundance within the FERC project boundary, qualitative surveys were conducted in both the recreational and main lake of Monticello Reservoir (Figure 1).

4.1 Mussel Surveys for this Project

Surveys were conducted by 3Oaks personnel Tom Dickinson, Tim Savidge, and Evan Morgan on September 16-17, 2015, and by Tim Savidge and Nathan Howell on November 06, 2015. Nicole Riddle of SCDOT provided support for survey efforts on November 06. Weather conditions were sunny and warm during the September 16-17 surveys, and cloudy/rainy and cool during the November 06 surveys. The water was very clear during all surveys.

4.2 Methodology

Visual surveys were conducted using SCUBA and mask/snorkel techniques. Personnel using mask and snorkel covered a depth range of 0-3 feet (ft), while personnel using SCUBA covered a depth range of 3-18 ft. Surveys began at a distinct point along the shoreline and the surveyors evaluated the substrate for mussels from the shoreline out to a point where mussels were no longer present. Generally, mussels were present at depths of 2-4 ft down to 15-18 ft. The depth at which mussels were found varied from site to site, but were more related to water levels at the time than distance from the shoreline, as there is a wide daily fluctuation in water levels within the reservoir. Surveys began at approximately 9:00 am on all three days and ended at 7:00 pm on September 16-17 and at 6:00 pm on November 06. Water levels, measured as pool elevation dropped steadily from the beginning to the end of the surveys on all three days:

a) 09-16: 423.7204895 ft. to 422.7026062 ft.

b) 09-17: 423.8225098 ft. to 422.1596985 ft.

c) 11-06: 423.3981934 ft. to 422.5299988 ft.

Survey sites are denoted by the last two digits of the year (15 for 2015), followed by the two-digit month (09 for September, etc.) and two-digit day followed by a period and the survey number for that date (i.e.1,2,3….) and the initials for the survey lead (tws for Tim Savidge, or ted for Tom Dickinson). For instance, the first survey conducted on September 16 by Tom Dickinson corresponds to site 150916.1ted.

Ten survey locations were larger in area than the others in terms of a starting and endpoint and overlapped. These sites were combined as appropriate due to proximity into five sites (150916.4ted, 150917.8ted, 151106.3tws, 151106.6tws and 151106.7tws).

All freshwater bivalves were recorded and returned to the substrate. Representative photographs of each species were taken. Timed survey efforts provided Catch per Unit Effort (CPUE) data for each species found. Relative abundance estimates for freshwater snails and freshwater clam species were developed using the following criteria:

- (VA) Very abundant > 30 per square meter
- (A) Abundant 16-30 per square meter
- (C) Common 6-15 per square meter
- (U) Uncommon 3-5 per square meter
- (R) Rare 1-2 per square meter
- (P-) Ancillary adjective "Patchy" indicates an uneven distribution of the species within the sampled site.

5.0 RESULTS

Six species of freshwater mussels were found in Monticello Reservoir, only one of which was found within the recreational lake (relict shell evidence only). The survey results for each site are presented below.

5.1 Site 150916.1ted

This site was located at the mouth of a cove on the southeast side of the recreational lake, and was surveyed to a depth of 10 ft. The substrate along the shoreline consisted of mud and gradually transitioned to a sandy mud in the deeper areas. Large mats of Water Willow (*Justicia americana*) occurred along the shoreline. Surveys were conducted for 1.0 person hour, and one relict shell of the Paper Pondshell (*Utterbackia imbecillis*) was found. Other mollusk species found include the Japanese Mysterysnail (*Cipangopaludina japonica*) and the Asian Clam (*Corbicula fluminea*), which were uncommon (Table 1). Although live individuals of the Asian Clam were uncommon, relict shells were fairly common suggesting a large die off in recent years.

Table 1. Results in Monticello Reservoir Recreational Lake, Site 150916.1ted

Scientific Name	Common Name	Number	CPUE (#/hr)
Freshwater Mussels			
Utterbackia imbecillis	Paper Pondshell	1 shell	~

Freshwater Snails and Clams			Relative Abundance
Cipangopaludina japonica	Japanese Mysterysnail	~	U
Corbicula fluminea	Asian Clam	~	U

5.2 Site 150916.2ted

This site was located at the upper portion of the cove where Site # 150916.1ted is located. Habitat conditions were similar to the site at the mouth of the cove; with the exception of maximum depth, which was 6 ft. Surveys were conducted for 1.17 person hours. Relict shells of the Japanese Mysterysnail and Asian Clam were found in low numbers (Table 2).

Table 2. Results in Monticello Reservoir Recreational Lake, Site 150916.2ted

Scientific Name	Common Name	Number	CPUE (#/hr)
Freshwater Mussels			
None	~	~	~
Freshwater Snails and Clams			**Relative Abundance**
Cipangopaludina japonica	Japanese Mysterysnail	~	Shell only
Corbicula fluminea	Asian Clam	~	Shell Only

5.3 Site 150916.3ted

This site was located along a large point in the northeast portion of the recreational lake. The substrate consisted of large accumulations of silt over gravel. Surveys were conducted from the shoreline down to a depth of 12 ft for 1.0 person hour. Relict shells of the Asain Clam were uncommon (Table 3).

Table 3. Results in Monticello Reservoir Recreational Lake, Site 150916.3ted

Scientific Name	Common Name	Number	CPUE (#/hr)
Freshwater Mussels			
None	~	~	~
Freshwater Snails and Clams			**Relative Abundance**
Corbicula fluminea	Asian Clam	~	Shell Only

5.4 Site 150916.4ted

This combined site was located on both sides of the northern most cove within the recreational lake; surveys were conducted along both shorelines as well as in the middle of the cove, which had a maximum depth of 15 ft. The substrate consisted of mud and sand. Surveys were conducted for 2.0 person hours, and live individuals of the Asian Clam were rare; however, relict shells were fairly common (Table 4).

Table 4. Results in Monticello Reservoir Recreational Lake, Site 150916.4ted

Scientific Name	Common Name	Number	CPUE (#/hr)
Freshwater Mussels			
None	~	~	~
Freshwater Snails and Clams			**Relative Abundance**
Corbicula fluminea	Asian Clam	~	R

5.5 Site 150916.5ted

This site was located along a wide point in the northwest portion of the recreational lake. Several old pilings were present in this area. The substrate consisted of sand with submerged and emergent vegetation. Surveys were conducted to a depth of 6.5 ft for 1.0 person hour. The Asian Clam was found in low numbers (Table 5).

Table 5. Results in Monticello Reservoir Recreational Lake, Site 150916.5ted

Scientific Name	Common Name	Number	CPUE (#/hr)
Freshwater Mussels			
None	~	~	~
Freshwater Snails and Clams			**Relative Abundance**
Corbicula fluminea	Asian Clam	~	R

5.6 Site 150916.6ted

This site was located within the vicinity of the swimming area of the recreational lake. Substrate consisted of sand and clay. Surveys were conducted to a maximum depth of 8 ft for 1.50 person hours. The Asian Clam was rare (Table 6).

Table 6. Results in Monticello Reservoir Recreational Lake, Site 150916.6ted

Scientific Name	Common Name	Number	CPUE (#/hr)
Freshwater Mussels			
None	~	~	~
Freshwater Snails and Clams			**Relative Abundance**
Corbicula fluminea	Asian Clam	~	R

5.7 Site 150916.7ted

This site was located within the recreational lake along the causeway that separates the lake from Monticello Reservoir. The substrate consisted of rock rip/rap with sand and silt in-between. Surveys were conducted to a depth of 8 ft for 0.67 person hour. Asian Clam shells were uncommon as were live Japanese Mystersnail individuals (Table 7).

Table 7. Results in Monticello Reservoir Recreational Lake, Site 150916.7ted

Scientific Name	Common Name	Number	CPUE (#/hr)
Freshwater Mussels			
None	~	~	~
Freshwater Snails and Clams			**Relative Abundance**
Cipangopaludina japonica	Japanese Mysterysnail	~	Uncommon
Corbicula fluminea	Asian Clam	~	Shell Only

5.8 Site 150916.8ted

This site was located off a point in the northeast portion of Monticello Reservoir. The substrate consisted of sand overlain with silt. Surveys were conducted from the shoreline to a maximum depth of 14 ft; however, the majority of mussels were found between 4 and 10 ft. Three native freshwater mussel species, the Carolina Lance (*Elliptio angustata*), Eastern Floater (*Pyganadon cataracta*) and Eastern Creekshell (*Villosa delumbis*) were found, along with the Asian Clam, Japanese Mysterysnail and the Banded Mysterysnail (*Viviparus georgianus*) in 1.5 person hours (Table 8).

Table 8. Results in Monticello Reservoir, Site 150916.8ted

Scientific Name	Common Name	Number	CPUE (#/hr)
Freshwater Mussels			
Elliptio angustata	Carolina Lance	12	8.0/hr
Pyganadon cataracta	Eastern Floater	39	26.0/hr
Villosa delumbis	Eastern Creekshell	5	3.3/hr
Freshwater Snails and Clams			**Relative Abundance**
Cipangopaludina japonica	Japanese Mysterysnail	~	C
Corbicula fluminea	Asian Clam	~	C
Viviparus georgianus	Banded Mysterysnail	~	R

5.9 Site 150916.9ted

This site was located in the vicinity of a small island in the northeast portion of Monticello Reservoir. Surveys were conducted on both sides of the island from the shoreline to a maximum depth of 14 ft. The substrate consisted of a mixture of sand and gravel. Three mussel species, the Carolina Lance, Eastern Floater and Florida Pondhorn (*Uniomerus carolinianus*) were found in 1.75 person hours (Table 9.

Table 9. Results in Monticello Reservoir, Site 150916.9ted

Scientific Name	Common Name	Number	CPUE (#/hr)
Freshwater Mussels			
Elliptio angustata	Carolina Lance	18	10.29/hr
Pyganadon cataracta	Eastern Floater	41	23.43/hr
Uniomerus carolinianus	Florida Pondhorn	1	0.57/hr
Freshwater Snails and Clams			**Relative Abundance**
Cipangopaludina japonica	Japanese Mysterysnail	~	C
Corbicula fluminea	Asian Clam	~	C
Viviparus georgianus	Banded Mysterysnail	~	R

5.10 Site 150917.1ted

This site was located along a broad point on the western shore in the central portion of Monticello Reservoir. Surveys were conducted from the shoreline to a maximum depth of 15 feet; however, the majority of mussels were found between 5 and 10 ft deep. The substrate consisted of sand overlain with silt. Five mussel species were found in 1.5 person hours (Table 10).

Table 10. Results in Monticello Reservoir, Site 150917.1ted

Scientific Name	Common Name	Number	CPUE (#/hr)
Freshwater Mussels			
Elliptio angustata	Carolina Lance	53	29.3/hr
Pyganadon cataracta	Eastern Floater	47	5.3/hr
Uniomerus carolinianus	Florida Pondhorn	2	8.0/hr
Utterbackia imbecillis	Paper Pondshell	3	7.3/hr
Villosa delumbis	Eastern Creekshell	3	
Freshwater Snails and Clams			**Relative Abundance**
Cipangopaludina japonica	Japanese Mysterysnail	~	C
Corbicula fluminea	Asian Clam	~	C
Viviparus georgianus	Banded Mysterysnail	~	PC

5.11 Site 150917.2ted

This site was located along the west shoreline on the north side of a large peninsula in the central portion of Monticello Reservoir. Surveys were conducted to a maximum depth of 14 ft; however, the majority of effort was located between 6 to 8 ft. The substrate consisted of a mixture of sand and mud. Five mussel species were found in 1.0 person hours (Table 11).

Table 11. Results in Monticello Reservoir, Site 150917.2ted

Scientific Name	Common Name	Number	CPUE (#/hr)
Freshwater Mussels			
Elliptio angustata	Carolina Lance	123	123.0/hr
Pyganadon cataracta	Eastern Floater	76	76.0/hr
Unimoerus carolinianus	Florida Pondhorn	2	2.0/hr
Utterbackia imbecillis	Paper Pondshell	5	5.0/hr
Villosa delumbis	Eastern Creekshell	10	10.0/hr
Freshwater Snails and Clams			**Relative Abundance**
Cipangopaludina japonica	Japanese Mysterysnail	~	C
Corbicula fluminea	Asian Clam	~	VA
Viviparus georgianus	Banded Mysterysnail	~	U

5.12 Site 150917.3ted

This site was located along the west shore within a small cove in the north-central portion of Monticello Reservoir. Surveys were conducted to a maximum depth of 14 ft; however, the majority of effort occurred between 6 to 8 ft. The substrate consisted of a mixture of sand and cobble. Four mussel species were found in 1.67 person hours (Table 12).

Table 12. Results in Monticello Reservoir, Site 150917.3ted

Scientific Name	Common Name	Number	CPUE (#/hr)
Freshwater Mussels			
Elliptio angustata	Carolina Lance	24	14.4/hr
Pyganadon cataracta	Eastern Floater	34	20.4/hr
Utterbackia imbecillis	Paper Pondshell	3	1.84/hr
Villosa delumbis	Eastern Creekshell	6	3.6/hr
Freshwater Snails and Clams			**Relative Abundance**
Cipangopaludina japonica	Japanese Mysterysnail	~	C
Corbicula fluminea	Asian Clam	~	C
Viviparus georgianus	Banded Mysterysnail	~	C

5.13 Site 150917.4ted

This site was located along the west shoreline in the south central portion of Monticello Reservoir. The shoreline has been armored with rip rap to stabilize the adjacent roadbed. Surveys were conducted to a maximum depth of 18 ft; however, the majority of effort occurred between 6 and 8 ft. The substrate consisted of a mixture of sand and gravel beyond the rip rap. All six mussel species found during this survey effort were found in 1.23 person hours (Table 13).

Table 13. Results in Monticello Reservoir, Site 150917.4ted

Scientific Name	Common Name	Number	CPUE (#/hr)
Freshwater Mussels			
Elliptio angustata	Carolina Lance	69	56.1/hr
Pyganadon cataracta	Eastern Floater	50	40.7/hr
Uniomerus carolinianus	Florida Pondhorn	10	8.1/hr
Utterbackia imbecillis	Paper Pondshell	4	3.7/hr
Villosa delumbis	Eastern Creekshell	12	9.8/hr
Villosa vaughaniana	Carolina Creekshell	3	2.4/hr
Freshwater Snails and Clams			**Relative Abundance**
Cipangopaludina japonica	Japanese Mysterysnail	~	C
Corbicula fluminea	Asian Clam	~	A
Viviparus georgianus	Banded Mysterysnail	~	C

5.14 Site 150917.5ted

This site was located adjacent to an island in the west central portion of Monticello Reservoir. Surveys were conducted from the western shoreline of the island to a maximum depth of 12 ft; however, the majority of effort occurred between 3 and 8 ft. The substrate consisted of sand overlain with silt. Five mussel species were found in 1.0 person hours (Table 14).

Table 14. Results in Monticello Reservoir, Site 150917.5ted

Scientific Name	Common Name	Number	CPUE (#/hr)
Freshwater Mussels			
Elliptio angustata	Carolina Lance	112	112.0/hr
Pyganadon cataracta	Eastern Floater	58	58.0/hr
Uniomerus carolinianus	Florida Pondhorn	4	4.0/hr
Utterbackia imbecillis	Paper Pondshell	1	1.0/hr
Villosa delumbis	Eastern Creekshell	3	3.0/hr
Freshwater Snails and Clams			**Relative Abundance**
Cipangopaludina japonica	Japanese Mysterysnail	~	A
Corbicula fluminea	Asian Clam	~	C
Viviparus georgianus	Banded Mysterysnail	~	C

5.15 Site 150917.6ted

This site was located along the east shoreline in the north-central portion of Monticello Reservoir. Surveys were conducted from the sandy beach along the shore to a maximum depth of 12 ft; however, the majority of effort occurred between 3 and 5 ft. The substrate consisted of sand with some silt. Four mussel species were found in 1.1 person hours (Table 15).

Table 15. Results in Monticello Reservoir, Site 150917.6ted

Scientific Name	Common Name	Number	CPUE (#/hr)
Freshwater Mussels			
Elliptio angustata	Carolina Lance	20	18.2/hr
Pyganadon cataracta	Eastern Floater	21	19.1/hr
Utterbackia imbecillis	Paper Pondshell	3	2.7/hr
Villosa delumbis	Eastern Creekshell	1	0.9/hr
Freshwater Snails and Clams			**Relative Abundance**
Cipangopaludina japonica	Japanese Mysterysnail	~	C
Corbicula fluminea	Asian Clam	~	C
Viviparus georgianus	Banded Mysterysnail	~	C

5.16 Site 150917.7ted

This site was located adjacent to a narrow peninsula along the east shoreline in the central portion of Monticello Reservoir. A bedrock outcropping extends from the point of the peninsula, with the remainder of the shoreline consisting of a sandy beach. Surveys were conducted to a maximum depth of 14 ft, with the majority of mussels found between 3 and 8 ft. Six mussel species were found in 1.7 person hours (Table 16).

Table 16. Results in Monticello Reservoir, Site 150917.7ted

Scientific Name	Common Name	Number	CPUE (#/hr)
Freshwater Mussels			
Elliptio angustata	Carolina Lance	60	35.3/hr
Pyganadon cataracta	Eastern Floater	48	28.2/hr
Uniomerus carolinianus	Florida Pondhorn	2	1.2/hr
Utterbackia imbecillis	Paper Pondshell	3	1.8/hr
Villosa delumbis	Eastern Creekshell	4	2.4/hr
Villosa vaughaniana	Carolina Creekshell	1	0.6/hr
Freshwater Snails and Clams			**Relative Abundance**
Cipangopaludina japonica	Japanese Mysterysnail	~	C
Corbicula fluminea	Asian Clam	~	U
Viviparus georgianus	Banded Mysterysnail	~	C

5.17 Site 150917.8ted

This combined site was located in the vicinity of a small island off the eastern shoreline in the central portion of Monticello Reservoir. The shoreline of the island is rocky. All sides of the island were surveyed to a depth of 14 ft. Pockets of sand covered the rocks along the bottom. Five mussel species were found in 2.01 person hours (Table 17).

Table 17. Results in Monticello Reservoir, Site 150917.8ted

Scientific Name	Common Name	Number	CPUE (#/hr)
Freshwater Mussels			
Elliptio angustata	Carolina Lance	26	12.9/hr
Pyganadon cataracta	Eastern Floater	29	14.4/hr
Uniomerus carolinianus	Florida Pondhorn	6	3.0/hr
Utterbackia imbecillis	Paper Pondshell	7	3.5/hr
Villosa delumbis	Eastern Creekshell	7	3.5/hr
Freshwater Snails and Clams			**Relative Abundance**
Cipangopaludina japonica	Japanese Mysterysnail	~	A
Corbicula fluminea	Asian Clam	~	A
Viviparus georgianus	Banded Mysterysnail	~	PU

5.18 Site 151106.1tws

This site was located adjacent to the boat landing along the eastern shore off of SC 215 in the southern portion of Monticello Reservoir. The shoreline has been armored with rip rap to stabilize the parking area. Surveys were conducted from the shoreline to a maximum depth of 20 ft. The substrate graded from the rip rap along the shoreline to sand. Most of the mussels were found between 4 and 10 ft. Four mussel species were found in 1.5 person hours (Table 18).

Table 18. Results in Monticello Reservoir, Site 151106.1tws

Scientific Name	Common Name	Number	CPUE (#/hr)
Freshwater Mussels			
Elliptio angustata	Carolina Lance	44	29.3/hr
Pyganadon cataracta	Eastern Floater	8	5.3/hr
Utterbackia imbecillis	Paper Pondshell	12	8.0/hr
Villosa delumbis	Eastern Creekshell	11	7.3/hr
Freshwater Snails and Clams			**Relative Abundance**
Cipangopaludina japonica	Japanese Mysterysnail	~	A
Corbicula fluminea	Asian Clam	~	A
Viviparus georgianus	Banded Mysterysnail	~	PU

5.19 Site 151106.2tws

This site was located just south of the SC 215 boat landing and extended from the sandy beach on the shoreline to a depth of 18 ft, with the majority of mussels found between 6 and 12 ft. The substrate consisted of a mixture of sand and gravel. Five mussel species were found in 1.0 person hours (Table 19).

Table 19. Results in Monticello Reservoir, Site 151106.2tws

Scientific Name	Common Name	Number	CPUE (#/hr)
Freshwater Mussels			
Elliptio angustata	Carolina Lance	24	24.0/hr
Pyganadon cataracta	Eastern Floater	2	2.0/hr
Uniomerus carolinianus	Florida Pondhorn	1 shell	~
Utterbackia imbecillis	Paper Pondshell	6	6.0/hr
Villosa delumbis	Eastern Creekshell	18	18.0/hr
Freshwater Snails and Clams			**Relative Abundance**
Cipangopaludina japonica	Japanese Mysterysnail	~	A
Corbicula fluminea	Asian Clam	~	A
Viviparus georgianus	Banded Mysterysnail	~	PU

5.20 Site 151106.3tws

This combined site was located adjacent to Monticello Park off SC 215 along the eastern shore of Monticello Reservoir. The surveyed reaches extend along the shoreline of long peninsula around the point. Surveys were conducted to a depth of 18 ft; however, most mussels were found between 6 and 12 ft. The substrate consisted of sand and cobble. Five mussel species were found in 2.0 person hours (Table 20).

Table 20. Results in Monticello, Site 151106.3tws

Scientific Name	Common Name	Number	CPUE (#/hr)
Freshwater Mussels			
Elliptio angustata	Carolina Lance	71	35.5/hr
Pyganadon cataracta	Eastern Floater	9	4.5/hr
Uniomerus carolinianus	Florida Pondhorn	3	1.5/hr
Utterbackia imbecillis	Paper Pondshell	9	4.5/hr
Villosa delumbis	Eastern Creekshell	13	6.5/hr
Freshwater Snails and Clams			**Relative Abundance**
Cipangopaludina japonica	Japanese Mysterysnail	~	A
Corbicula fluminea	Asian Clam	~	A
Viviparus georgianus	Banded Mysterysnail	~	PU

5.21 Site 151106.4tws

This site was located south of the Monticello Park off of SC 215, and was accessed from a pull off on SC 215. Surveys were conducted from the shoreline to a maximum depth of 18 ft. The substrate graded from clay along the banks to sand downslope. The majority of mussels were found in 3 to 8 ft of water in sandy clay substrate. Five mussel species were found in 1.0 person hours (Table 21).

Table 21. Results in Monticello Reservoir, Site 151106.4tws

Scientific Name	Common Name	Number	CPUE (#/hr)
Freshwater Mussels			
Elliptio angustata	Carolina Lance	48	48.0/hr
Pyganadon cataracta	Eastern Floater	14	14.0/hr
Uniomerus carolinianus	Florida Pondhorn	2	2.0/hr
Utterbackia imbecillis	Paper Pondshell	5	5.0/hr
Villosa delumbis	Eastern Creekshell	14	14.0/hr
Freshwater Snails and Clams			**Relative Abundance**
Cipangopaludina japonica	Japanese Mysterysnail	~	A
Corbicula fluminea	Asian Clam	~	A
Viviparus georgianus	Banded Mysterysnail	~	PU

5.22 Site 151106.5tws

This site was located adjacent to the southern edge of Monticello Park. Surveys were conducted from the shoreline to a maximum depth of 20 ft. Although a few mussels were found at the maximum depth, most were found between 6 and 10 ft. The substrate consisted of sand and cobble. Five mussel species were found in 1.2 person hours (Table 22).

Table 22. Results in Monticello Reservoir, Site 151106.5tws

Scientific Name	Common Name	Number	CPUE (#/hr)
Freshwater Mussels			
Elliptio angustata	Carolina Lance	48	40.0/hr
Pyganadon cataracta	Eastern Floater	23	11.6/hr
Uniomerus carolinianus	Florida Pondhorn	1 shell	~
Utterbackia imbecillis	Paper Pondshell	1	0.8/hr
Villosa delumbis	Eastern Creekshell	12	10.0/hr
Freshwater Snails and Clams			**Relative Abundance**
Cipangopaludina japonica	Japanese Mysterysnail	~	A
Corbicula fluminea	Asian Clam	~	A
Viviparus georgianus	Banded Mysterysnail	~	PU

5.23 Site 151106.6tws

This combined site was located adjacent to the boat landing off of Ladds Road in the northern portion of Monticello Reservoir and extended into the cove northwest of the parking area. The maximum depth surveyed was 21 ft, although most mussels were found between 4 and 10 ft. Substrate consisted of sand and cobble. Six mussel species were found in 1.95 person hours (Table 23).

Table 23. Results in Monticello Reservoir, Site 151106.6tws

Scientific Name	Common Name	Number	CPUE (#/hr)
Freshwater Mussels			
Elliptio angustata	Carolina Lance	6	3.1/hr
Pyganadon cataracta	Eastern Floater	89	45.6/hr
Uniomerus carolinianus	Florida Pondhorn	7	3.6/hr
Utterbackia imbecillis	Paper Pondshell	33	16.9/hr
Villosa delumbis	Eastern Creekshell	5	2.6/hr
Villosa vaughaniana	Carolina Creekshell	2	1.0/hr
Freshwater Snails and Clams			**Relative Abundance**
Campeloma deisum	Pointed Campeloma	~	PU
Cipangopaludina japonica	Japanese Mysterysnail	~	A
Corbicula fluminea	Asian Clam	~	A
Viviparus georgianus	Banded Mysterysnail	~	PU

5.24 Site 151106.7tws

This combined site extended along a cove northwest of the Ladds Road boat landing and was accessed via a foot trail through the woods originating next to the parking area. Multiple transects were surveyed along the cove extending from the shoreline to a depth of 18 ft. The substrate graded from mud along the shoreline to sand at greater depths. Six freshwater mussel species were found in 1.9 person hours (Table 24).

Table 24. Results in Monticello Reservoir, Site 151106.7tws

Scientific Name	Common Name	Number	CPUE (#/hr)
Freshwater Mussels			
Elliptio angustata	Carolina Lance	5	2.63/hr

Pyganadon cataracta	Eastern Floater	58	30.52/hr
Uniomerus carolinianus	Florida Pondhorn	2	1.1/hr
Utterbackia imbecillis	Paper Pondshell	40	21.1/hr
Villosa delumbis	Eastern Creekshell	8	4.2/hr
Villosa vaughaniana	Carolina Creekshell	1	0.5/hr
Freshwater Snails and Clams			**Relative Abundance**
Campeloma deisum	Pointed Campeloma	~	PU
Cipangopaludina japonica	Japanese Mysterysnail	~	A
Corbicula fluminea	Asian Clam	~	A
Viviparus georgianus	Banded Mysterysnail	~	PU

5.25 Site 151106.8tws

This site was located just east of the Ladds Road boat landing, and extended from the shoreline to a maximum depth of 18 ft. A small area along the shoreline was armored with rip rap. The substrate was dominated by a mixture of sand and cobble. Five mussel species were found in 1.3 person hours (Table 25).

Table 25. Results in Monticello Reservoir, Site 151106.8tws

Scientific Name	Common Name	Number	CPUE (#/hr)
Freshwater Mussels			
Elliptio angustata	Carolina Lance	13	10.0/hr
Pyganadon cataracta	Eastern Floater	22	16.9/hr
Uniomerus carolinianus	Florida Pondhorn	2	1.5/hr
Utterbackia imbecillis	Paper Pondshell	9	6.9/hr
Villosa delumbis	Eastern Creekshell	5	3.8/hr
Freshwater Snails and Clams			**Relative Abundance**
Cipangopaludina japonica	Japanese Mysterysnail	~	C
Corbicula fluminea	Asian Clam	~	A
Viviparus georgianus	Banded Mysterysnail	~	PU

6.0 MUSSEL SPECIES FOUND

The survey results indicate that at least six freshwater mussel species occur in Monticello Reservoir; however, only one species of freshwater mussel (Paper Pondshell), represented by a single relict shell was observed in the adjacent, and hydrologically connected recreational lake. Brief descriptions of the six freshwater mussel species found are provided below.

6.1 Carolina Lance (Elliptio angustata)

This species was described from the Cooper River, South Carolina (Lea 1831). The shell is more than twice as long as high coming to a posterior point, below the midline between the dorsal and ventral margins. The dorsal margin is straight and essentially parallel to the ventral margin. Umbos are slightly elevated with beak sculpture consisting of strong ridges. Johnson (1970) synominized this species and over 20 other named species of lance-shaped elliptio mussels into Elliptio lanceolata. Recent genotypic and phenotypic analysis suggests that some of these formally described species are valid, including “true” Elliptio lanceolata (type locality-Tar River). The Carolina Lance ranges from the Ogeechee, Georgia north to the Potomac River in Maryland and Virginia. The species is usually found in large steams or rivers in thalweg habitat and is associated with coarse substrates. It is not typically found in reservoir habitats (personal observations). This species was found at every site sampled within Monticello Reservoir and was the most abundant species encountered (776 total live individuals). Williams et al. (1993) list this species as special concern.

6.2 Eastern Floater *(Pyganadon cataracta)*

Described by Say (1817) in the deep part of a milldam presumably near Philadelphia, this species is wide ranging in the Atlantic drainages from the lower St. Lawrence River Basin south to the Altamaha River Basin, Georgia, and in the Alabama-Coosa River drainage, and the Apalachicola and Coctawhatchee River Basins, Florida. The shells of this species are uniformly thin, and lack hinge teeth. The shell shape is ovate, subelliptical and elongate, with an evenly rounded anterior margin and a broadly rounded ventral margin. The periostracum is light to dark green with broad green rays on the posterior slope. Ortman (1919) recognized three generalized shell forms, the pond form, the creek/small river form and the big river form, that were related to environmental conditions. The pond form occurs in small ponds with muddy substrates, and is characterized by very thin elongate inflated shells. The creek form occurs in riffle-pool habitats in gravel substrates, and is much thicker and more compressed. The big river form is generally short and inflated and occurs in soft substrates. It often occurs in reservoirs, and was found at every site sampled in Monticello Reservoir and was second in total numbers (668 individuals. This species is considered common and currently stable throughout its range (Williams et al. 1993).

6.3 Florida Pondhorn *(Uniomerus carolinianus)*

Described by (Bosc 1801-1804) from “the Carolinas,” this species ranges from Ocmulgee River in Georgia north to the Chowan River in Virginia. Shells are usually inflated rhomboid, to long rhomboid and reach lengths to 114 mm. The species generally exhibits a dark brown to black periostracum with a slightly roughened, satiny sheen. Teeth of the left valve contain two subequal pseudocardinals, often with a vestigal tooth above them, and one lateral tooth. It was found at eleven sites within Monticello Reservoir in fairly low numbers (41 total). This species is considered common and currently stable throughout its range (Williams et al. 1993).

6.4 Paper Pondshell *(Utterbackia imbecillis)*

Described from the Wabash River in Indiana, this mussel occurs throughout the Mississippi River and Great Lakes drainages, as well as sporadically along the Atlantic slope (Say 1829). It has an extremely thin shell that is oblong and inflated. The dorsal and ventral margins are nearly straight and parallel. The periostracum is greenish yellow with fine green rays. It was found at all but two of the sites sampled in Monticello Reservoir, and was the third most abundant species encountered (144 individuals). With the exception of two sites in the northern portion of the reservoir (151106.7tws and 151106.6tws) it was generally found in low numbers; however, a total of 40 and 33 individuals were recorded respectively at these sites. It was the only freshwater mussel species observed in the recreational lake; however, it was represented by only one relict shell. This species is considered common throughout its range (Williams et al. 1993).

6.5 Eastern Creekshell *(Villosa delumbis)*

This species, described by Conrad (1834) from small streams near the Cooper River South Carolina, ranges from Ocmulgee River, Georgia north to the Cape Fear River in North Carolina. Johnson (1970) synonomized three other species described from the greater CSB with *V. delumbis*. One of these, *V. vaughaniana*, is currently recognized as a valid species (Bogan and Alderman 2008), and was found during this study (see description below). The Eastern Creekshell has a generally thin shell that is ovate in outline. Like other members of this genus, this species is sexually dimorphic, with the shells of the male being more elongate, and the females more rounded and swollen, particularly in the posterior margin. The periostracum is yellow with numerous green rays that are broken along the prominent growth lines. It was found at all but one of the sites sampled in Monticello Reservoir (150916.9ted). It was the fourth most abundant species encountered (137 individuals). Williams et al. (1993) consider this species to be stable; however, Bogan and Alderman (2008) propose it a conservation status of special concern in South Carolina.

6.6 Carolina Creekshell (*Villosa vaughaniana*)

This species was described from Sawney's Creek near Camden, South Carolina (Lea 1838). As discussed above under the description for *V. delumbis*, Johnson (1970) synonomized this species under *V. delumbis*; however, it is currently recognized as a valid species (Bogan and Alderman 2004). The previously reported range extends from the Wateree River Basin portion of the Greater Cooper Santee Basin in South Carolina north to the Cape Fear River Basin in North Carolina (Bogan and Alderman 2008). Like other members of this genus, this species is sexually dimorphic, with the shells of the male being more elongate, and the females more inflated and rounded in the posterior margin. The periostracum is usually dark yellow brown with many green, unbroken rays. The shell of this species is generally thicker, with more prominent pseudocardinal teeth than the similar (in shell characteristics) Eastern Creekshell. A total of seven individuals were found at 4 sites in Monticello Reservoir. The species is usually restricted to small, or medium size streams and is rarely found in large bodies of water, and has not previously been reported from reservoirs (John Alderman and Art Bogan, personal communication). Given that it is uncommon to find this species outside of stream habitats, it is possible that these individuals are simply unusual specimens of the Eastern Creekshell. However, the seven individuals identified as Carolina Creekshell were done so based on conchological (shell), and soft part anatomy characteristics, and should be considered as such until further study proves otherwise. Two voucher specimens were preserved in 95% ethanol and will be deposited in an appropriate museum collection to allow for genetic evaluation to be performed. Williams et al. (1993) lists this species as special concern. It is proposed as Endangered in South Carolina (Bogan and Alderman 2008).

7.0 CONCLUSIONS

The survey results indicate that Monticello Reservoir supports a mussel fauna of at least six species. Mussels were found at every site sampled and most likely occur throughout the reservoir in areas that are not exposed during the daily water fluctuations, down to depths of 16-20 ft. With the exception of the Carolina Creekshell, multiple size (= age) classes of all species were observed, suggesting that the daily water level fluctuation regime is not limiting population sustainability of these species. Three of these species, Carolina Creekshell, Carolina Lance, and Eastern Creekshell have some reported level of conservation concern (see Sections 6.6, 6.1 and 6.5 respectively).

The two most common species encountered, the Carolina Lance and the Eastern Floater, were found at every site sampled; however, the Eastern Floater was definitely more common than the Carolina Lance at the sites sampled in the northern portion of the lake. Likewise, the Paper Pondshell which typically occupies similar habitats (ponded conditions, soft substrate) as the Eastern Floater, was more common in the northern portion of the reservoir than anywhere else. It is unclear however, if this is due to location within the reservoir, or simply related to site specific habitat conditions.

Considering the level of coverage within the reservoir and the relative consistent species distribution between sites, it is unlikely that other freshwater mussel species occur within the reservoir. The two target species, the Carolina Heelsplitter and the Savannah Liliput described in Section 2.0 and 3.0 respectively, are not known from the Broad River Basin and are very unlikely to occur in the reservoir. The Carolina Heelsplitter is known to occur only within lotic habitats. While historically it was reported from mill ponds, it is now believed that these were likely occurrences just below mill ponds as site locality data were often not very specific (i.e. lat/long coordinates) and a mill pond is a recognizable landmark. The Savannah Liliput is known to occur within reservoirs; however, it usually occupies very shallow habitats along the shoreline. The daily fluctuations of water levels in Monticello Reservoir would likely preclude this species from ever becoming established.

The recreational lake does not currently appear to support a viable mussel fauna. The reasons for this are unclear; however, physical habitat conditions (substrate, water depth) do not appear to be limiting factors.

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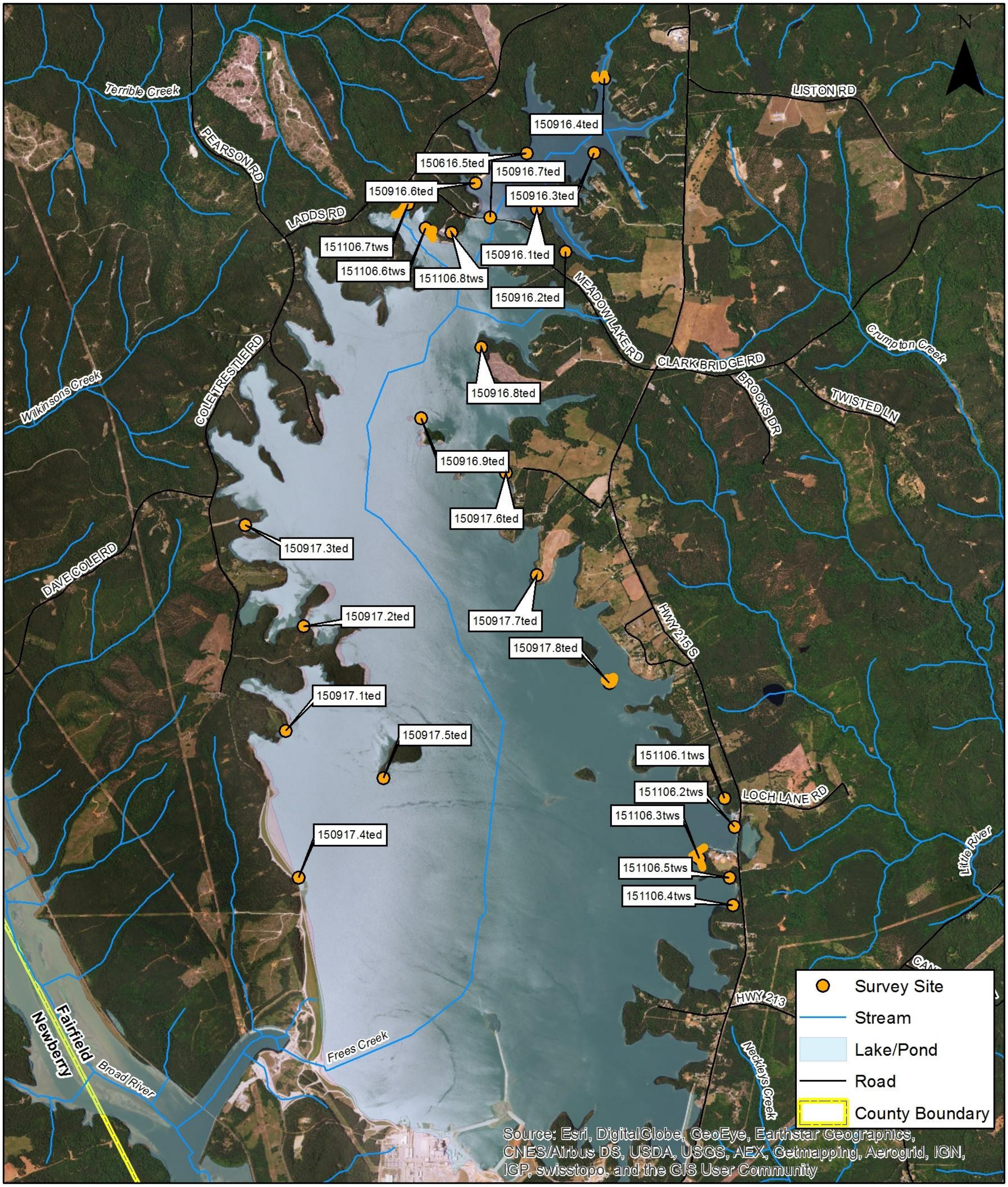
APPENDIX A: Figure 1



Prepared For:

Kleinschmidt

Freshwater Mussel Survey
Monticello Reservoir

Date: December 2015

Scale 0 1,000 2,000 Feet

Job No.:

Figure

1

APPENDIX B: Select Photographs

PARR AND MONTICELLO RESERVOIR FLUCTUATION STUDY

PARR HYDROELECTRIC PROJECT

FERC NO. 1894

Prepared for:

South Carolina Electric & Gas Company
Cayce, South Carolina

Prepared by:

Kleinschmidt

Lexington, South Carolina
www.KleinschmidtGroup.com

April 2016

PARR AND MONTICELLO
RESERVOIR FLUCTUATION STUDY

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SOUTH CAROLINA ELECTRIC & GAS COMPANY

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PARR AND MONTICELLO
RESERVOIR FLUCTUATIONS STUDY

PARR HYDROELECTRIC PROJECT
FERC NO. 1894

SOUTH CAROLINA ELECTRIC & GAS COMPANY

1.0 INTRODUCTION

South Carolina Electric & Gas Company (SCE&G) is the Licensee of the Parr Hydroelectric Project (FERC No. 1894) (Project). The Project consists of the Parr Shoals Development and the Fairfield Pumped Storage Development. Both developments are located along the Broad River in Fairfield and Newberry Counties, South Carolina.

The Project is currently involved in a relicensing process which involves cooperation and collaboration between SCE&G, as licensee, and a variety of stakeholders including state and federal resource agencies, state and local government, non-governmental organizations (NGOs), and interested individuals. SCE&G established several Technical Working Committees (TWCs) comprised of interested stakeholders with the objective of identifying Project-related resource issues and impacts.

During issue scoping meetings, the Fisheries TWC identified the need for a Reservoir Fluctuation Study on the Parr and Monticello Reservoirs. The operating regime for the Project consists of a lowering and a refilling of the Project's two reservoirs on a daily basis. Parr Reservoir is currently permitted by the FERC license to fluctuate up to 10 feet and Monticello Reservoir can fluctuate up to 4.5 feet. However, the amount that the Project reservoirs fluctuate will vary dependent on load demands and system needs. The magnitude of daily fluctuations also varies seasonally in both impoundments, with the largest average daily fluctuations generally occurring in June, July, and August in both reservoirs (see Table 1-1 and Table 1-2).

TABLE 1-1 PARR RESERVOIR MONTHLY AVERAGE ELEVATIONS: 2005-2013

Monthly Average Res. Elev.			
	Max	**Min**	**Range**
Jan	263.04	259.96	3.08
Feb	262.88	260.01	2.87
Mar	263.44	260.32	3.13
Apr	263.81	259.61	4.20
May	264.22	258.79	5.43
June	264.59	258.09	6.49
Jul	264.72	257.96	6.75
Aug	264.74	257.71	7.03
Sep	264.17	258.27	5.90
Oct	263.60	259.14	4.46
Nov	263.53	259.97	3.56
Dec	263.38	260.11	3.28
Average	**263.84**	**259.16**	**4.68**

TABLE 1-2 MONTICELLO RESERVOIR MONTHLY AVERAGE ELEVATIONS: 2005-2013

Monthly Average Res. Elev.			
	Max	**Min**	**Range**
Jan	423.92	422.32	1.60
Feb	423.93	422.45	1.49
Mar	423.82	422.18	1.66
Apr	424.08	421.88	2.22
May	424.42	421.64	2.80
June	424.74	421.42	3.33
Jul	424.69	421.38	3.29
Aug	424.71	421.31	3.40
Sep	424.53	421.45	3.06
Oct	424.02	421.83	2.18
Nov	423.61	422.00	1.61
Dec	423.86	422.28	1.58
Average	**424.19**	**421.84**	**2.35**

During February through April, when many fish species are spawning in shallow water habitat, average daily fluctuations range from 2.9-4.2 feet in Parr Reservoir and from 1.6-2.4 feet in Monticello Reservoir (TWC meeting presentation 12-19-13). Resource agencies and stakeholders expressed concerns that these daily and seasonal fluctuations may be affecting aquatic habitat along the shorelines of the reservoirs and fish spawning and recruitment.

2.0 STUDY OBJECTIVES

2.1 PARR RESERVOIR STUDY OBJECTIVES

Study objectives with regards to Parr Reservoir include providing a qualitative and quantitative assessment of the potential effects of operational reservoir fluctuations on aquatic habitat and navigation within the reservoir. This study provides information to characterize habitat types that are exposed during lake-level fluctuations as well as identify areas with potential navigation issues caused by fluctuations. Data collected will characterize the degree to which reservoir fluctuations affect navigation in the reservoir and identify portions of the reservoir which are potentially influenced through dewatering of aquatic habitat and/or constricted channel.

2.2 MONTICELLO RESERVOIR STUDY OBJECTIVES

The objective of this study with regards to Monticello Reservoir is two-fold. First, SCE&G will provide a qualitative assessment of the potential effects of operational reservoir fluctuations on aquatic habitat within the reservoir. Areas of shoreline are exposed during impoundment fluctuations, but the type and quality of those areas are not currently documented. This study provides information on areas of the reservoir identified by the TWC that are eligible for habitat enhancements that will promote or enhance fish spawning and recruitment.

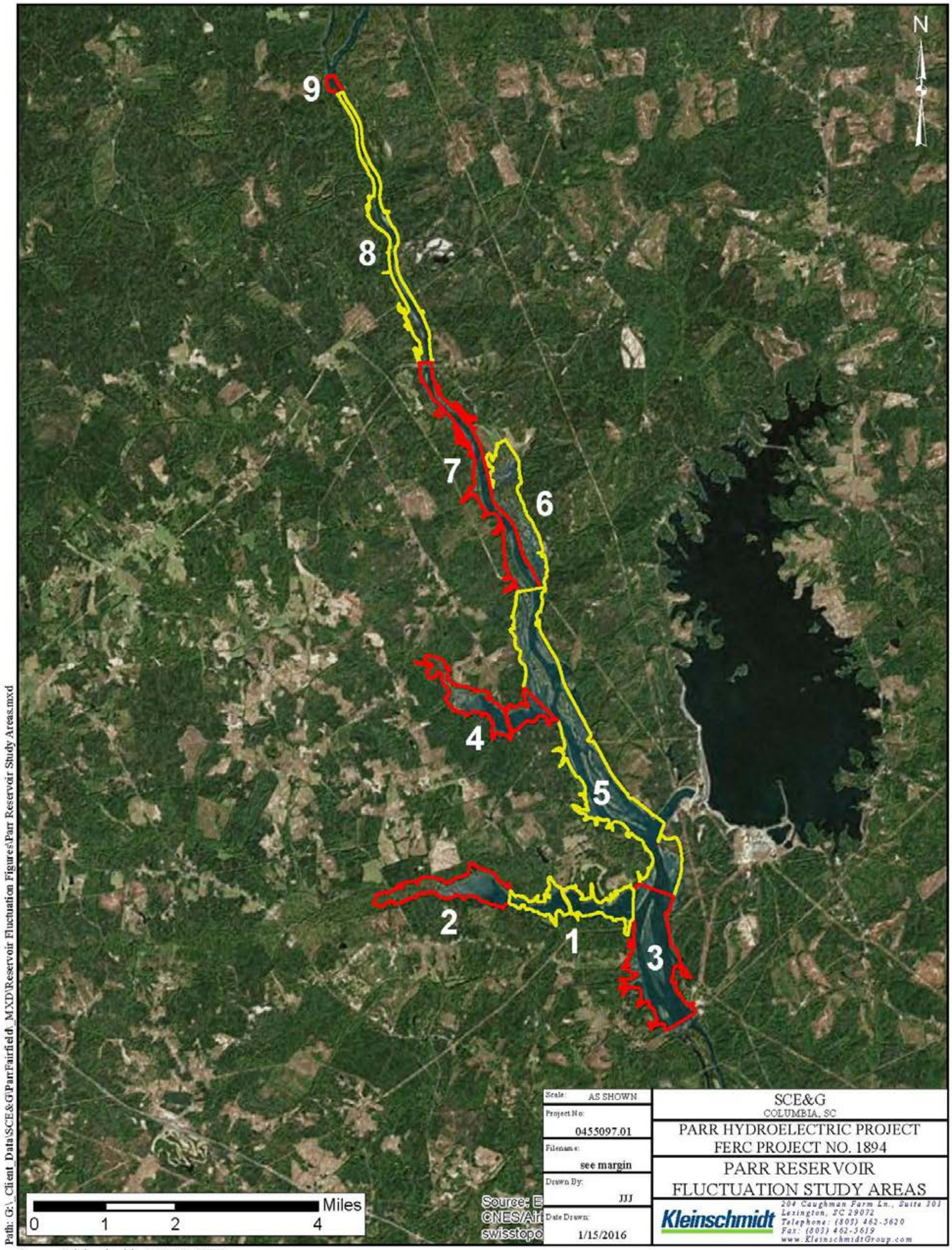
3.0 METHODS AND MATERIALS

The study area includes both Parr and Monticello Reservoirs. TWC members performed field observations of the reservoirs during 2015 to assess the variety of existing aquatic habitat types. In addition to the TWC observations, digital imagery of the reservoirs was collected during a drawdown period (9.9 foot down from full pool on Parr and 2.25 foot down from full pool on Monticello) so that substrate types could be observed. SCE&G used photogrammetry to convert the digital imagery to a Digital Elevation Model (DEM) for both reservoirs at 2 foot contours (Orbis 2015).

3.1 PARR RESERVOIR FLUCTUATION

The Parr Reservoir DEM covered the shoreline from elevation 266’ msl down to 256.1’ msl. Initially, Parr Reservoir was separated into 9 Study Areas based on reservoir characteristics and TWC input (Figure 3-1). Using GIS, a grid system was then applied to each Study Area and approximately 10 percent subsample of each Study Area was selected by random sample. Based on the digital imagery and personal observation/photographs collected during the drawdown, the subsampled shoreline area substrates were classified as mud/silt, sand, or gravel/cobble. Areas of structure (trees, stumps, stream channels and submerged vegetation) were also identified.

After classifications were completed, 2 foot contours for the entire Study Area were established using GIS and photogrammetry. The total acreage of the subsample and the entire Study Area was also determined. The substrate and structure type was summed for each 2 foot contour within the subsample area. The subsample breakdowns of substrate by 2 foot contour were then converted to percent composition based on the total area of the subsample within each 2 foot contour. The subsample percentages were then multiplied by the area within each 2 foot contour for the entire Study Area to determine the breakdown of substrate acreage for each 2 foot contour for each Study Area.

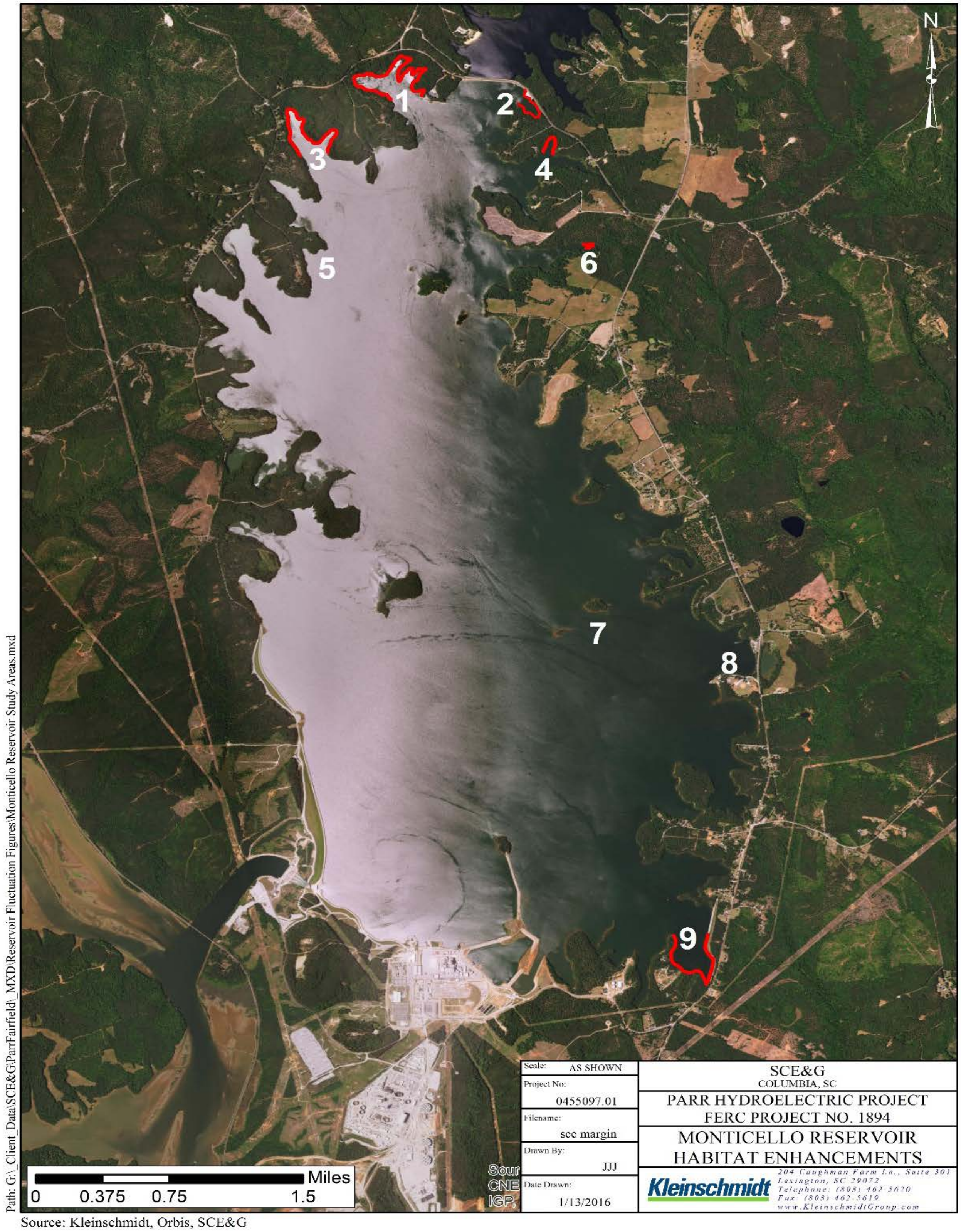


Source: Kleinschmidt, SCE&G, ESRI

FIGURE 3-1 PARR RESERVOIR STUDY AREA SECTIONS

3.2 MONTICELLO RESERVOIR FLUCTUATION

On Monticello Reservoir, SCE&G also collected digital imagery during a partial drawdown (425’ msl to 422.75’ msl) and used it to create a DEM that could be viewed and assessed using GIS. SCE&G and TWC members reviewed the DEM and digital imagery information during the September 29, 2015 TWC meeting to identify areas to consider for potential habitat enhancement measures. The TWC also identified the types of enhancement measures (spawning, fry protection, and adult fish structure) that could be incorporated (Figure 3-2). Nine enhancement areas were identified on the reservoir based on the digital imagery and TWC recommendations. At each of the nine enhancement locations, GIS was used to calculate the amount of shoreline area available (for spawning and fry protection) within the identified area. These measurements will be used to help identify the amount (linear area enhanced or number of enhancements) of habitat enhancement structures that could be installed.



Source: Kleinschmidt, Orbis, SCE&G

FIGURE 3-2 MONTICELLO SHORELINE HABITAT ENHANCEMENT AREAS IDENTIFIED BY TWC

4.0 RESULTS

4.1 PARR RESERVOIR

Parr Reservoir results are provided below in tabular format. Substrate and structure acreage estimates are provided for each of the Study Areas on Parr Reservoir. Results are separated by both habitat and substrate types along with the associated elevation range. A 95% confidence interval (CI) was also calculated for each estimate to demonstrate the GIS accuracy for each estimate. In some cases total acreage by elevation does not equal the sum of the substrate or structure breakdowns, because there are slight errors in using GIS. These variances were not significant. The area at 256’ was also provided to show how much of the reservoir was still wetted. Note that the reservoir drawdown level was 256.1’, yet DEM labeled some areas that had shallow depressions on mud flats as 256’. This created an anomaly when GIS analysis counted some areas below the 256’ elevation as “dewatered” (Figure 4-1). This GIS artifact appeared in Areas 2, 5 and 6 but were not a significant number or amount of area. Figures for each Parr Study Area are included in Appendix A.

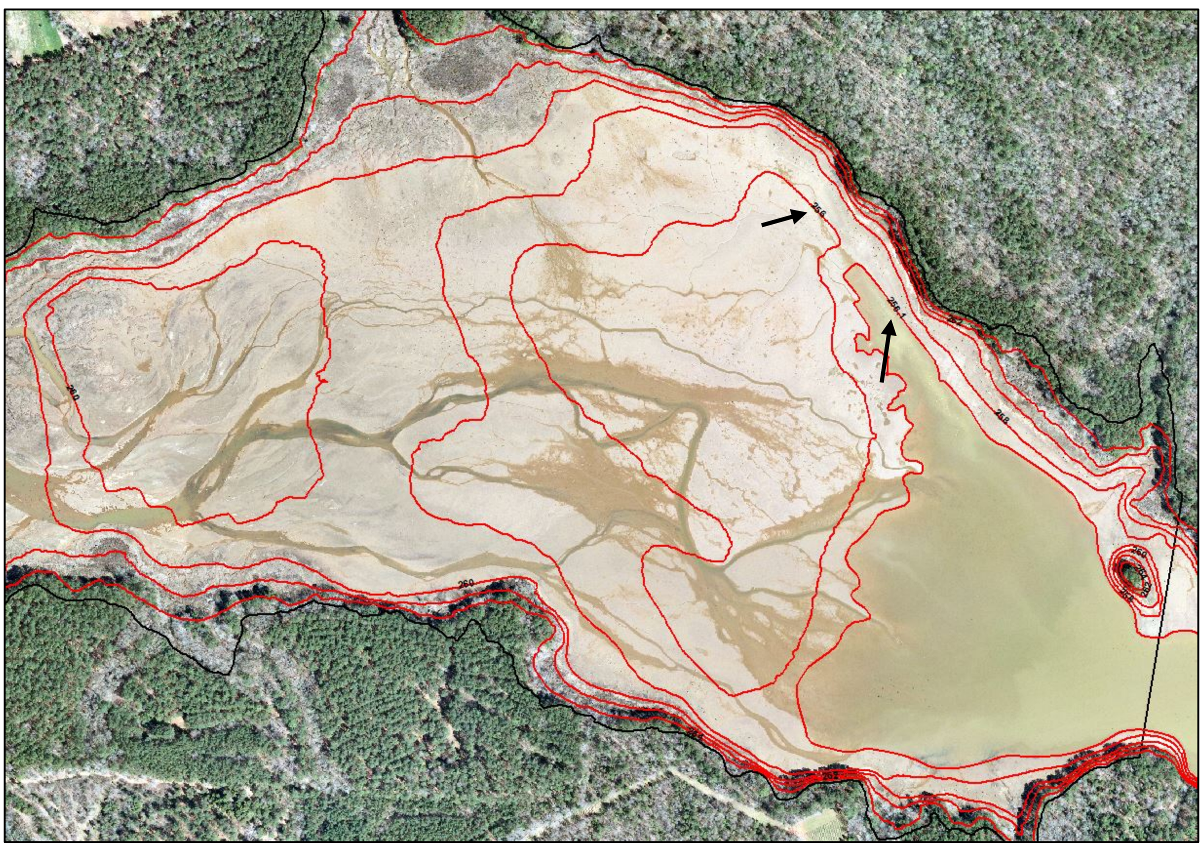


FIGURE 4-1 PARR RESERVOIR - EXAMPLE OF ELEVATION 256 ANOMALY

4.1.1 PARR STUDY AREA 1

Study Area 1 is located in Cannons Creek near the mainstem of the reservoir. The study area is primarily made up of silt and sand substrates with stumps representing the primary structure. Elevations 256-258’ and 258-260’ contain the largest portions of the study area that are periodically exposed by reservoir fluctuations. This elevation band also contains the most structure used by typical warmwater species present within the Reservoir (SCANA 2016). Substrate composition shifts from silt at 256-260’ to sand at 260-264’. The elevation band from 264-266’ is dominated by terrestrial plants with unknown substrates due to tree cover.

TABLE 4-1 SUBSTRATE AND STRUCTURE COMPOSITION OF EXPOSED SHORELINES IN STUDY AREA 1 OF PARR RESERVOIR

SS1 EXTRAPOLATED		**SUBSTRATE**									
		SAND		**SILT**		**GRAVEL/COBBLE**		**UNKNOWN**		**UNEXPOSED**	
Elev Range	Acreage	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI
264-266	19.60	0.00	0.00	0.00	0.00	1.11	0.12	18.40	0.26	0.00	0.00
262-264	19.19	9.62	0.40	0.00	0.00	0.80	0.07	8.77	0.10	0.00	0.00
260-262	15.97	13.63	0.08	1.51	0.04	0.83	0.07	0.00	0.00	0.00	0.00
258-260	23.09	2.82	0.08	19.59	0.26	0.61	0.06	0.00	0.00	0.00	0.00
256-258	25.38	2.54	0.33	22.08	0.24	0.76	0.08	0.00	0.00	0.00	0.00
< 256	223.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	223.03	2.18

SS1 EXTRAPOLATED		**STRUCTURE**							
		TREES		**SUBMERGED VEGETATION**		**STUMPS**		**STREAM CHANNELS**	
Elev Range	Acreage	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI
264-266	19.60	17.63	0.29	0.00	0.00	0.00	0.00	0.00	0.00
262-264	19.19	5.70	0.14	0.13	0.00	5.37	0.80	0.00	0.00
260-262	15.97	1.06	0.50	3.07	0.27	2.08	0.13	0.00	0.00
258-260	23.09	0.02	0.00	0.06	0.00	9.42	0.39	0.00	0.00
256-258	25.38	0.01	0.00	0.00	0.00	11.65	0.24	0.00	0.00
< 256	223.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

4.1.2 PARR STUDY AREA 2

Study Area 2 is located in the upper portion of Cannons Creek and offers more backwater rather than mainstem habitat characteristics. The study area is dominated by silt and sand substrates with stumps and aquatic vegetation representing the primary structure. The study area as a whole displays significant dewatering during reservoir fluctuation, exposing creek channels in the upper portion of the study area. Substrate composition shifts from silt at 256-260’ to sand at 260-264’. Elevation 264-266’ is dominated by terrestrial plants with unknown substrates due to tree cover and contains the most area exposed by fluctuations in the reservoir. Note: There were a few spots below the 256’ elevation line that showed up as “dewatered” despite the reservoir height being at 256’, which is an artifact of the GIS analysis.

TABLE 4-2 SUBSTRATE AND STRUCTURE COMPOSITION OF EXPOSED SHORELINES IN STUDY AREA 2 OF PARR RESERVOIR

SS2 EXTRAPOLATED		**SUBSTRATE**									
		SAND		**SILT**		**GRAVEL/COBBLE**		**UNKNOWN**		**UNEXPOSED**	
Elev Range	Acreage	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI
264-266	114.65	13.40	0.89	0.00	0.00	0.00	0.00	100.86	5.03	0.39	0.00
262-264	45.81	34.63	0.63	0.00	0.00	0.00	0.00	9.58	0.48	1.60	0.36
260-262	49.69	33.06	0.62	12.70	0.72	0.00	0.00	0.00	0.00	3.93	0.20
258-260	34.68	4.07	0.27	29.08	1.01	0.00	0.00	0.00	0.00	1.52	0.92
256-258	35.48	0.00	0.00	31.37	1.00	0.00	0.00	0.00	0.00	4.10	0.35
< 256	55.90	0.00	0.00	5.35	3.41	0.00	0.00	0.00	0.00	50.52	3.86

SS2 EXTRAPOLATED		**STRUCTURE**							
		TREES		**SUBMERGED VEGETATION**		**STUMPS**		**STREAM CHANNELS**	
Elev Range	Acreage	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI
264-266	114.65	54.20	1.55	60.09	7.03	0.00	0.00	0.00	0.00
262-264	45.81	6.49	0.62	35.34	0.79	0.15	0.03	0.00	0.00
260-262	49.69	0.00	0.00	28.96	0.83	0.06	0.04	1.46	0.78
258-260	34.68	0.00	0.00	2.67	1.75	15.71	2.63	0.00	0.00
256-258	35.48	0.00	0.00	0.00	0.00	14.91	2.04	2.37	0.81
< 256	55.90	0.00	0.00	0.00	0.00	0.00	0.00	0.43	0.00

4.1.3 PARR STUDY AREA 3

Study Area 3 is the downstream most study area along the mainstem reservoir adjacent to the dam. The study area is dominated by silt and sand substrates with stumps and aquatic vegetation representing the primary structure. Substrate composition shifts from silt at 256-260’ to sand at 260-264’. The upper two feet affected by fluctuations is dominated by terrestrial plants with unknown substrates due to tree cover. Elevation 258-260’ contains the most area exposed by fluctuations in the reservoir. Note: This study area also contains some small areas that showed up as dewatered below elevation 256’.

Table 4-3 Substrate and Structure Composition of Exposed Shorelines in Study Area 3 of Parr Reservoir

SS3 Extrapolated		Substrate									
		Sand		Silt		Gravel/Cobble		Unknown		Unexposed	
Elev Range	Acreage	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI
264-266	15.33	0.00	0.00	0.00	0.00	0.00	0.00	15.33	9.81	0.00	0.00
262-264	22.29	22.17	0.50	0.09	0.00	0.03	0.00	0.00	0.00	0.00	0.00
260-262	31.80	25.36	0.14	6.41	0.06	0.00	0.00	0.00	0.00	0.00	0.00
258-260	159.41	6.07	0.18	152.95	1.11	0.00	0.00	0.00	0.00	0.40	0.00
256-258	66.95	1.67	0.22	68.16	1.04	0.00	0.00	0.00	0.00	0.00	0.00
< 256	405.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	399.36	2.26

SS3 Extrapolated		Structure							
		Trees		Submerged Vegetation		Stumps		Stream Channels	
Elev Range	Acreage	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI
264-266	15.33	14.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00
262-264	22.29	0.63	0.00	21.27	0.50	0.66	0.00	0.00	0.00
260-262	31.80	0.00	0.00	17.35	0.36	0.33	0.03	0.00	0.00
258-260	159.41	0.00	0.00	0.00	0.00	17.37	4.07	0.00	0.00
256-258	66.95	0.00	0.00	0.00	0.00	9.27	0.23	0.00	0.00
< 256	405.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

4.1.4 PARR STUDY AREA 4

Study Area 4 is the located in Hellers Creek off the mainstem of the reservoir. The study area is dominated by silt and sand substrates with stumps and aquatic vegetation representing the primary structure. Substrate composition shifts from silt at 256-260’ to sand at 260-264’. The upper two feet (264-266’) of the fluctuation zone is dominated by terrestrial plants with unknown substrates due to tree cover. Elevation 256-258’ contains the most area exposed by fluctuations in reservoir elevation.

TABLE 4-4 SUBSTRATE AND STRUCTURE COMPOSITION OF EXPOSED SHORELINES IN STUDY AREA 4 OF PARR RESERVOIR

SS4 EXTRAPOLATED		SUBSTRATE									
		SAND		SILT		GRAVEL/COBBLE		UNKNOWN		UNEXPOSED	
Elev Range	Acreage	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI
264-266	57.85	7.96	0.00	0.00	0.00	8.42	1.84	41.47	9.40	0.00	0.00
262-264	36.54	34.73	1.27	0.00	0.00	0.76	0.15	1.05	0.62	0.00	0.00
260-262	33.72	24.69	0.99	1.07	0.47	0.79	0.14	0.00	0.00	7.06	0.53
258-260	32.77	3.69	0.42	28.07	1.03	1.01	0.20	0.00	0.00	0.00	0.00
256-258	89.40	0.85	0.11	88.03	1.49	0.52	0.04	0.00	0.00	0.00	0.00
< 256	105.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	105.66	3.02

SS4 EXTRAPOLATED		STRUCTURE							
		TREES		SUBMERGED VEGETATION		STUMPS		STREAM CHANNELS	
Elev Range	Acreage	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI
264-266	57.85	49.44	3.71	0.00	0.00	0.00	0.00	0.00	0.00
262-264	36.54	1.05	0.62	31.79	1.32	2.94	0.00	0.00	0.00
260-262	33.72	0.00	0.00	18.19	5.58	0.00	0.00	0.00	0.00
258-260	32.77	0.00	0.00	0.00	0.00	2.26	1.50	0.00	0.00
256-258	89.40	0.00	0.00	0.00	0.00	17.81	0.29	0.00	0.00
< 256	105.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

4.1.5 PARR STUDY AREA 5

Study Area 5 is the located along the mainstem of the reservoir. The study area is dominated by silt and sand substrates with stumps and aquatic vegetation representing the primary structure. Substrate composition shifts from silt at 256-260’ to sand at 260-264’. The upper two feet of the fluctuation zone (264-266’) is dominated by terrestrial plants with unknown substrates due to tree cover. The study area becomes more riverine as water levels drop with the channel becoming more defined. Elevation 258-260’ contains the most area exposed by fluctuations in the reservoir. Note: This study area also contains some small areas that showed up as dewatered below elevation 256’.

TABLE 4-5 SUBSTRATE AND STRUCTURE COMPOSITION OF EXPOSED SHORELINES IN STUDY AREA 5 OF PARR RESERVOIR

SS5 EXTRAPOLATED		**SUBSTRATE**									
		SAND		**SILT**		**GRAVEL/COBBLE**		**UNKNOWN**		**UNEXPOSED**	
Elev Range	Acreage	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI
264-266	106.88	69.77	2.02	0.00	0.00	0.00	0.00	37.11	1.58	0.00	0.00
262-264	159.03	158.64	0.16	0.00	0.00	0.00	0.00	0.39	0.00	0.00	0.00
260-262	118.77	66.86	0.08	51.89	0.14	0.00	0.00	0.00	0.00	0.00	0.00
258-260	265.78	6.79	0.22	258.99	0.62	0.00	0.00	0.00	0.00	0.00	0.00
256-258	185.72	3.57	2.13	182.15	0.88	0.00	0.00	0.00	0.00	0.00	0.00
< 256	506.27	0.00	0.00	60.91	3.46	0.00	0.00	0.00	0.00	445.36	6.15

SS5 EXTRAPOLATED		**STRUCTURE**							
		TREES		**SUBMERGED VEGETATION**		**STUMPS**		**STREAM CHANNELS**	
Elev Range	Acreage	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI
264-266	106.88	73.75	1.55	32.61	1.71	0.00	0.00	0.00	0.00
262-264	159.03	2.06	0.21	153.05	0.19	0.46	0.00	0.00	0.00
260-262	118.77	0.35	0.00	24.39	0.17	0.00	0.00	0.00	0.00
258-260	265.78	0.00	0.00	0.00	0.00	62.52	4.40	0.00	0.00
256-258	185.72	0.00	0.00	0.00	0.00	23.35	0.83	0.00	0.00
< 256	506.27	0.00	0.00	0.00	0.00	18.98	0.00	0.00	0.00

4.1.6 PARR STUDY AREA 6

Study Area 6 is a backwater area located off the mainstem of the reservoir near the Broad River WMA. The study area is dominated by silt and sand substrates with stumps and aquatic vegetation representing the primary structure. Substrate composition shifts from silt at 256-262' to sand at 262-266'. The area is dominated by aquatic vegetation throughout the study area, with stumps most common below elevation 262'. Elevation 264-266' contains the most area exposed by fluctuations in reservoir elevation. Note: This study area also contains some small areas that showed up as dewatered below elevation 256'.

TABLE 4-6 SUBSTRATE AND STRUCTURE COMPOSITION OF EXPOSED SHORELINES IN STUDY AREA 6 OF PARR RESERVOIR

SS6 EXTRAPOLATED		SUBSTRATE									
		SAND		SILT		GRAVEL/COBBLE		UNKNOWN		UNEXPOSED	
Elev Range	Acreage	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI
264-266	101.31	101.27	0.99	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00
262-264	100.98	100.98	0.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
260-262	89.20	32.52	0.26	56.66	0.35	0.00	0.00	0.00	0.00	0.00	0.00
258-260	53.50	0.07	0.00	53.43	1.01	0.00	0.00	0.00	0.00	0.00	0.00
256-258	14.60	0.00	0.00	14.60	1.05	0.00	0.00	0.00	0.00	0.00	0.00
< 256	12.35	0.00	0.00	0.42	0.14	0.00	0.00	0.00	0.00	11.93	0.67

SS6 EXTRAPOLATED		STRUCTURE							
		TREES		SUBMERGED VEGETATION		STUMPS		STREAM CHANNELS	
Elev Range	Acreage	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI
264-266	101.31	90.09	1.27	7.84	2.46	0.00	0.00	0.00	0.00
262-264	100.98	11.14	1.20	67.97	0.80	0.00	0.00	0.00	0.00
260-262	89.20	0.00	0.00	20.08	1.07	18.63	1.13	0.51	0.05
258-260	53.50	0.00	0.00	0.00	0.00	6.85	1.27	4.78	1.20
256-258	14.60	0.00	0.00	0.00	0.00	9.81	1.72	0.00	0.00
< 256	12.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

4.1.7 PARR STUDY AREA 7

Study Area 7 is located along the mainstem of the reservoir adjacent to Study Area 6. The area is long and narrow with a well-defined channel with sparse sandbars and backwater areas. The study area is dominated by silt and sand substrates with aquatic and riparian vegetation representing the primary structure. Substrate composition shifts from silt at 256-262’ to sand at 262-266’. Elevation 264-266’ contains the most area exposed by fluctuations in reservoir elevation.

TABLE 4-7 SUBSTRATE AND STRUCTURE COMPOSITION OF EXPOSED SHORELINES IN STUDY AREA 7 OF PARR RESERVOIR

SS7 EXTRAPOLATED		**SUBSTRATE**									
		SAND		**SILT**		**GRAVEL/COBBLE**		**UNKNOWN**		**UNEXPOSED**	
Elev Range	Acreage	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI
264-266	52.98	37.84	1.42	0.00	0.00	0.00	0.00	15.14	0.32	0.00	0.00
262-264	36.54	33.85	0.83	0.51	0.14	0.00	0.00	2.17	0.13	0.00	0.00
260-262	46.39	6.97	0.11	38.97	1.65	0.00	0.00	0.44	0.14	0.00	0.00
258-260	27.04	15.78	2.95	10.78	0.13	0.00	0.00	0.44	0.10	0.05	0.01
256-258	21.88	6.66	0.69	15.05	0.23	0.00	0.00	0.14	0.00	0.03	0.00
< 256	223.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	223.95	1.98

SS7 EXTRAPOLATED		**STRUCTURE**							
		TREES		**SUBMERGED VEGETATION**		**STUMPS**		**STREAM CHANNELS**	
Elev Range	Acreage	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI
264-266	52.98	29.01	1.13	8.54	0.00	1.76	0.00	0.00	0.00
262-264	36.54	2.72	0.12	20.29	0.00	0.00	0.00	0.00	0.00
260-262	46.39	0.00	0.00	0.00	0.00	6.31	0.37	4.51	0.45
258-260	27.04	0.00	0.00	0.00	0.00	4.13	0.06	3.09	0.79
256-258	21.88	0.00	0.00	0.00	0.00	1.74	0.16	0.00	0.00
< 256	223.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

4.1.8 PARR STUDY AREA 8

Study Area 8 is located along the mainstem in the upper portion of the reservoir. The area is long and narrow with a well-defined channel and steep banks. The study area is dominated by silt and sand substrates with riparian vegetation and channels representing the primary structure. Substrate composition shifts from silt at 258-260’ to sand at 260-266’. Elevation 262-264’ contains the most area exposed by fluctuations in the reservoir.

TABLE 4-8 SUBSTRATE AND STRUCTURE COMPOSITION OF EXPOSED SHORELINES IN STUDY AREA 8 OF PARR RESERVOIR

SS8 EXTRAPOLATED		SUBSTRATE									
		SAND		SILT		GRAVEL/COBBLE		UNKNOWN		UNEXPOSED	
Elev Range	Acreage	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI
264-266	23.87	15.74	1.17	0.00	0.00	0.00	0.00	8.13	0.09	0.00	0.00
262-264	152.60	5.23	0.62	3.47	0.07	0.00	0.00	1.14	0.06	142.73	1.56
260-262	79.86	3.32	1.58	13.68	0.78	0.00	0.00	0.00	0.00	62.85	3.13
258-260	12.89	0.00	0.00	12.89	8.93	0.00	0.00	0.00	0.00	0.00	0.00
256-258	0.77	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
< 256	0.11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

SS8 EXTRAPOLATED		STRUCTURE							
		TREES		SUBMERGED VEGETATION		STUMPS		STREAM CHANNELS	
Elev Range	Acreage	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI
264-266	23.87	23.11	0.28	0.00	0.00	0.00	0.00	0.00	0.00
262-264	152.60	0.15	0.10	0.00	0.00	0.08	0.00	3.58	0.00
260-262	79.86	0.00	0.00	0.00	0.00	1.56	0.31	3.95	0.00
258-260	12.89	0.00	0.00	0.00	0.00	0.00	0.00	12.89	0.00
256-258	0.77	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
< 256	0.11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

4.1.9 PARR STUDY AREA 9

No substrate and structure data could be collected in Study Area 9 due to the riverine nature of the study area. This Study Area did not exhibit any measurable habitat dewatering resulting from reservoir fluctuations at the flow experienced on the day of data collections. The area does contain ledges that offer significant riverine habitat but none of these were exposed even at the lowest observed reservoir elevations of 256.1’ msl at the dam.

4.1.10 TOTAL PARR RESERVOIR AREAS

The total amount of shoreline exposed at each two foot drawdown is shown in Table 4-9. The estimated acreage exposed was calculated by subtracting unexposed area estimates from the total area within each contour interval.

TABLE 4-9 TOTAL AREA OF SHORELINES EXPOSED IN ALL STUDY AREAS OF PARR RESERVOIR COMBINED

ELEVATION	ESTIMATED ACREAGE EXPOSED	ESTIMATED TOTAL CUMULATIVE ACREAGE EXPOSED
264-266	492.08	492.08
262-264	428.63	920.71
260-262	391.54	1312.25
258-260	607.20	1919.44
256-258	436.05	2355.49

4.1.11 PARR RESERVOIR NAVIGATION

Navigation restrictions were noted during the TWC field observations at elevation 256.1 msl. Navigation in the mainstem of the reservoir did not appear to be restricted as a definite channel was observed throughout the reservoir. During the observations, a navigation channel was most restricted in the mouth of Heller’s and Cannon’s creeks. Heller’s Creek had both sediments and stumps that reduced or prevented boat traffic at the lowest level of drawdown. Cannon’s Creek was restricted mostly by the presence of stumps. However, a navigation channel was navigable between the stumps from the mouth upstream to the Cannon’s Creek boat access (Mealing pers. com. 2015).

4.2 MONTICELLO RESERVOIR

During the September 29, 2015 Fisheries TWC meeting, critical habitat areas on Monticello Reservoir were identified to be analyzed for potential enhancement measures. Because the reservoir experiences several feet of fluctuation each day and it is not a natural stream bank, the shoreline diversity is very limited. There is a general lack of structure and stable substrates in shallow areas that would be used by typical warmwater species present in the reservoir. TWC discussions identified three types of aquatic enhancements that would be beneficial primarily to the Centrarchid (and secondarily to the Ictalurid) populations in the reservoir. These enhancements included: shallow water spawning areas, fry rearing structures to be positioned near the identified spawning areas, and deep water structures to attract adult fishes and enhance recreational fishing. The TWC noted that any enhancements installed should be located below elevation 420’ msl to ensure that they would not be exposed during reservoir fluctuations or serve as a navigation hazard.

TWC discussions indicated that spawning area enhancements should be located in cove areas with stable sloped banks, which include Areas 1, 2, 3, 4, 6, and 9 (Table 4-10). Table 4-10 also included the total length of shoreline for each Area to give a relative understanding of the amount of proposed spawning enhancements. In Areas where shoreline spawning enhancements were proposed, fry rearing structures were also proposed to help protect swim up fry as they migrate from the spawning area enhancement.

Deep water structures were identified for Areas 1, 3, 4, 5, 7, 8, and 9. These structures were positioned in open cove areas, cove mouth areas, or in open water areas adjacent to islands in Monticello Reservoir. The proposed habitat enhancements are also included within the table and illustrated in Figures 1-9 in Appendix B.

A preliminary list of costs for the various habitat enhancement structures (not including labor for installation) is provided in Appendix C (Mossback 2015). These prices are based on the Mossback company designs and price list available at http://www.mossbackrack.com/. These structures were selected as a basis for costs because of the product durability and presence and use in southeastern reservoirs. Initial contacts with Mossback have indicated the company’s ability to work as a contractor for installation and design of habitat enhancements for specific reservoir applications. Unit costs for spawning areas is not as definitive at this point and will require additional discussions with the TWC on final length and location, design, and type of product used to build and maintain them.

TABLE 4-10 POTENTIAL MONTICELLO HABITAT ENHANCEMENTS

MONTICELLO RESERVOIR CRITICAL HABITAT AREAS		**POTENTIAL HABITAT ENHANCEMENTS**			
Area Number	Shoreline Length (ft)	Spawning Habitat (ft)	Percent of Shoreline (%)	Fry Rearing	Deepwater Attractor
1	8947	450	5.0	3	3
2	2422	100	4.1	1	0
3	5966	225	3.8	2	2
4	1434	150	10.5	2	1
5	deep water	0	0	0	2
6	629	50	7.9	1	0
7	deep water	0	0	0	3
8	deep water	0	0	0	2
9	4936	150	3.0	0*	1
TOTALS	**24334**	**1125**		**9**	**14**

*Fry habitat was not proposed for Area 9 due to the extensive amount of rip-rap areas adjacent to the proposed spawning enhancement.

5.0 DISCUSSION

The Parr Reservoir results will be reviewed and discussed with the TWC[1]. The study results will provide a basis for the TWC to identify the magnitude of impact associated with reservoir fluctuations and develop potential alternatives to reduce the impacts, as well as aid in the identification of priority areas for potential PM&E measures that could be considered as part of the Settlement Agreement.

The Monticello Reservoir results will also be presented to the TWC for review and discussion. The proposed habitat enhancements should provide a basis for discussion and recommendation of the types and amounts of habitat enhancements that could be proposed for the Settlement Agreement. The proposed enhancements should provide benefits to various life stages of Centrarchids (spawning and fry rearing) within Monticello Reservoir. The deep-water structures should provide habitat for several types of adult fish and enhance fishing opportunities in the reservoir. While Centrarchids are the primary focus of the listed aquatic habitat enhancements, the stable structures may provide additional benefits to other species of fish and aquatic biota (mussels and macroinvertebrates).

[1] A Fisheries TWC meeting was held on March 3, 2016 to discuss this report. Meeting notes are included in Appendix D.

6.0 REFERENCES

Orbis. 2015. Contractor for collection of Photogrammetry data and conversion to a Digital Elevation Model for Parr and Monticello Reservoirs, March 2015.

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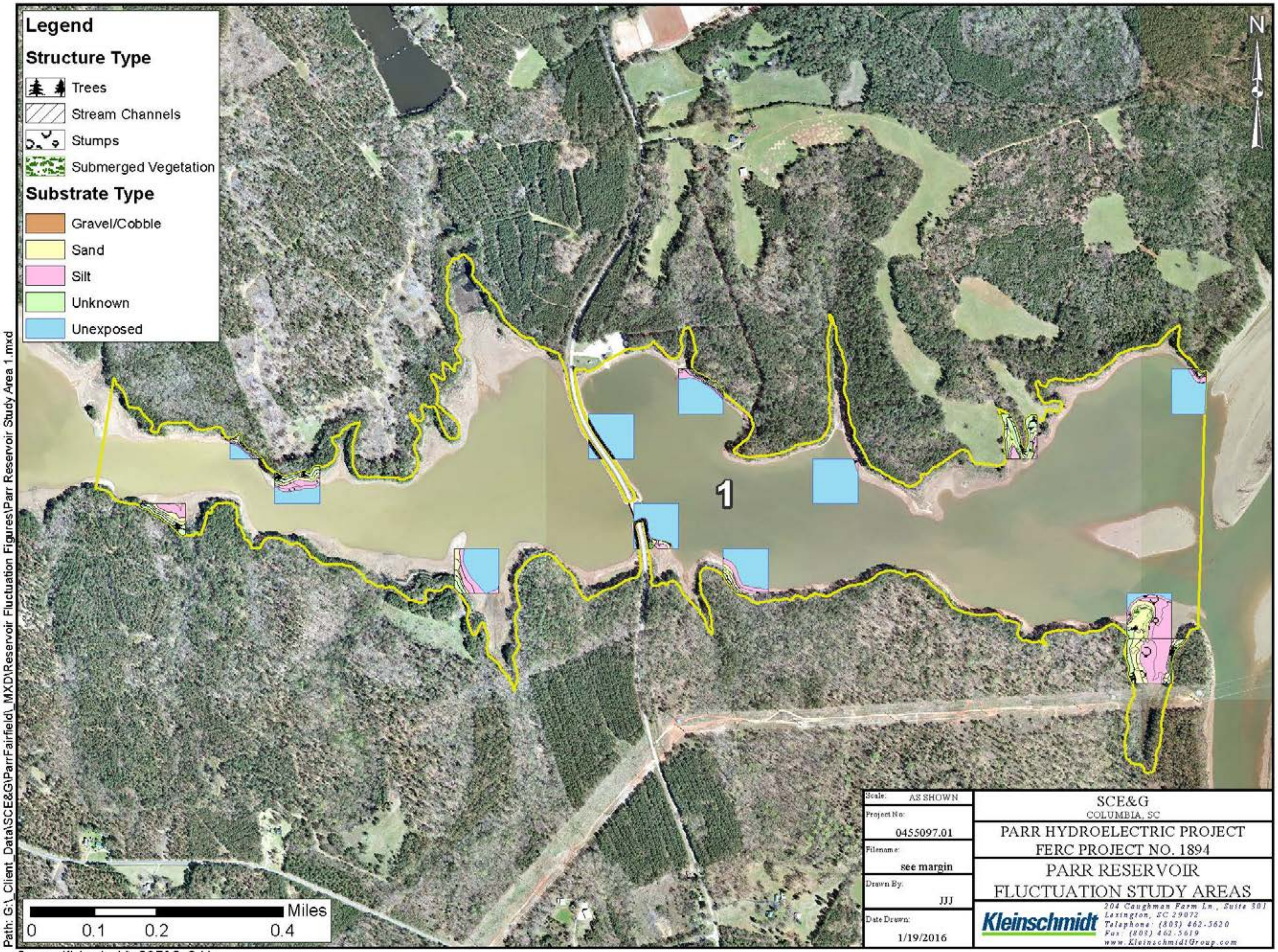
APPENDIX A

PARR RESERVOIR STUDY AREAS



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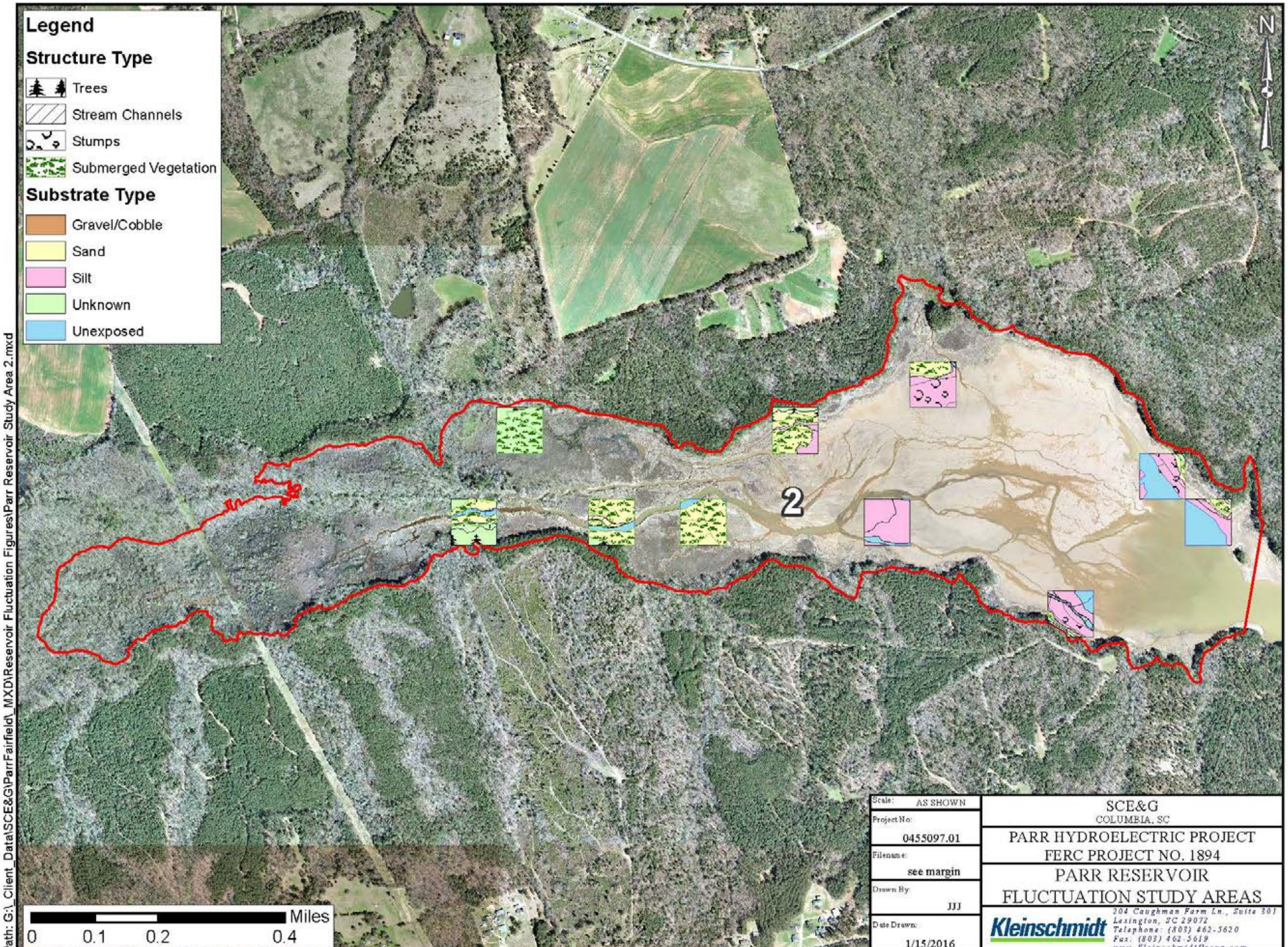

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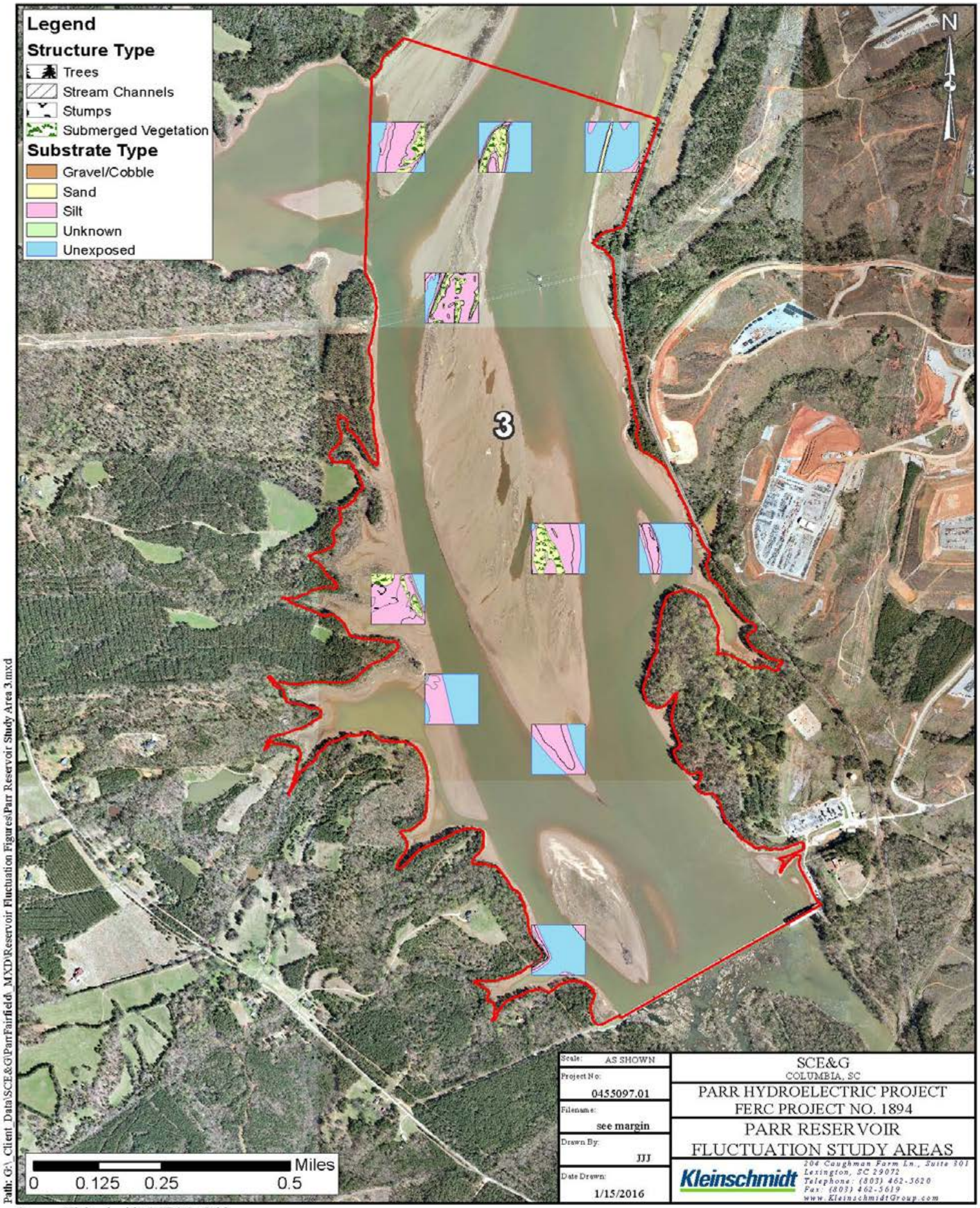

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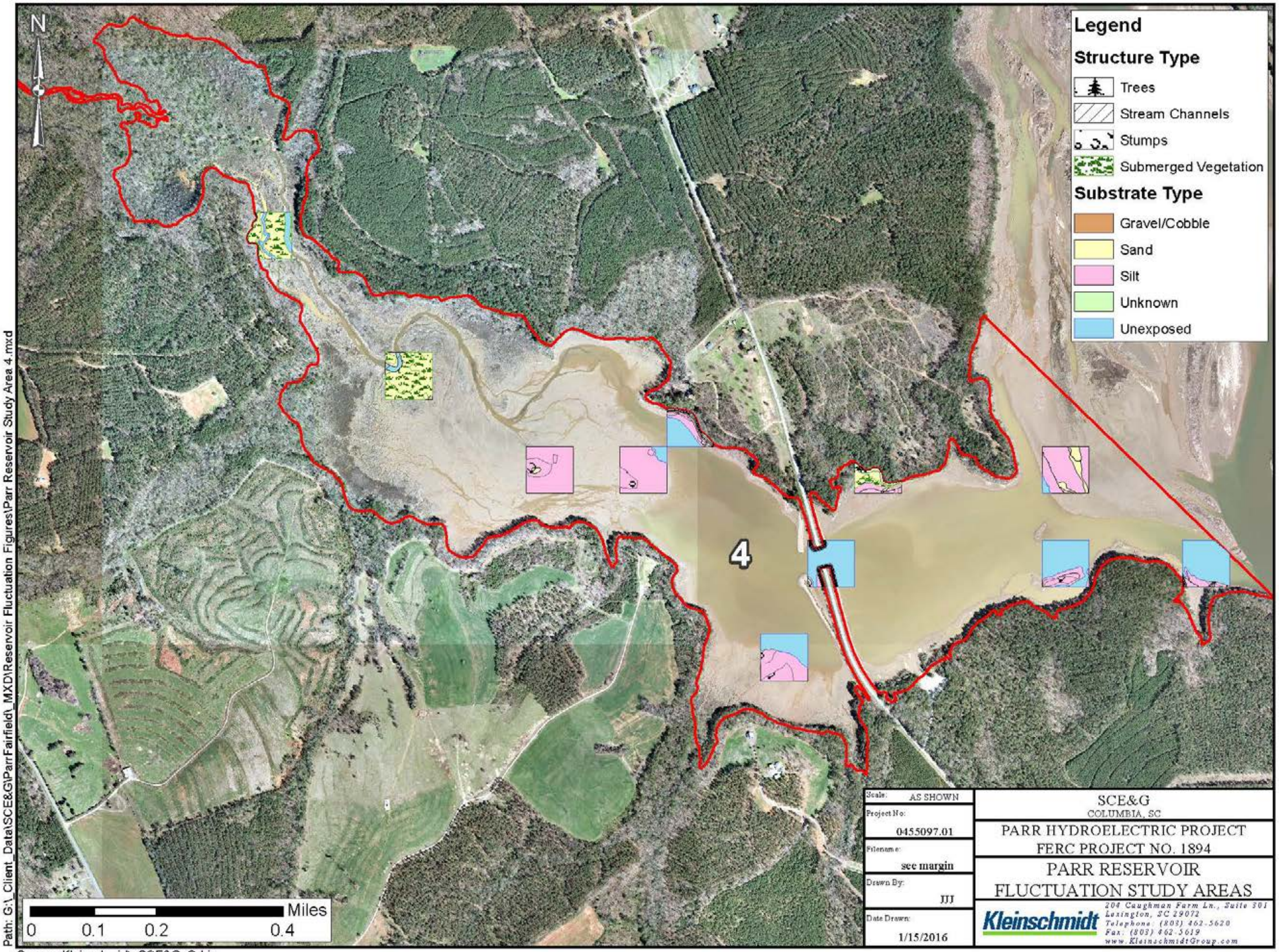

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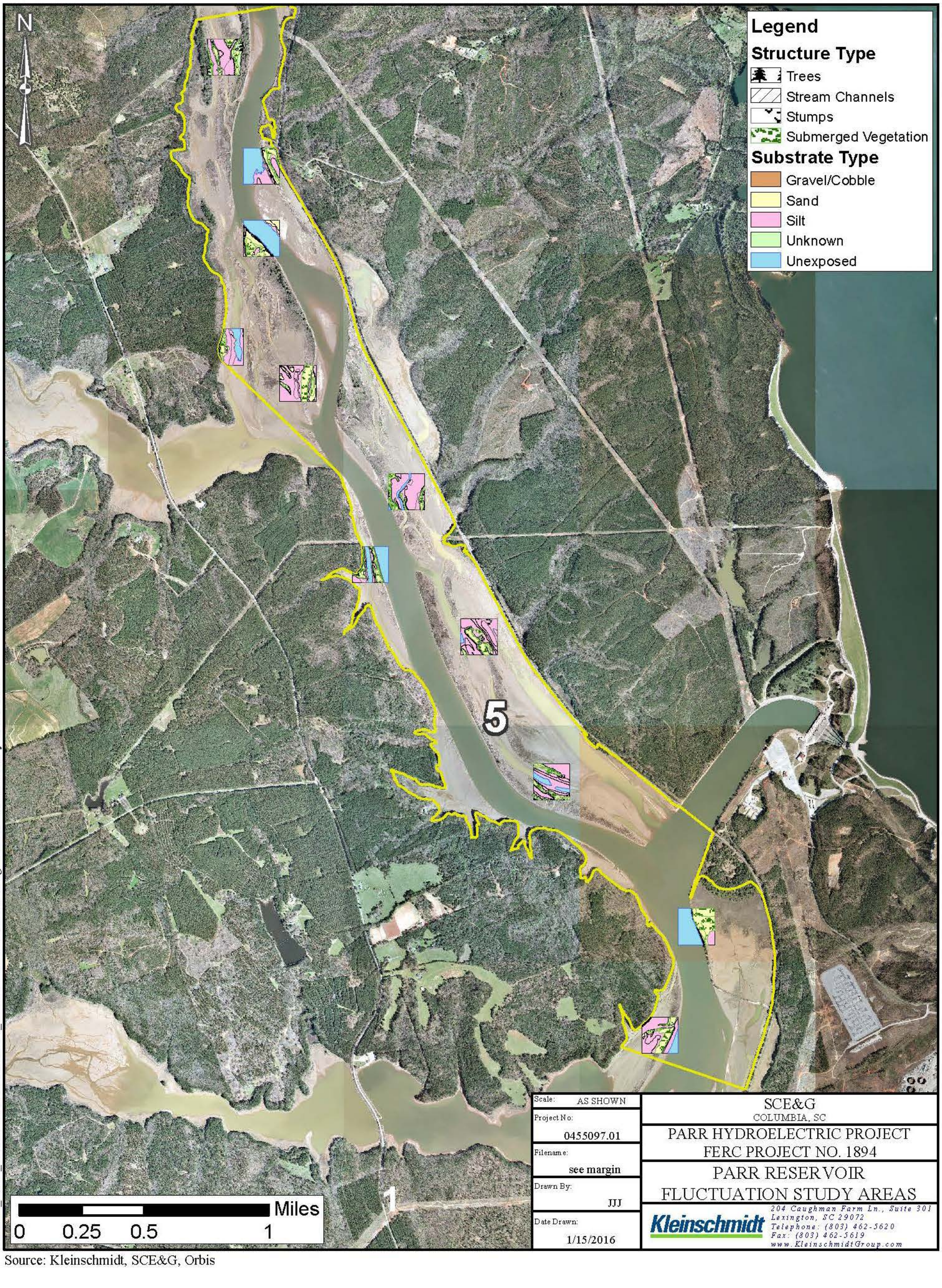

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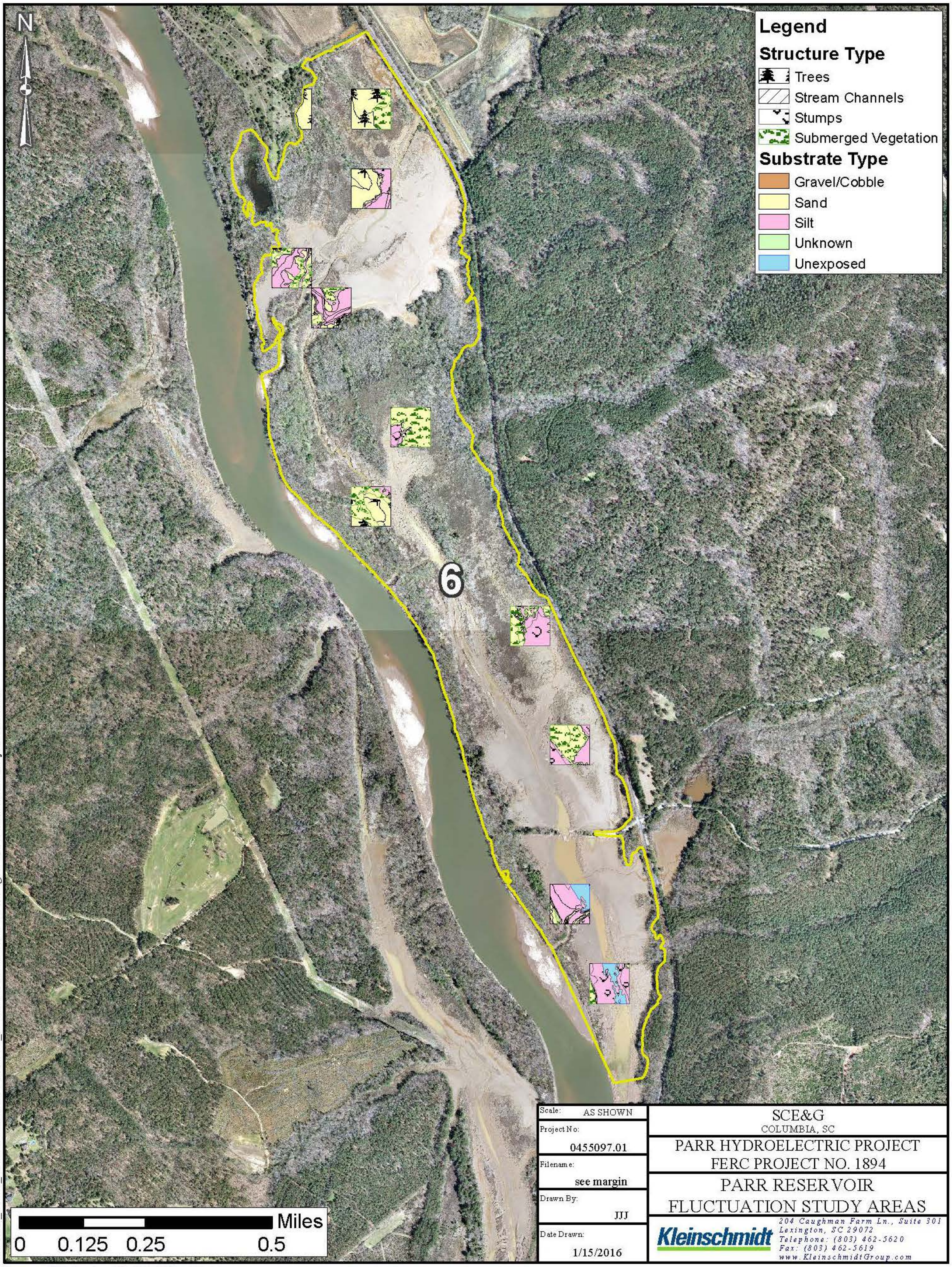

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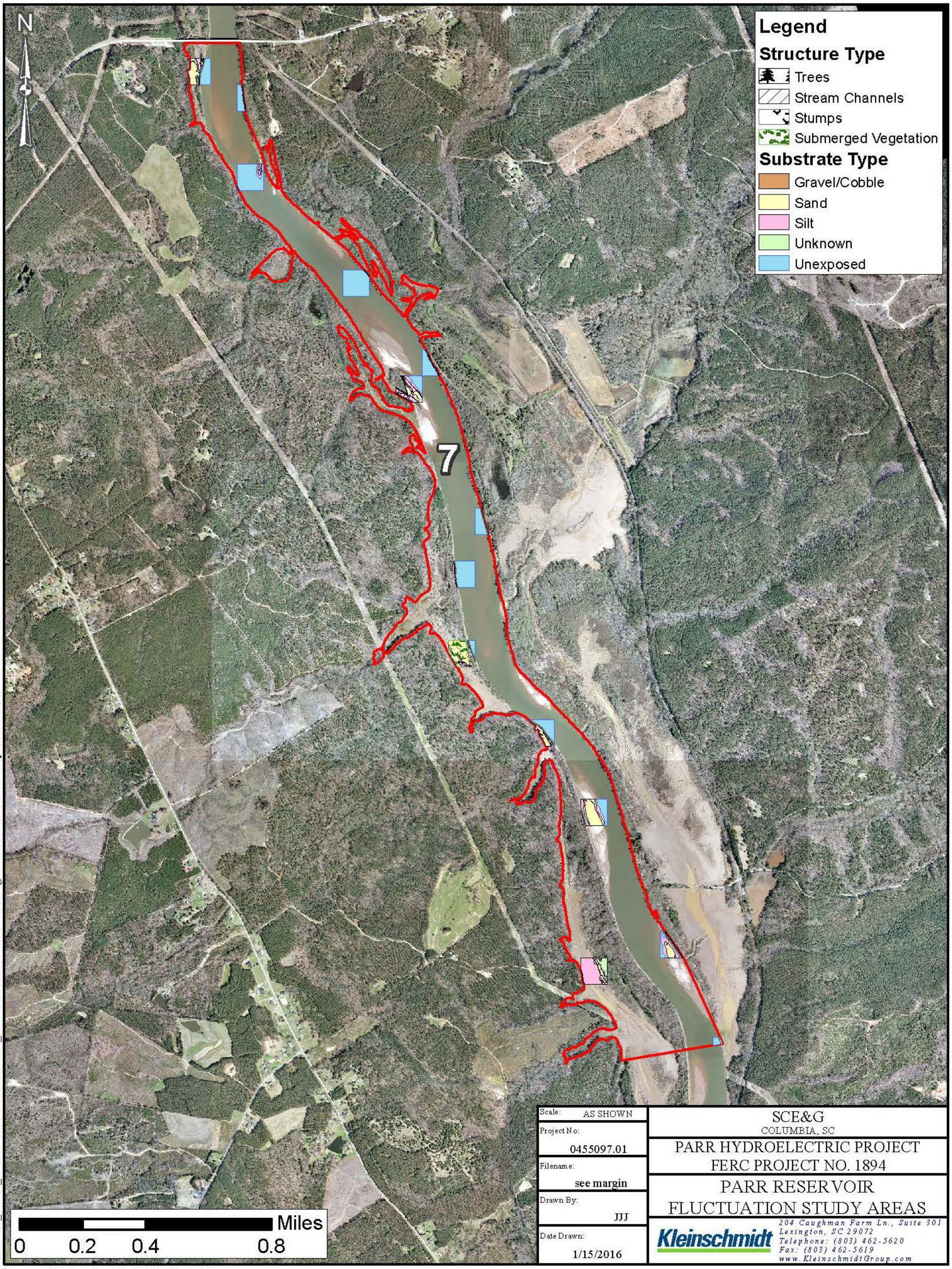

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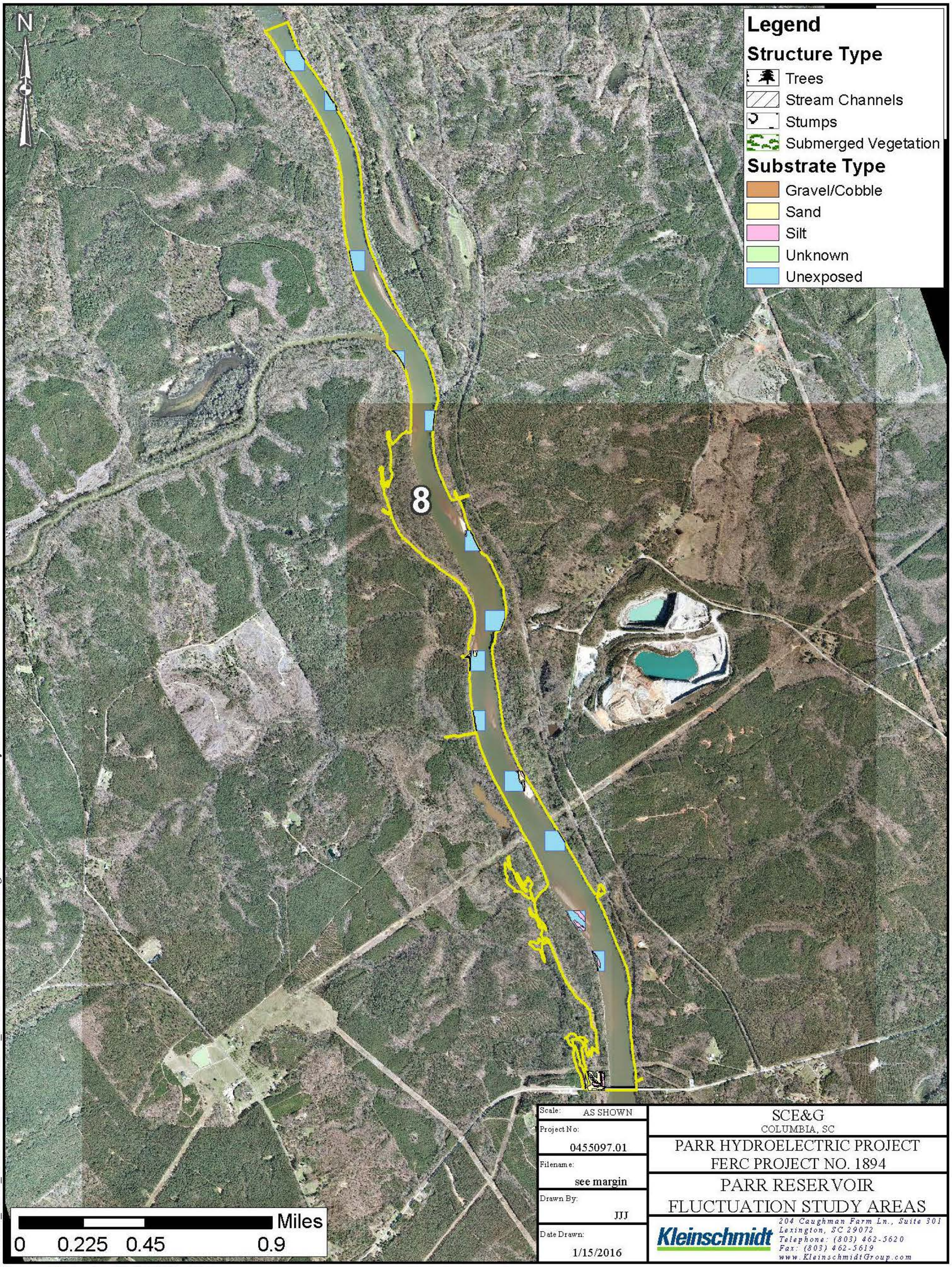

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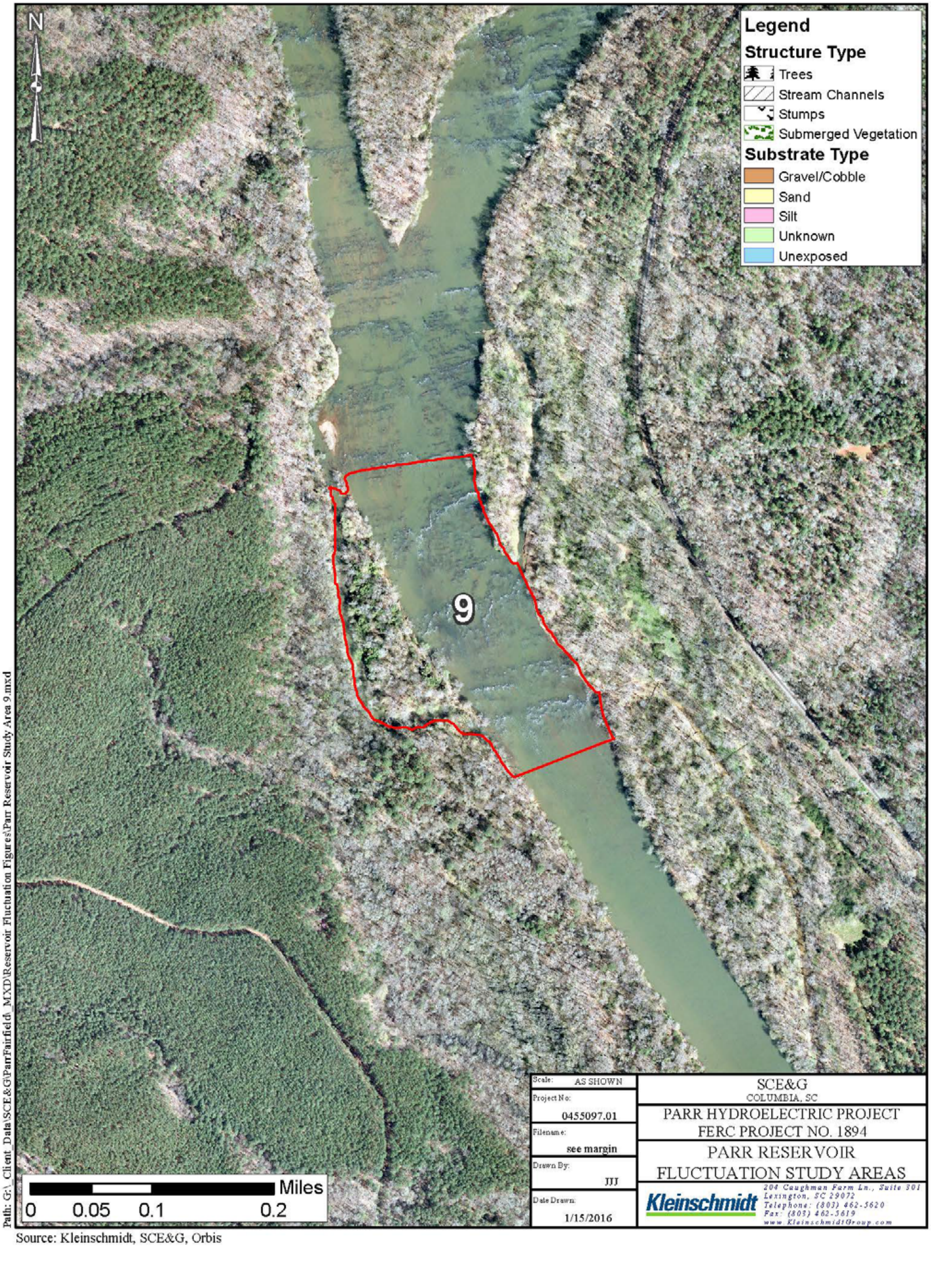

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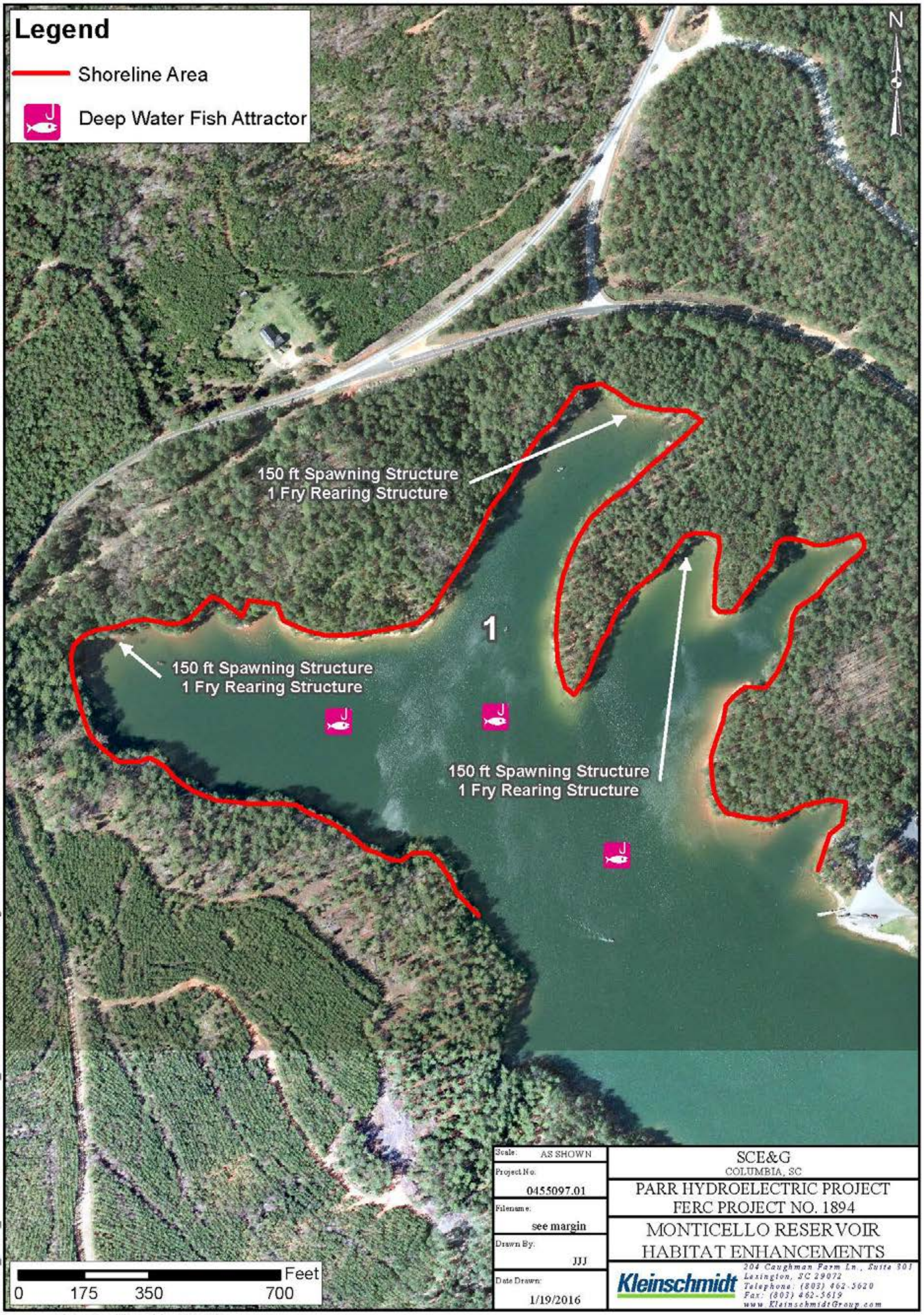
Source: Kleinschmidt, SCE&G, Orbis

APPENDIX B

MONTICELLO RESERVOIR STUDY AREA HABITAT ENCHANTMENTS



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Source: Kleinschmidt, Orbis, SCE&G

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Source: Kleinschmidt, Orbis, SCE&G

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Project No: 0455097.01	PARR HYDROELECTRIC PROJECT FERC PROJECT NO. 1894
Filename: see margin	MONTICELLO RESERVOIR HABITAT ENHANCEMENTS
Drawn By: JJJ	
Date Drawn: 1/13/2016	Kleinschmidt 204 Caughman Farm Ln., Suite 301 Lexington, SC 29072 Telephone: (803) 462-5620 Fax: (803) 462-5619 www.KleinschmidtGroup.com

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Source: Kleinschmidt, Orbis, SCE&G

Scale: AS SHOWN	SCE&G COLUMBIA, SC
Project No: 0455097.01	PARR HYDROELECTRIC PROJECT FERC PROJECT NO. 1894
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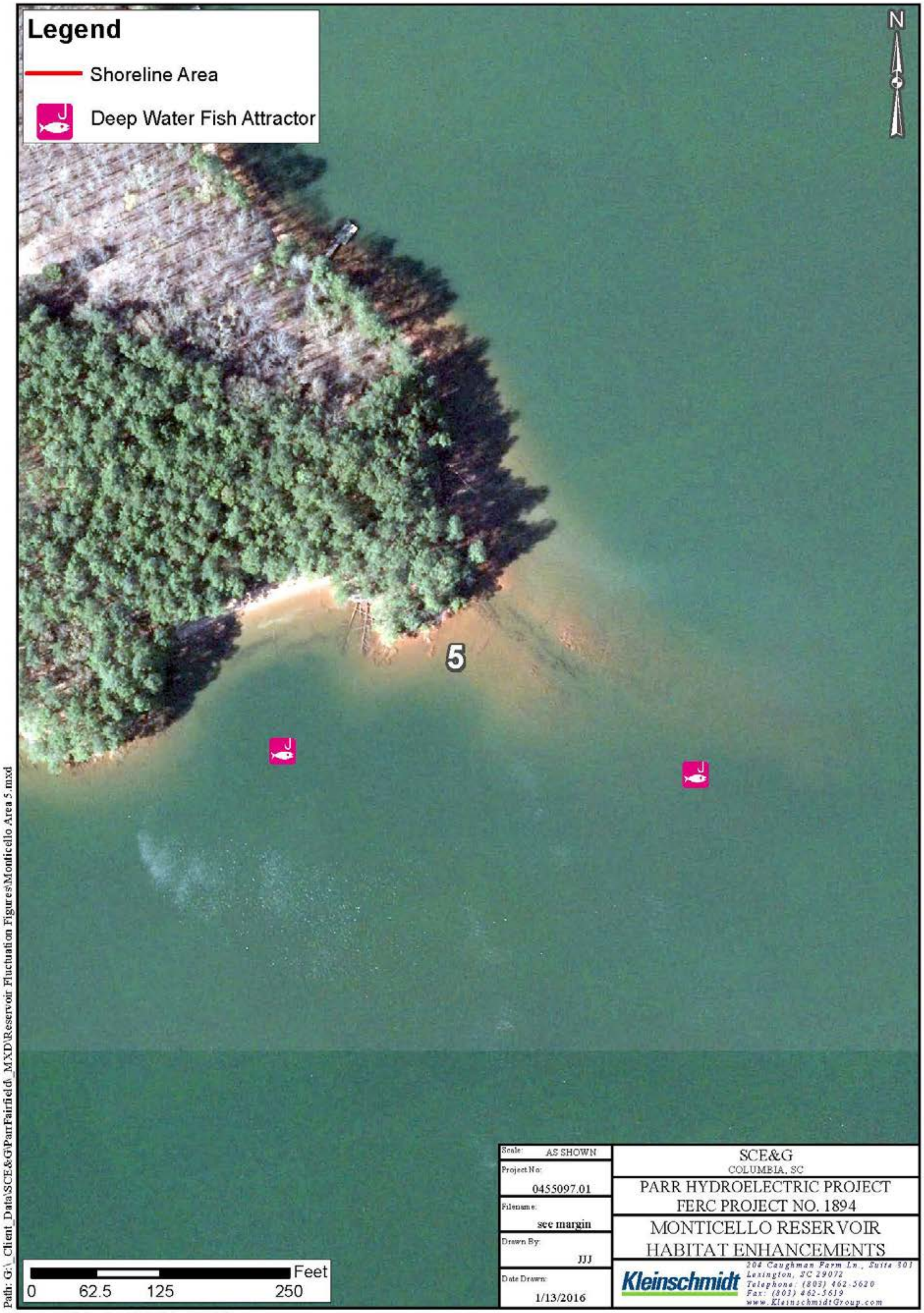
Source: Kleinschmidt, Orbis, SCE&G



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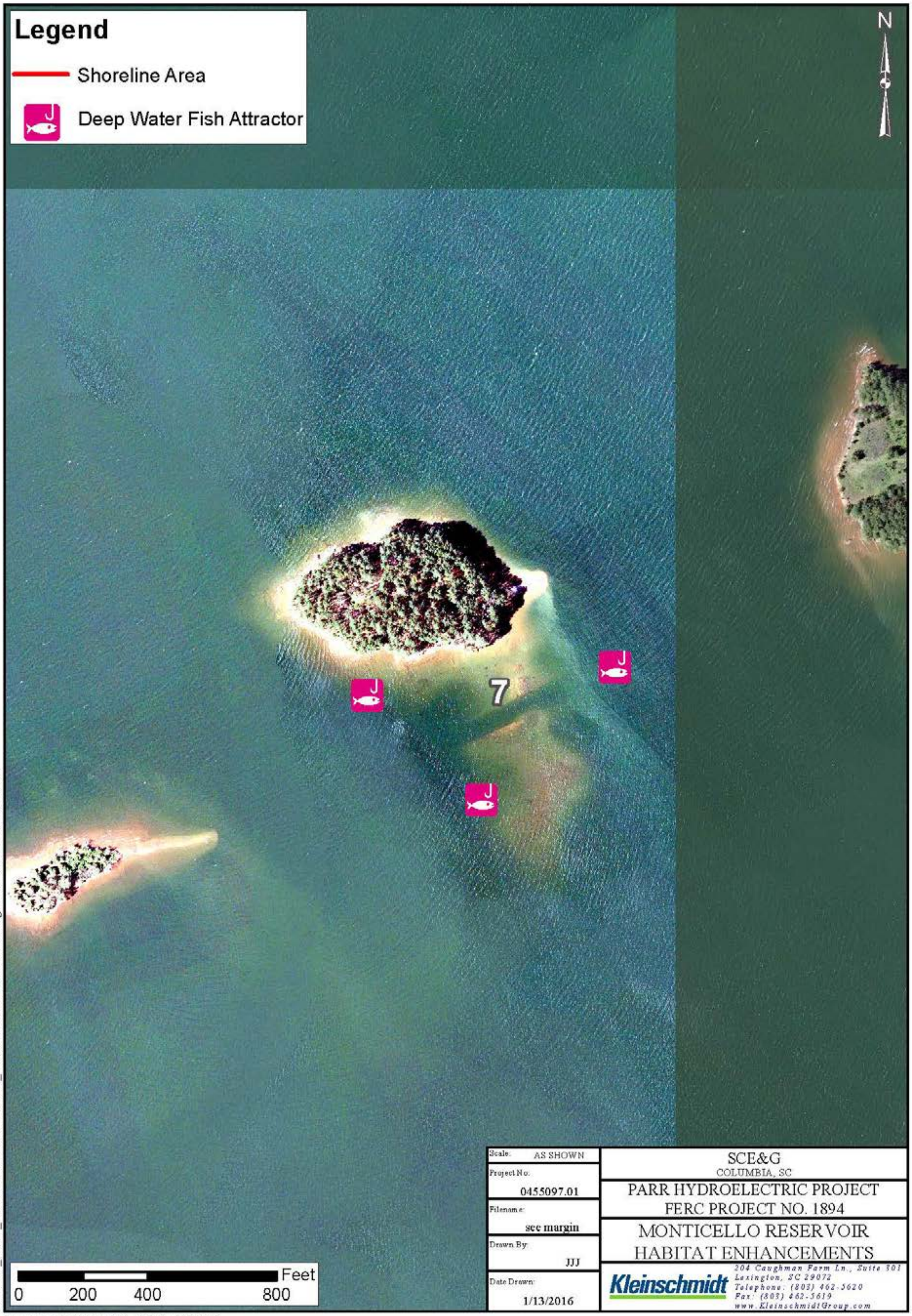

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Source: Kleinschmidt, Orbis, SCE&G

APPENDIX C

MOSSBACK FISH HABITAT STRUCTURE COSTS

TABLE 4-1 MOSSBACK FISH HABITAT STRUCTURE COSTS

MOSSBACK FISH ATTRACTOR KITS	
Juvenile Structure	Cost
Fry Cage	$499.95
Safe Haven 5-Post	$224.95
Safe Haven 9-Post	$529.95
Adult Structure	Cost
MB1 Trophy Tree	$324.95
MB2 Trophy Tree	$599.95
Reef Kit	$499.95
Mega Reef Kit	$1,129.95

APPENDIX D

FISHERIES TWC MEETING NOTES
MARCH 3, 2016

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
Fisheries TWC Meeting

March 3, 2016

Final KMK 03-07-16

ATTENDEES:

Bill Argentieri (SCE&G)
Ray Ammarell (SCE&G)
Randy Mahan (SCE&G)
Brandon Stutts (SCANA)
Caleb Gaston (SCANA)
Tom McCoy (USFWS) via conf. call
Fritz Rohde (NOAA) via conf. call

Dick Christie (SCDNR)
Bill Marshall (SCDNR)
Alex Pellett (SCDNR) via conf. call
Henry Mealing (Kleinschmidt)
Kelly Kirven (Kleinschmidt)
Jordan Johnson (Kleinschmidt)

These notes serve as a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

Henry opened the meeting with introductions and told the group the purpose of the meeting was to review the Reservoir Fluctuation Report and identify any Protection, Mitigation and Enhancement (PM&E) measures that might be associated with fluctuation of Parr and Monticello reservoirs.

<u>Parr Reservoir</u>

Henry explained the methodology included in the study, where Parr Reservoir was divided into nine segments and 10% of each segment was analyzed to determine how much and what type of habitat was dewatered at each 2 foot increments from 266 down to 256.1 msl.

TWC members had expressed concern over the fluctuation of Parr Reservoir, and so the group tried to identify ways to improve habitat and navigation in the reservoir.

Bill M. asked for ways that navigation could be improved when the reservoir was low. Henry said that at Heller's Creek, stumps could be removed, however this would also remove important fish habitat. Bill M. suggested that only some stumps be removed, to allow for better navigation, but to still provide some fish habitat. Henry said that improving access from Heller's Landing could be considered as a PM&E measure.

Dick said another idea would be to limit fluctuations on both Parr and Monticello reservoirs during spring fish spawning. He understands that this is a difficult issue to address and that this could be something that is done only when conditions allow. Bill A. asked if it's more important to keep the habitat wetted or dry and Dick said that it's more important for the reservoir level to remain stable. Ideally, both reservoirs would be full and stable during spawning, however if the reservoir can't be full, then they should be stable, so fish nests aren't left dry when the water level drops. Bill A. and

Ray said they would talk with operators to see if this is possible. It would also depend on how much water is coming from upstream, although in the spring, generally there is excess water, which may make it easier to hold the reservoir at a steady level.

Henry said that Ron Ahle (SCDNR) had mentioned in a previous TWC meeting that it would be nice to stabilize one of the side channels as a small impoundment in Parr Reservoir, similar to the Recreation Lake at Monticello Reservoir, as a PM&E measure. The group discussed the possibility of this and how the US Army Corps of Engineers (USACE) might handle it. The group looked at maps of Parr and identified a small side channel area as the potential site for an impoundment. Brandon said it would likely be difficult to obtain a permit, plus mitigation would need to be done to account for the loss of wetlands or streams. The railroad would also need to be contacted to see how this would possibly affect their operations, since the railroad tracks run close to the area in question. Caleb also mentioned that duck hunters would need to be considered, since this proposed area for the impoundment is a heavily used location for duck hunting. Navigation into and out of this area could become an issue.

The group also listed the following items for consideration regarding the impoundment:

- build a berm or gate around the 262' or 260' mark, approximately 125 feet long
- the impoundment would need to be somewhat small, so it wouldn't affect storage in Parr (how many acre feet would this take away from operations)
- build a temporary structure that could be installed only during the spring (March, April, May), so sediment doesn't build up, hunting isn't affected, and water doesn't get stagnant
- potentially build a boat ramp that allows for access inside the impoundment (could be considered a recreation enhancement as well)

Tom was concerned about how this structure may cause navigation issues and possible sediment issues for fish and mussels when removed each year. He indicated that a permanent structure, such as a rice trunk, may be the best option. The group decided that this option needs to be discussed further, both internally for SCE&G and externally with the USACE.

Henry said the take-home message regarding Parr Reservoir fluctuations is that SCE&G doesn't bring the pond level up to 266' very often, as evidenced by the amount of vegetation growing in the upper contours. Below elevation 260', substrate is mainly sand and silt with large numbers of stumps. There is a large amount of natural structure occurring lower in the reservoir along the shorelines, while the upstream sections of the reservoir are more riverine.

<u>Monticello Reservoir</u>

One of the goals identified by the TWC in the Study Plan was to focus on identifying PM&E measures in this reservoir to enhance spawning/recruitment/and fishing to mitigate for fluctuations. Prior to the meeting, Dick prepared and distributed a document outlining potential enhancements for Monticello Reservoir, from SCDNR's perspective. This document is attached to the end of these notes.

Bill A. asked how SCE&G will show compliance with some of the enhancements that Dick proposed. Dick said that license articles could be worded to require consultation with agencies. Implementation of enhancements can be documented and agencies would send in letters of confirmation that work was completed. He is not concerned with performing creel surveys or other studies to prove that enhancements are improving fish recruitment in the reservoir. He believes that the enhancements he is proposing have already been proven in many studies in other reservoirs to increase fish production. The installation of these enhancements should be considered successful compliance with the license article.

SCE&G said they are concerned about some of the proposed enhancements, including the amount of gravel needed and possible re-contouring of shorelines. Dick said these are just examples of some things that can be done, but SCDNR would be willing to negotiate on these items. He said that ideally, SCE&G would install all of the agreed upon enhancements versus just providing the funding for work to be done. However, SCDNR may be able to provide some assistance during installation, in the way of boats or technicians.

The group discussed the different ideas that Dick presented and agreed that a PM&E measure could address installing three different types of fish habitat: spawning, nursery, and deep water, which agrees with the report. Some of the attractors could be purchased from Mossback, or a similar company, and some could be built by SCE&G. Brandon and Caleb brought an example of a deep water attractor to the meeting that they built using scrap parts. A photo is included below.

PHOTO 1 DEEP WATER FISH ATTRACTOR BUILT BY SCE&G

The TWC and report initially identified “9 enhancement areas” on Monticello. The group discussed these and other areas of the reservoir and identified approximately 20 areas around the lake where spawning, nursery, and/or deep water fish attractors could be installed. Some of the 20 areas included all three components, while others included only one or two. The group agreed to the following specifics for each habitat type:

- Spawning – areas will be approximately 1000ft x 10ft, and will include up to 200 spawning disks or gravel beds – spawning disks will be installed in groups of 3-5
- Nursery – areas will be paired with spawning sites above and will include approximately 15 nursery/fry structures, such as the fry cage built by Mossback or handmade stake beds or bamboo structures built by SCE&G.
- Deep water – each deep water site will be approximately 1500 square feet, with approximately 15 structures scattered around a central buoy. Structures can be constructed by SCE&G or purchased from Mossback.

SCE&G and Kleinschmidt will put together a PM&E proposal that addresses site location, cost estimation, and installation schedule. This will be brought back to the TWC for review and discussion. The group discussed several different schedules for the term of the new license, including installing enhancements in two sessions several years apart, or installing one or two sites per year for 15 years. The group also discussed prioritizing sites and installing in phases during the first 30 years of the license. Everyone agreed that at least one pause in the timeline is necessary for a check and adjust on the process.

Kleinschmidt will order a few fish attractors from Mossback to use for testing. The TWC will plan to meet at the reservoir later in the spring to field verify the sites identified and possibly install a few fish attractors to determine level of difficulty. Dick noted that Robert Stroud (SCDNR) should be involved, since he is the SCDNR representative assigned to Monticello Reservoir. Scott Collins (SCE&G) will also be consulted to ensure that the sites identified are not located in areas where docks can be permitted.

The meeting adjourned. Action items from this meeting are listed below.

ACTION ITEMS:

- SCE&G will discuss internally the option of building a berm at the site on Parr Reservoir identified in the meeting. Depending on the outcome of this discussion, they, potentially along with SCDNR, will talk with USACE about permitting this action.
- SCE&G and Kleinschmidt will put together a PM&E proposal detailing the next steps for installing fish habitat enhancement in Monticello Reservoir – types, places, timeline.
- Kleinschmidt will order some fish attractors from Mossback for testing.
- The TWC will meet later in the spring to visit the Monticello Reservoir sites identified in the meeting for fish habitat enhancement.

Aquatic habitat enhancement in Monticello Reservoir

Monticello Reservoir is a 6,800 acre impoundment associated with the Parr Shoals Hydroelectric Project (project). This project is a pump-back project that utilizes the Fairfield Pumped Storage Facility to generate electricity and refill the lake. The project has the capacity to transfer up to 29,000 acre-feet of water between Parr Shoals reservoir and Lake Monticello, and for the period 2005-2013, average daily fluctuations in Lake Monticello were 2.35 feet. However, the authorized daily operational range is 4.5 feet, which could result in a minimum reservoir level (MRL) of 420.5 feet and should be considered in the placement of any fish habitat.

When the project is operated at the minimum reservoir levels, the surface acreage is reduced from 6,800 acres to 6,467 acres, which results in the dewatering of about 333 acres or (14.5 million sq. feet) This shoreline, which is exposed on a daily basis, is generally devoid of aquatic or terrestrial vegetation, woody debris, or other structure that could provide habitat for aquatic organisms. Much of this shoreline is a silt/clay hardpan material.

To mitigate project effects on littoral habitat, the fisheries technical working committee (TWC) is developing a proposal to supplement aquatic habitat in Monticello Reservoir. The TWC recommended 1) enhancements should provide habitat for spawning, nursery area and deep water cover; 2) they should be installed in close proximity to facilitate movements from one habitat type to another; and 3) ideal spawning habitat would be located in the backs of coves protected from the wind.

Draft DNR Proposal: DNR recommends a robust fisheries enhancement program be implemented over the term of the new license. If the new license is issued for a term of 30-years, we recommend enhancement of a minimum of 15 coves on Lake Monticello. In the event a License is issued for more than 30 years, an additional 5 coves should be enhanced for each additional 10-year period. Enhancement efforts should focus on the creation of spawning, nursery and deep water cover or attraction habitats. In keeping with proposed language in the General Permit (GP) for Lake Monticello, *inshore enhancements* would include spawning and nursery habitats, and be placed in shallow water areas along shorelines and within coves, in a minimum depth of 3 feet below MRL (with the exception of felled or hinged trees). Ideal areas for inshore structures exist in areas with little to no human habitation, docks, piers or boat landings. *Open water enhancements* would be located in deep water areas away from shorelines, in water depths where the tops of the structures would be a minimum of 6 (?) feet below MRL and would not interfere with navigation. Ideal areas for open water structures exist where the absence of aquatic vegetation, submerged woody debris, or topographical depressions may provide natural fish habitat.

Spawning habitat – Cove selection is important and should be conducted in coordination with the resource agencies. Selected coves would be enhanced with structure that provides substrate suitable for spawning and cover to attract spawning fish and to provide protection for fry. Area covered (square feet) is probably more important than height (cubic feet) for spawning habitat. Spawning habitat should cover an area ranging from about 0.25 to 1 acre in each cove, which would result in a total reservoir enhancement of between 3.75 and 15 acres. Each area would be from 1000 – 2000 linear feet in length and 10-20 feet wide, depending on topography, and these areas would be located primarily in the backs of coves.

Enhancement materials could include, but are not limited to:

- gravel beds 3-4 inches in depth with aggregate ranging in size from pea gravel to crusher run (or native stone equivalent);
- spawning benches created by utilizing a 4 to 6 foot piece of log sawed lengthwise in half and attached to cinder blocks on each end; and
- spawning discs such as the Honey Hole spawning disc. Honey Hole recommends installing up to 24 discs per acre in groups of 3 to 8. We are thinking that a minimum of 200 discs/1000 linear feet of shoreline may be adequate if used alone, fewer if other spawning habitats are also used.

A combination of these various habitat types is recommended. Rock jetties less than 2 feet high and or stump fields and felled trees should be placed near the spawning habitat to provide cover for all life stages and to stabilize gravel. During periods of low water levels, exposed lake bottoms may be re-contoured to excavate a shallow depression in which to hold gravel for spawning beds. All of the structures utilized to provide spawning habitat would be generally located in water depths of 3 – 6 feet below MRL and marked with appropriate signage and/or noted with downloadable GPS data.

Nursery habitat – for each cove, several shallow water structures should be established to serve as nursery habitat. These structures should be designed to provide cover for fry and juveniles and substrate for periphyton, and would be placed near the spawning areas and in depths of water ranging from 6 -10 feet at MRL. The goal would be to establish a minimum of 2-3 "nursery areas" associated with each spawning area, each consisting of a minimum of 12 habitat units (8 feet by 8 feet) spread over an 800 -1000 square foot area. Some vertical profile is important (2-4 feet tall) for this habitat type, as is the need for numerous small interstitial spaces that exclude fish larger than 6 inches. Enhancement areas would be marked with appropriate signage and/or noted with downloadable GPS data.

Enhancement materials for nursery habitat could include:

- rock jetties 3-4 feet tall;
- stump fields;
- a combination of rock jetties and stump fields;
- concrete or corrugated culverts no greater than 24 inches in diameter;
- homemade pvc attractors;

- commercial artificial structures such as the Mossback safehaven or 9-post safehaven structures; and
- low-profile horizontal bamboo bream nursery mats.

Open water habitat - open water habitat enhancement (fish attractors) will be established at suitable locations, and would generally be located in the proximity of the spawning/nursery area enhancements but could also be located in other areas as determined by the TWC. The purpose of these areas is to enhance structure and habitat to provide cover, feeding areas and attraction for larger fish, and they would be placed in water depths between 12 and 20 feet at MRL. Vertical profile is very important for attraction habitat. The goal would be to establish at least one attractor per cove, and each attractor should cover at least 2,000 square feet (1/10 of a surface acre) and provide vertical profile (50% of water depth). All open water enhancement areas would be marked with "Coast Guard" yellow fish attractor buoys.

Enhancement materials for open water attractors could include:

- homemade PVC;
- small and large diameter corrugated and/or concrete pipe;
- concrete products or clean construction debris;
- bamboo, recycled coniferous trees and other large woody debris with concrete block anchors;
- commercially available products such as the larger Mossback safehaven structures.

Staging areas - Designated staging areas will need to be developed at Lake Monticello. These could be at existing lake access areas, or could be in areas previously used by SCDNR for Canada Geese restoration activities. Best Management Practices will be incorporated throughout the use of these areas as temporary staging for loading of materials. The proposed materials may be transported by boat or barge to a site from the designated staging areas and placed. Because of the high fluctuations in water levels, it will be necessary to use heavy materials to insure they remain where they are deployed. A mini-excavator and a skid-loader (or similar equipment) will be needed to load and off-load the material to and from the barge.

Excavation may be required in order for habitat barges to reach staging areas for load of material. Excavation is limited to the minimum necessary for access to temporary staging areas, and excavated material must be properly disposed of on an upland site. All disposed material shall be properly stabilized or contained so as to preclude entry into any surface waters, wetlands, streams or any other waters of the United States, or public property. The disposed material shall not affect cultural or historic resources or threatened or endangered species. All disposal sites must be authorized by the lake manager.

Material outlined above (ex. large rock, logs, gravel) may be used to form a temporary ramp or nosing area to load material onto boat or barge from the staging area. Stabilization of the shoreline using a rock loading ramp will prevent gouging and shoreline erosion during construction. Temporary matting may also be used where applicable. When appropriate the materials in the loading/nosing areas will be removed, though some residual material may be left in place as bank stabilization and/or habitat enhancement (i.e. gravel beds) where applicable.

Approach – SCE&G would ultimately be responsible for conducting this work. DNR will consult with SCE&G to identify the specific areas for enhancement, to develop cove-specific descriptions of the enhancement activities, and to provide other guidance as needed for the selection of enhancement materials and deployment. We recommend that the project be phased over the term of the new license by the establishment of 10-year work periods. Annual meetings would be held to discuss the progress and accomplishments of the program and to conduct planning and coordination for annual activities. A 10-year meeting would be conducted in the last year of the work period to discuss and formulate the next 10-year work plan.

WATER QUALITY IN DOWNSTREAM WEST CHANNEL STUDY REPORT

PARR HYDROELECTRIC PROJECT

(FERC NO. 1894)

Prepared for:

South Carolina Electric & Gas Company
Cayce, South Carolina

Prepared by:

Kleinschmidt

Lexington, South Carolina
www.KleinschmidtGroup.com

April 2016

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SOUTH CAROLINA ELECTRIC & GAS COMPANY

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PARR HYDROELECTRIC PROJECT
(FERC NO. 1894)

SOUTH CAROLINA ELECTRIC & GAS COMPANY

1.0 INTRODUCTION

South Carolina Electric & Gas Company (SCE&G) is the Licensee for the Parr Hydroelectric Project (FERC No. 1894) (Project). SCE&G is currently seeking a new license from the Federal Energy Regulatory Commission (FERC), as their current license is set to expire on June 30, 2020. The Project consists of two developments, including the Parr Shoals Development and the Fairfield Pumped Storage Development.

The Parr Reservoir, located in Fairfield and Newberry counties, South Carolina, is a 4,400 acre impoundment formed by the Broad River and the Parr Shoals Dam and serves as the lower reservoir for the Fairfield Pumped Storage Development. Monticello Reservoir, a 6,800 acre impoundment is formed by a series of four earthen dams and serves as the upper reservoir for the pumped storage development. While the stretch of the Broad River downstream of the Parr Shoals Dam (Parr Dam) is not included in the Project Boundary Line (PBL), Project operations do influence this area. For this reason, this downstream area, specifically the west channel area of the Broad River immediately downstream of the Parr Dam, was examined for water quality.

The Project is currently involved in a relicensing process which involves cooperation and collaboration between SCE&G, as licensee, and a variety of stakeholders including state and federal resource agencies, state and local government, non-governmental organizations (NGO), and interested individuals. SCE&G has established several Technical Working Committees (TWC's) comprised of members from the interested stakeholders. The TWC's objectives include the evaluation of relicensing issues and seeking consensus for addressing these issues in the new license.

A Water Quality TWC was formed to address potential water quality issues associated with the Project, and is comprised of a variety of stakeholders, including the U.S. Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), the South Carolina Department of Health and Environmental Control (SCDHEC) and the South Carolina Department of Natural Resources (SCDNR), among others. During issues scoping, the TWC identified the west channel area of the Broad River downstream of the Parr Dam as a potential area in need of water quality study. SCDNR expressed concern regarding low dissolved oxygen (DO) levels in this area of the Broad River during the warmer months.

SCE&G developed a study plan to assess the water quality, specifically dissolved oxygen (DO) levels, of the west channel of the Broad River, immediately downstream the Parr Dam.

2.0 STUDY AREA

The Broad River immediately downstream of the Parr Dam is naturally divided by Hampton Island, creating an eastern and western channel along the length of the island, which is approximately 1.25 miles. Water temperature and DO were monitored at three sites along the western channel, including just downstream of the Parr Dam, midway down Hampton Island near the Highway 213 bridge, and at the lower extent of the western channel, just upstream of the confluence with the Broad River main channel. A fourth site was monitored as a control, and was located along the eastern channel, at the approximate mid-point of the island. The monitoring sites are shown below in Figure 2-1.

The study took place beginning April 1, 2015 and extended through October 15, 2015. The study was originally scheduled to extend through November 30, 2015, however due to extreme high flows and flooding in early October, HOBO monitors were removed from the river soon after high flows subsided, to ensure data would not be lost during another high flow event.

FIGURE 2-1 WATER QUALITY IN DOWNSTREAM WEST CHANNEL MONITORING SITES

3.0 COLLECTION METHODS

Water temperature and DO were monitored in the west channel area of the Broad River using HOBO U26 Dissolved Oxygen Loggers. The loggers were deployed at the four monitoring sites on March 31, 2015 and were attached to floats and concrete weights to allow for suspension at approximate mid-depth in the river channel. The loggers were calibrated according to the manufacturer's specifications and were set to collect temperature and DO data on hourly intervals. The logger manufacturer, Onset, specifies that the dissolved oxygen monitors have an accuracy of +/- 0.2 mg/L. Data were downloaded on a monthly basis using manufacturer's software and compiled at the end of the monitoring season. DO data werer also obtained from the USGS gage at Jenkinsville (2160991), which is located immediately downstream of the Parr Shoals Dam and powerhouse, on the east side of the channel.

Additionally, a calibrated YSI meter was used to collect DO and water temperature approximately once a month when data were downloaded from the HOBO loggers at each monitoring site.

Although the loggers were originally planned to be deployed through November, they were removed from the river in mid-October, following a series of heavy rain events that resulted in extreme flooding throughout the Broad River and the midlands of South Carolina. Due to the flooding, the logger located in the east channel was lost, along with the data it collected during September and October.

Data is also missing from the loggers located in the middle west channel and in the lower west channel, from late June through mid-July (middle west channel) and mid-June through late June (lower west channel). The loggers malfunctioned and had to be sent to the manufacturer for repair. The same loggers malfunctioned again in late July, and one day of data were lost at each site.

After the loggers were initially deployed, during the first download, it was obvious that the upper west channel logger was located in a poor area, where it was subject to extreme fouling from algae, sediments, and occasional de-watering. On May 11, the logger was removed from its initial location, cleaned, and re-deployed at a spot a few feet away, in a deeper pool. The logger remained in this location for the remainder of the study. Additionally during the first download, the logger located in the east channel was found on the bank, de-watered. The logger was re-deployed deeper in the east channel downstream of a bridge piling, and re-secured with weights and buoys to ensure it would stay underwater. The logger remained in this location for the remainder of the study, until it was lost during the fall flood. Although the logger remained in this position, at the end of the study data collected by this logger was deemed unreliable, due to interference from the bridge piling, collected debris, and susceptibility to algal growth. Because of this, data collected by the USGS gage at Jenkinsville (2160991) was added to the report to act as a control. The gage is located downstream of the Parr Project powerhouse, in the east channel.

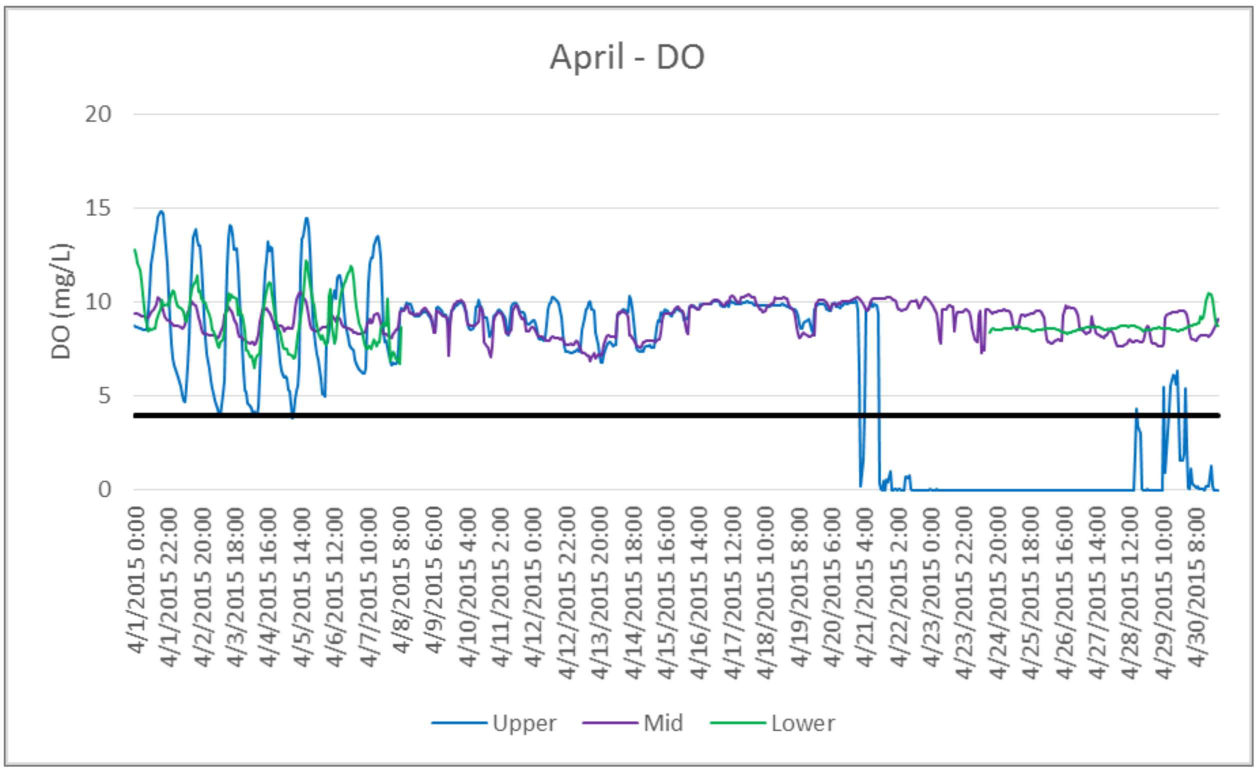
4.0 RESULTS

A summary of DO data collected each month is included in the following sections. Detailed temperature and DO data for each site is included in Appendix A.

4.1 April

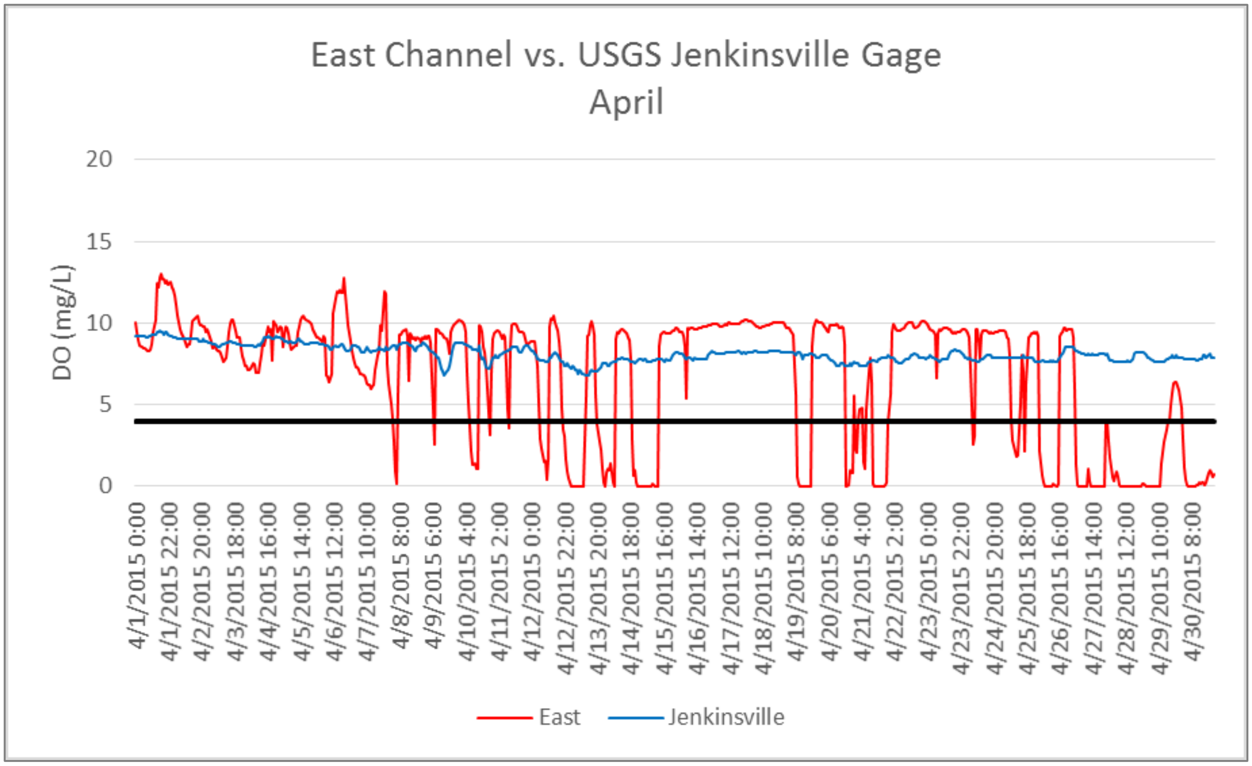
During the month of April (Figure 4-1; Figure 4-2; Table 4-1), DO levels at the upper west channel and east channel locations were not accurately collected. This is associated with poor site selection for the monitors and periodic dewatering. However, DO at the middle west channel and lower west channel locations reflected expected values for that time of year. DO levels were well above the DHEC instantaneous standard of 4.0 mg/L (SCDHEC 2012).

Figure 4-1 Dissolved Oxygen at the Upper, Middle, and Lower West Channel Locations – April 2015



*The upper west channel monitor was initially located in an area subject to fouling and de-watering.

FIGURE 4-2 DISSOLVED OXYGEN AT THE EAST CHANNEL AND THE USGS JENKINSVILLE GAGE 2160991 – APRIL 2015



*The east channel monitor was initially located in an area subject to fouling and de-watering.

TABLE 4-1 MAXIMUM, MINIMUM AND AVERAGE TEMPERATURES AND DISSOLVED OXYGEN FOR APRIL

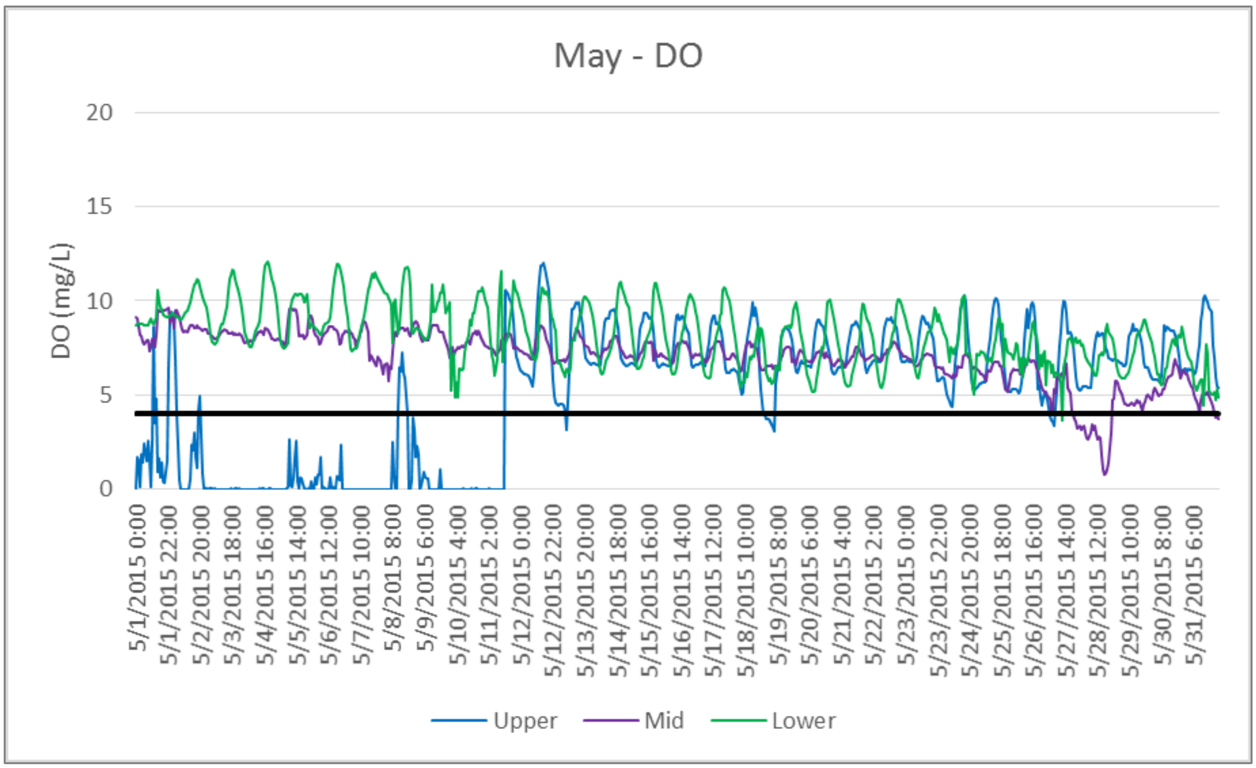
April						
	Temperature			Dissolved Oxygen		
	Max	Min	Ave	Max	Min	Ave
Upper West	77.3	55.7	65.3	14.8	0.0	6.3
Middle West	70.0	58.6	64.5	10.6	6.9	9.0
Lower West	76.8	59.0	68.9	12.8	6.5	8.9
East	71.5	58.5	65.0	13.0	0.0	6.8
Jenkinsville	69.8	58.3	64.6	9.5	6.8	8.1

4.2 MAY

The first data download occurred on May 11, 2015. At this time, the loggers located at the upper west channel and the east channel were cleaned and relocated due to fouling and de-watering vulnerability. After May 11th, all four loggers appeared to be collecting accurate data. Diel fluctuations at all sites were apparent, with DO at all sites ranging each day from approximately 5 to 10 mg/L (Figure 4-3; Figure 4-4; Table 4-2). DO occasionally dipped below the instantaneous minimum of 4.0 mg/L at the upper and middle west channel sites and once on the east channel site.

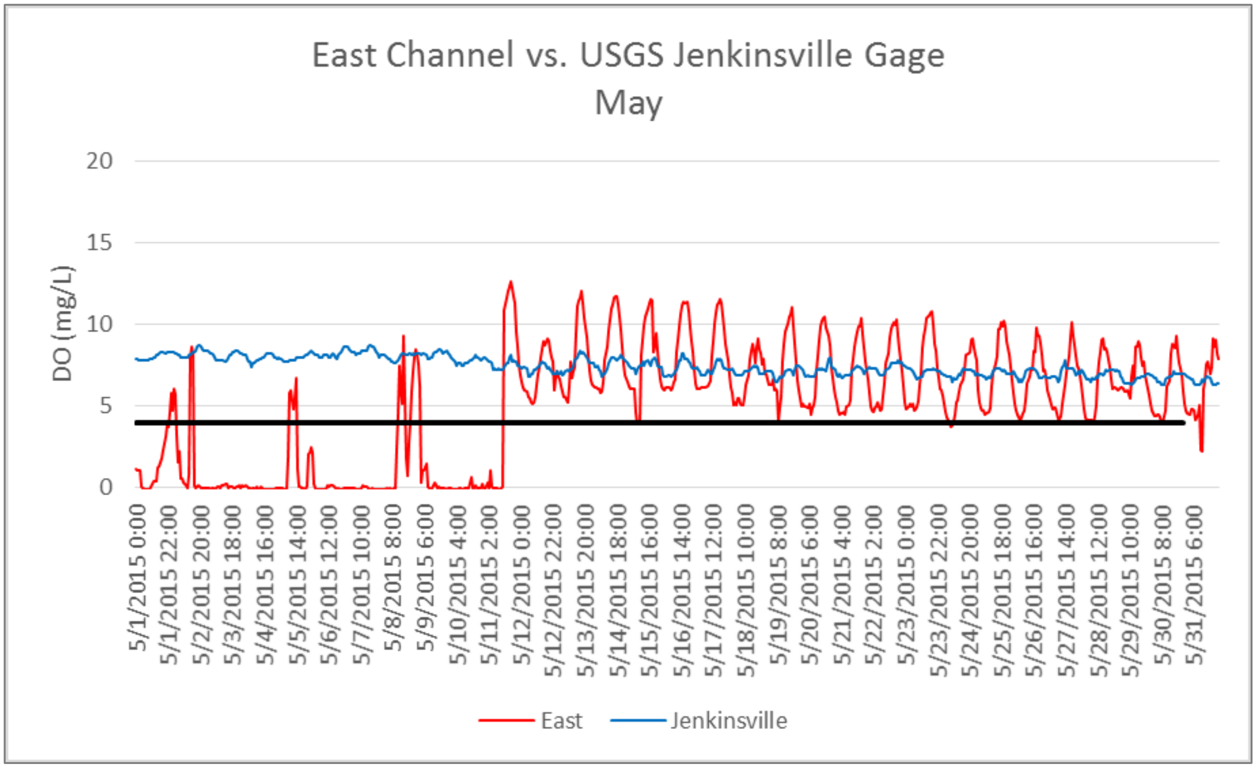
On the east channel, the Jenkinsville data and the east channel HOBO monitor data follow a similar diel pattern, however the east channel monitor exhibited a greater daily range in DO levels. This is likely caused by the east channel monitor being located in an area with less water exchange that was more susceptible to algal and aquatic plant growth, which might cause greater swings in DO throughout a normal day.

FIGURE 4-3 DISSOLVED OXYGEN AT THE UPPER, MIDDLE, AND LOWER WEST CHANNEL LOCATIONS – MAY 2015



*Upper west channel was relocated on May 11, 2015 during a routine data download. Previous to the relocation, the logger was subject to fouling and de-watering.

FIGURE 4-4 DISSOLVED OXYGEN AT THE EAST CHANNEL LOCATION AND USGS JENKINSVILLE GAGE 2160991 – MAY 2015



*East channel was relocated on May 11, 2015 during a routine data download. Previous to the relocation, the logger was subject to fouling and de-watering.

TABLE 4-2 MAXIMUM, MINIMUM, AND AVERAGE TEMPERATURES AND DISSOLVED OXYGEN FOR MAY

May						
	Temperature			Dissolved Oxygen		
	Max	Min	Ave	Max	Min	Ave
Upper West	86.5	63.5	73.5	12.0	0.0	5.0
Middle West	81.4	64.2	72.5	9.6	0.7	7.0
Lower West	82.0	63.8	74.2	12.1	3.6	8.2
East	85.8	62.9	73.9	12.6	0.0	5.0
Jenkinsville	81.1	64.0	73.0	8.7	6.3	7.4

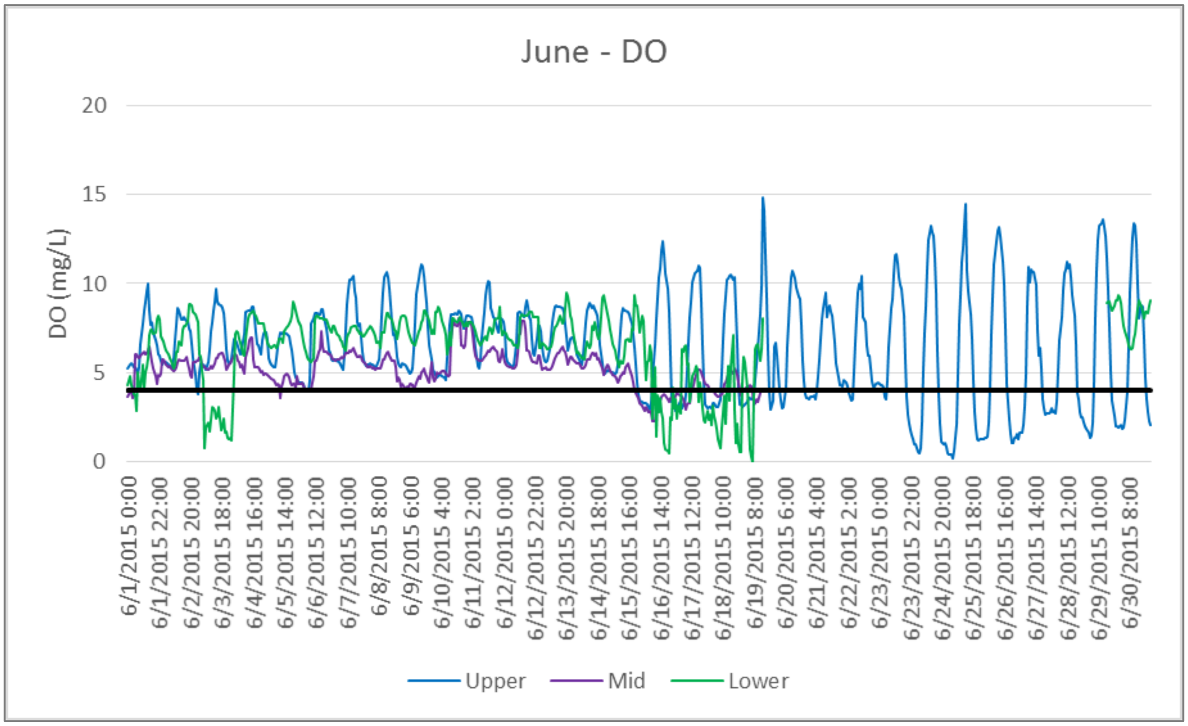
4.3 JUNE

DO followed the same pattern at all logger sites through mid-June (Figure 4-5; Figure 4-6; Table 4-3), as air and water temperatures began to rise. As temperatures rose, DO levels ranged from approximately 14 mg/L down to 1 mg/L at the upper west channel location. DO levels at the east channel location appeared to continue the same diel pattern observed during May. The pronounced swings in DO levels (especially in the upper west channel) are likely a result of heavy algal growth on the monitors. Technicians noted that on the days of downloading data several of the monitors were completely wrapped in dense layers of filamentous algae.

Data were downloaded from all loggers on June 19, 2015. Loggers at the middle and lower west channel locations malfunctioned during downloading and had to be sent to the manufacturer for repair. No data were collected at these sites during the repair process.

When data were downloaded on June 19th, DO and temperature were recorded with a YSI meter at each site at approximately 2:00 PM. At the upper west channel site, the YSI meter recorded DO as 11.92 mg/L and temperature as 91.4°F. The upper west channel monitor recorded DO as 14.88 mg/L and temperature as 93.45°F. At the middle west channel site, the YSI meter recorded DO as 7.66 mg/L and temperature as 90.68°F. The middle west channel monitor recorded DO as 4.04 mg/L and temperature as 85.71°F. At the lower west channel site, the YSI meter recorded DO as 9.36 mg/L and temperature as 92.3°F. The lower west channel monitor recorded DO as 8.02 mg/L and temperature as 89.56°F. At the east channel site, the YSI meter recorded DO as 6.5 mg/L and temperature as 86.0°F. The east channel monitor recorded DO as 6.92 mg/L and temperature as 88.41°F.

FIGURE 4-5 DISSOLVED OXYGEN AT THE UPPER, MIDDLE, AND LOWER WEST CHANNEL LOCATIONS – JUNE 2015



*Loggers at the middle and lower west channel locations were removed from the river on June 19, 2015 and sent to the manufacturer for repair. The lower west channel logger was replaced to the river on June 29, 2015.

FIGURE 4-6 DISSOLVED OXYGEN AT THE EAST CHANNEL LOCATION AND USGS JENKINSVILLE GAGE 2160991 – JUNE 2015

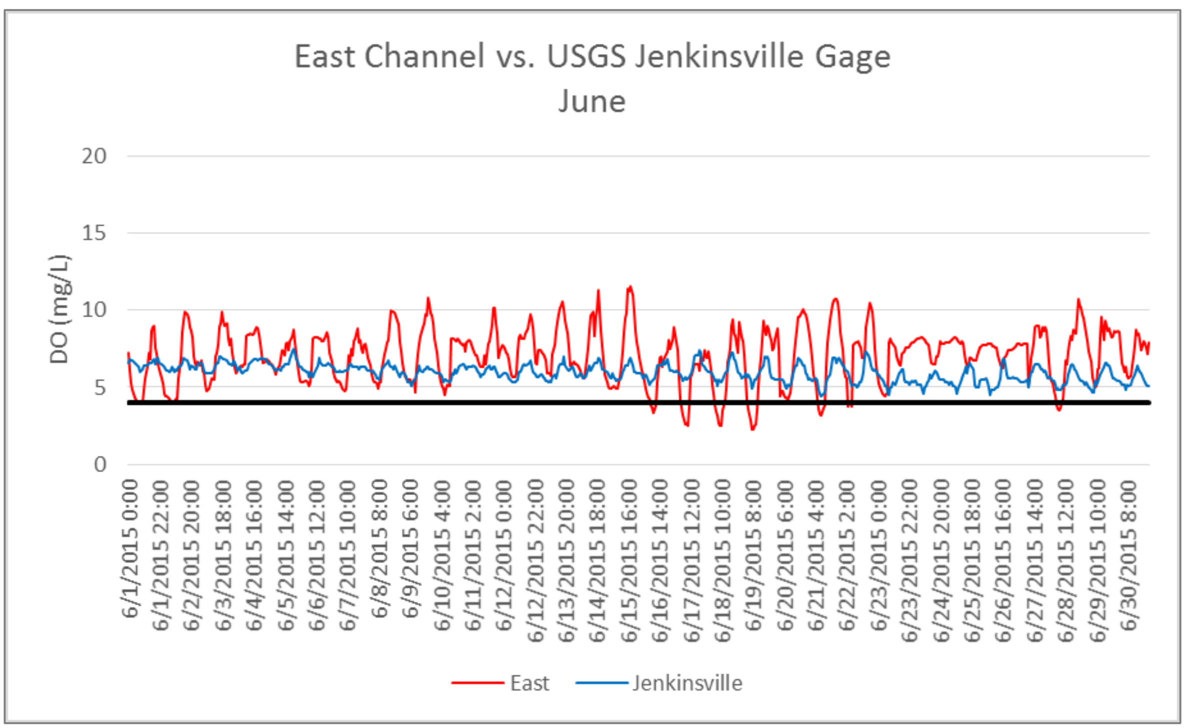


TABLE 4-3 MAXIMUM, MINIMUM, AND AVERAGE TEMPERATURES AND DISSOLVED OXYGEN FOR JUNE

June						
	Temperature			Dissolved Oxygen		
	Max	Min	Ave	Max	Min	Ave
Upper West	98.2	74.5	82.4	14.9	0.2	6.5
Middle West	87.7	75.7	79.6	8.0	2.3	5.2
Lower West	89.6	72.8	81.6	9.5	0.0	6.4
East	109.7	74.3	82.9	11.6	2.3	7.0
Jenkinsville	88.7	76.1	81.5	7.5	4.4	6.0

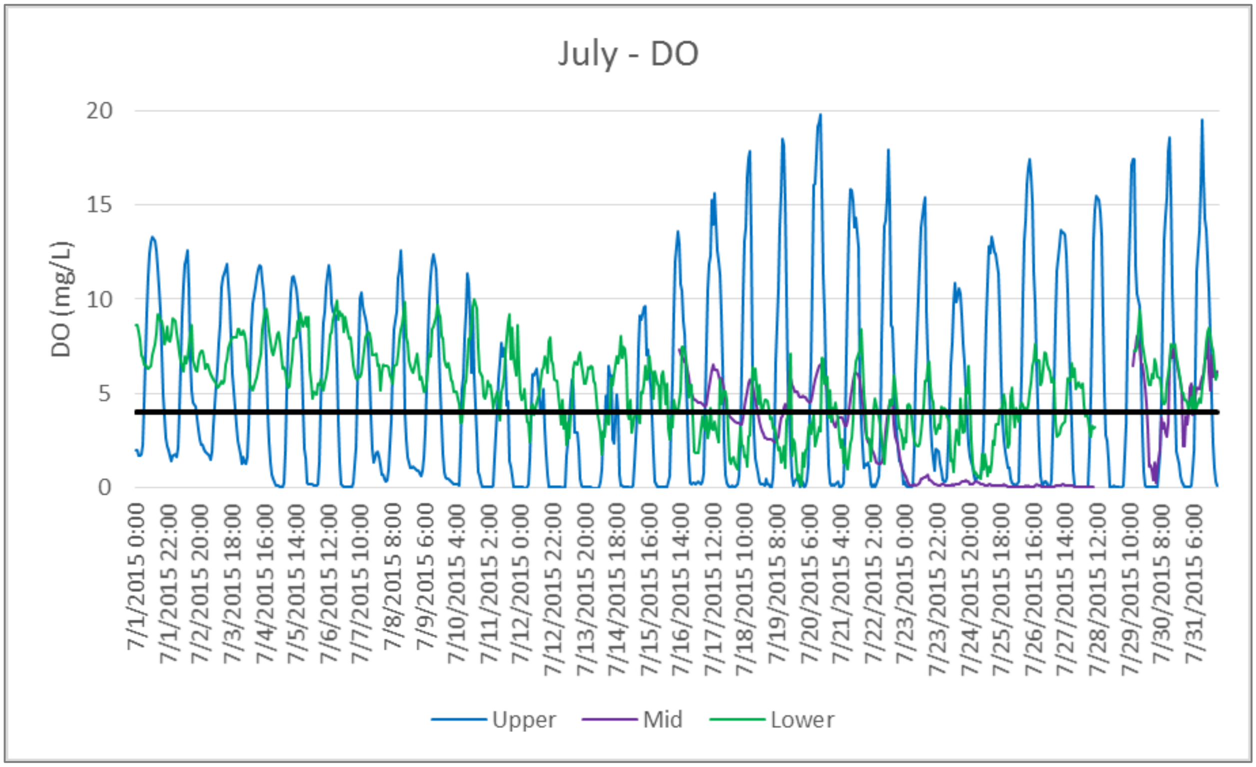
4.4 JULY

During early July (Figure 4-7; Figure 4-8; Table 4-4), DO levels at the lower west channel and east channel locations followed generally the same pattern, ranging from approximately 5 mg/L to 10 mg/L. As the month progressed, and water temperatures rose, DO levels decreased, ranging from approximately 2-3 mg/L to 7 mg/L. DO at the upper west channel location ranged from approximately 0 mg/L to 13 mg/L during early July. In mid to late July, DO at the upper west channel location experienced huge swings in DO from approximately 0 mg/L to 20 mg/L. These swings in DO were associated with dense growth of filamentous algae that resulted in DO levels that rose rapidly at sunup and throughout the day (production) and then dropped rapidly after dark (consumption).

The logger at the middle west channel location remained at the manufacturer for repair until July 16, 2015.

When data were downloaded on July 28th, DO and temperature were recorded with a YSI meter at each site at approximately 12:00 PM. At the upper west channel site, the YSI meter recorded DO as 10.12 mg/L and temperature as 89.78^{o}F. The upper west channel monitor recorded DO as 15.49 mg/L and temperature as 90.75^{o}F. At the middle west channel site, the YSI meter recorded DO as 6.08 mg/L and temperature as 86.0^{o}F. The middle west channel monitor recorded DO as 0.0 mg/L and temperature as 86.29^{o}F. At the lower west channel site, the YSI meter recorded DO as 5.89 mg/L and temperature as 86.0^{o}F. The lower west channel monitor recorded DO as 3.21 mg/L and temperature as 86.18°F. At the east channel site, the YSI meter recorded DO as 6.23 mg/L and temperature as 86.0°F. The east channel monitor recorded DO as 5.84 mg/L and temperature as 87.69°F. Technicians also noted some sediment build up on the monitors.

FIGURE 4-7 DISSOLVED OXYGEN AT THE UPPER, MIDDLE, AND LOWER WEST CHANNEL LOCATIONS – JULY 2015



*The middle west channel logger was at the manufacturer for repair through July 16, 2015. The lower west channel logger was also removed from the river for repair in the Kleinschmidt office for one day in late July.

FIGURE 4-8 DISSOLVED OXYGEN AT THE EAST CHANNEL LOCATION AND THE USGS JENKINSVILLE GAGE 2160991 – JULY 2015

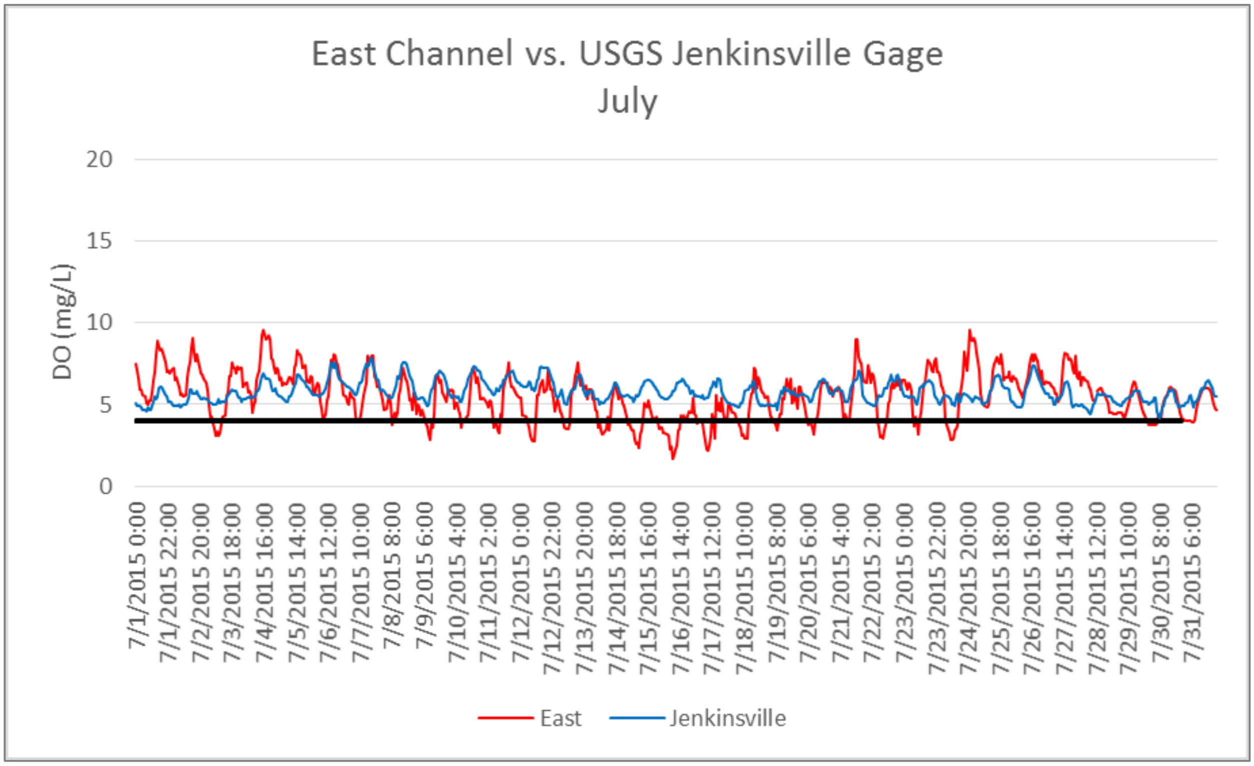


TABLE 4-4 MAXIMUM, MINIMUM, AND AVERAGE TEMPERATURES AND DISSOLVED OXYGEN FOR JULY

July						
	Temperature			Dissolved Oxygen		
	Max	Min	Ave	Max	Min	Ave
Upper West	96.7	77.3	85.7	19.8	0	4.9
Middle West	89.7	81.6	85.9	8.1	0	2.8
Lower West	92.8	79.7	86.4	10	0.1	5.3
East	92.1	78.2	86	9.6	1.7	5.5
Jenkinsville	88.5	80.2	84.7	7.8	4.2	5.8

4.5 AUGUST

During the month of August (Figure 4-5; Table 4-5), DO levels for the middle and lower west channel and the east channel followed similar patterns, with DO readings ranging from approximately 4 mg/L up to 10 mg/L. Diel fluctuations were obvious and DO levels rarely dropped below 4 mg/L. Throughout the month of August, the upper west channel logger continued the same pattern as observed in late July, with DO levels ranging from 0 mg/L to 17-

20 mg/L. Technicians again noted that large mats of filamentous algae were present in the monitor location. Technicians noted that the east channel monitor area was influenced by a log and debris that lodged upstream of the monitor and had further cut off flow to the monitor location. Low water levels, sediment build up, and debris likely resulted in the periodic low DO levels observed at the HOBO monitor as opposed to the DO measured at the Jenkinsville gage.

FIGURE 4-9 DISSOLVED OXYGEN AT THE UPPER, MIDDLE, AND LOWER WEST CHANNEL LOCATIONS – AUGUST 2015

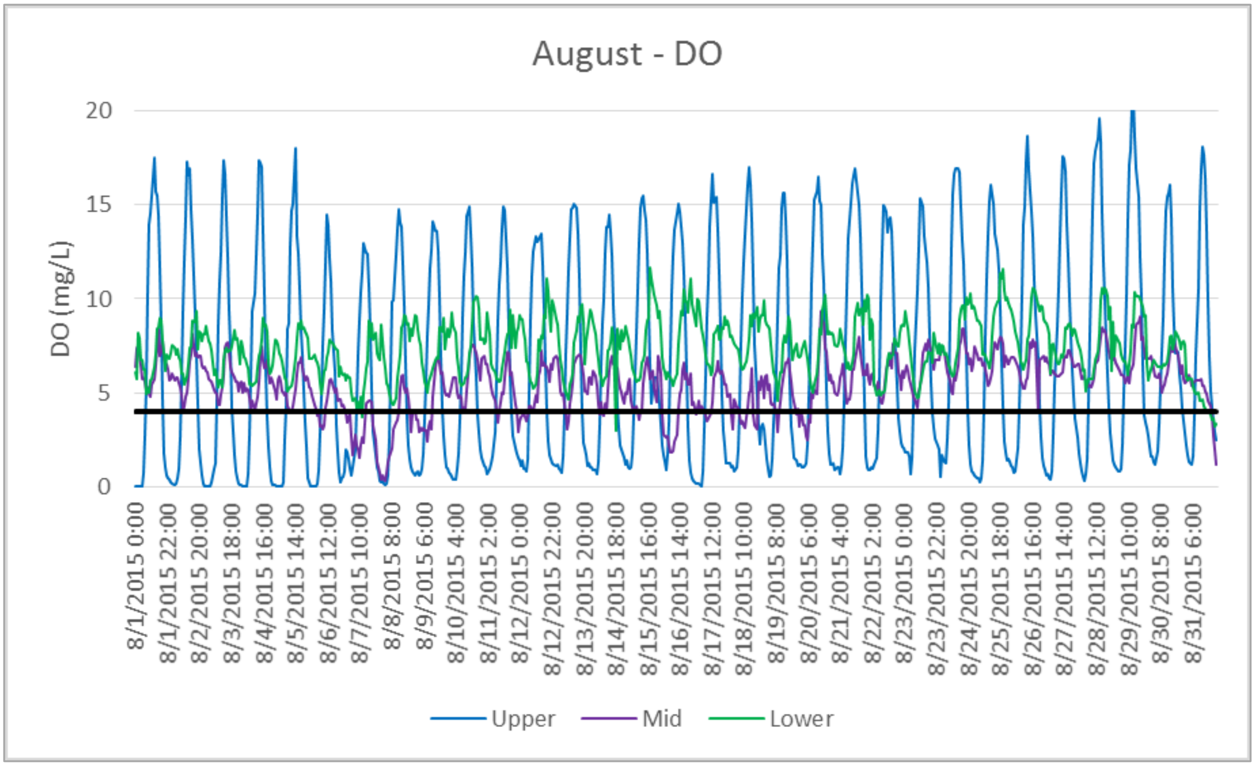


FIGURE 4-10 DISSOLVED OXYGEN AT THE EAST CHANNEL LOCATION AND THE USGS JENKINSVILLE GAGE 2160991 – AUGUST 2015

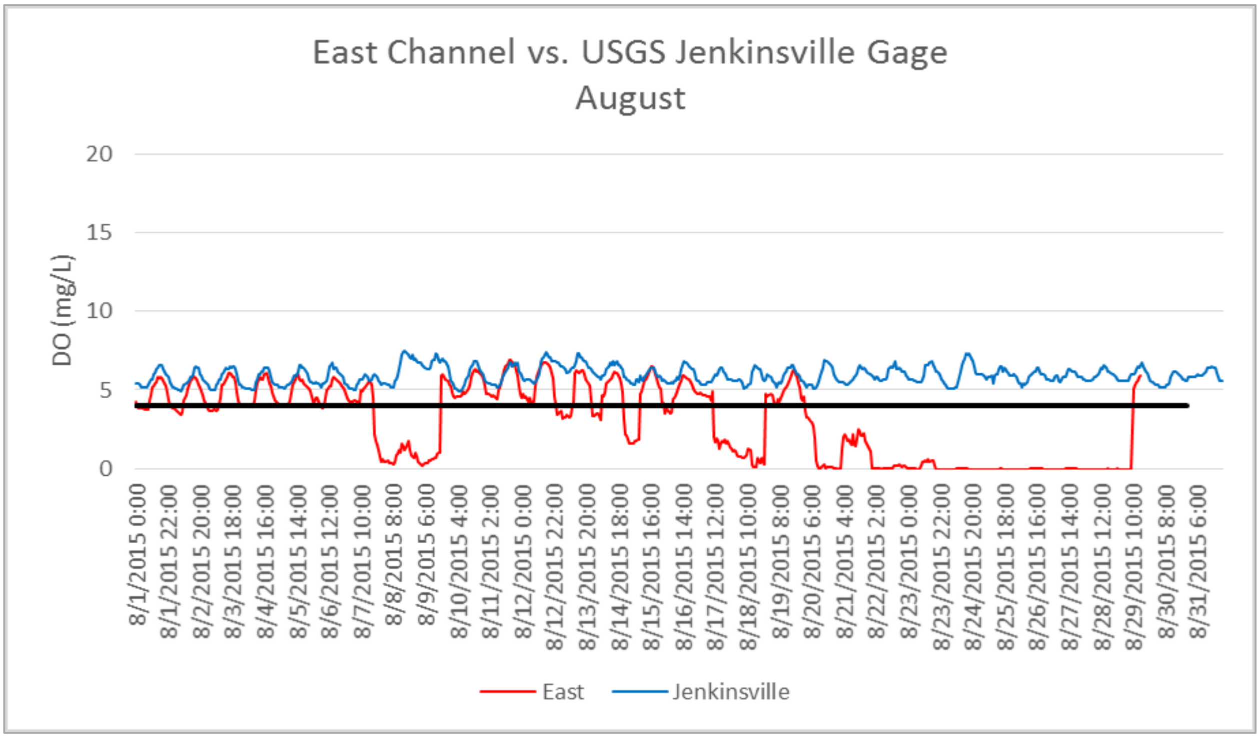


TABLE 4-5 MAXIMUM, MINIMUM, AND AVERAGE TEMPERATURES AND DISSOLVED OXYGEN FOR AUGUST

August						
	Temperature			Dissolved Oxygen		
	Max	Min	Ave	Max	Min	Ave
Upper West	95.4	74.3	85.1	20.8	0.0	6.7
Middle West	90.0	71.2	84.2	9.4	0.3	5.5
Lower West	90.9	72.9	85.5	11.7	3.0	7.4
East	89.6	82.7	85.8	6.9	0.0	2.9
Jenkinsville	88.9	80.8	86.0	7.5	4.9	5.9

4.6 SEPTEMBER

At the upper west channel location (Figure 4-6; Table 4-6), DO readings continued to range from 0 mg/L to 20 mg/L daily through early September. As water temperatures began to decrease, DO levels began to normalize and technicians noted that algae mats were decreasing in density, with smaller daily fluctuations, ranging from 2-3 mg/L to 12-15 mg/L. DO readings collected in the middle and lower west channel also began to rise throughout September, with very few instances of DO levels below 4.0 mg/L.

As mentioned, data collected in the east channel was lost when the logger could not be recovered after the flood that occurred in early October.

When data were downloaded on September 30th, DO and temperature readings were recorded with a YSI meter at the upper and middle west channel sites at approximately 12:00 PM. At the upper west channel site, the YSI meter recorded DO as 7.8 mg/L and temperature as 76.46°F. The upper west channel monitor recorded DO as 8.69 mg/L and temperature as 76.93°F. At the middle west channel site, the YSI meter recorded DO as 7.68 mg/L and temperature as 76.46°F. The middle west channel monitor recorded DO as 8.16 mg/L and temperature as 76.28°F.

FIGURE 4-11 DISSOLVED OXYGEN AT THE UPPER, MIDDLE, AND LOWER WEST CHANNEL LOCATIONS – SEPTEMBER 2015

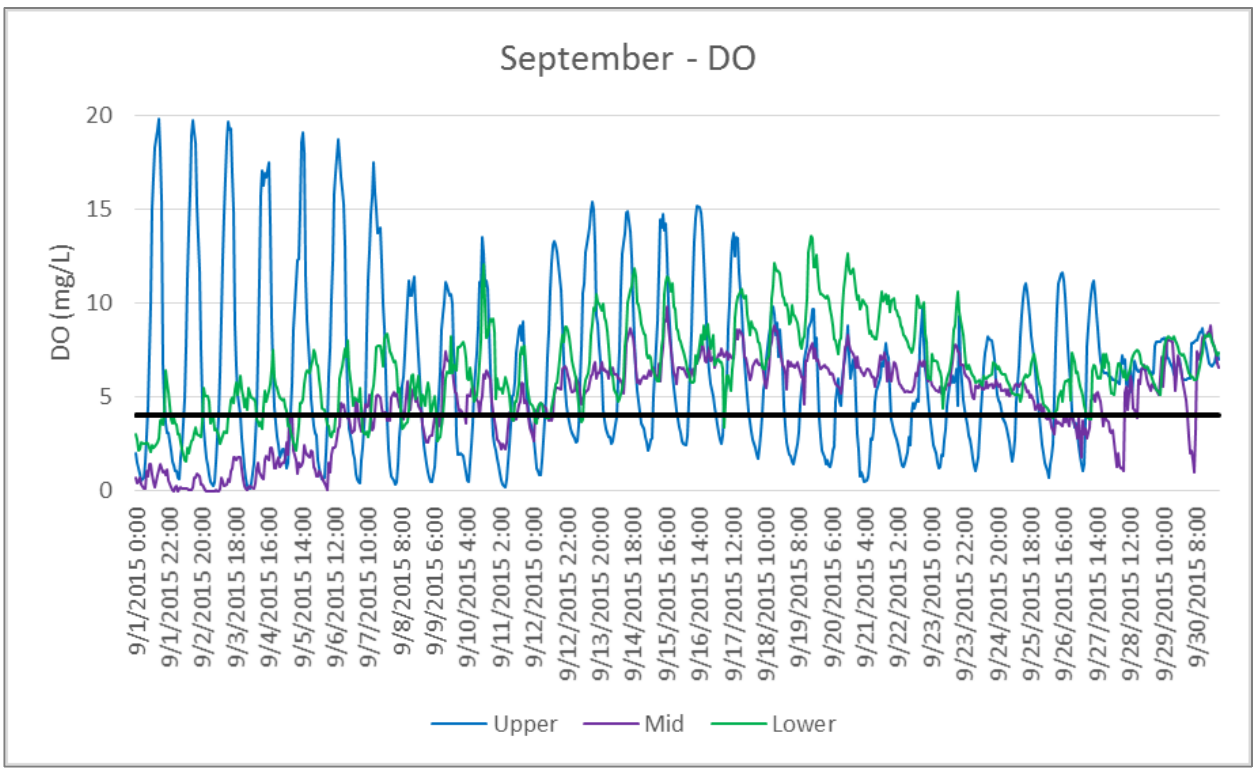


TABLE 4-6 MAXIMUM, MINIMUM, AND AVERAGE TEMPERATURES AND DISSOLVED OXYGEN FOR SEPTEMBER

September						
	Temperature			Dissolved Oxygen		
	Max	Min	Ave	Max	Min	Ave
Upper West	88.7	69.2	77.7	19.8	0.1	6.4
Middle West	83.4	67.1	76.0	9.9	0.0	4.7
Lower West	87.6	70.2	78.1	13.6	1.6	6.6
East	-	-	-	-	-	-
Jenkinsville	86.7	73.4	80.4	8.2	5.0	6.6

4.7 OCTOBER

On October 3-4, 2015, a large rain event occurred that caused wide-spread flooding in South Carolina, including the Broad River Basin. Because of this flood, large amounts of water with debris and sediment moved through the water system, causing the loggers to collect widely variable data. Therefore, data collected during the month of October is unreliable, and should not be considered as a normal representation of DO in the east and west channels during this timeframe.

FIGURE 4-12 DISSOLVED OXYGEN AT THE UPPER, MIDDLE, AND LOWER WEST CHANNEL AND EAST CHANNEL LOCATIONS – OCTOBER 2015

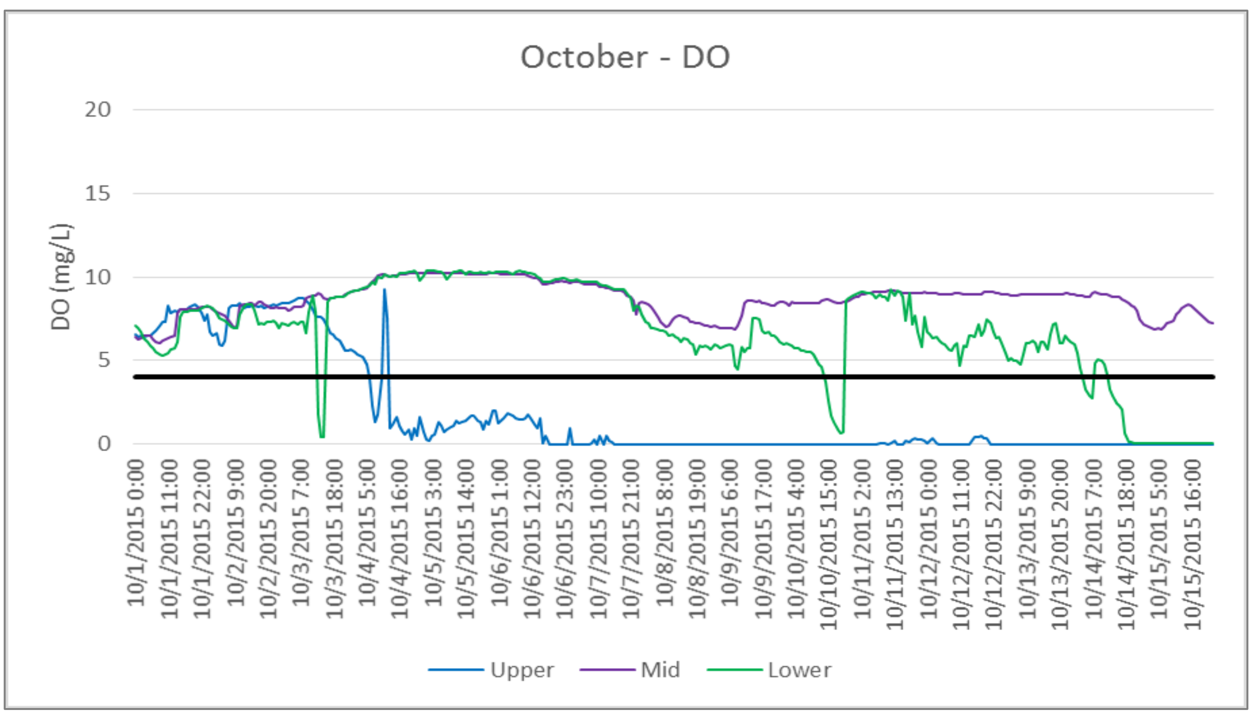


TABLE 4-7 MAXIMUM, MINIMUM, AND AVERAGE TEMPERATURES AND DISSOLVED OXYGEN FOR OCTOBER

October						
	Temperature			Dissolved Oxygen		
	Max	Min	Ave	Max	Min	Ave
Upper West	76.8	63.3	67.7	9.3	0.0	1.9
Middle West	76.4	63.2	67.8	10.3	6.1	8.7
Lower West	76.7	63.2	67.7	10.4	0.0	6.8
East	-	-	-	-	-	-
Jenkinsville	77.7	63.5	67.8	10.0	6.3	7.3

5.0 DISCUSSION

This study identified that DO levels in the west channel are periodically below the SCDHEC standard of 4.0 mg/l. Dissolved oxygen levels in the upper west channel of the Broad River, downstream of Parr Shoals Dam, were consistently lower than those further down the west channel and in the east channel. This is likely due to the shallow nature of the river in this area, as well as the presence of dense algal mats. Also, during drier weather conditions, the west channel does not receive a consistent flow of water, except for small amounts of leakage from the dam.

Throughout the study, fouling of the HOBO loggers was a constant issue. DO measurements recorded by the YSI meter often displayed very different readings than those collected by the HOBO loggers in the same locations.

The study data shows that DO levels in the west channel are variable. Dissolved oxygen levels are lowest in the west channel directly below the dam during the summer months, however these levels increase as the distance from the dam increases. Dissolved oxygen levels at the lower west channel site, located approximately 1 mile downstream of the dam, and at the east channel site, located approximately 0.5 miles downstream of the dam, were generally above the SCDHEC instantaneous standard of 4.0 mg/L and were often similar. As water depths increase in the middle west channel site, the influence of diel respiration was less drastic and there is likely some re-aeration that occurs in the shallow sections of the lower west channel. The lower west channel site DO levels may also periodically (based on flows) receive some positive influence from main channel flows

6.0 REFERENCES

SCDHEC. 2012. Water Classifications and Standards (R. 61-68). [Online] URL: https://www.scdhec.gov/Agency/docs/lwm-regs/r61-68.pdf. Accessed December 29, 2015.

APPENDIX A

ADDITIONAL GRAPHS

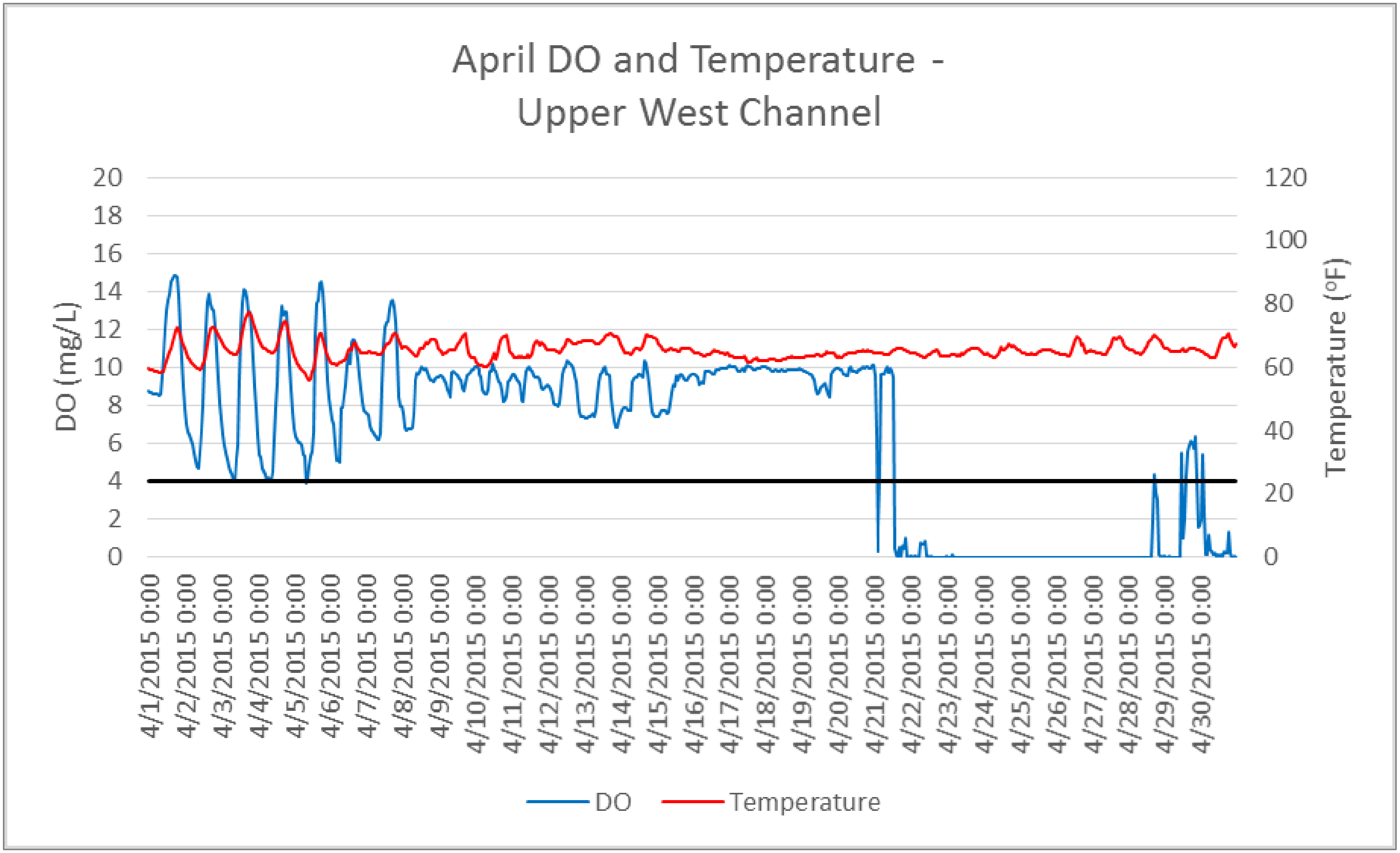


FIGURE 1 DISSOLVED OXYGEN AND TEMPERATURE IN THE UPPER WEST CHANNEL – APRIL 2015

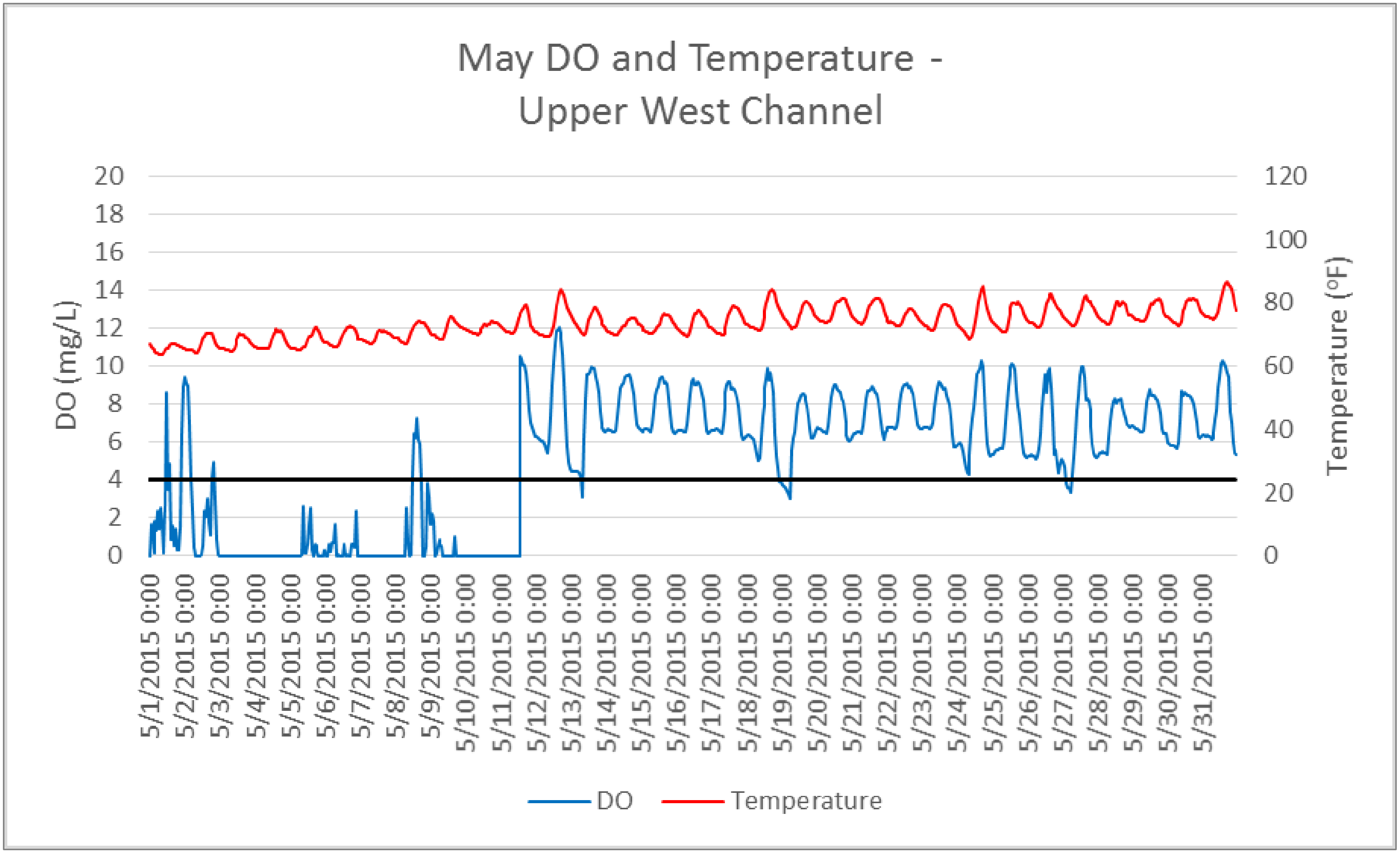


FIGURE 2 DISSOLVED OXYGEN AND TEMPERATURE IN THE UPPER WEST CHANNEL – MAY 2015

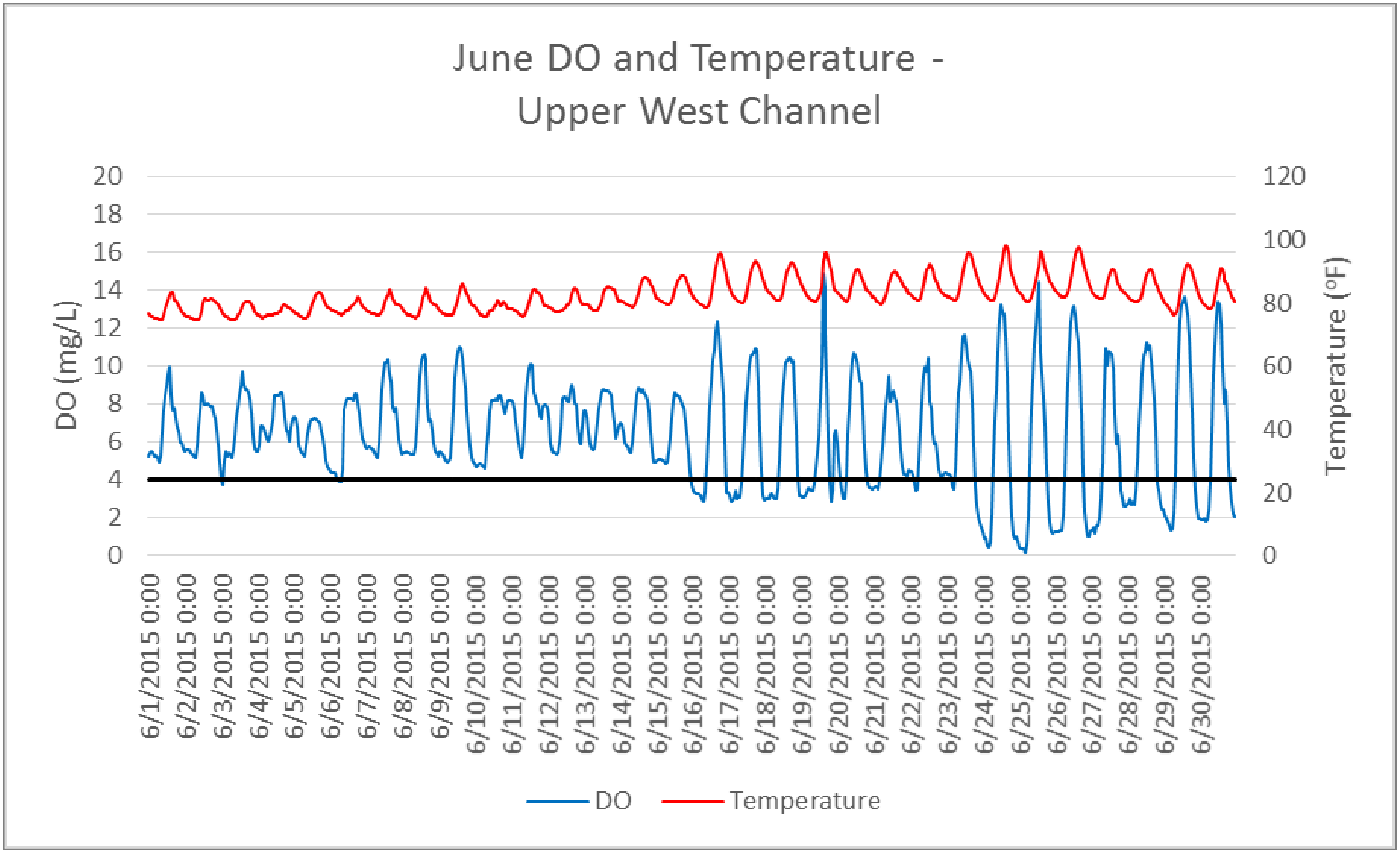


FIGURE 3 DISSOLVED OXYGEN AND TEMPERATURE IN THE UPPER WEST CHANNEL – JUNE 2015

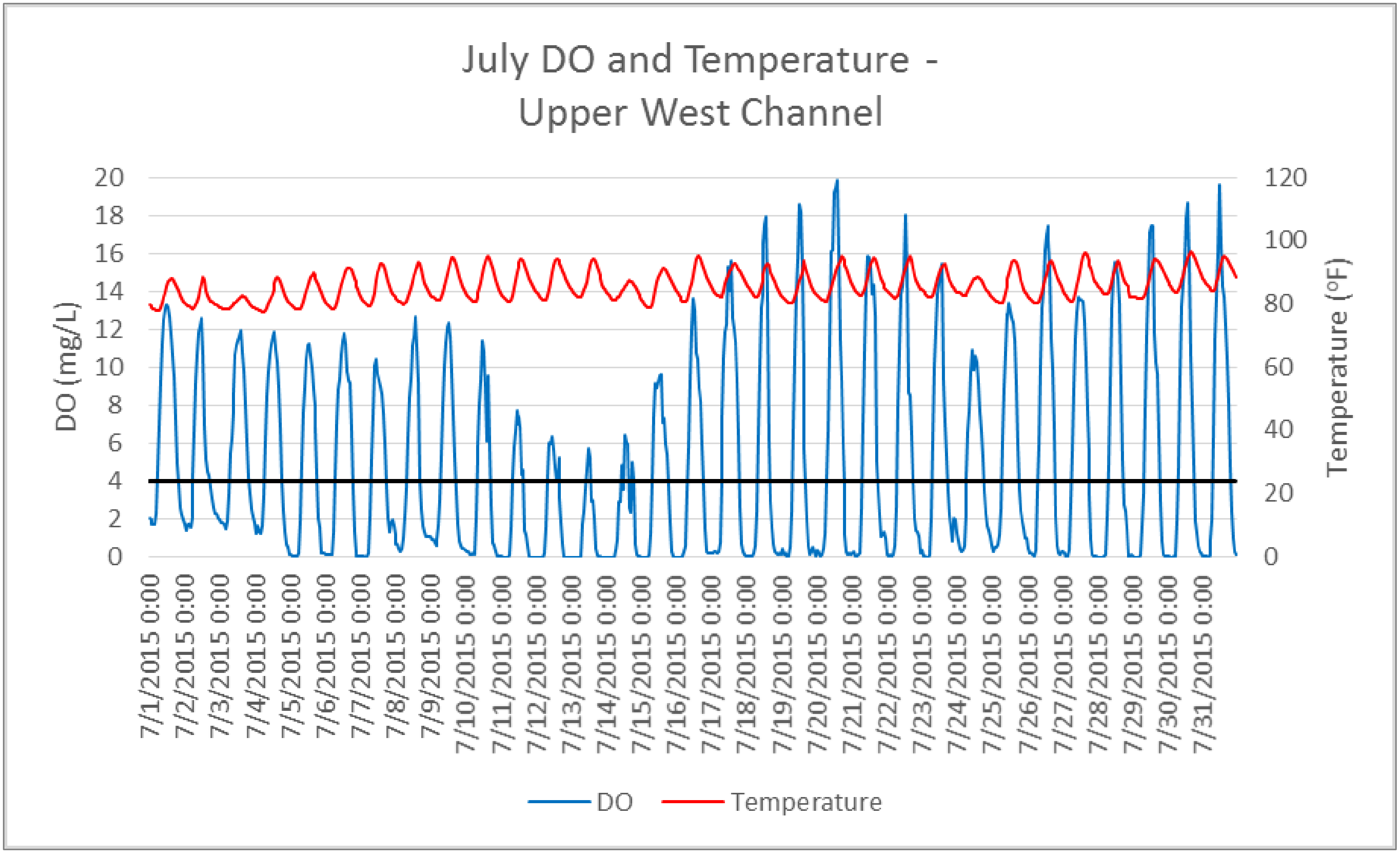


FIGURE 4 DISSOLVED OXYGEN AND TEMPERATURE IN THE UPPER WEST CHANNEL – JULY 2015

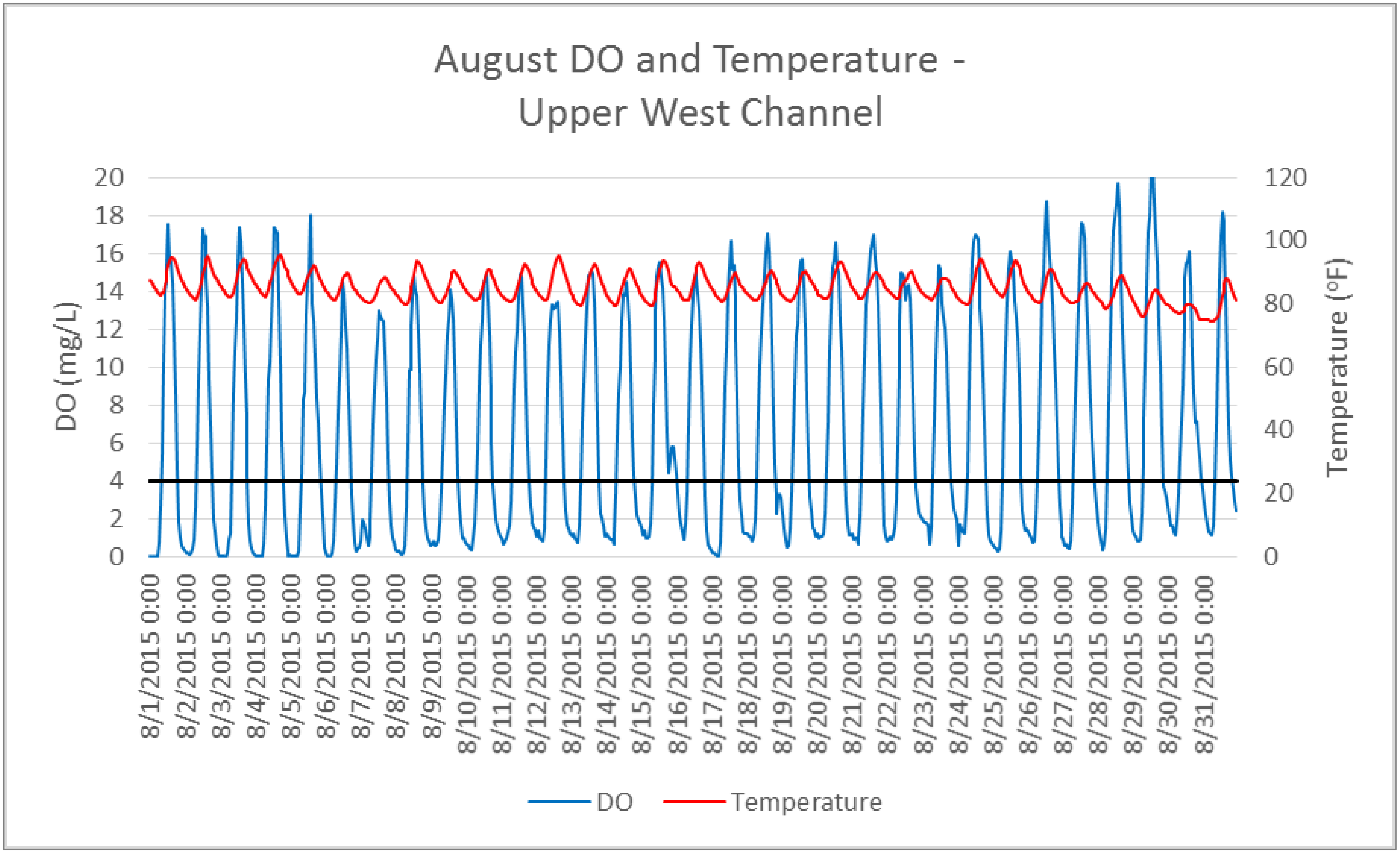


FIGURE 5 DISSOLVED OXYGEN AND TEMPERATURE IN THE UPPER WEST CHANNEL – AUGUST 2015

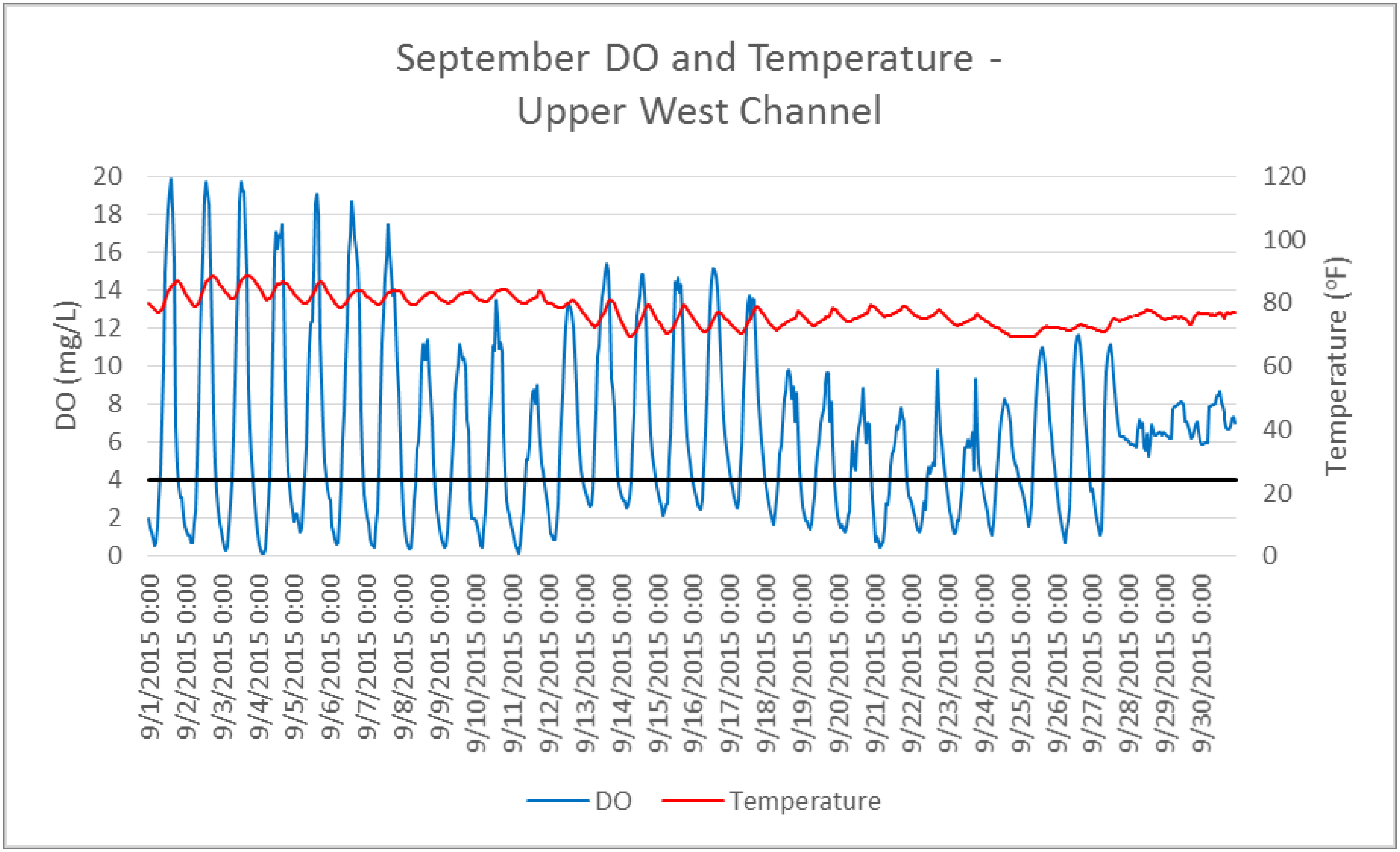


Figure 6 Dissolved Oxygen and Temperature in the Upper West Channel – September 2015

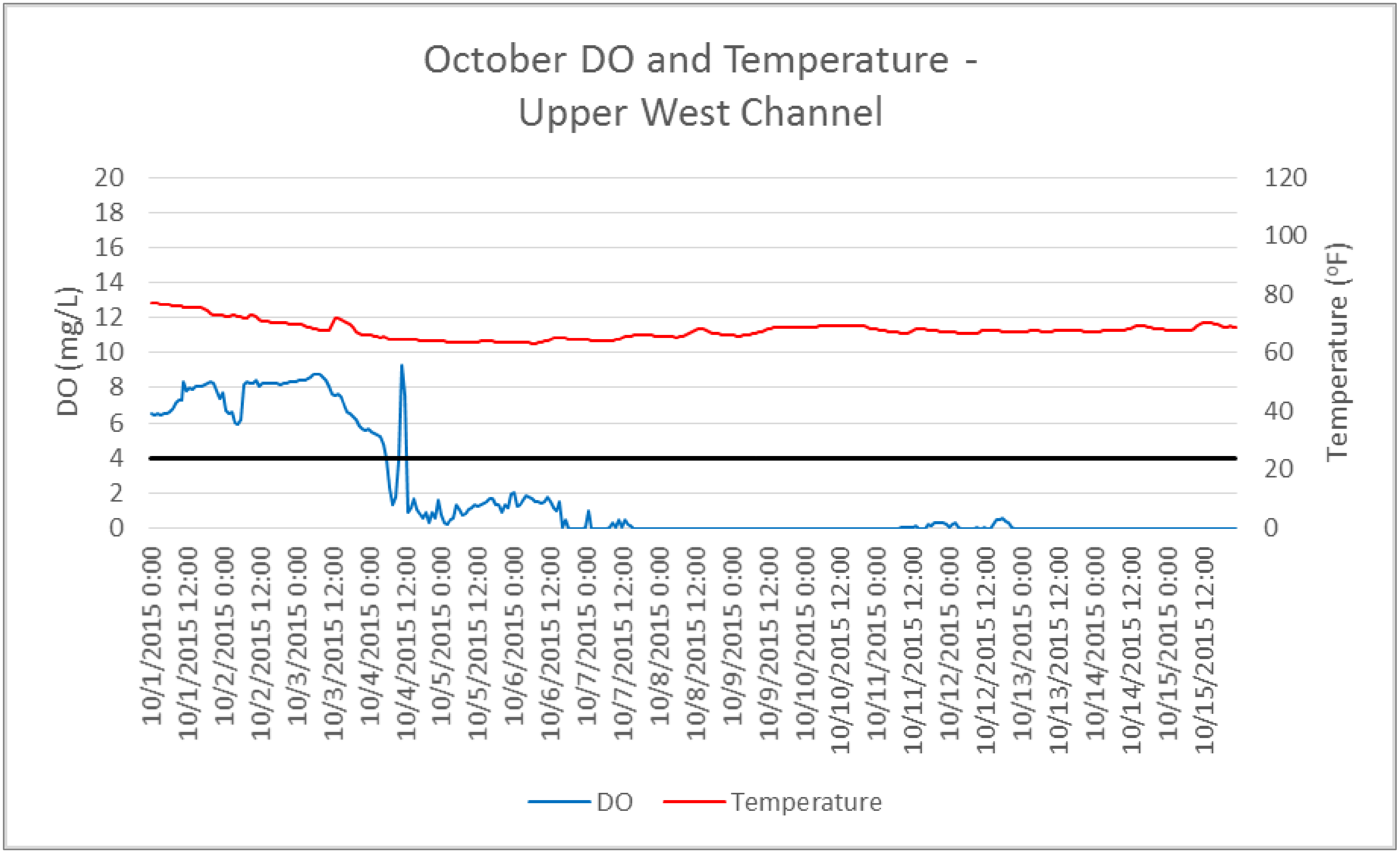


FIGURE 7 DISSOLVED OXYGEN AND TEMPERATURE IN THE UPPER WEST CHANNEL – OCTOBER 2015

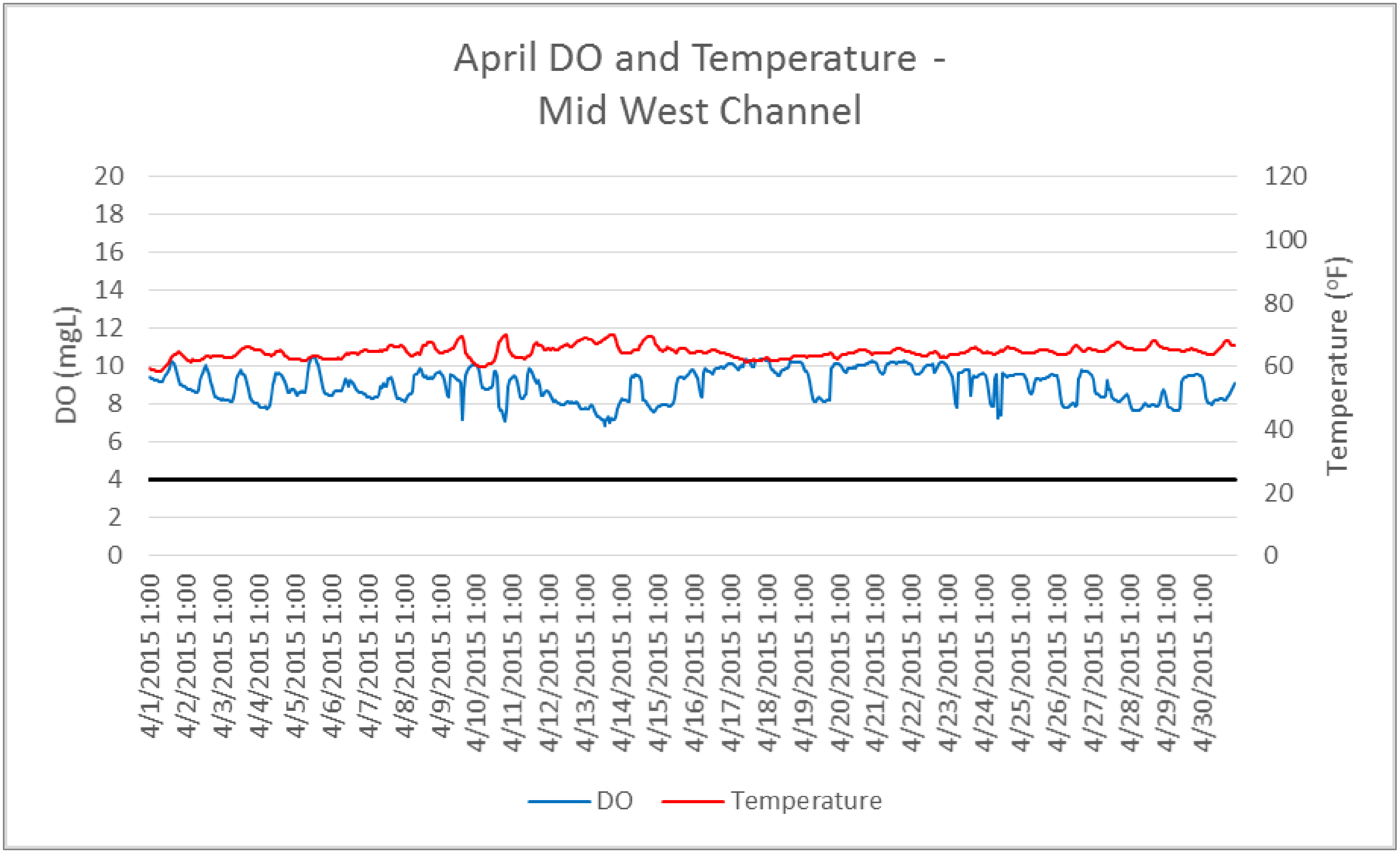


FIGURE 8 DISSOLVED OXYGEN AND TEMPERATURE IN THE MIDDLE WEST CHANNEL – APRIL 2015

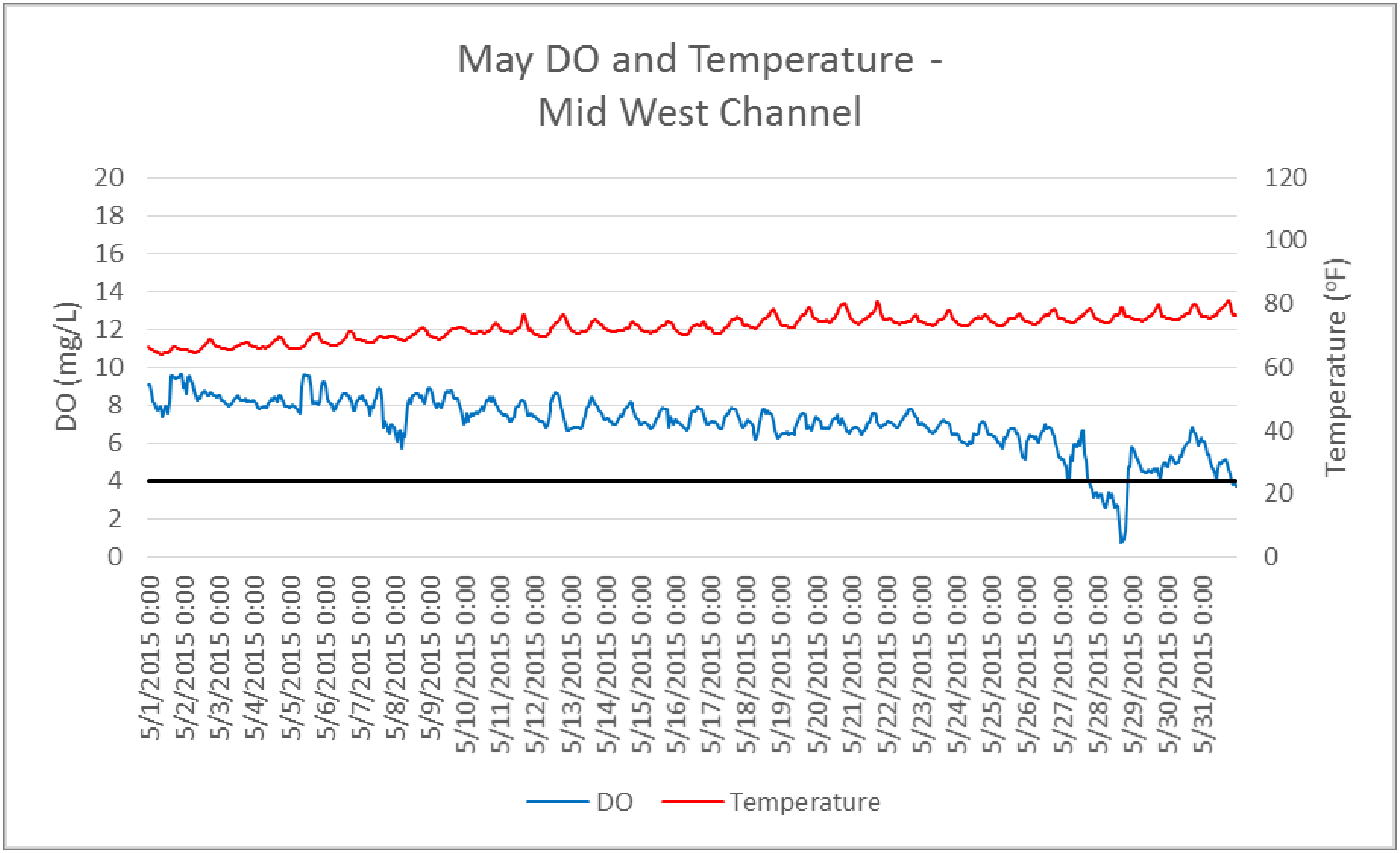


FIGURE 9 DISSOLVED OXYGEN AND TEMPERATURE IN THE MIDDLE WEST CHANNEL – MAY 2015

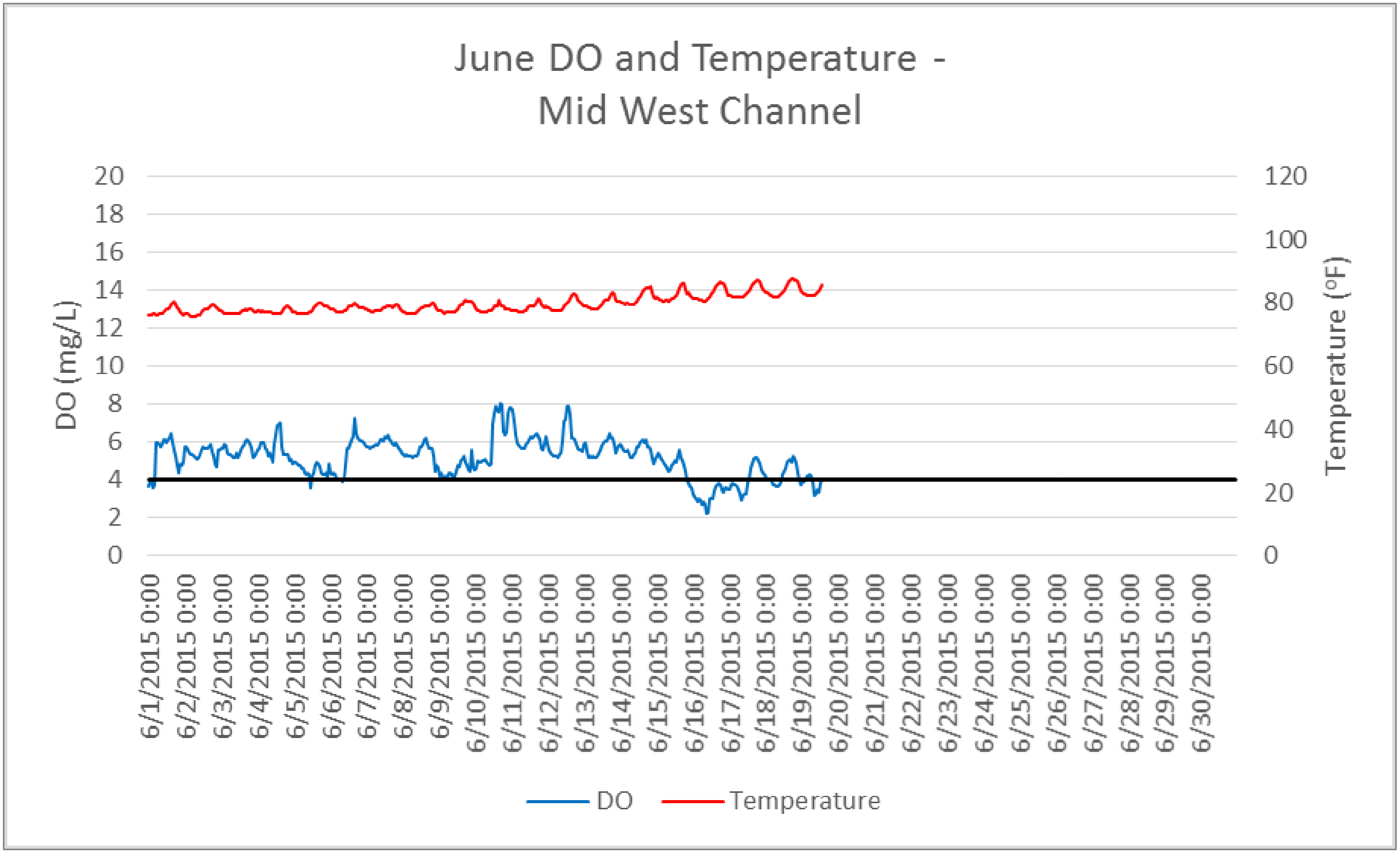


FIGURE 10 DISSOLVED OXYGEN AND TEMPERATURE IN THE MIDDLE WEST CHANNEL – JUNE 2015

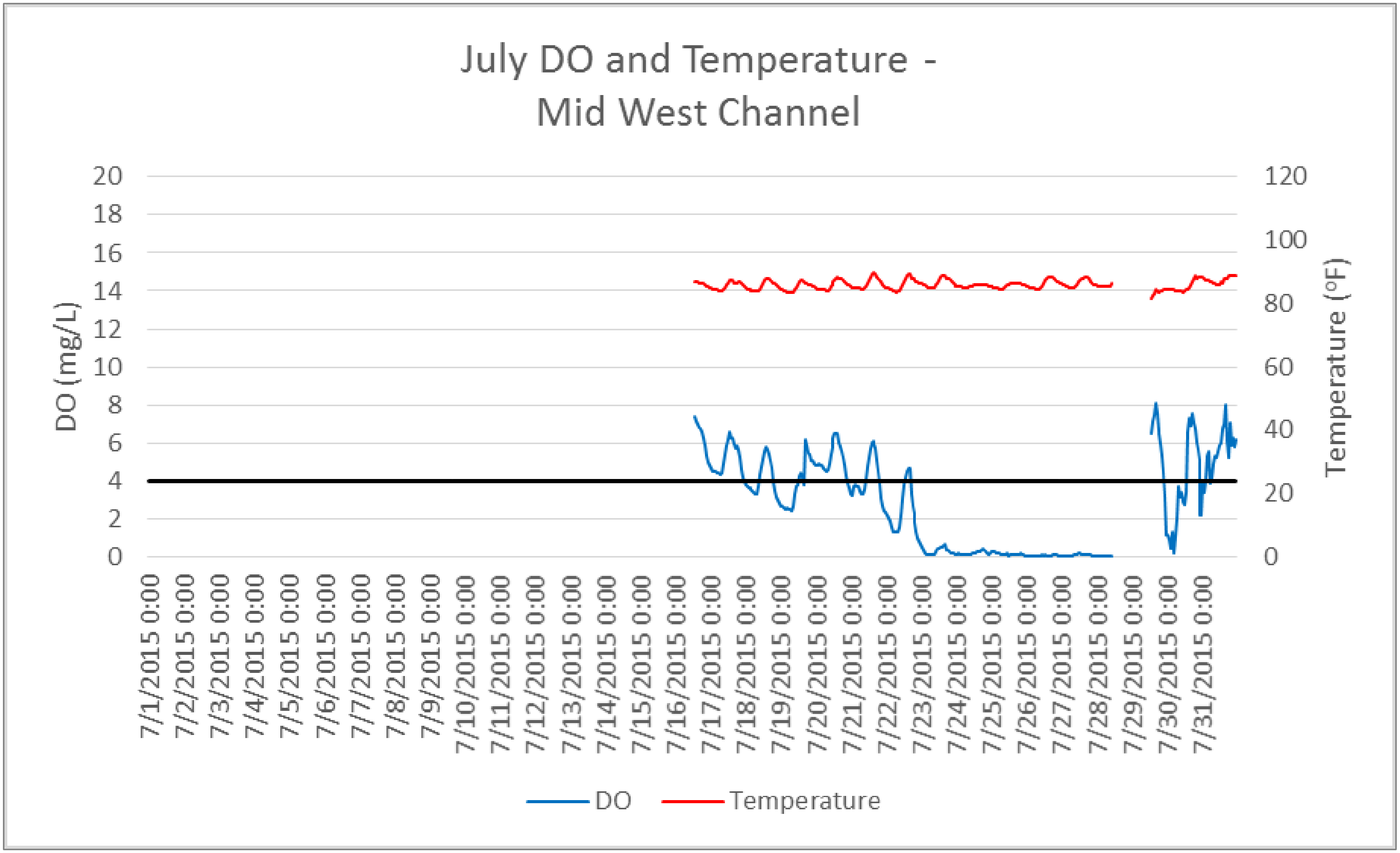


FIGURE 11 DISSOLVED OXYGEN AND TEMPERATURE IN THE MIDDLE WEST CHANNEL – JULY 2015

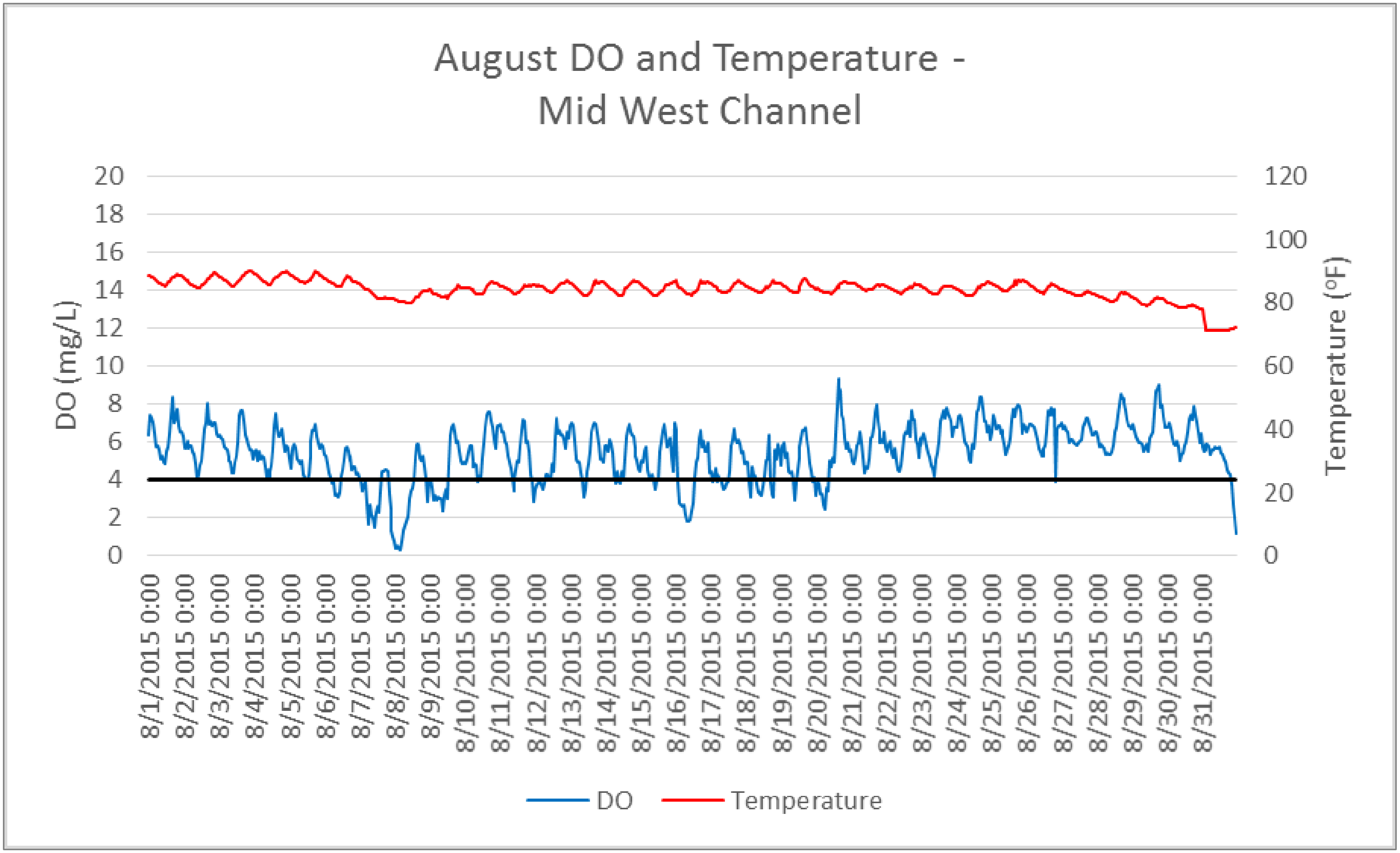


FIGURE 12 DISSOLVED OXYGEN AND TEMPERATURE IN THE MIDDLE WEST CHANNEL – AUGUST 2015

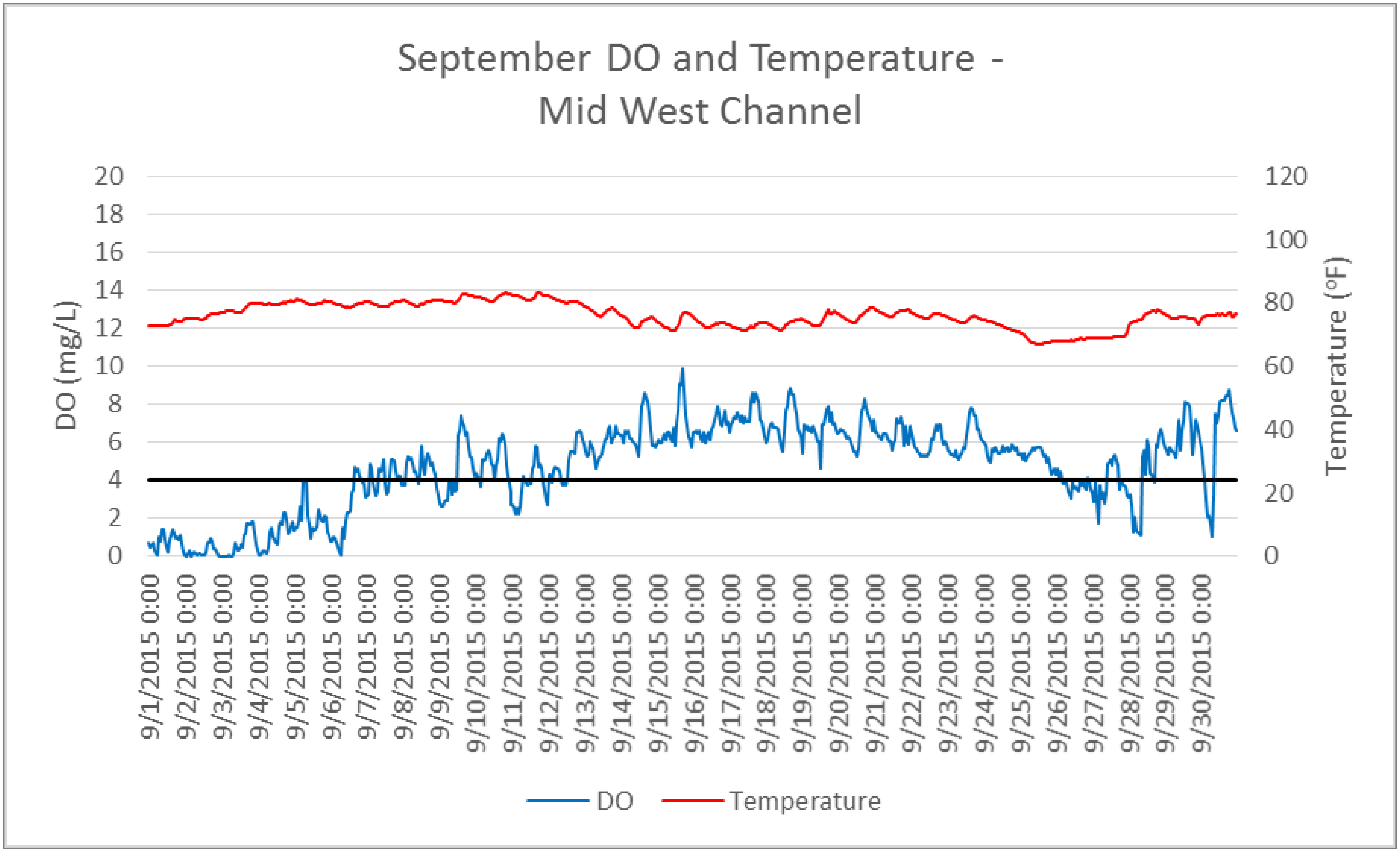


FIGURE 13 DISSOLVED OXYGEN AND TEMPERATURE IN THE MIDDLE WEST CHANNEL – SEPTEMBER 2015

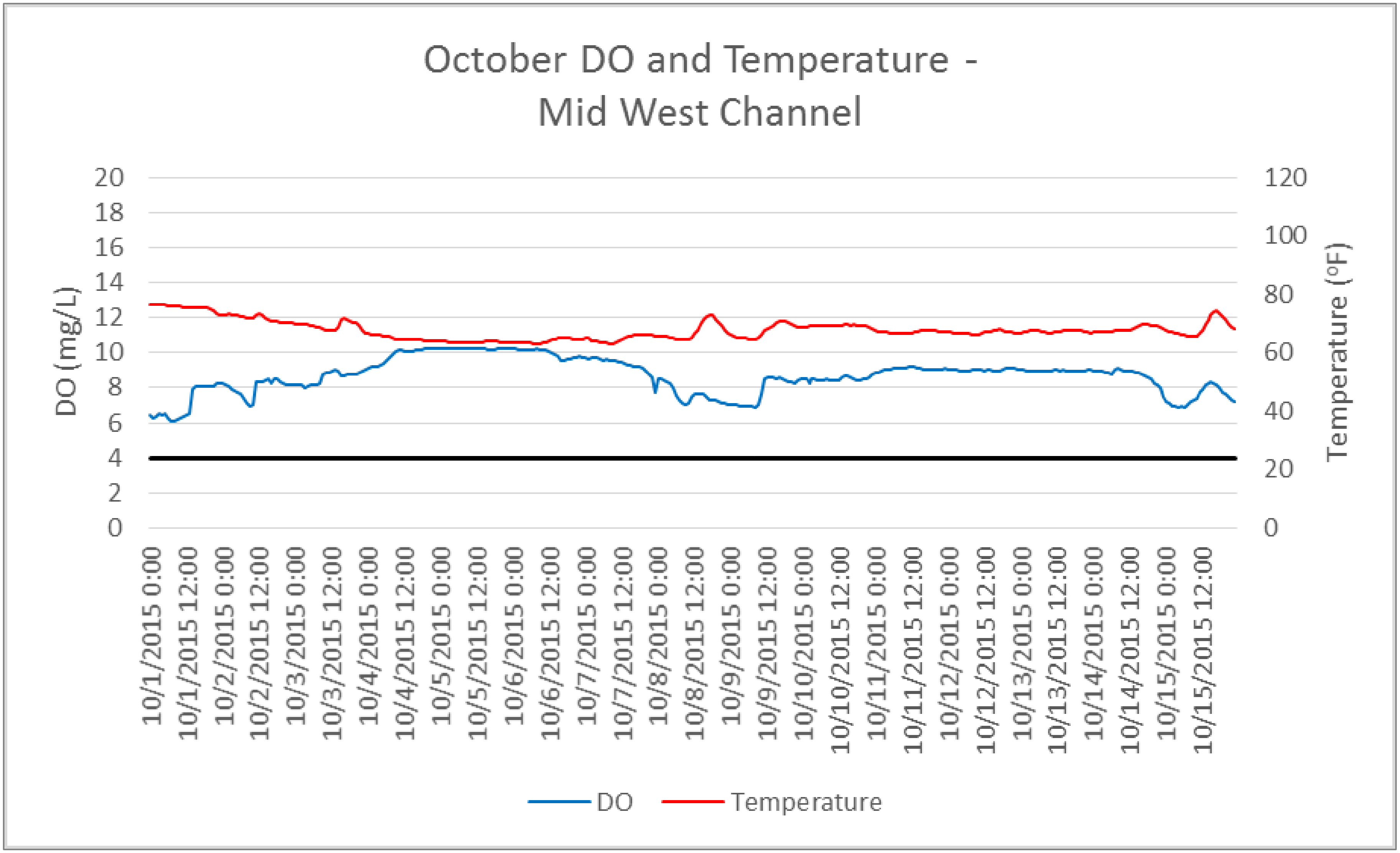


FIGURE 14 DISSOLVED OXYGEN AND TEMPERATURE IN THE MIDDLE WEST CHANNEL – OCTOBER 2015

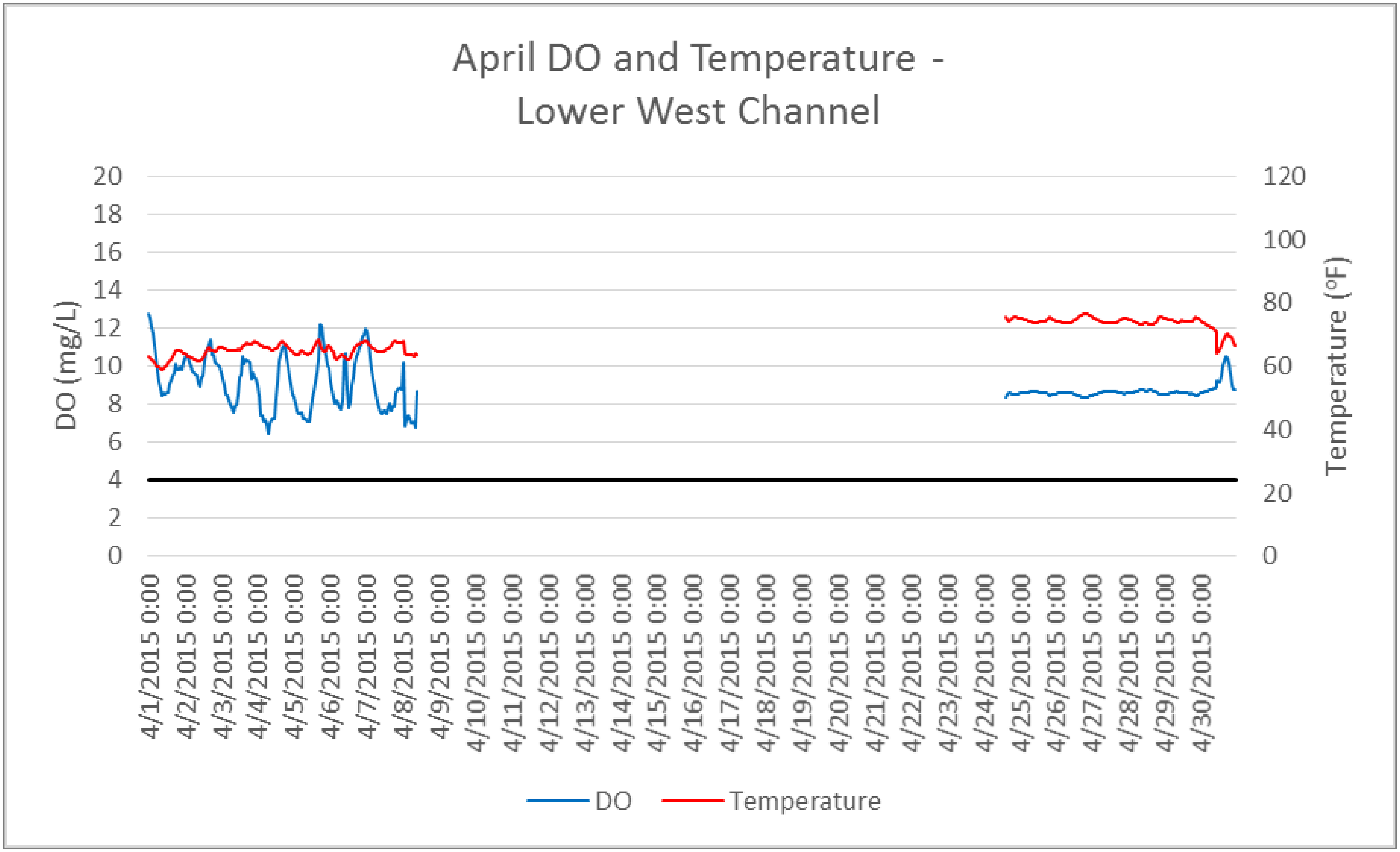


Figure 15 Dissolved Oxygen and Temperature in the Lower West Channel – April 2015

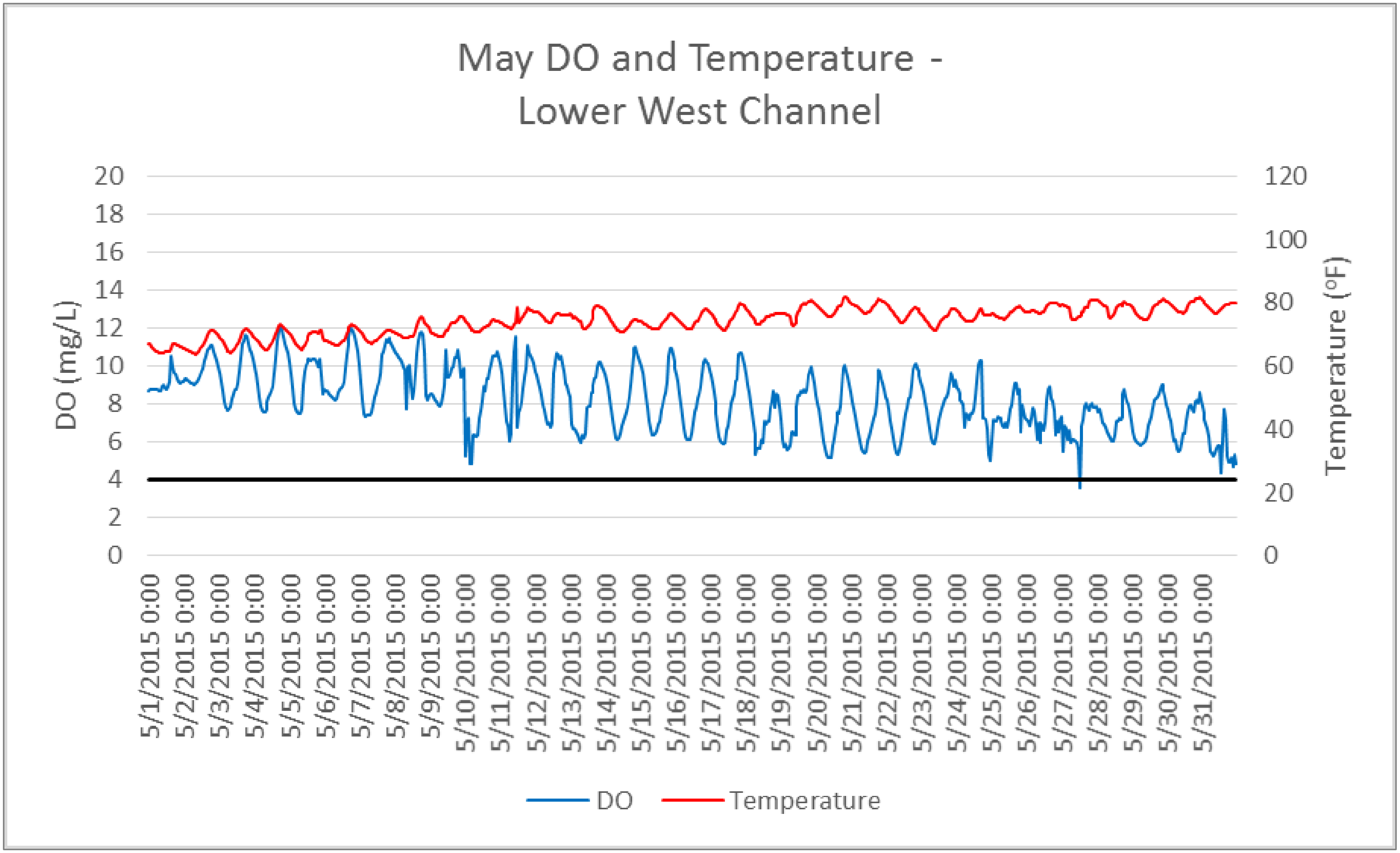


FIGURE 16 DISSOLVED OXYGEN AND TEMPERATURE IN THE LOWER WEST CHANNEL – MAY 2015

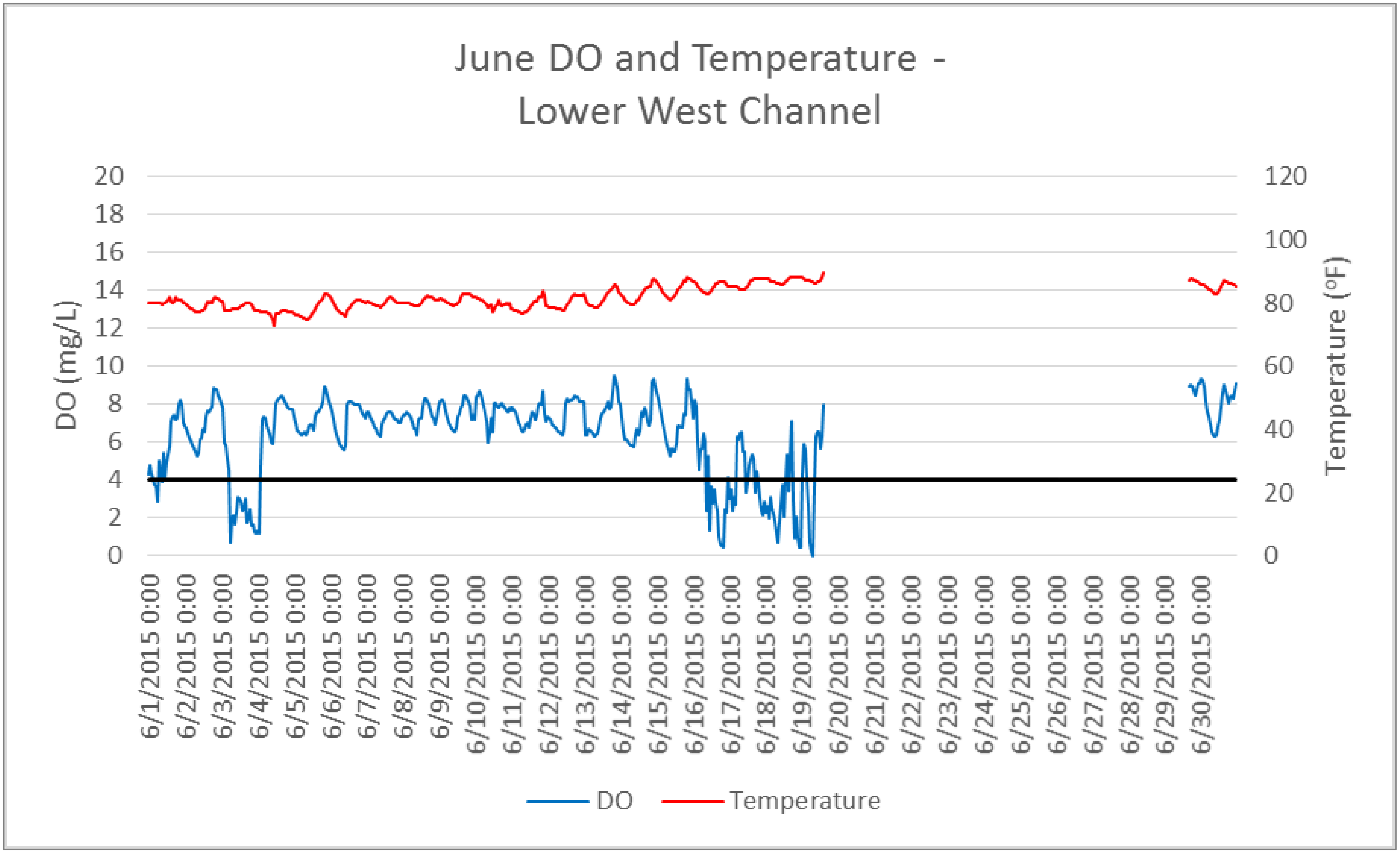


FIGURE 17 DISSOLVED OXYGEN AND TEMPERATURE IN THE LOWER WEST CHANNEL – JUNE 2015

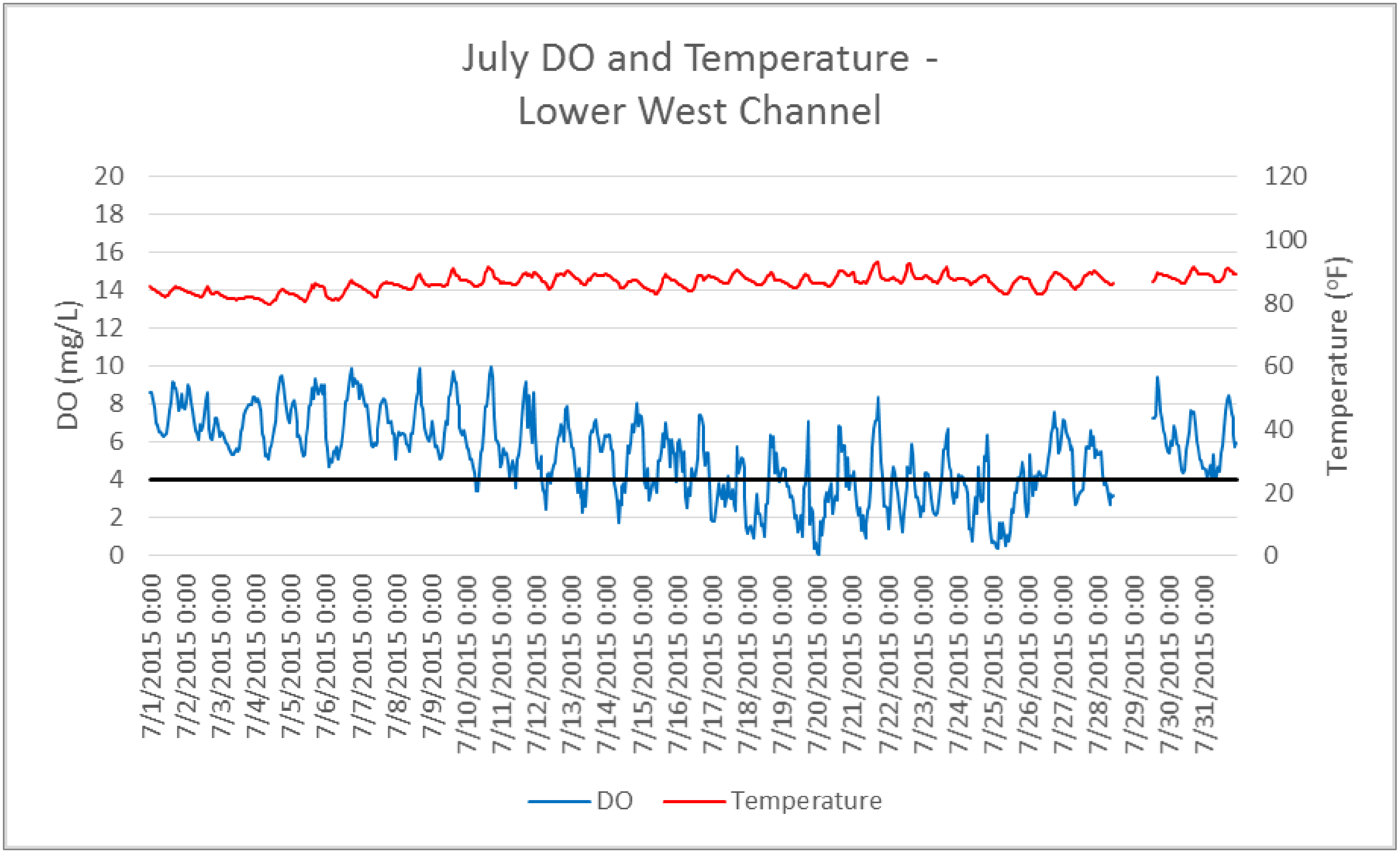


FIGURE 18 DISSOLVED OXYGEN AND TEMPERATURE IN THE LOWER WEST CHANNEL – JULY 2015

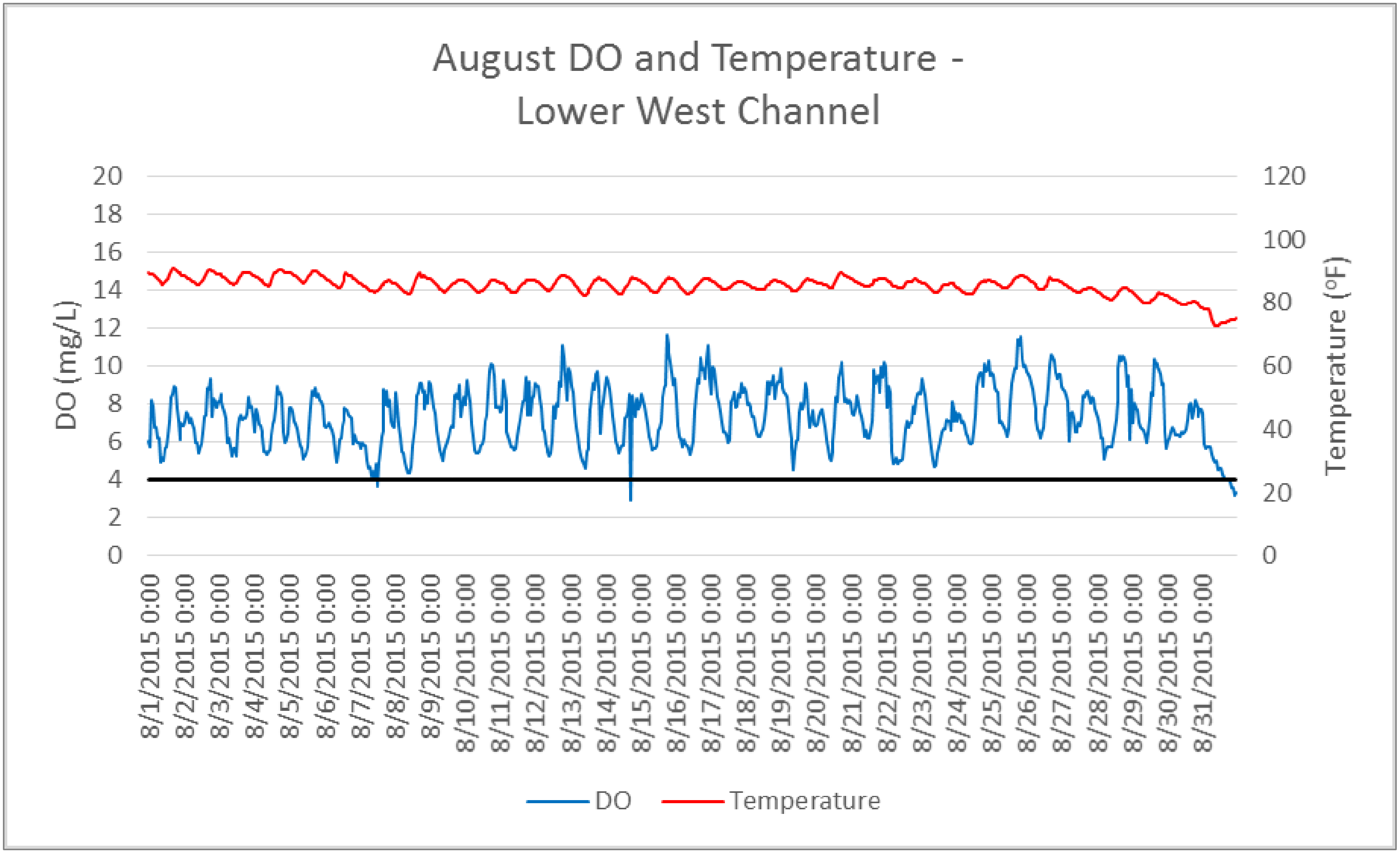


FIGURE 19 DISSOLVED OXYGEN AND TEMPERATURE IN THE LOWER WEST CHANNEL – AUGUST 2015

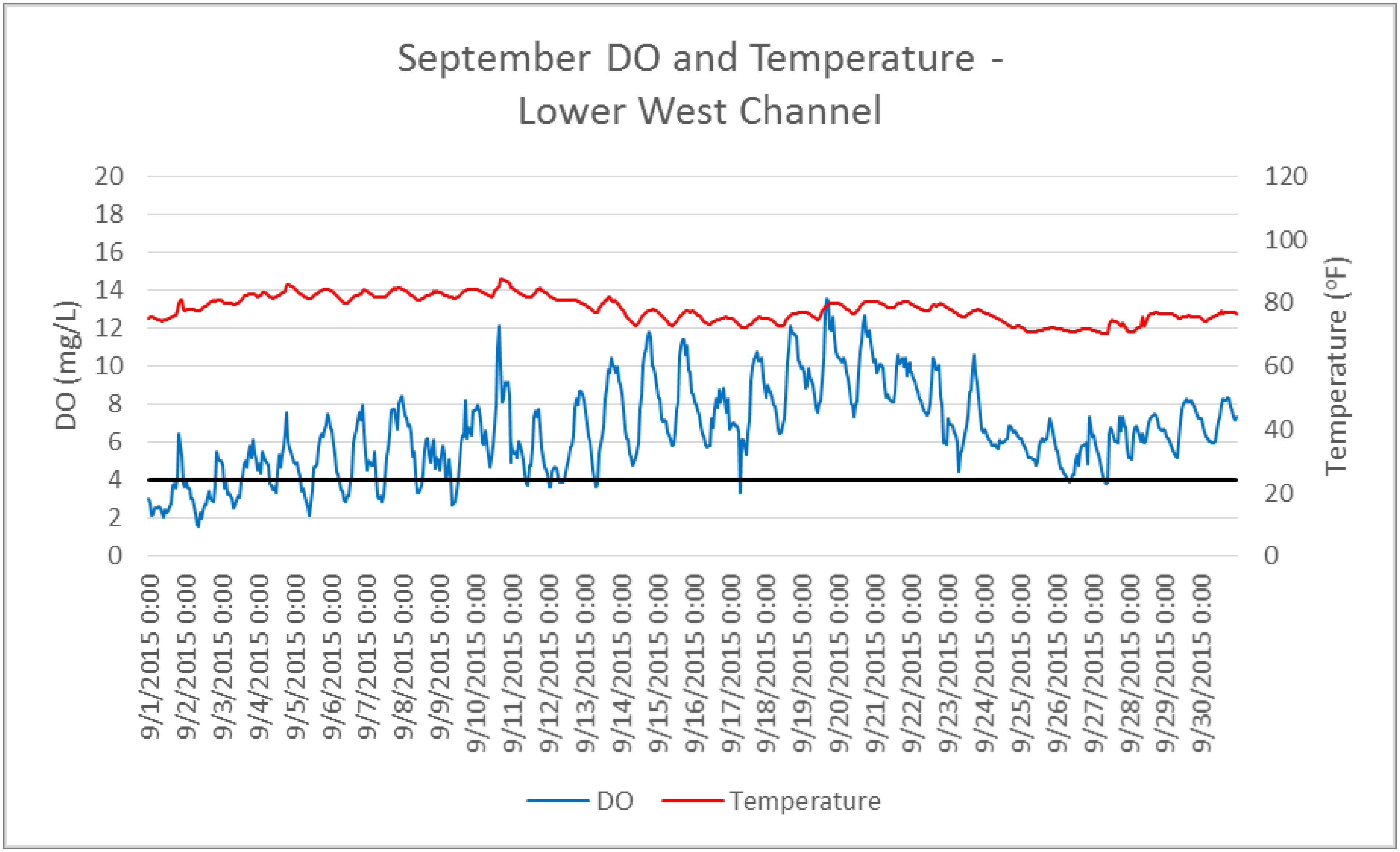


FIGURE 20 DISSOLVED OXYGEN AND TEMPERATURE IN THE LOWER WEST CHANNEL – SEPTEMBER 2015

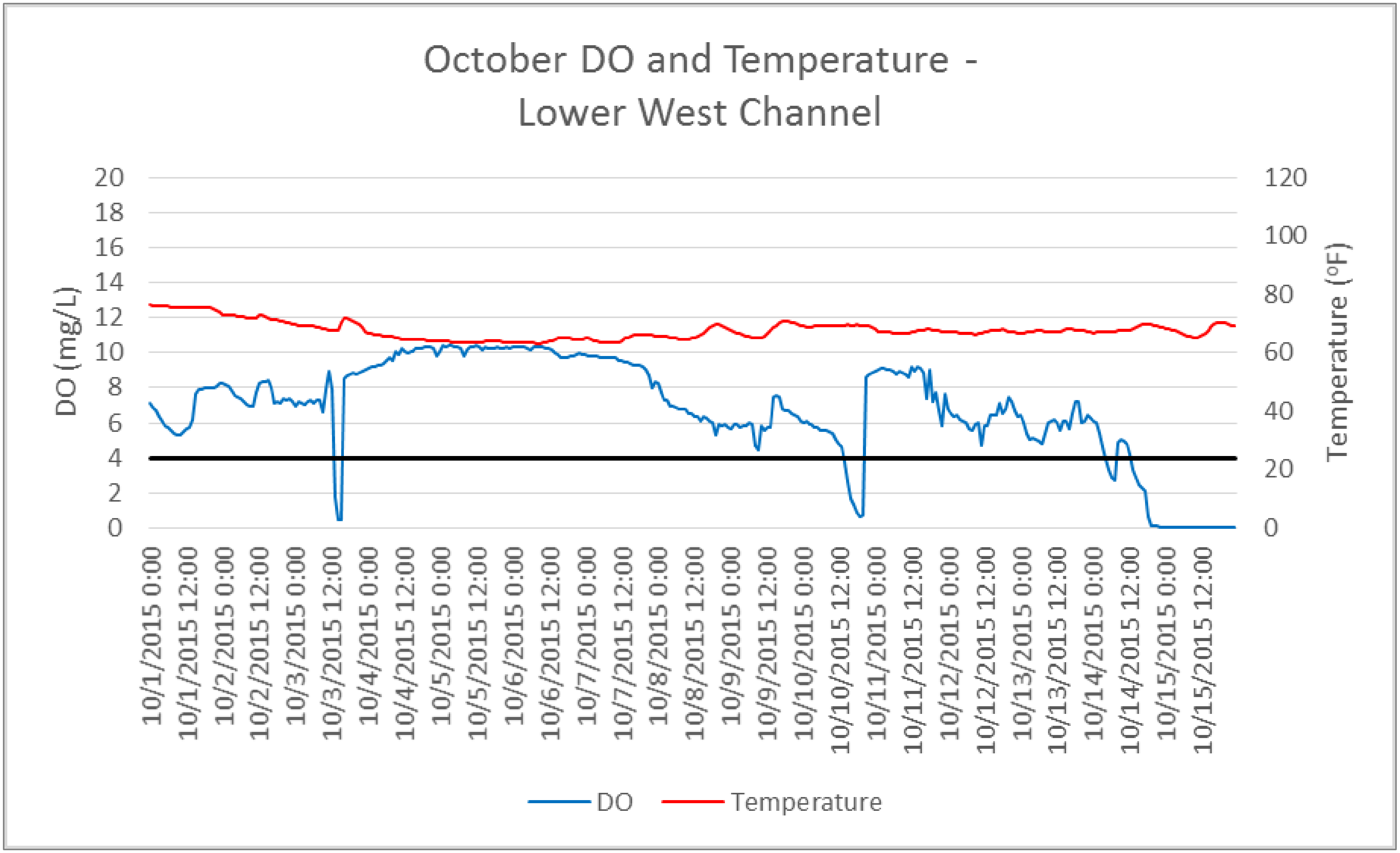


FIGURE 21 DISSOLVED OXYGEN AND TEMPERATURE IN THE LOWER WEST CHANNEL – OCTOBER 2015

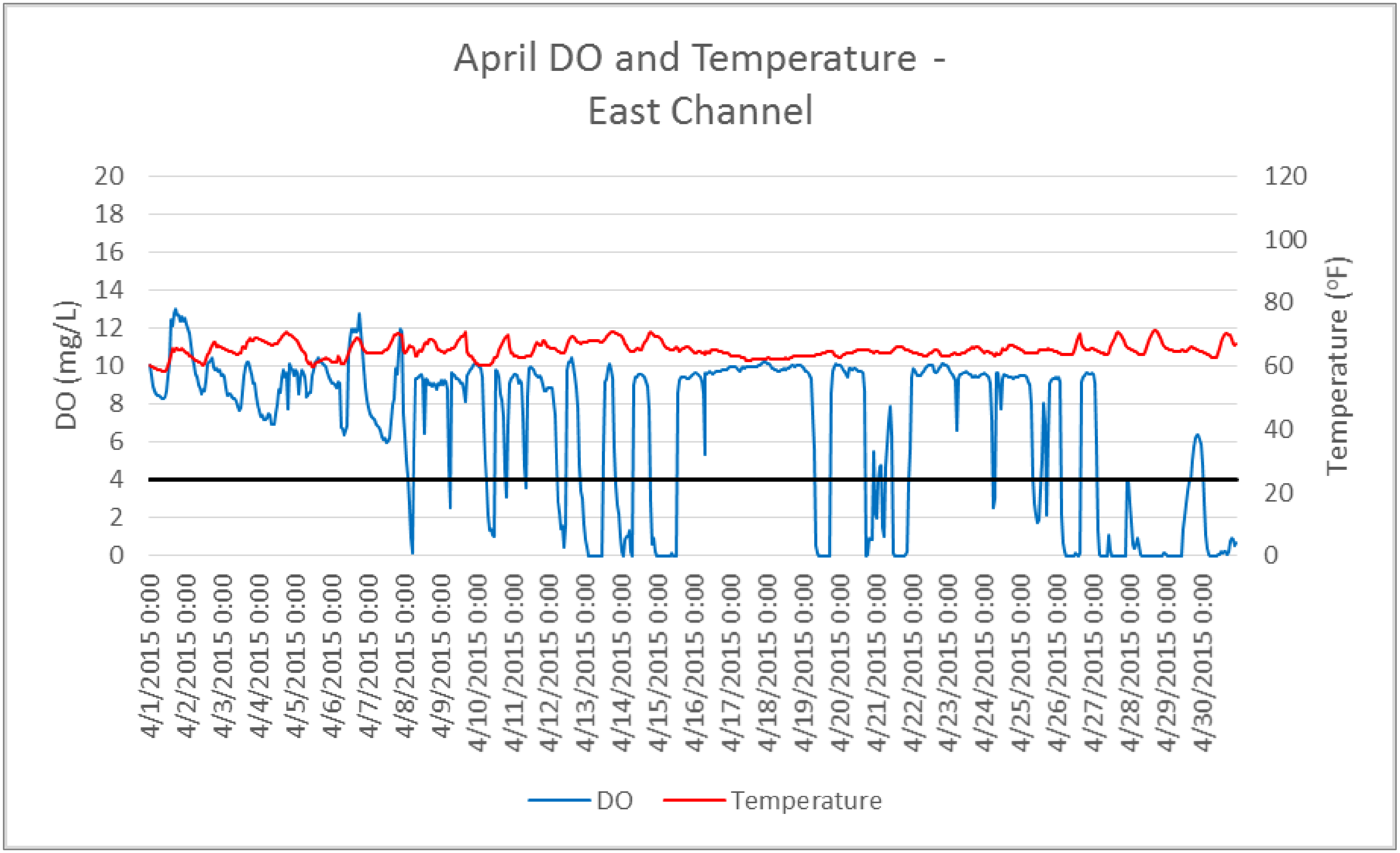
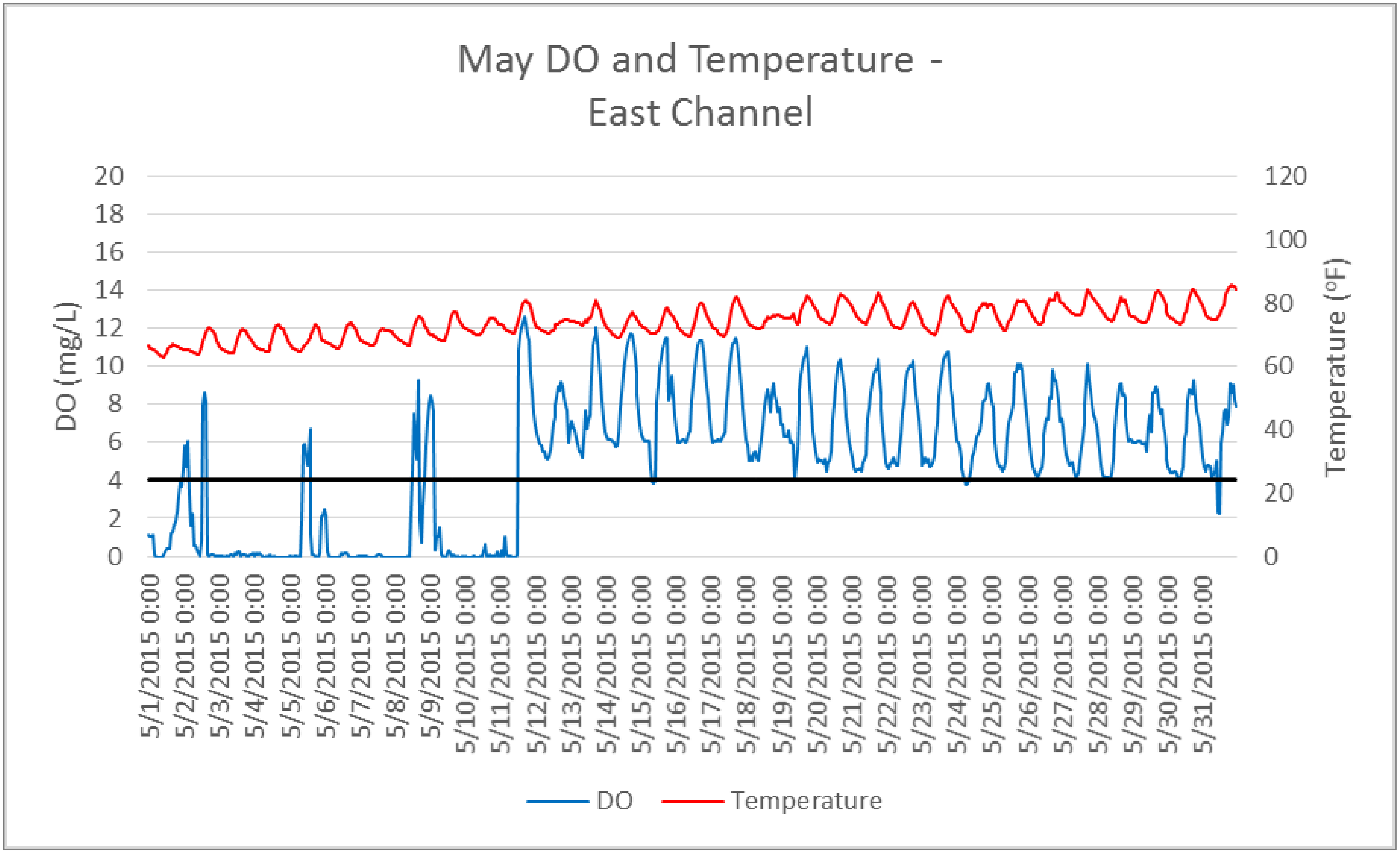


FIGURE 22 DISSOLVED OXYGEN AND TEMPERATURE IN THE EAST CHANNEL – APRIL 2015



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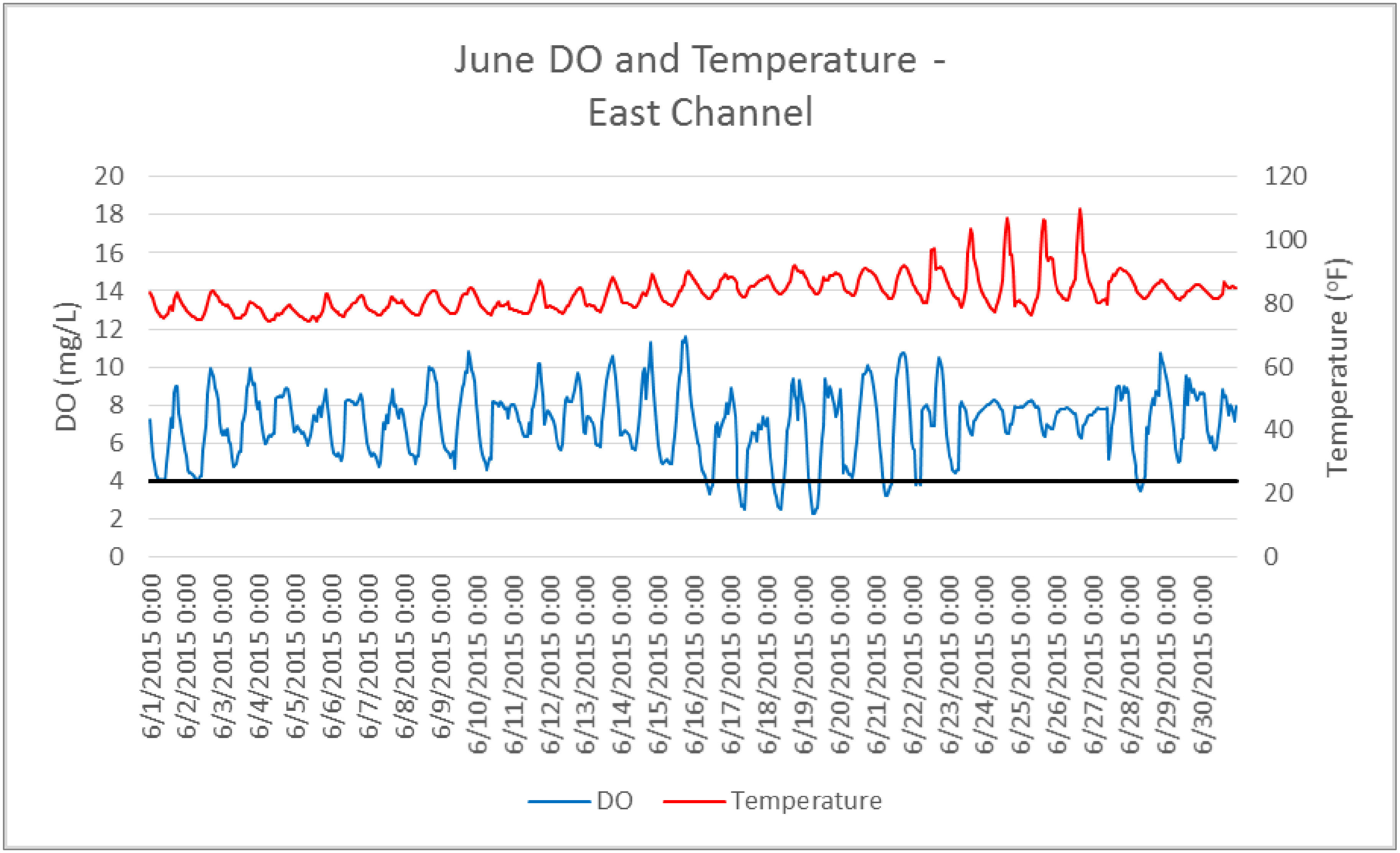


FIGURE 24 DISSOLVED OXYGEN AND TEMPERATURE IN THE EAST CHANNEL – JUNE 2015

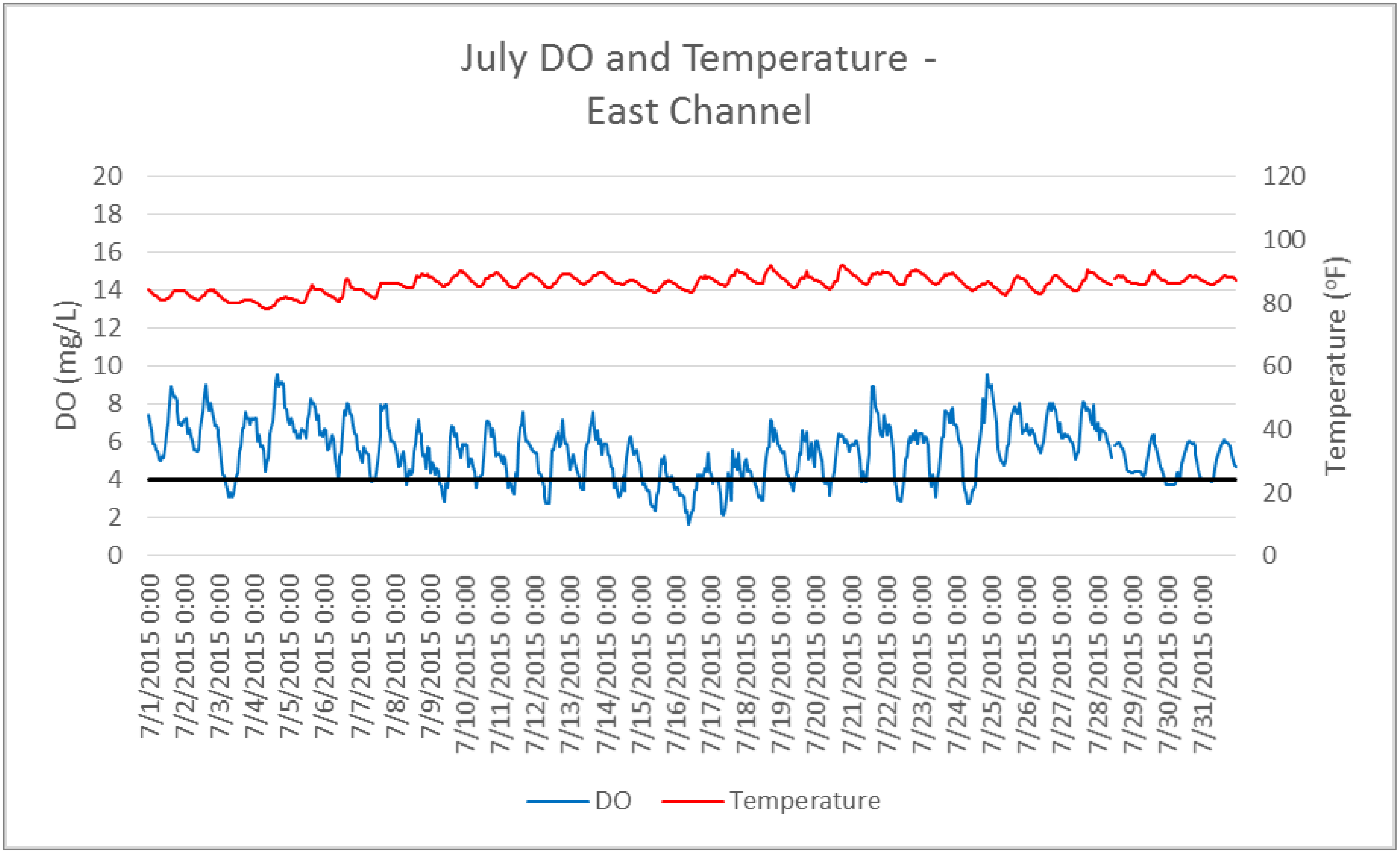
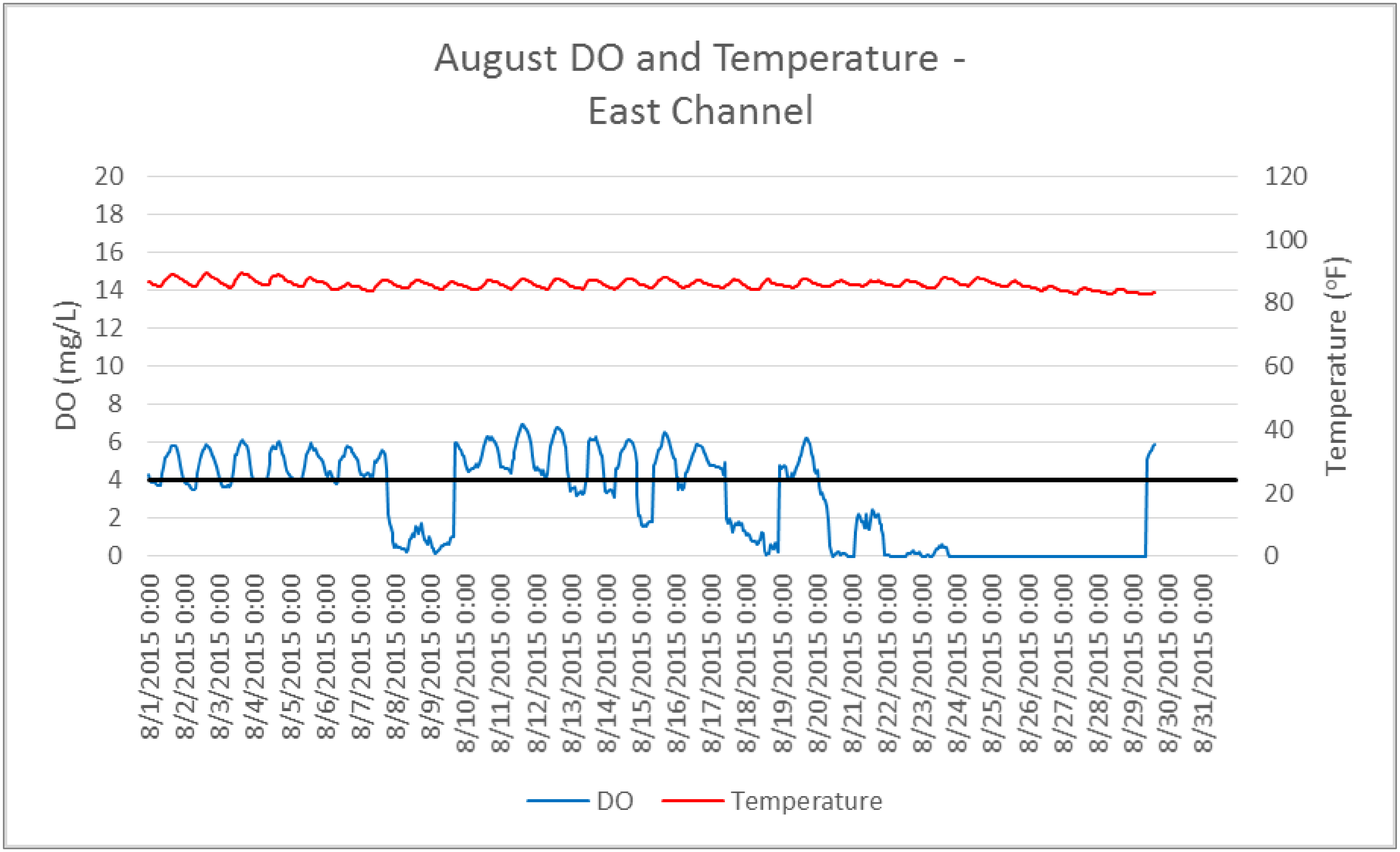


FIGURE 25 DISSOLVED OXYGEN AND TEMPERATURE IN THE EAST CHANNEL – JULY 2015



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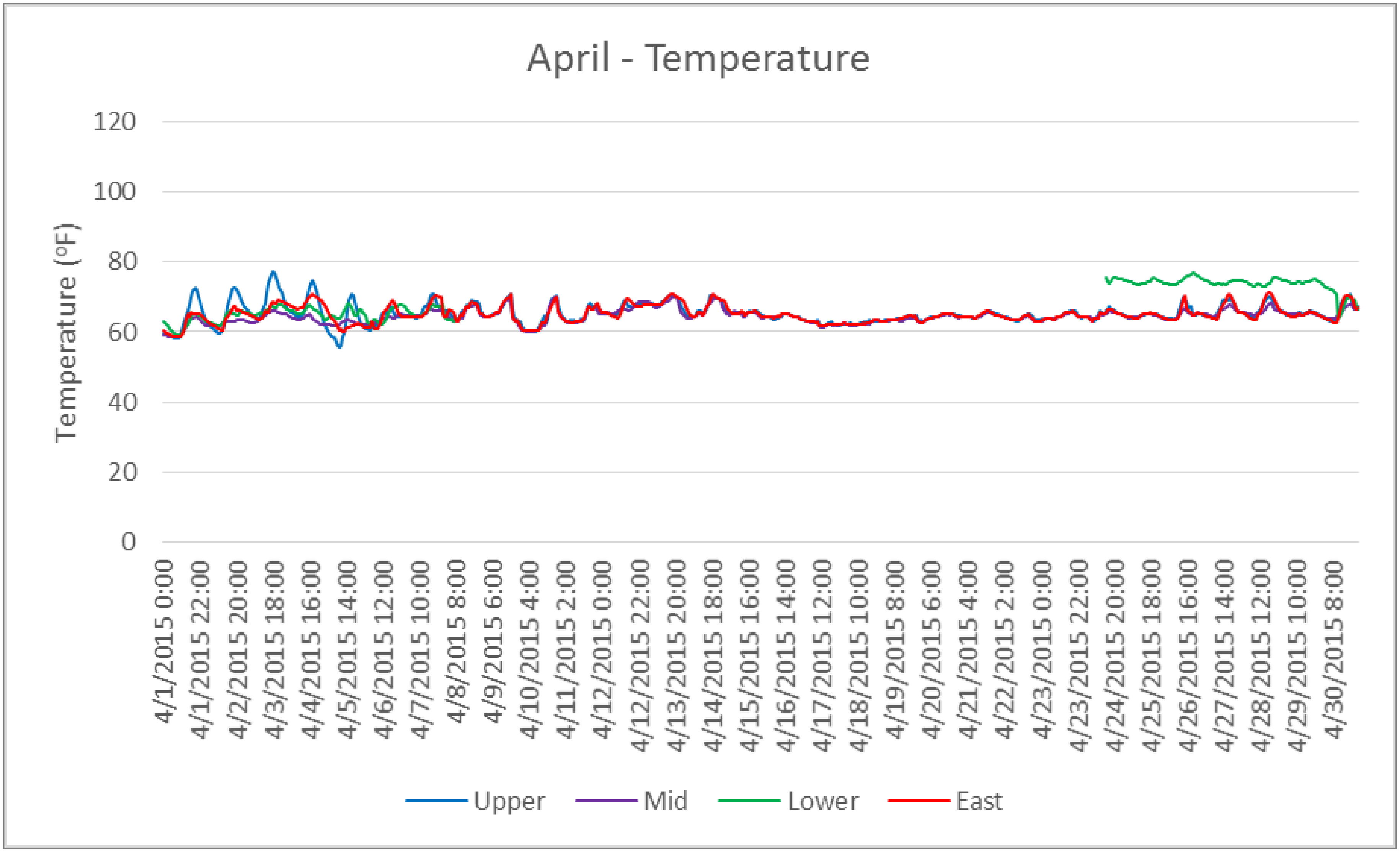

FIGURE 27 TEMPERATURE IN THE UPPER, MIDDLE, AND LOWER WEST CHANNEL AND EAST – APRIL 2015

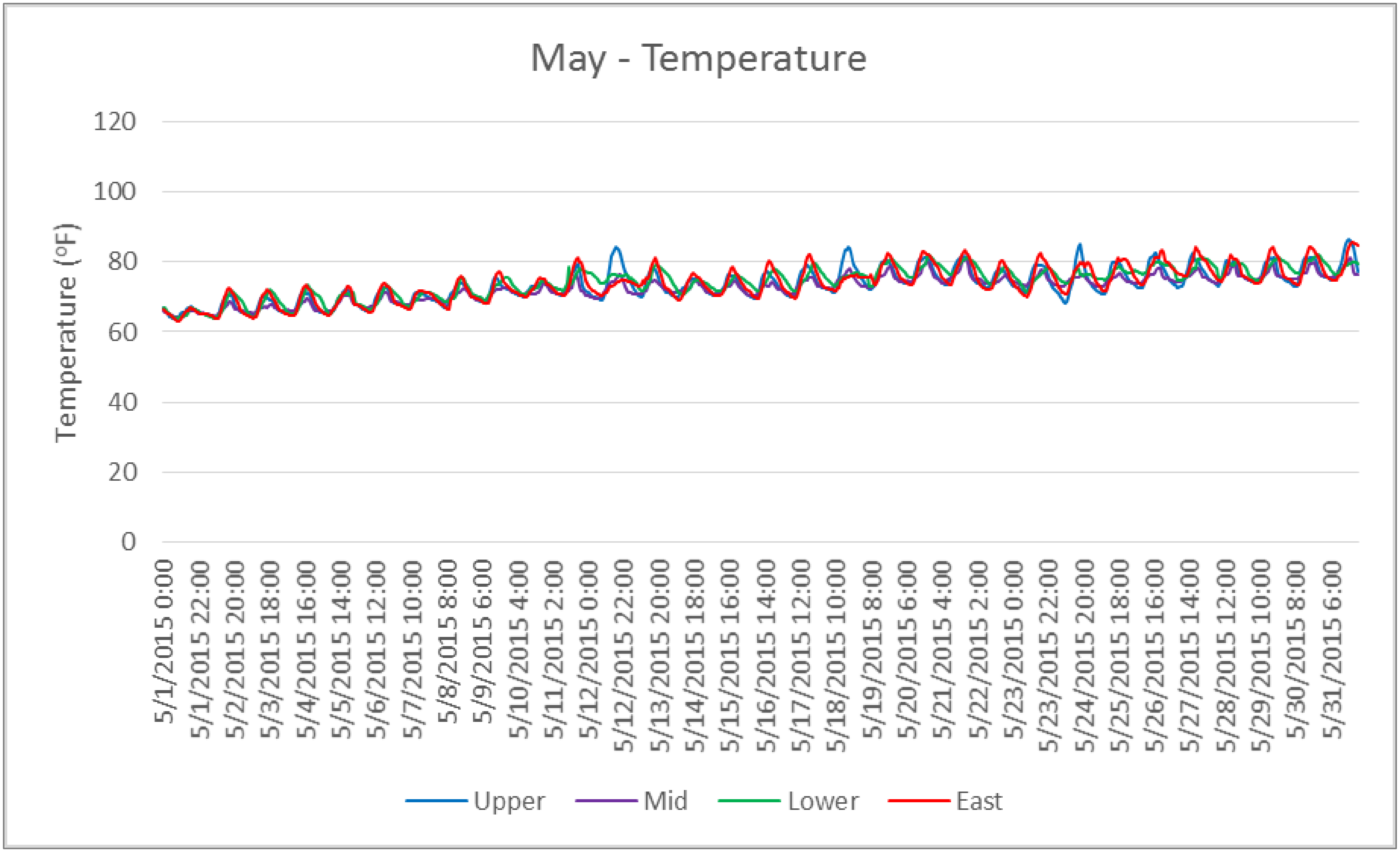

FIGURE 28 TEMPERATURE IN THE UPPER, MIDDLE, AND LOWER WEST CHANNEL AND EAST – MAY 2015

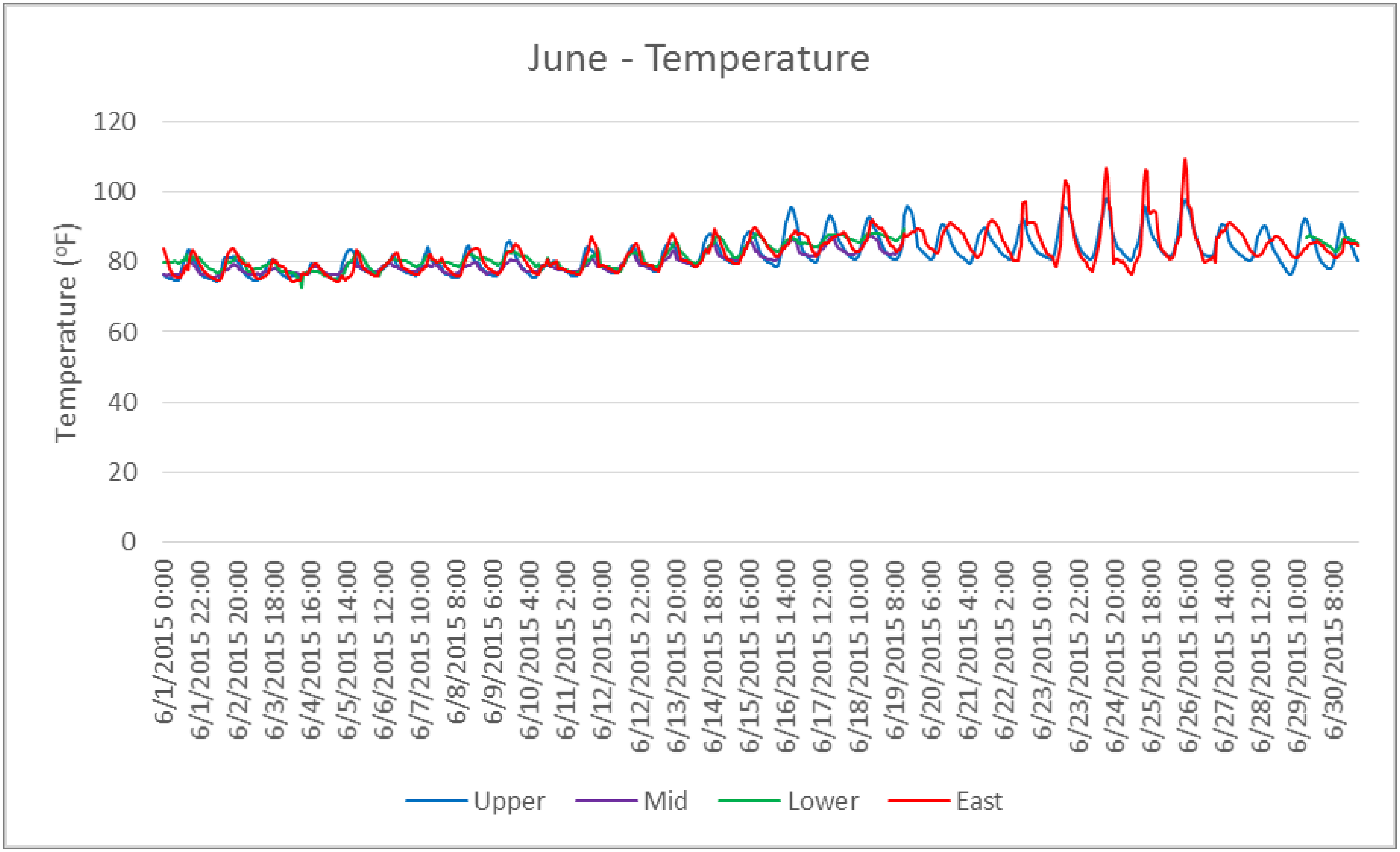

FIGURE 29 TEMPERATURE IN THE UPPER, MIDDLE, AND LOWER WEST CHANNEL AND EAST – JUNE 2015

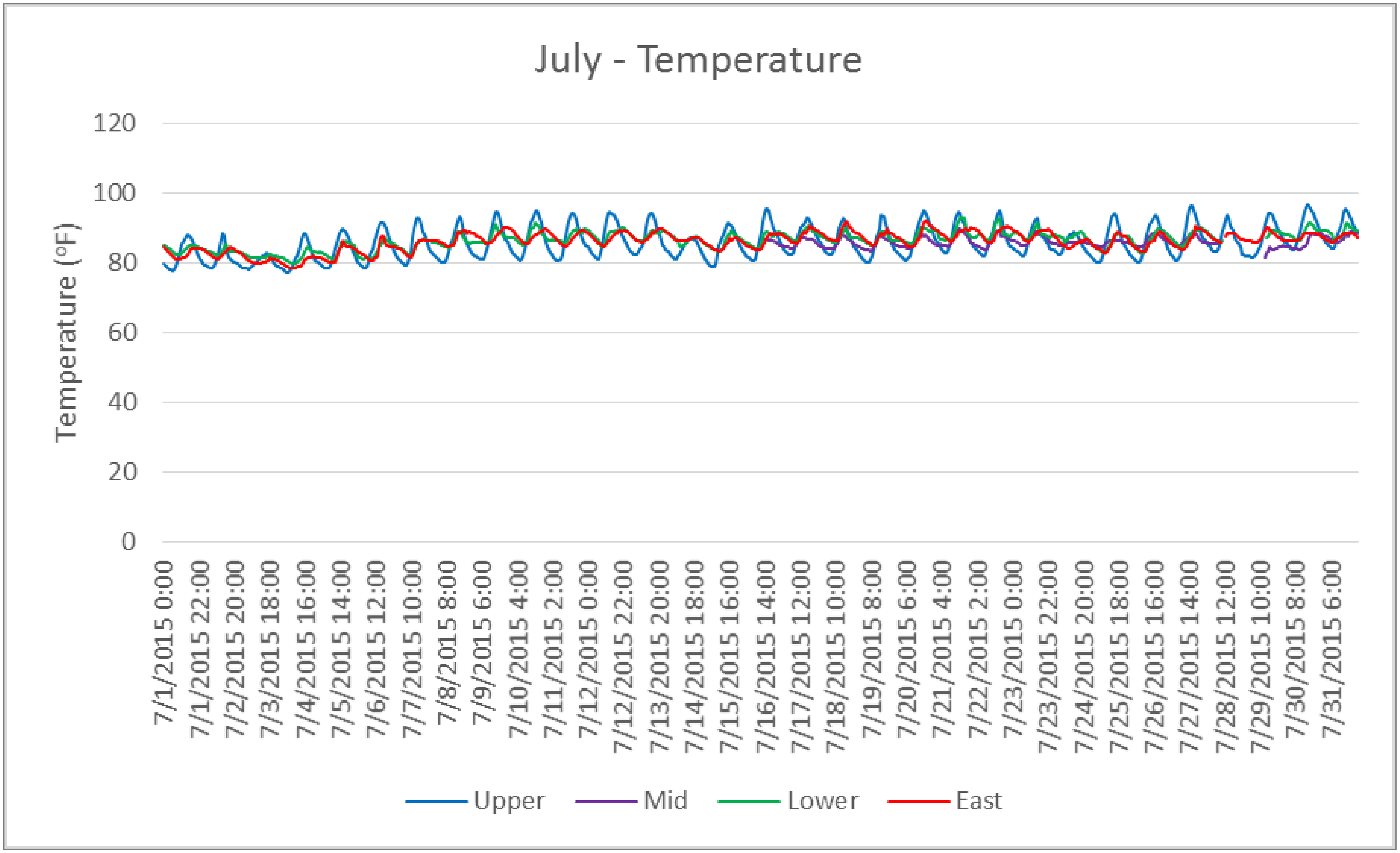

FIGURE 30 TEMPERATURE IN THE UPPER, MIDDLE, AND LOWER WEST CHANNEL AND EAST – JULY 2015

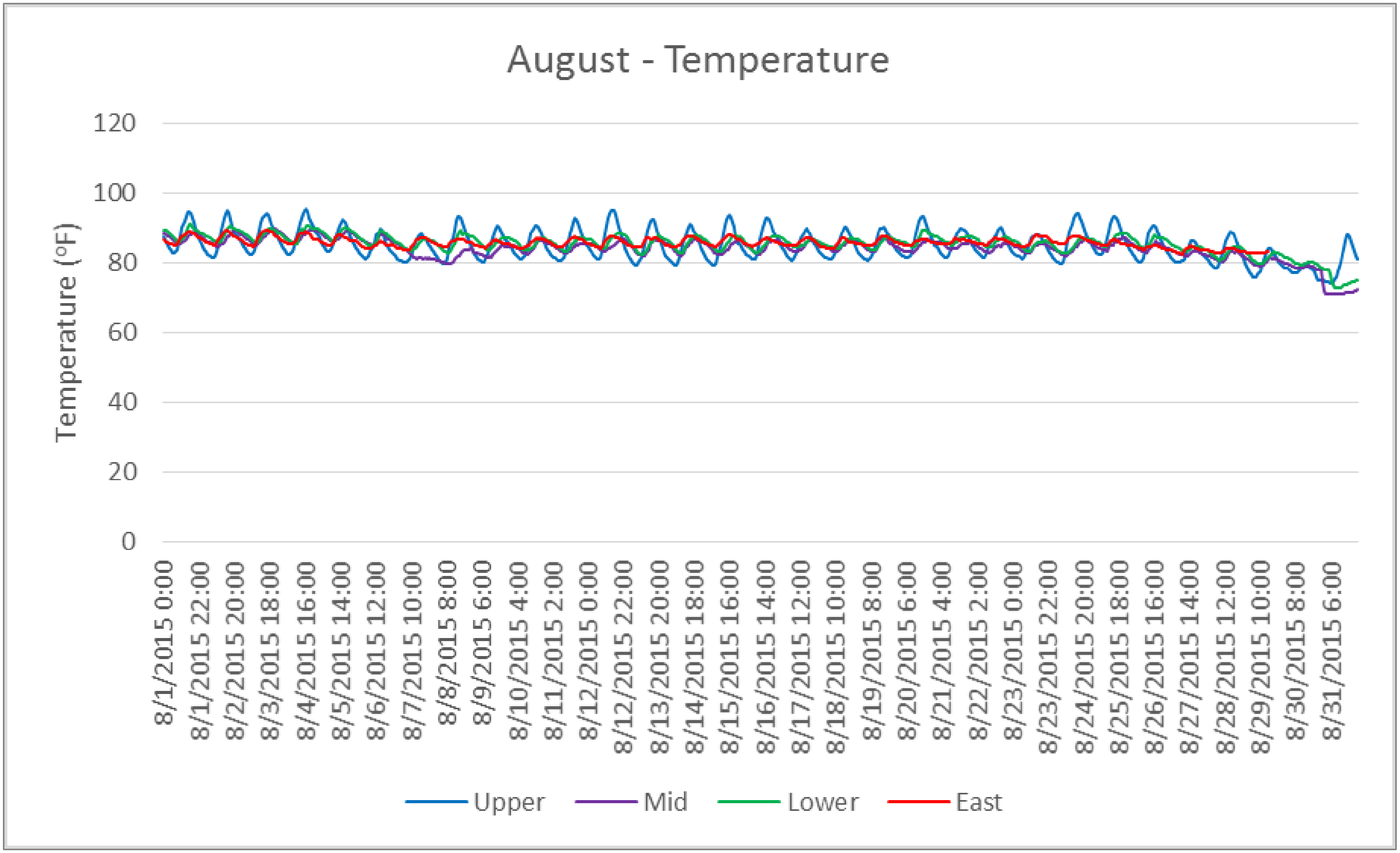

FIGURE 31 TEMPERATURE IN THE UPPER, MIDDLE, AND LOWER WEST CHANNEL AND EAST – AUGUST 2015

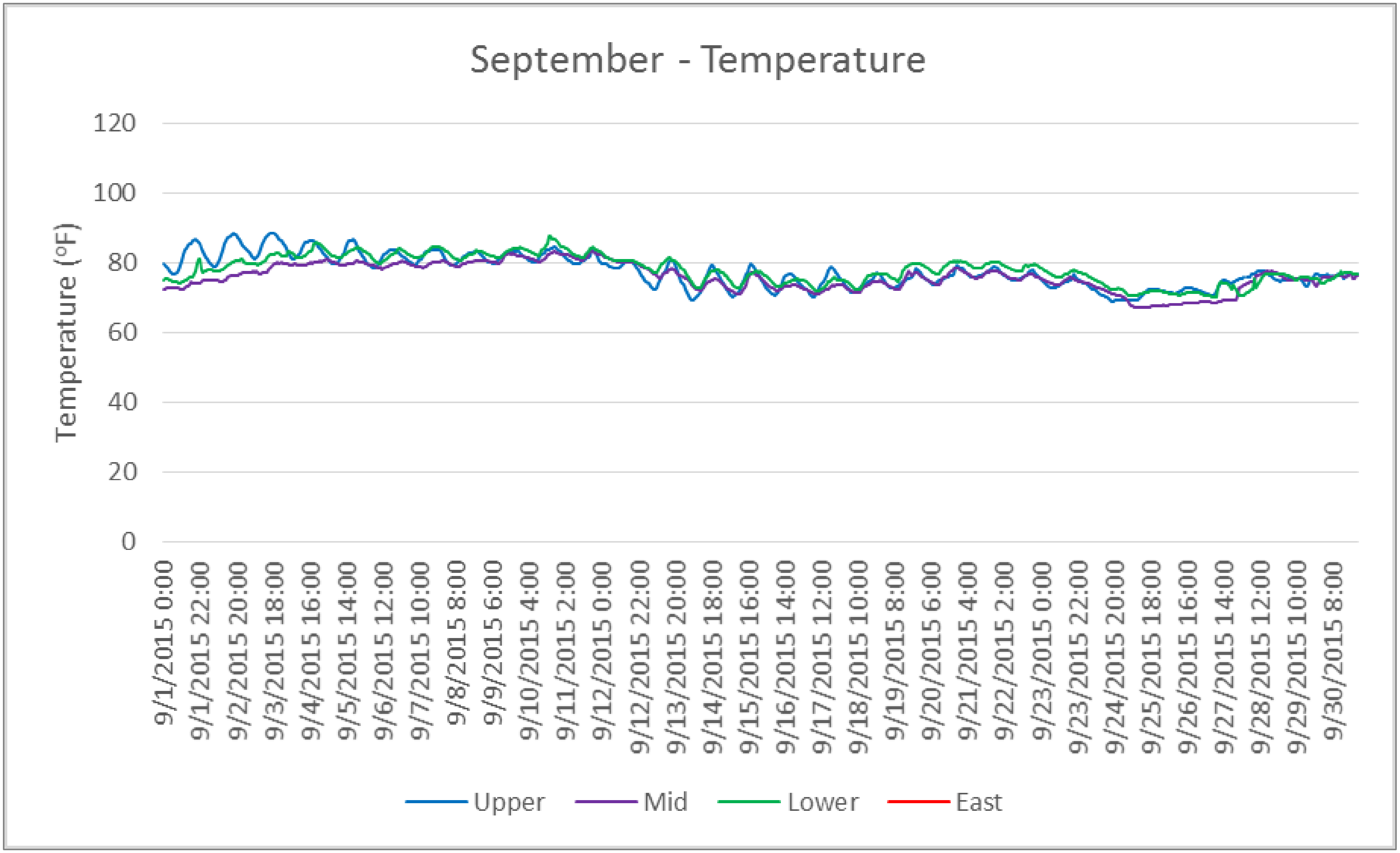

FIGURE 32 TEMPERATURE IN THE UPPER, MIDDLE, AND LOWER WEST CHANNEL AND EAST – SEPTEMBER 2015

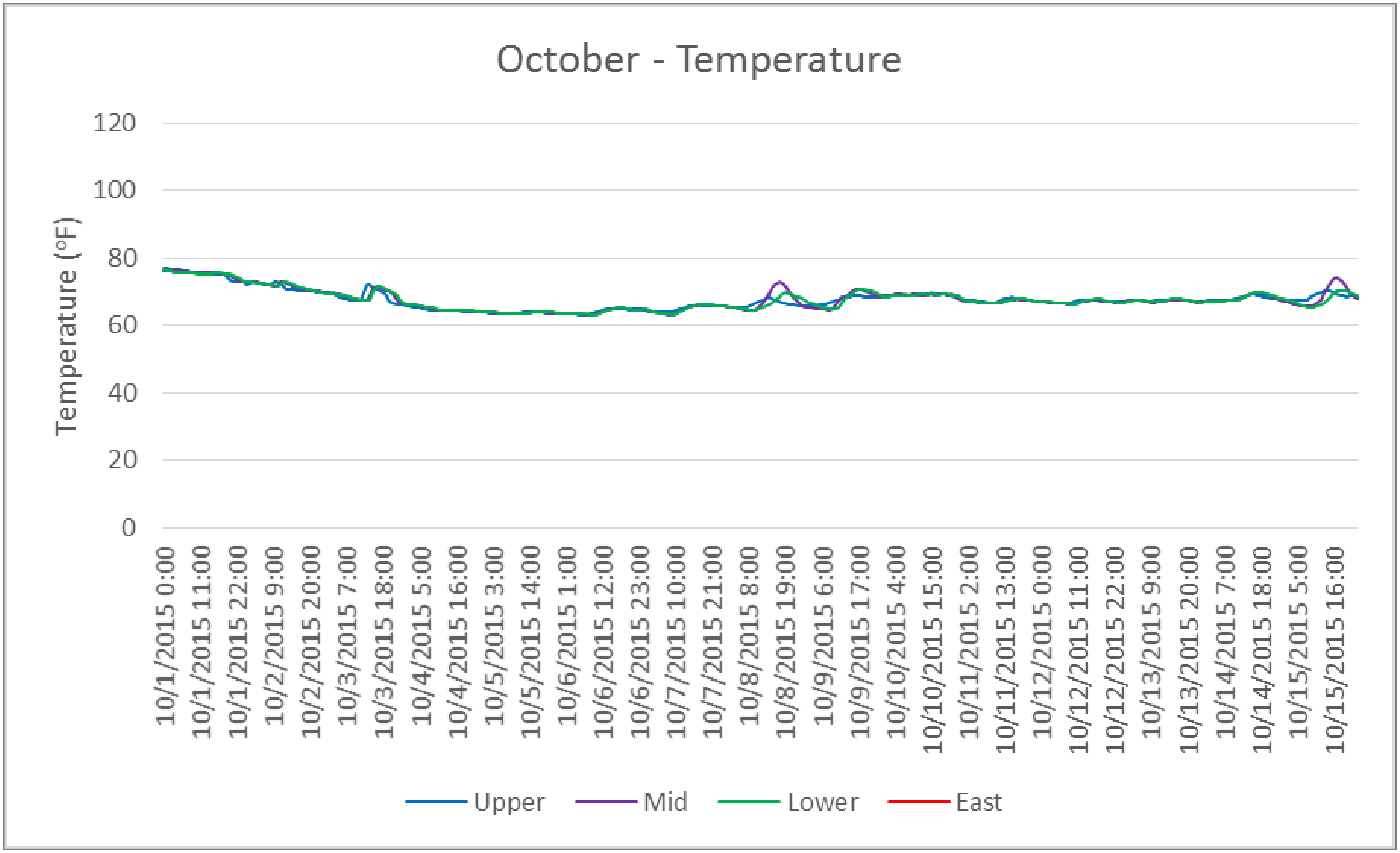

FIGURE 33 TEMPERATURE IN THE UPPER, MIDDLE, AND LOWER WEST CHANNEL AND EAST – OCTOBER 2015

West Channel Water Quality Second Year Study Report

Parr Hydroelectric Project

FERC No. 1894

Prepared for:

South Carolina Electric & Gas Company
Cayce, South Carolina

Prepared by:

Kleinschmidt

Lexington, South Carolina
www.KleinschmidtGroup.com

January 2017

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WEST CHANNEL WATER QUALITY
SECOND YEAR STUDY REPORT

PARR HYDROELECTRIC PROJECT
(FERC NO. 1894)

SOUTH CAROLINA ELECTRIC & GAS COMPANY

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1.0 INTRODUCTION

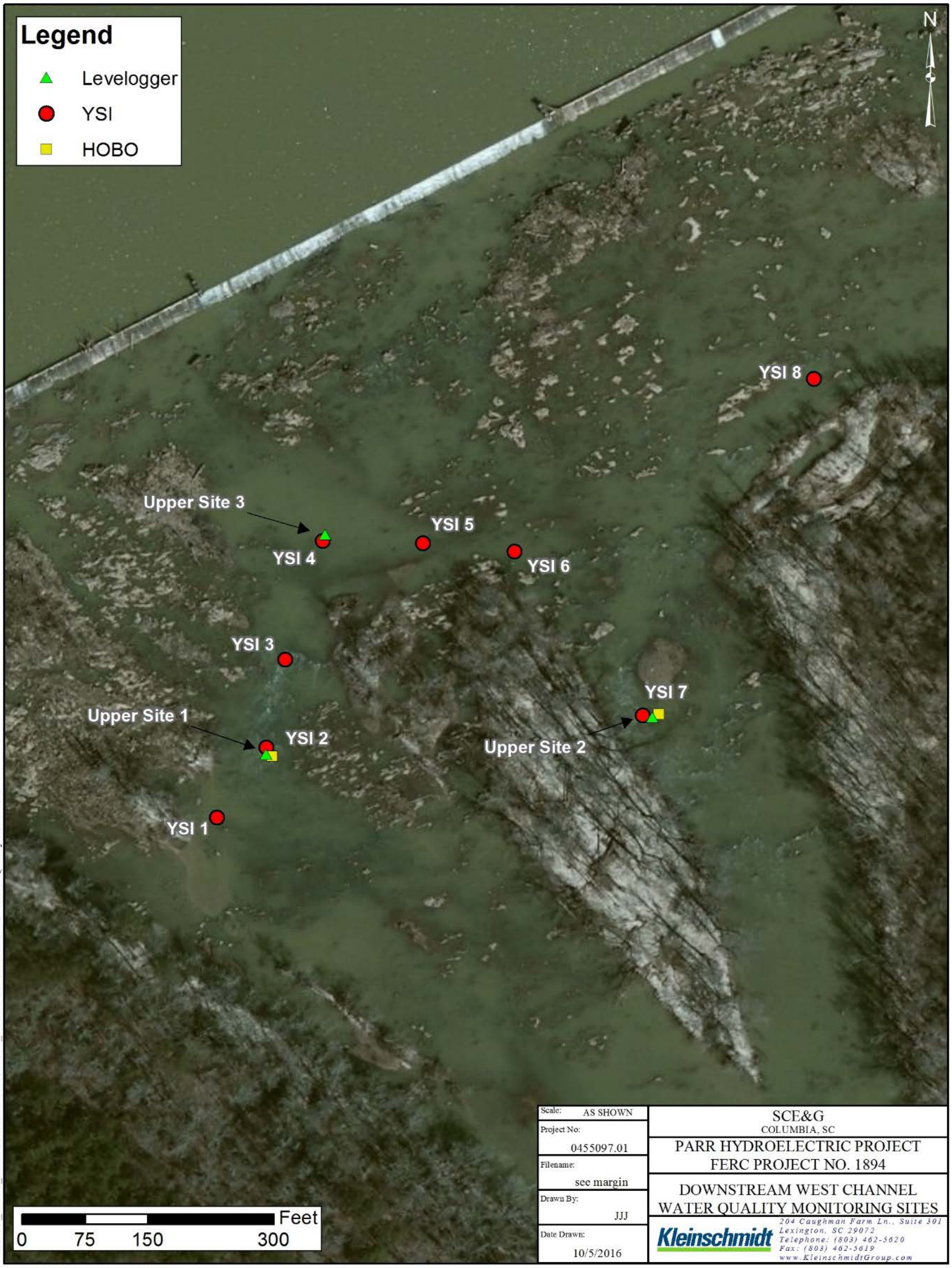
South Carolina Electric & Gas Company (SCE&G) is the Licensee for the Parr Hydroelectric Project (FERC No. 1894) (Project). SCE&G is currently seeking a new license from the Federal Energy Regulatory Commission (FERC), as their current license is set to expire on June 30, 2020. The Project consists of two developments, the Parr Shoals Development and the Fairfield Pumped Storage Development. Parr Reservoir, located in Fairfield and Newberry counties, South Carolina, is a 4,400-acre impoundment formed by the Broad River and the Parr Shoals Dam (Parr Dam) and serves as the lower reservoir for the Fairfield Pumped Storage Development. Monticello Reservoir is a 6,800-acre impoundment formed by a series of four earthen dams, and serves as the upper reservoir for the pumped storage development. While the stretch of the Broad River downstream of the Parr Dam is not included in the Project Boundary Line (PBL), Project operations do influence this area.

The Project is currently involved in a relicensing process which involves cooperation between SCE&G and a variety of stakeholders including state and federal resource agencies, state and local government, non-governmental organizations (NGO), and interested individuals. SCE&G has established several Technical Working Committees (TWCs) comprised of members from the interested stakeholders. A Water Quality TWC was formed to address potential water quality issues associated with the Project. During issues scoping, the TWC identified the west channel area of the Broad River downstream of the Parr Dam as a potential area for a water quality study. The TWC specifically expressed concern about low dissolved oxygen (DO) levels in this area of the Broad River during the warmer summer and fall months.

SCE&G performed initial sampling in the west channel during 2015 and presented that data to the Water Quality TWC. The TWC recommended that SCE&G perform additional collections during 2016 to verify some of the high water temperatures and low dissolved oxygen readings recorded during late summer of 2015. SCE&G performed collections of water temperature and DO during August 2016 to verify baseline conditions and to evaluate how discrete spillway releases or pulses through the spillway gates affect water quality in the west channel. The results of this study will be used to develop measures for improving water quality in the west channel during future operations in the new license.

2.0 STUDY AREA

The Broad River immediately downstream of the Parr Dam is naturally divided by Hampton Island, creating an eastern and western channel along the length of the island, which is approximately 1.25 miles long. Water temperature and DO were continuously monitored at four sites along the western channel: two locations just downstream of the Parr Dam (Upper Site 1 and Upper Site 2), one location midway down Hampton Island near the Highway 213 bridge (Middle West Channel), and one location at the lower extent of the western channel, just upstream of the confluence with the Broad River main channel (Lower West Channel). Additional water quality sites were also sampled for DO and water temperature periodically during the study (YSI-1 through YSI-8). Level logger data were collected at 3 locations in the upper west channel (Upper Site 1, Upper Site 2, and Upper Site 3), and stream flow measurements were collected at two locations in the upper west channel (Upper Site 1 and Upper Site 2). Each of the monitoring sites are shown in Figures 2-1 and 2-2.



Path: G:_Client_Data\SCE&G\ParrFairfield_MXD\Parr West Channel Water Quality 2016.mxd

Source: Kleinschmidt, ESRI

FIGURE 2-1 UPPER WEST CHANNEL MONITORING SITES

Source: Kleinschmidt, ESRI

FIGURE 2-2 LOWER WEST CHANNEL MONITORING SITES

3.0 COLLECTION METHODS

The TWC requested that water temperature, DO, and water depth/flow be collected during the testing period. Water temperature and DO were monitored in the west channel area of the Broad River using HOBO U26 Dissolved Oxygen Loggers. The HOBO loggers were attached to floats and weights and deployed at the four monitoring sites on August 1, 2016, and retrieved on August 29, 2016. The loggers were calibrated according to the manufacturer's specifications and were set to collect temperature and DO data on 15 minute intervals. The logger manufacturer, Onset, specifies that the dissolved oxygen monitors have an accuracy of +/- 0.2 mg/L. Data were downloaded on a weekly basis using manufacturer's software and compiled throughout the monitoring period.

Additionally, a calibrated YSI meter was used to collect DO and water temperature approximately once a week when data were downloaded from the HOBO loggers at each monitoring site and at additional sites in the vicinity of the HOBO loggers. These collections were used to verify HOBO logger data.

Calibrated level loggers were also installed in three locations in the upper west channel area. The data collected with these loggers was analyzed to determine how water levels changed in the west channel due to spillway leakage, spillway pulsing, and flows from the Parr powerhouse tailrace. Stream flow was measured periodically at Upper Site 1 and Upper Site 2 to determine stream flow - depth relationship.

During the collection period, SCE&G released discrete pulses from spillway gates 1 and 2 to determine how pulse flows may influence DO and temperature levels at each of the HOBO loggers. Unplanned additional spillway flows related to project operations and reservoir inventory were also released during the study. Our schedule for testing was as follows:

August 1, 2016	deploy monitors – baseline data, no pulse
August 6, 2016	unplanned spill event, approximately 15,000 cfs peak flow
August 7, 2016	unplanned spill event, approximately 7,500 cfs peak flow
August 8, 2016	download data, clean, and redeploy monitors – pulse flow
August 10, 2016	unplanned spill event, approximately 16,500 cfs peak flow

August 11, 2016 unplanned spill event, approximately 9,000 cfs peak flow

August 15, 2016 download data, clean, and redeploy monitors – pulse flow

August 18, 2016 pulse flow

August 22, 2016 download data, clean, and redeploy monitors – baseline data no pulse

August 29, 2016 download data – remove all monitors

3.1 PULSE FLOWS

The pulse flows consisted of discrete releases through spillway gates 1 and 2 for approximately 3 hours. The spills were targeted to release 24 acre-feet of water into the West Channel. Table 3-1 contains specific information of each release.

TABLE 3-1 SPILLWAY PULSE FLOW RELEASES

Date	Release Time	Volume (acre-feet)
8/8/2016	0920-1220	24.33
8/15/2016	0800-1045	24.69
8/18/2016	0830-1130	22.22

TABLE 3-2 UNPLANNED SPILLWAY RELEASE FLOW

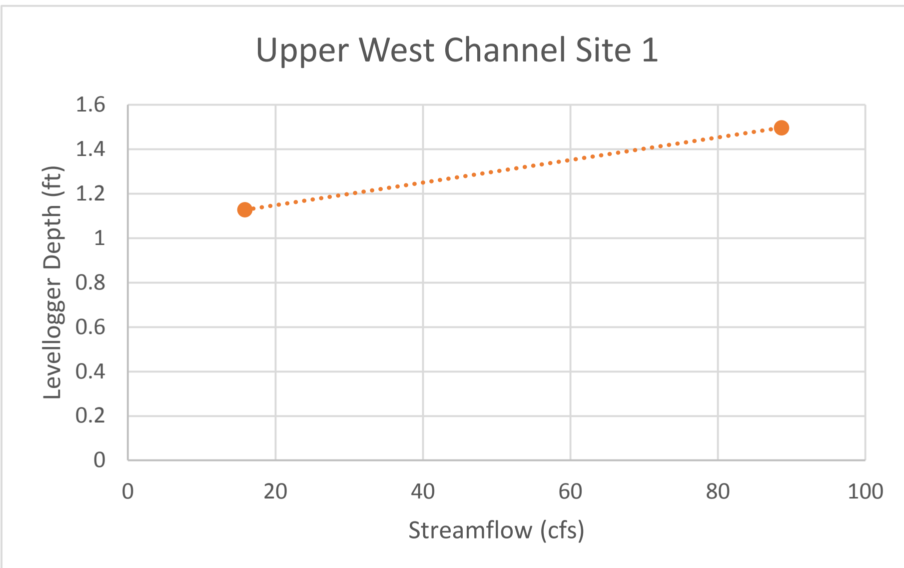
Date	Release Time	Peak Flow (cfs)
8/06-8/07 2016	1000-0745	15,100
8/07-8/08 2016	1600-0445	7,420
8/10-8/11 2016	0700-0130	16,600
8/11/2016	0930-1800	9,220

3.2 STREAM FLOW DATA COLLECTIONS

During installation of the stream monitors, field personnel noticed that stream flow from the tailrace area was passing into the west channel. Flows from the tailrace could affect DO and temperature levels in the west channel; therefore, Parr tailrace elevation was compared to level logger information to determine how streamflow in the two areas may be connected. Using standard USGS stream gaging methods, field crews measured streamflow at Sites 1 and 2 in the Upper West channel to establish a stage-discharge relationship.

4.0 RESULTS

There was a positive relationship between streamflow (turbines and/or spillway) and water levels in the west channel (Figure 4-1). Further, Parr tailrace elevations mirrored west channel water levels, suggesting some water released from the powerhouse flows laterally into the west channel and affects water levels in this reach. This relationship is depicted in Table 4-1, which shows stage-discharge estimates (based on Figure 4-1) for the tailrace and level loggers located at sites 1 and 2 in the upper west channel. As water levels in tailrace increase (i.e. discharge from the powerhouse increases), higher flows are observed in the west channel.



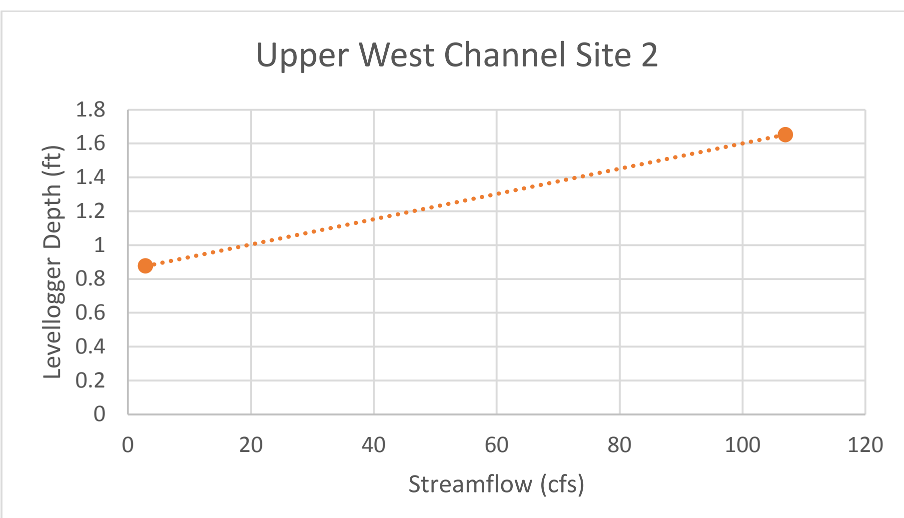
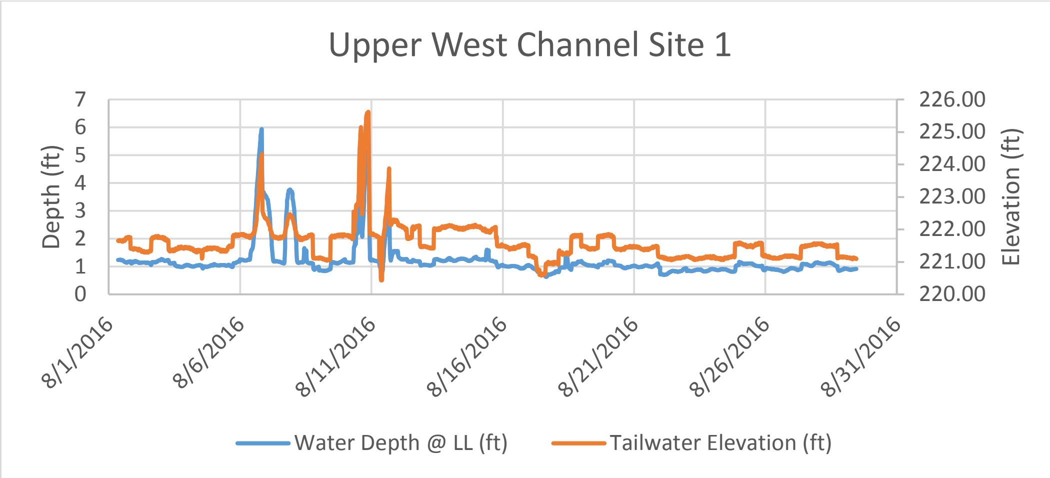
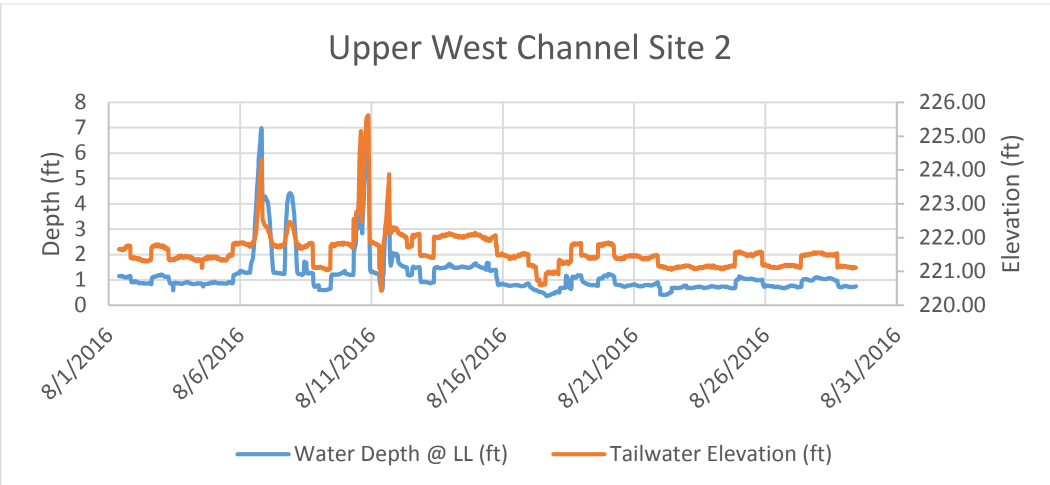


FIGURE 4-1 STREAM FLOW DATA FOR LEVEL LOGGER 1 AND 2 LOCATIONS





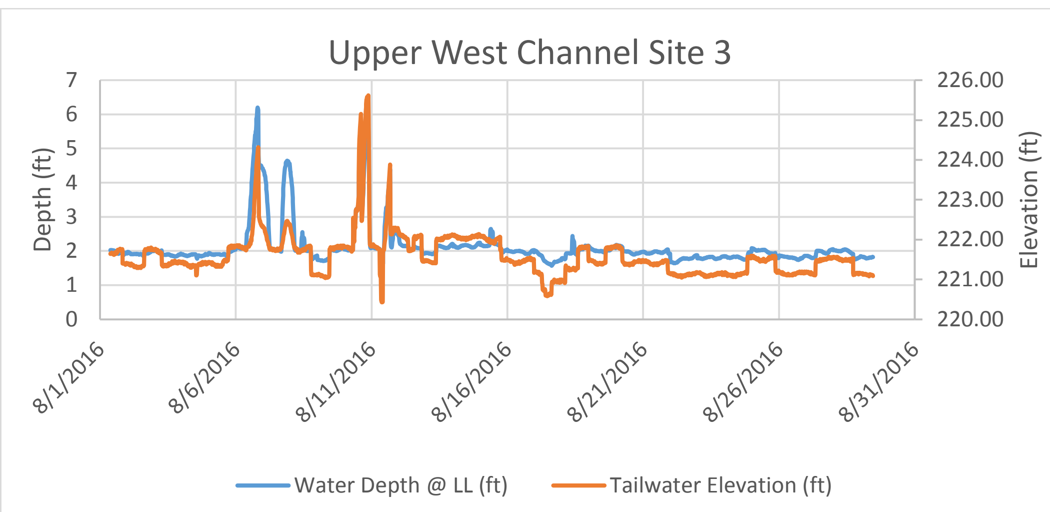


FIGURE 4-2 STREAM FLOW DATA FOR LEVEL LOGGER 1, 2, AND 3 LOCATIONS

TABLE 4-1 STREAM FLOW DATA FOR UPPER SITE 1 AND UPPER SITE 2

SITE 1		
FLOW (CFS)	LEVEL LOGGER DEPTH (FT)	TAILWATER ELEV. (FT)
16	1.13	221.34
20	1.15	221.70
40	1.25	221.85
60	1.35	222.00
80	1.45	222.10
89	1.50	222.20

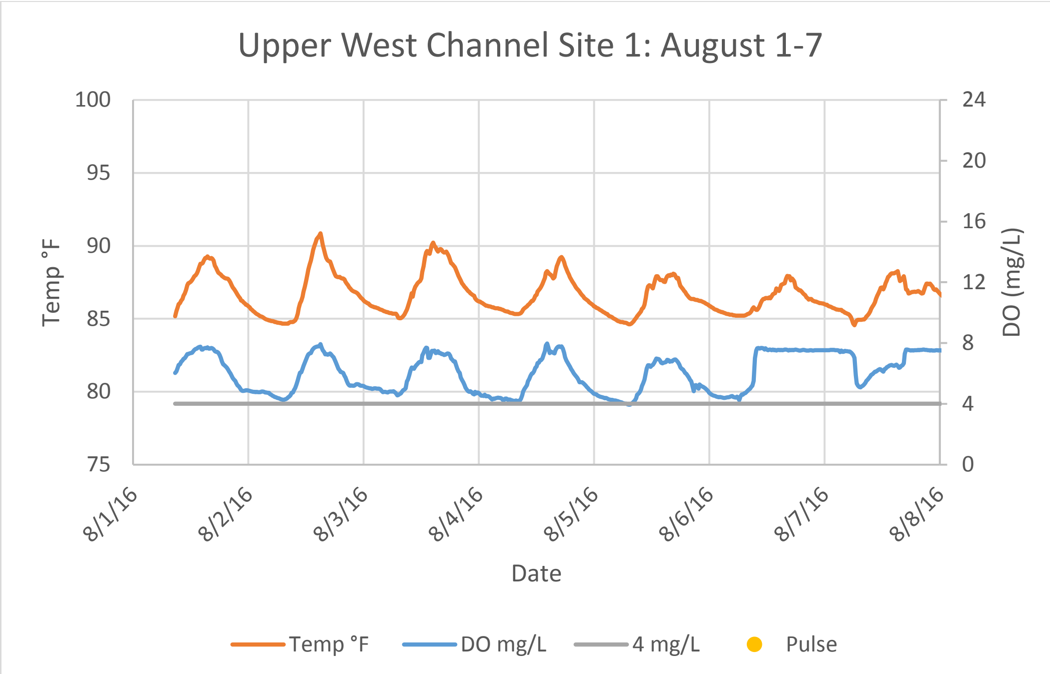
SITE 2		
FLOW (CFS)	LEVEL LOGGER DEPTH (FT)	TAILWATER ELEV. (FT)
3	0.88	221.36
20	1.00	221.60
40	1.15	221.70
60	1.30	221.80
80	1.45	221.95
100	1.60	222.00

4.1 DISSOLVED OXYGEN AND TEMPERATURE DATA

A summary of DO data collected during August is included in the following sections.

August 1-7, 2016

During the week of August 1-7, DO levels briefly dropped below 4 mg/L at the Middle West Channel Site, but DO levels greater than the DHEC standard of 4 mg/L (SCDHEC 2012) were observed for most sampling days at all 4 sites. Field crews noted considerable debris had accumulated around the Middle West Channel HOBO logger during the 8/8 download. The accumulation of debris around the logger could have caused the extremely low DO readings by the logger, which would not be representative of true river conditions. Diel fluctuations in both temperature and DO levels were observed. This week did not contain any planned pulse, but an unplanned operational spill of approximately 15,000 cfs (peak flow) occurred on August 6 and an unplanned operational spill of approximately 7,500 cfs peak flow occurred on August 7. These spill events did not appear to influence DO levels at the Upper or Lower Sites during or after the spills. The Middle Site DO levels appear to have improved with the large spill (Figure 4-3). Minimum and maximum DO and temperatures for each collection site are presented in Table 4-2. Upper Site 2 is a shallow side channel and appears to experience the largest diel swings. DO and temperature collected by YSI are presented in Table 4-3. Comparisons of DO and temperature data collected via HOBO and YSI are presented in Table 4-4 and verify the accuracy of the HOBO collections.



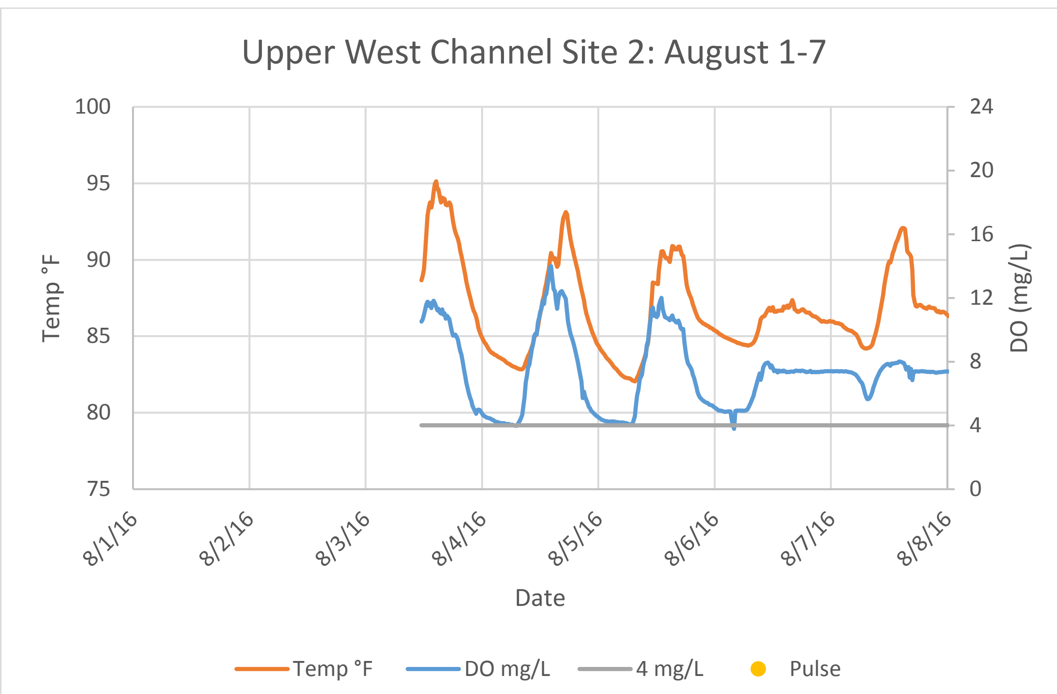
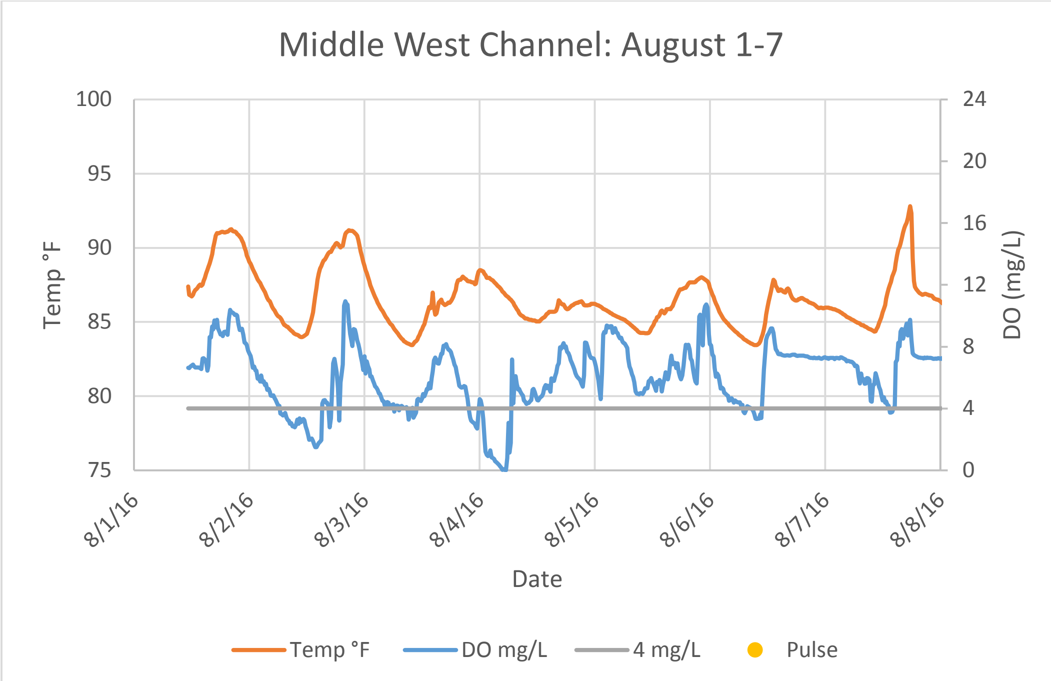
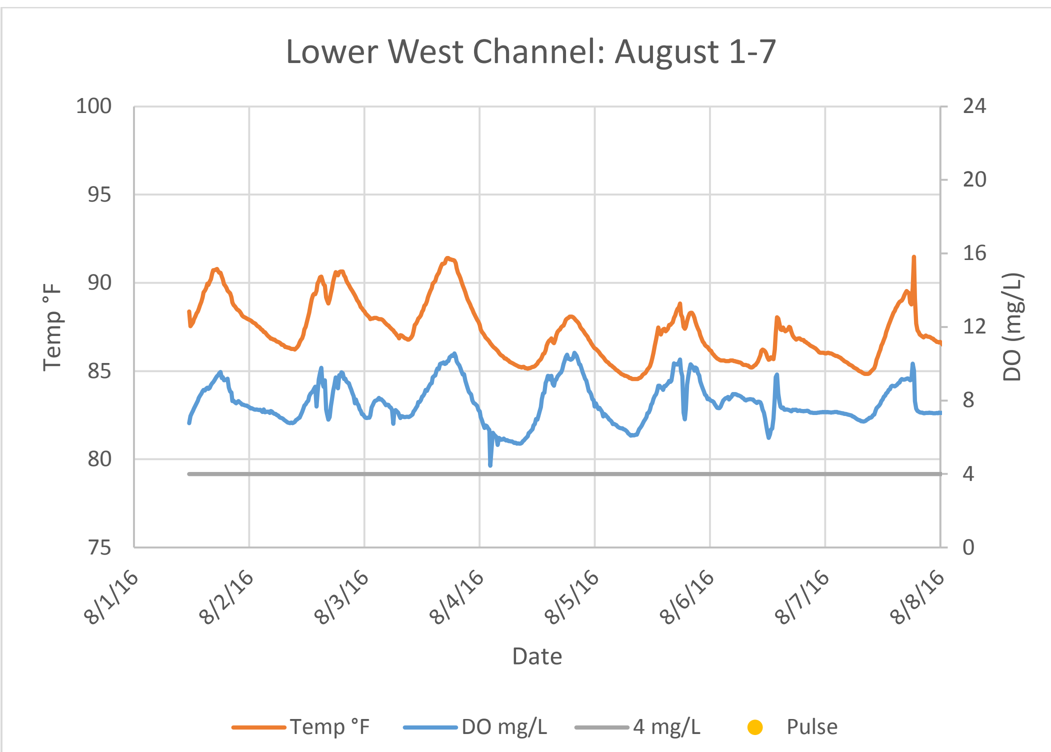


FIGURE 4-3 DISSOLVED OXYGEN AT THE UPPER, MIDDLE, AND LOWER WEST CHANNEL LOCATIONS – AUGUST 1-7





(Continued)

Figure 4-3 Dissolved Oxygen at the Upper, Middle, and Lower West Channel Locations – August 1-7

TABLE 4-2 MAXIMUM, MINIMUM, AND AVERAGE TEMPERATURES AND DISSOLVED OXYGEN FOR AUGUST 1-7, 2016

AUGUST 1-7, 2016						
	TEMPERATURE (°F)			DISSOLVED OXYGEN (MG/L)		
	MAX	MIN	AVG	MAX	MIN	AVG
Upper West Site 1	90.86	84.56	86.66	7.97	3.94	6.03
Upper West Site 2	95.14	82.04	86.84	13.99	3.79	7.34
Middle West	92.80	83.44	86.60	10.94	0.00	6.04
Lower West	91.47	84.56	87.26	10.59	4.45	7.91

TABLE 4-3 YSI SPOT MEASUREMENTS FOR AUGUST 1, 2016

Location	Time	YSI DO (mg/L)	YSI Temp (°F)
YSI 1	0800	4.59	84.6
YSI 2	0815	5.19	85.3
YSI 3	0840	5.60	85.3
YSI 4	0847	5.73	86.0
YSI 5	0855	5.72	86.0
YSI 6	0858	5.24	85.8
YSI 7	0905	5.95	85.1
YSI 8	n/a	n/a	n/a
Middle West Channel	1100	6.50	86.9
Lower West Channel	1130	6.36	87.1

TABLE 4-4 YSI DO VERIFICATION FOR AUGUST 1, 2016

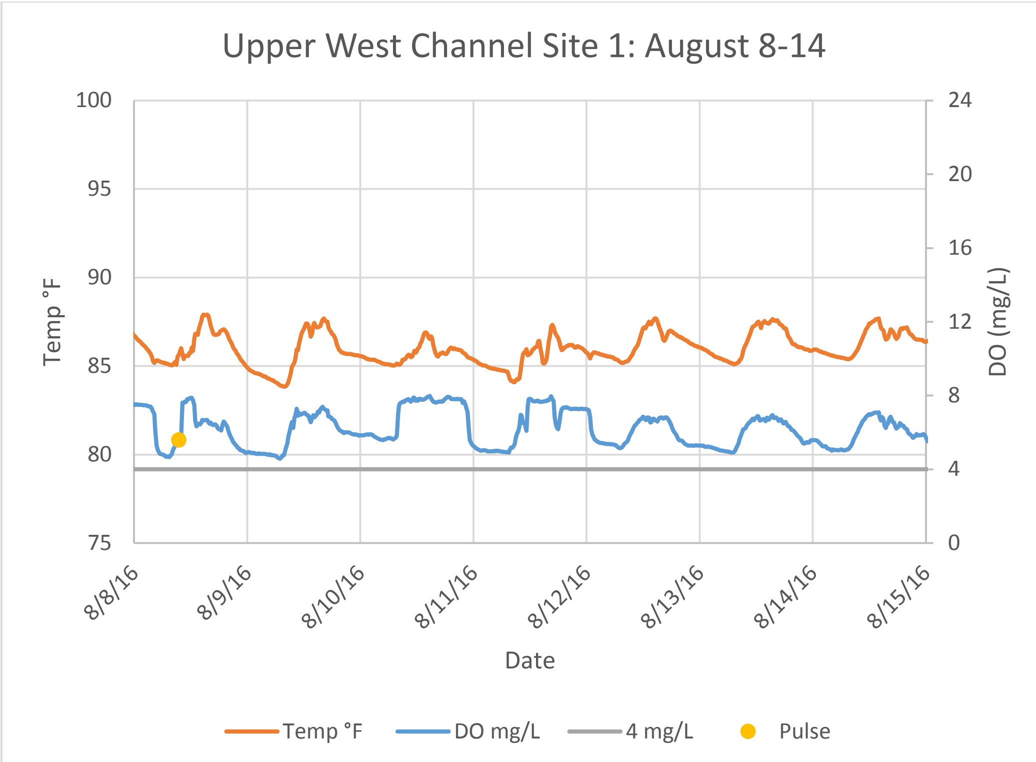
Location	Time	YSI DO (mg/L)	YSI Temp (°F)	HOBO DO (mg/L)	HOBO Temp (°F)
YSI 2	0815	5.19	85.3	6.03*	85.17*
YSI 7	0905	5.95	85.1	**	**
Middle West Channel	1100	6.50	86.9	6.63	87.40
Lower West Channel	1130	6.36	87.1	6.77	88.38

* First HOBO data point taken at 0845

** HOBO deployed on 8/3/16

August 8-14, 2016

During the week of August 8-14, DO levels briefly dropped below 4 mg/L during one day at Upper Site 2, but DO levels greater than 4 mg/L were observed during all other sampling days at all sampling sites. Diel fluctuations in both temperature and DO levels were observed at all sites (Figure 4-4). Minimum and maximum DO and temperatures for each collection site are presented in Table 4-5. Upper Site 2 again experienced the largest diel swings. There was a pulse of approximately 24 acre feet on August 8. DO and temperature collected by YSI prior to and during the planned pulse are presented in Table 4-6. These data show that the planned pulse provided a slight increase in DO during the pulse. There were also unplanned spills of 16,500 cfs peak flow on August 10 and 9,000 cfs peak flow on August 11. None of the spill events appeared to significantly affect DO readings in the west channel. However, these unplanned spills would have provided some flushing of the west channel and could have helped to improve overall water quality. A comparison of YSI and HOBO readings again showed that the HOBO's were collecting accurate data (Table 4-7).



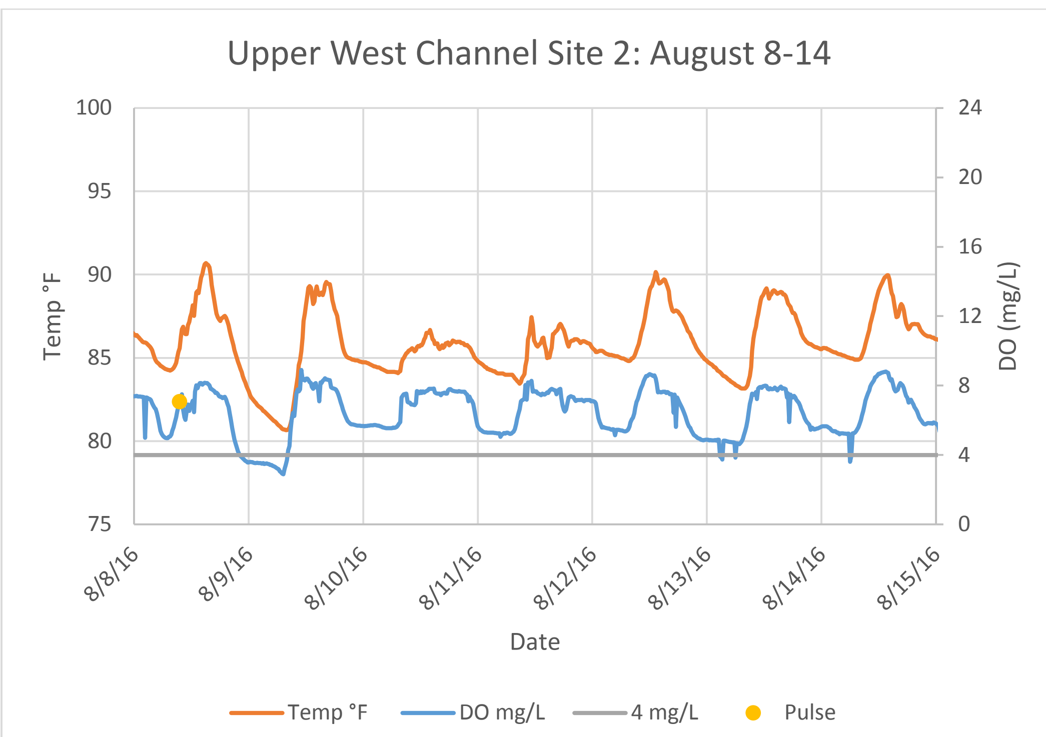
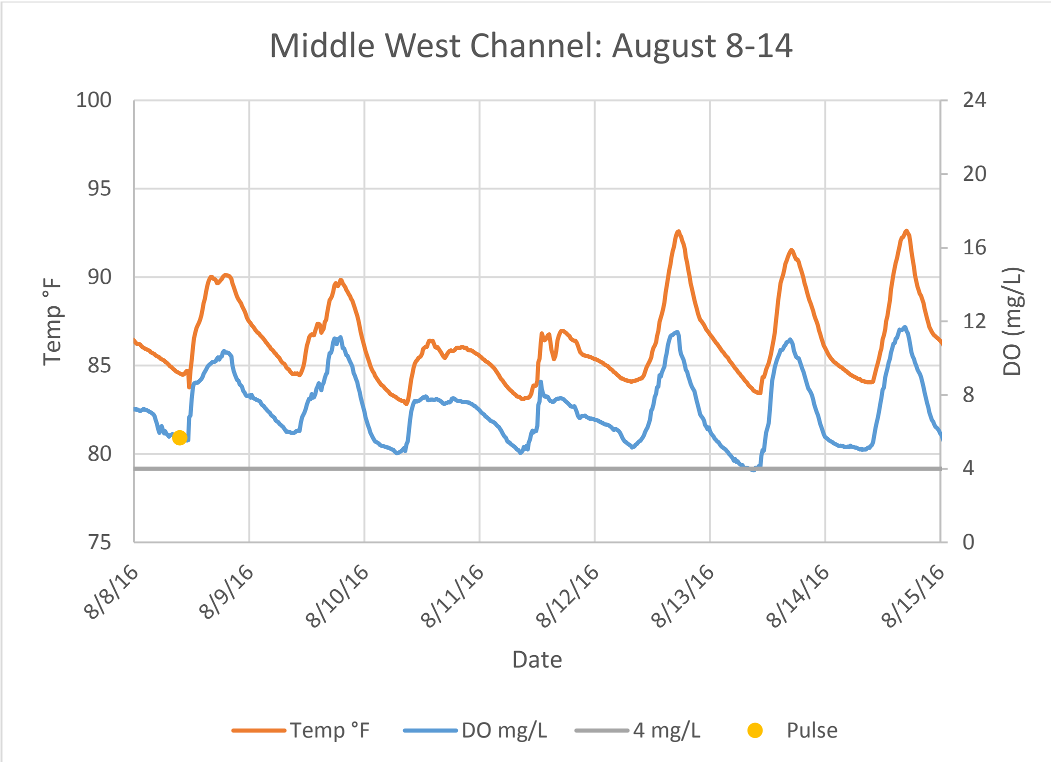


FIGURE 4-4 DISSOLVED OXYGEN AT THE UPPER, MIDDLE, AND LOWER WEST CHANNEL LOCATIONS - AUGUST 8-14, 2016



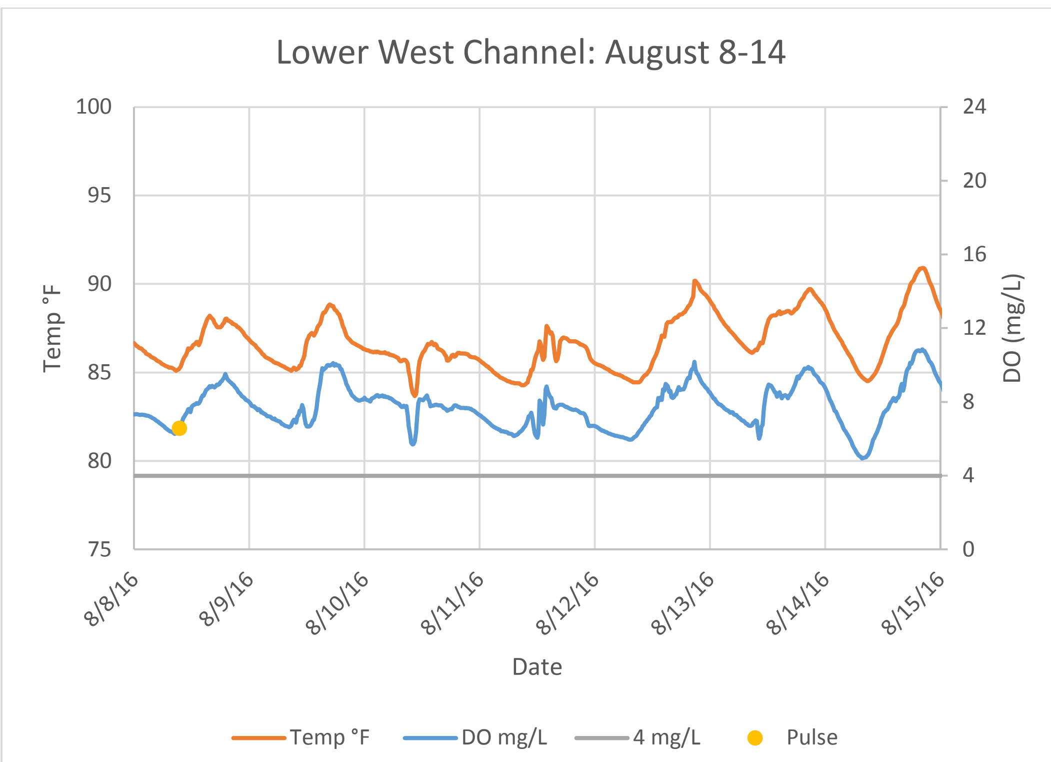


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Figure 4-4 Dissolved Oxygen at the Upper, Middle, and Lower West Channel Locations – August 8-14, 2016

TABLE 4-5 MAXIMUM, MINIMUM, AND AVERAGE TEMPERATURES AND DISSOLVED OXYGEN FOR AUGUST 8-14, 2016

AUGUST 8-14, 2016						
	TEMPERATURE (°F)			DISSOLVED OXYGEN (MG/L)		
	MAX	MIN	AVG	MAX	MIN	AVG
Upper West Site 1	87.91	83.84	85.97	7.97	4.58	6.20
Upper West Site 2	90.68	80.67	85.85	8.90	2.89	6.46
Middle West	92.62	82.83	86.41	11.68	3.91	7.28
Lower West	90.90	83.66	86.70	10.86	4.93	7.75

TABLE 4-6 YSI SPOT MEASUREMENTS FOR AUGUST 8, 2016

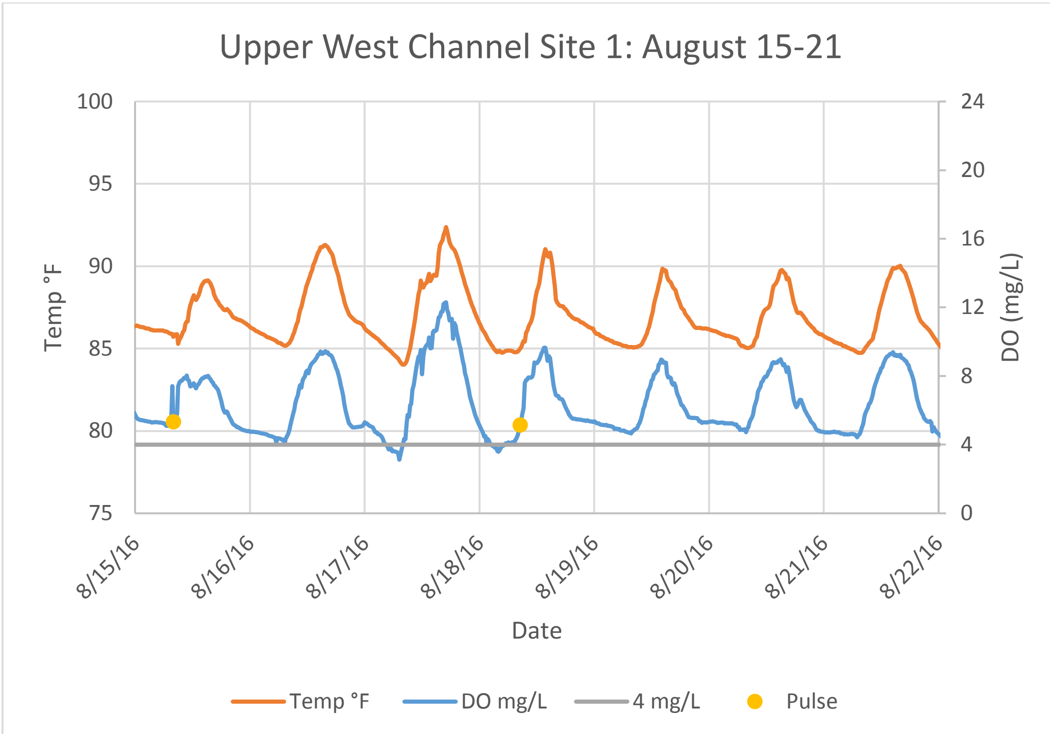
	PRE-PULSE			DURING PULSE		
LOCATION	DO (mg/L)	Temp (°F)	Time	DO (mg/L)	Temp (°F)	Time
YSI 1	5.49	85.1	0850	7.26	85.8	1100
YSI 2	5.11	85.3	0853	7.12	85.6	1028
YSI 3	5.24	85.5	0903	7.11	85.5	1031
YSI 4	4.80	85.6	0906	7.12	85.5	1033
YSI 5	4.91	85.8	0910	7.19	85.6	1036
YSI 6	5.13	85.8	0913	6.58	86.0	1038
YSI 7	6.49	86.0	0919	5.65	86.4	1041
YSI 8	6.26	86.4	0935	6.61	87.3	1046
Middle West Channel (Bridge)	n/a	n/a	n/a	6.42	84.9	1130
Lower West Channel	n/a	n/a	n/a	7.21	86.4	1149

TABLE 4-7 YSI DO VERIFICATION FOR AUGUST 8, 2016

Location	Time	YSI DO (mg/L)	YSI Temp (°F)	HOBO DO (mg/L)	HOBO Temp (°F)
YSI 2	0853	5.11	85.3	5.59	85.06
YSI 7	0919	6.49	86.0	6.81	85.35
Middle West Channel	1130	6.42	84.9	6.80	83.77
Lower West Channel	1149	7.21	86.4	7.45	86.36

August 15-21, 2016

During the week of August 15-21, DO levels below 4 mg/L were observed at several sites over several days, but never remained below 4 mg/L for more than several hours. Diel fluctuations in both temperature and DO levels were observed at all sites (Figure 4-5). Minimum and maximum DO and temperatures for each collection site are presented in Table 4-8. Upper Site 2 again experienced the largest diel swings. There were pulse flows of approximately 25 acre feet on 8/15 and 8/18. Both of the spill events appeared to have positive effects on DO levels in the Upper and Middle Sites. DO and temperature collected by YSI prior to and during the planned pulse are presented in Table 4-9. These data show that the planned pulse provided a slight increase in DO during the pulse. No unplanned spills occurred during the week. Comparison of the YSI readings and the HOBO logger data again showed that the HOBO's were collecting accurate data.



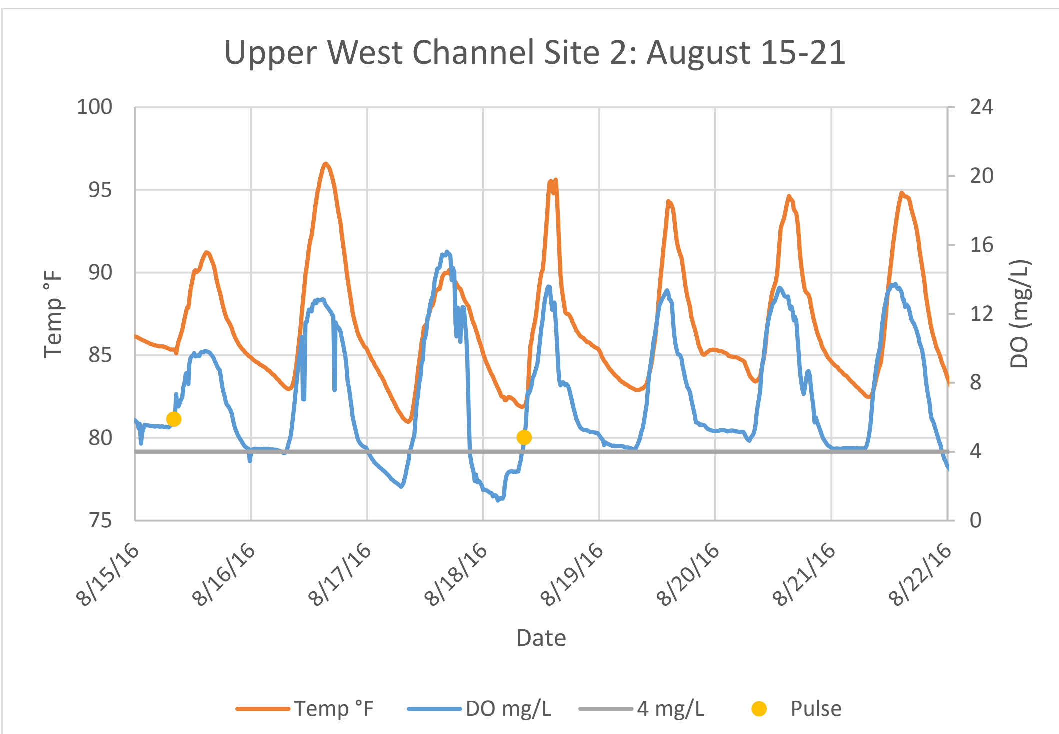
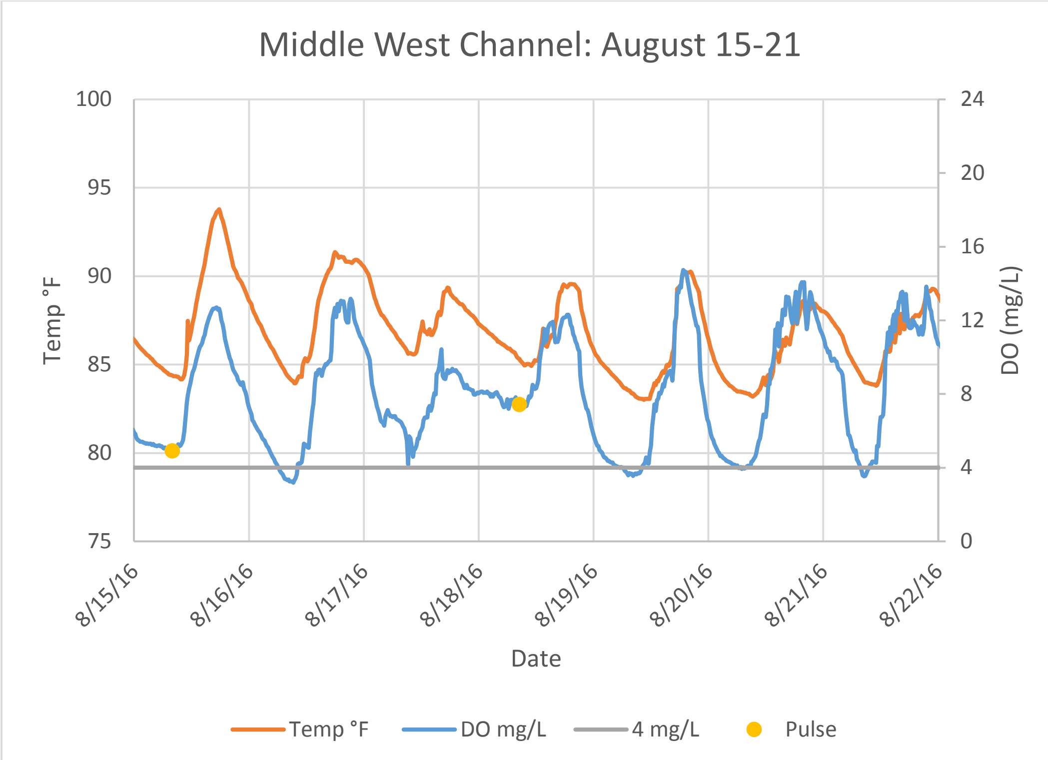


FIGURE 4-5 DISSOLVED OXYGEN AT THE UPPER, MIDDLE, AND LOWER WEST CHANNEL LOCATIONS - AUGUST 15-21, 2016



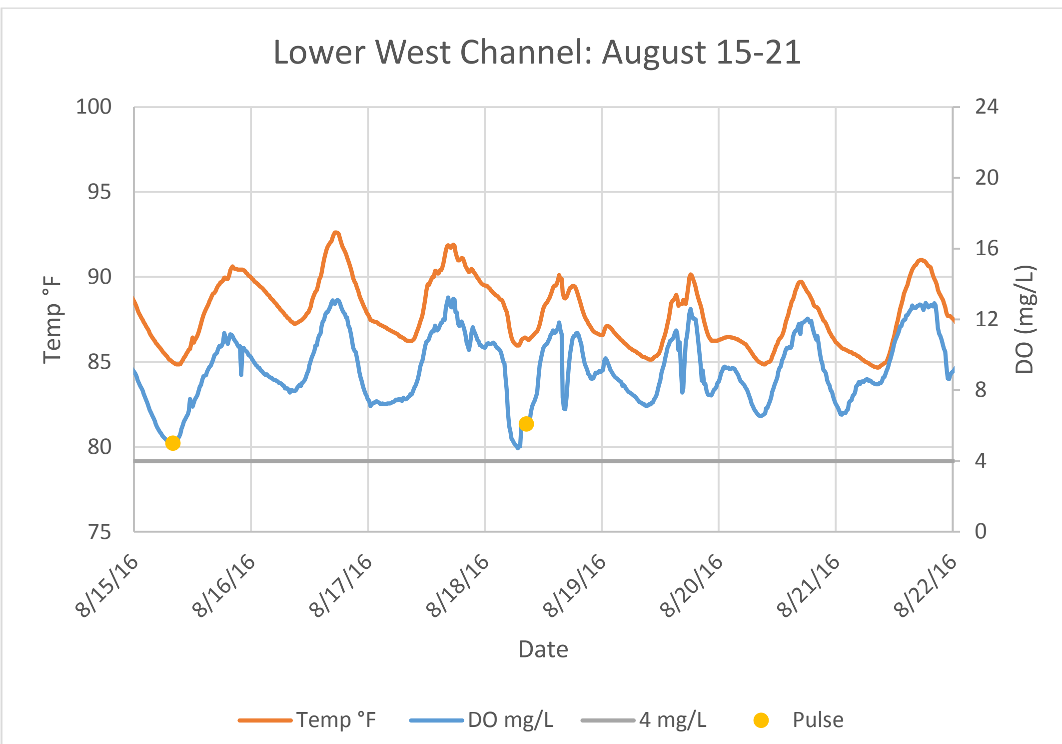


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FIGURE 4-5 DISSOLVED OXYGEN AT THE UPPER, MIDDLE, AND LOWER WEST CHANNEL LOCATIONS – AUGUST 15-21, 2016

TABLE 4-8 MAXIMUM, MINIMUM, AND AVERAGE TEMPERATURES AND DISSOLVED OXYGEN FOR AUGUST 15-21, 2016

AUGUST 15-21, 2016						
	TEMPERATURE (°F)			DISSOLVED OXYGEN (MG/L)		
	MAX	MIN	AVG	MAX	MIN	AVG
Upper West Site 1	92.37	84.02	86.97	12.30	3.12	6.38
Upper West Site 2	96.58	80.96	86.87	15.61	1.15	7.19
Middle West	93.78	83.01	86.82	14.74	3.18	8.13
Lower West	92.62	84.67	87.84	13.23	4.72	9.24

TABLE 4-9 YSI SPOT MEASUREMENTS FOR AUGUST 15, 2016

	PRE-PULSE			DURING PULSE		
LOCATION	DO (mg/L)	Temp (°F)	Time	DO (mg/L)	Temp (°F)	Time
YSI 1	5.40	85.5	0747	8.36	86.7	1023
YSI 2	5.50	86.0	0753	8.15	86.5	1020
YSI 3	5.45	86.1	0800	8.13	86.4	1017
YSI 4	5.44	86.1	0807	8.17	86.6	1015
YSI 5	5.44	86.1	0810	6.91	86.9	1013
YSI 6	5.31	85.6	0812	6.75	87.0	1011
YSI 7	6.59	85.7	0816	7.92	87.1	1000
YSI 8	5.91	85.9	0821	7.60	87.2	1008
Middle West Channel (Bridge)	n/a	n/a	n/a	8.00	86.7	
Lower West Channel	n/a	n/a	n/a	6.57	86.0	

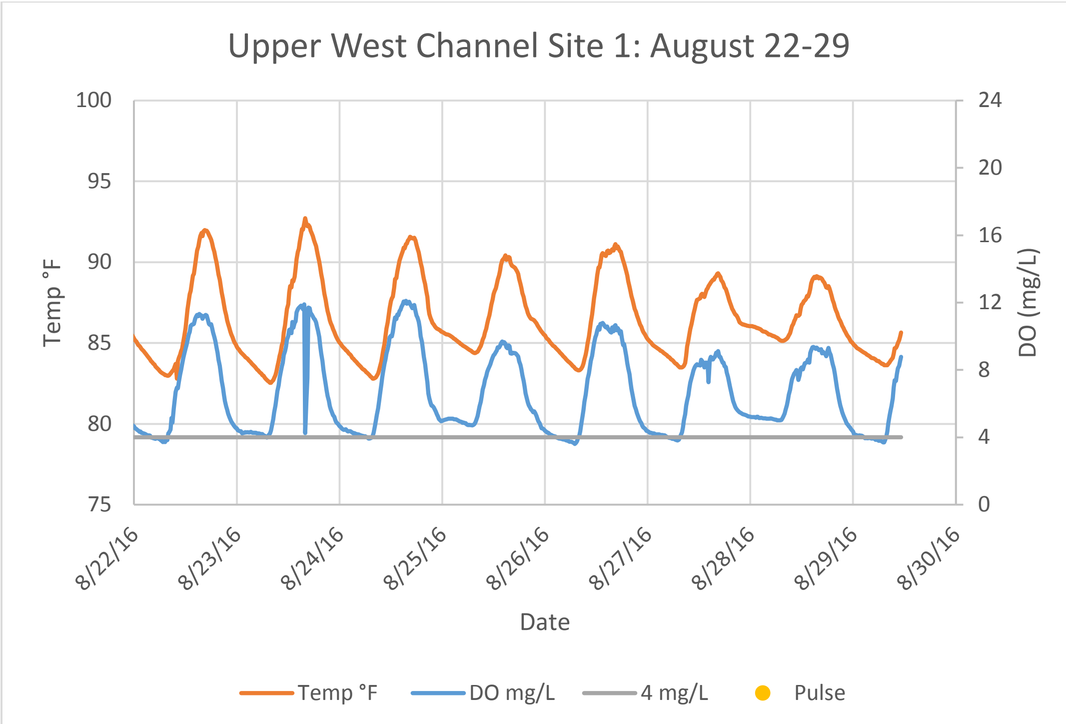
TABLE 4-10 YSI DO VERIFICATION FOR AUGUST 15, 2016

Location	Time	YSI DO (mg/L)	YSI Temp (°F)	HOBO DO (mg/L)	HOBO Temp (°F)
YSI 2	0753	5.50	86.0	5.33	85.71
YSI 7	0816	6.59	85.7	6.00	85.35
Middle West Channel		8.00	86.7	8.29	86.36
Lower West Channel		6.57	86.0	7.07	86.43

* Middle and Lower times estimated to be 1130 and 1200

August 22-29, 2016

During the week of August 22-29, there were no planned or un-planned spillway releases. There were a few DO excursions at the Upper Site 1, Middle, and Lower sites during the week (Figure 4-6). The largest diel fluctuations were observed at Upper Site 2, with DO levels dropping below 4 mg/L and rising up to 21.73 mg/L during a single 24-hour period (Table 4-11). DO and temperature data collected by YSI verified these DO spikes (Table 4-12). This increase in diel fluctuation is likely the result of low flows (no pulse & reduced generation) during the week and a rapid increase of vegetation at the two Upper Sites. Field crews noted a very large increase in the abundance of aquatic vegetation (Hydrilla and Spirogyra) during this last week of testing throughout the upper reach of the west channel (Photo 4-1; Photo 4-2).



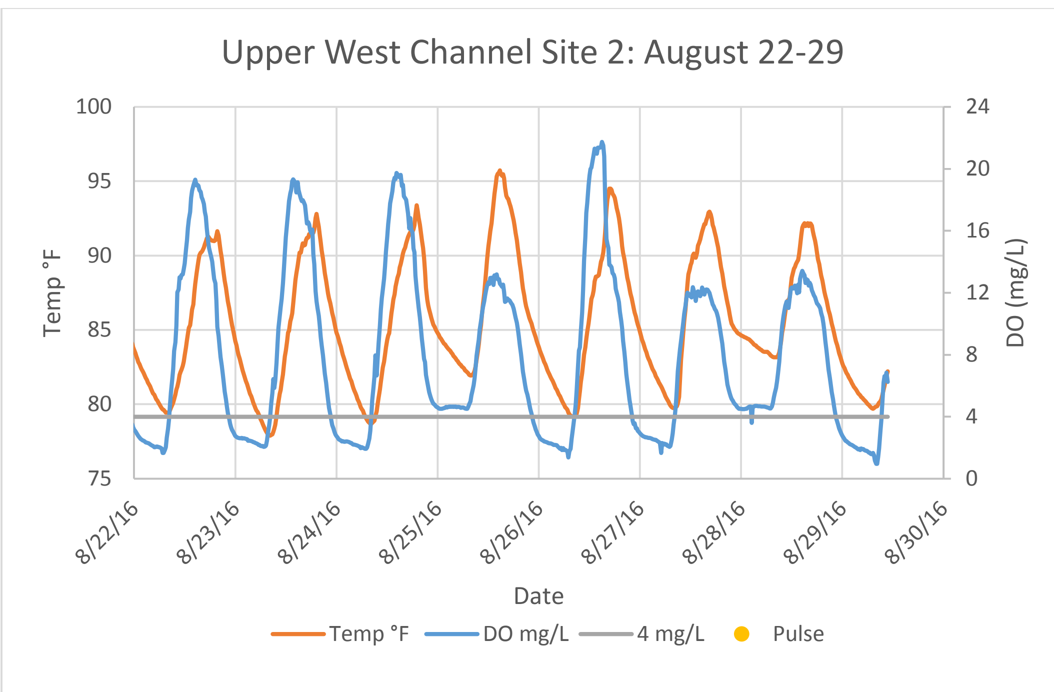
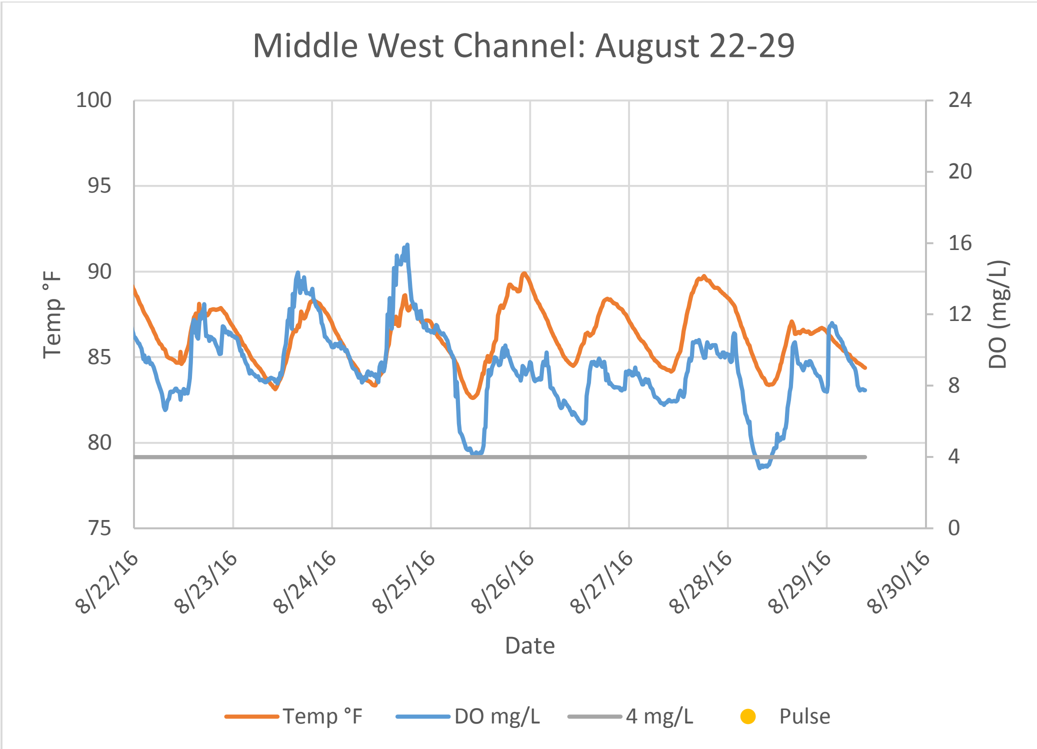


FIGURE 4-6 DISSOLVED OXYGEN AT THE UPPER, MIDDLE, AND LOWER WEST CHANNEL LOCATIONS - AUGUST 22-29, 2016



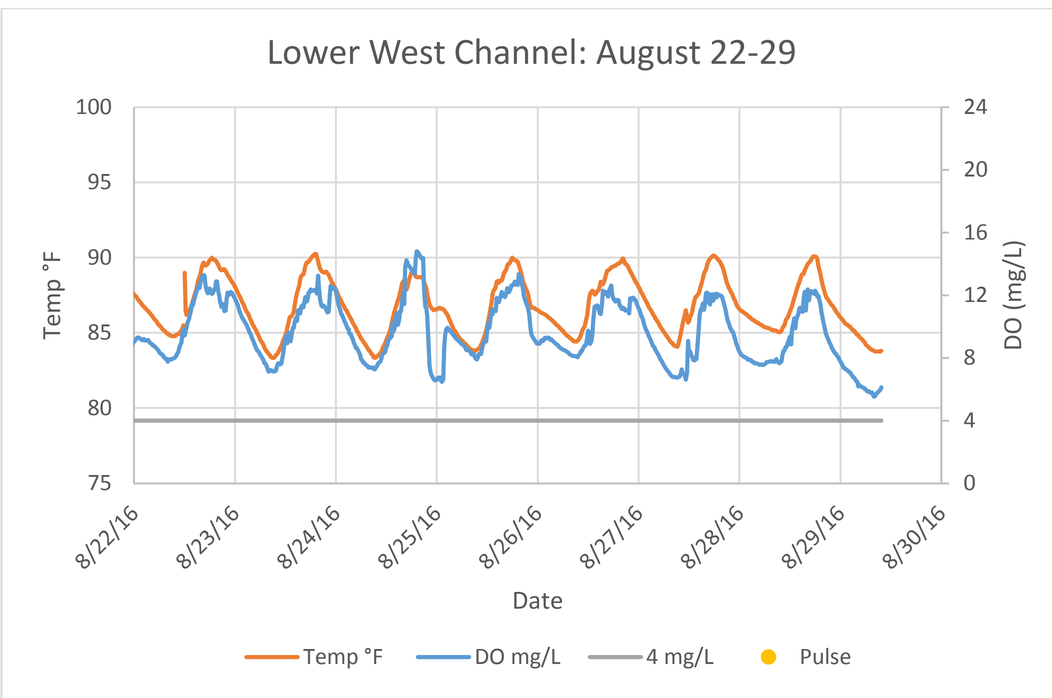


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FIGURE 4-6 DISSOLVED OXYGEN AT THE UPPER, MIDDLE, AND LOWER WEST CHANNEL LOCATIONS - AUGUST 22-29, 2016

TABLE 4-11 MAXIMUM, MINIMUM, AND AVERAGE TEMPERATURES AND DISSOLVED OXYGEN FOR AUGUST 22-29, 2016

AUGUST 22-29, 2016						
	TEMPERATURE (°F)			DISSOLVED OXYGEN (MG/L)		
	MAX	MIN	AVG	MAX	MIN	AVG
Upper West Site 1	92.73	82.54	86.41	12.11	3.60	6.68
Upper West Site 2	95.72	77.90	85.37	21.73	0.95	7.90
Middle West	89.89	82.62	86.24	15.91	3.37	9.00
Lower West	90.25	83.34	86.73	14.81	5.54	9.64

TABLE 4-12 YSI SPOT MEASUREMENTS FOR AUGUST 22 & 29, 2016

	August 22, 2016			August 29, 2019		
Location	DO (mg/L)	Temp (°F)	Time	DO (mg/L)	Temp (°F)	Time
YSI 1	8.58	83.7	0950			
YSI 2	7.18	83.8	0954	9.26	86.0	1124
YSI 3	6.97	83.8	1002	7.70	85.1	1037
YSI 4	6.34	84.4	1004	8.68	86.2	1114
YSI 5	7.13	84.0	1006	9.06	85.6	1111
YSI 6	12.80	83.7	1046	13.60	84.9	1109
YSI 7	12.97	81.5	1013	15.05	83.7	1057
YSI 8	8.13	81.3	1026	11.22	83.5	1047
Middle West Channel (Bridge)	7.18	84.7	1115	7.69	84.2	0925
Lower West Channel	0.42	85.6	1133	6.70	83.8	0940

TABLE 4-13 YSI DO VERIFICATION FOR AUGUST 22, 2016

Location	Time	YSI DO (mg/L)	YSI Temp (°F)	HOBO DO (mg/L)	HOBO Temp (°F)
YSI 2	0954	7.18	83.8	6.94	82.8
YSI 7	1013	12.97	81.5	12.04	81.18
Middle West Channel	1115	7.18	84.7	7.2	85.32
Lower West Channel	1133	10.10	85.6	9.57	85.32

TABLE 4-14 YSI DO VERIFICATION FOR AUGUST 29, 2016

Location	Time	YSI DO (mg/L)	YSI Temp (°F)	HOBO DO (mg/L)	HOBO Temp (°F)
YSI 2	1124	9.26	86.0	8.78	85.64
YSI 7	1057	15.05	83.7	6.84	82.22
Middle West Channel	0925	7.69	84.2	7.75	84.38
Lower West Channel	0940	6.70	83.8	6.12	83.8

PHOTO 4-1 UPPER REACH OF THE WEST CHANNEL (NOTE MULTIPLE POCKETS OF AQUATIC VEGETATION)

PHOTO 4-2 HYDRILLA AND SPIROGYRA IN THE UPPER REACH OF THE WEST CHANNEL

Comparison of 2015 and 2016 August Data

The 2015 report noted that the HOBO monitor in the Upper West Channel was frequently fouled by vegetation wrapping around the monitors and proposed that this fouling resulted in erroneous data collections. During 2016, the HOBO monitors were checked weekly and remained free of vegetation fouling.

The Upper West Channel 2015 data experienced large diel fluctuations for the entire month, with DO ranging from highs up to approximately 21 mg/L down to DO levels at or near 0 mg/L. The Upper Site 1 – 2016 data did not show these drastic swings and rarely documented DO below 4 mg/L. The Upper Site 2 – 2016 data was similar to the 2015 DO observations only during the latter part of the month when no pulsing flows were experienced. Upper Site 2 also had an abundance of aquatic vegetation throughout the study period and likely influenced the diel shifts observed during the last week of August 2016. The 2016 data showed that the Upper West Channel sites do not all experience DO levels consistently below 4 mg/L. The 2016 test also showed that pulsing spillway flows periodically during the summer improve DO levels in the Upper West Channel area.

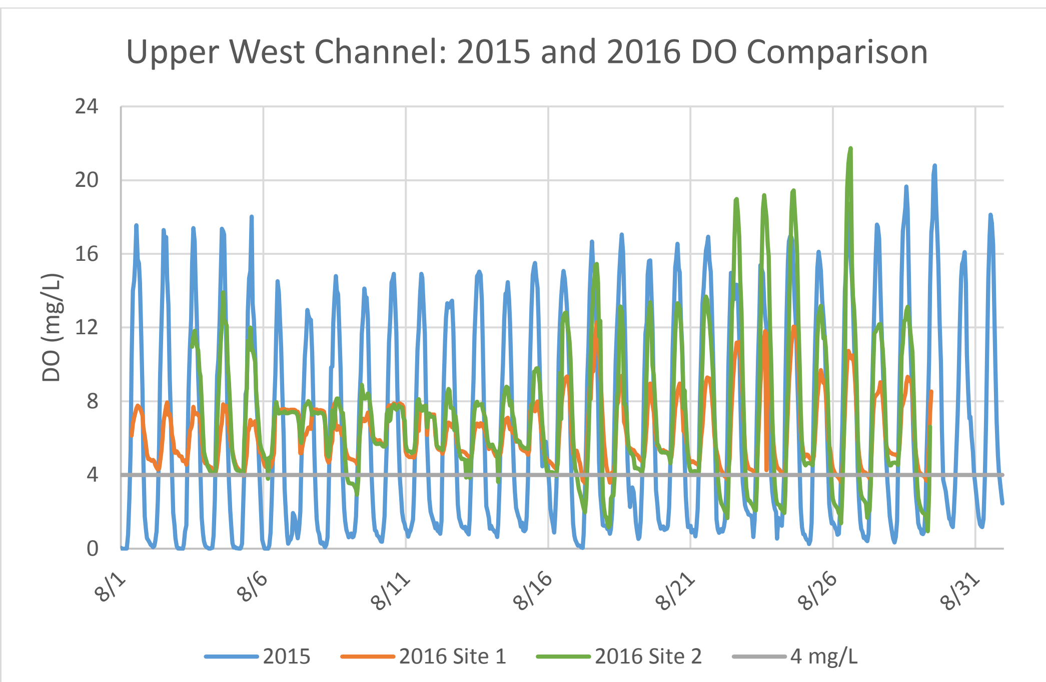

FIGURE 4-7 DISSOLVED OXYGEN AT THE UPPER WEST CHANNEL LOCATIONS - AUGUST 2015 AND 2016

Daily maximum DO levels in the Middle West Channel were higher in 2016 than in 2015. Diel fluctuations were also more pronounced in 2016. However, lower DO levels occurred during 2015 for most days in August. Diel fluctuations became more pronounced in 2016 towards the end of August (at the same time that the abundance of aquatic vegetation increased), whereas the fluctuations in 2015 remained relatively constant. It is likely that checking and cleaning the HOBO loggers weekly during 2016 resulted in better data. It appears that the spillway flows (both planned and unplanned) helped to increase the observed DO levels in 2016.

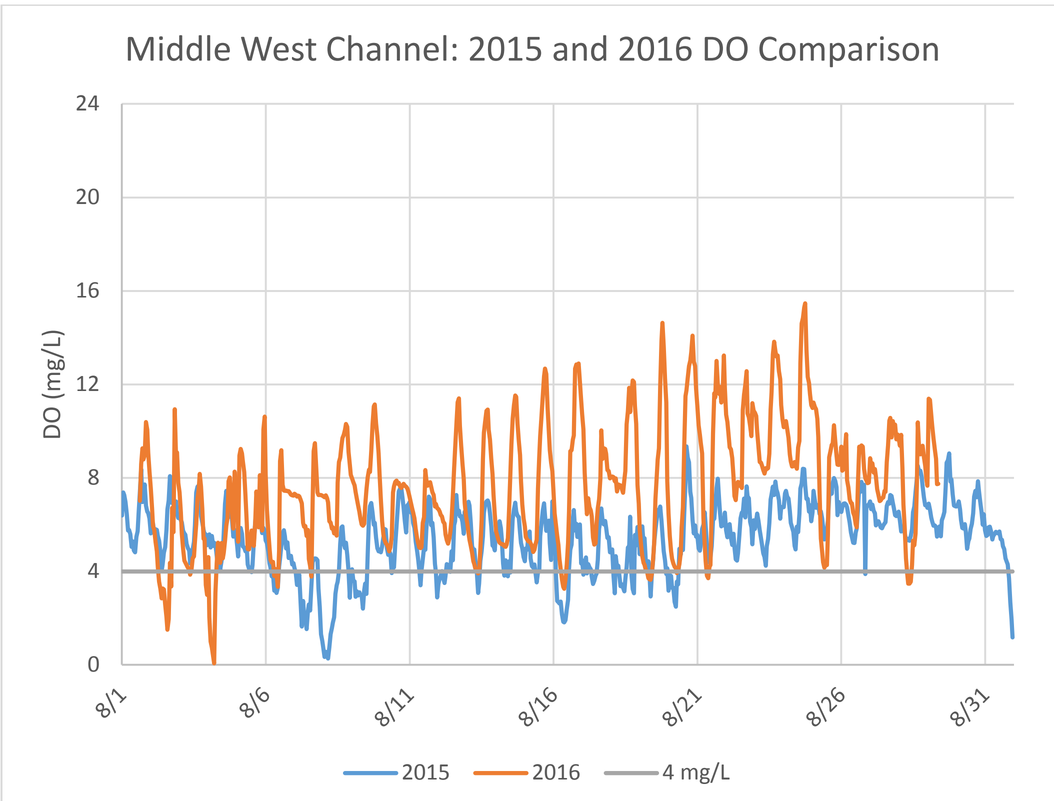

FIGURE 4-8 DISSOLVED OXYGEN AT THE MIDDLE WEST CHANNEL LOCATION - AUGUST 2015 AND 2016

DO levels were generally higher in 2016 than in 2015 at the lowest reach. Both years experienced diel fluctuations, with DO levels in 2015 reaching overall lower levels than those observed during 2016. The Lower West Channel site appears to be most affected by turbine operations as river flows back up into this area. DO levels for both of the years rarely dropped below 4 mg/L and this site should continue to meet DO standards in the future.

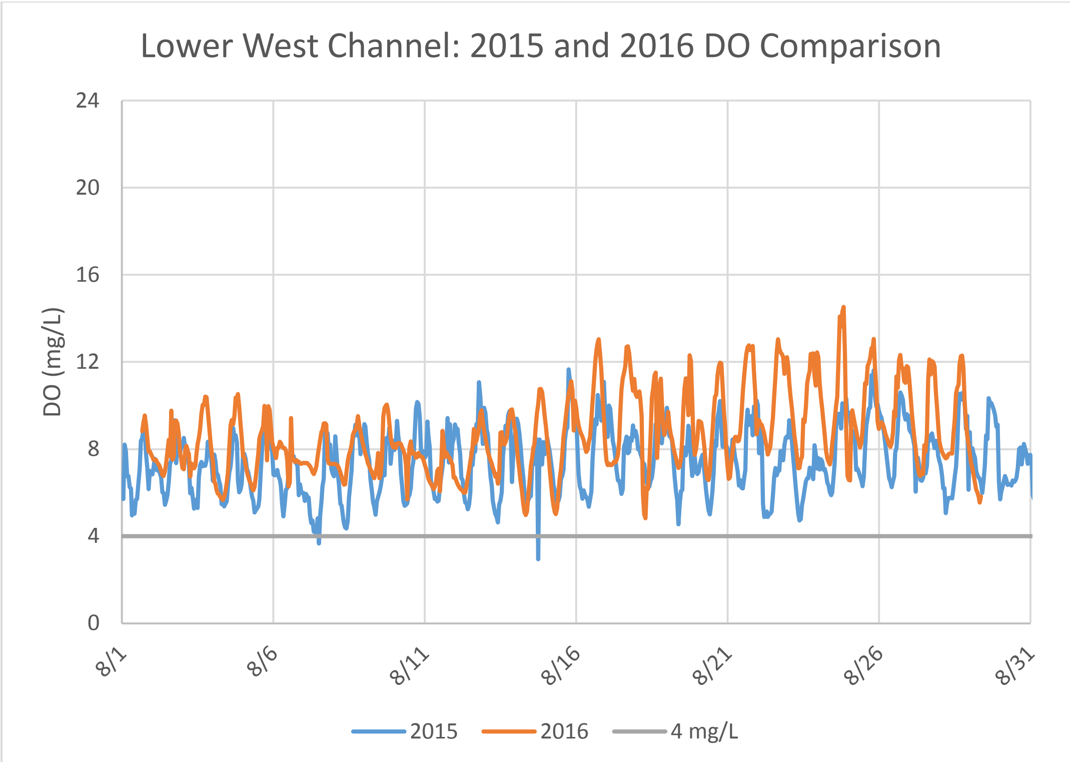

FIGURE 4-9 DISSOLVED OXYGEN AT THE LOWER WEST CHANNEL LOCATION - AUGUST 2015 AND 2016

5.0 DISCUSSION

DO levels generally remained above the DHEC standard of 4 mg/L (SCDHEC 2012) during 2016, with diel fluctuations in both temperature and DO occurring throughout the study. Greater fluctuations in DO were observed later in the month as aquatic vegetation increased and spillway flows were curtailed. Unlike the original 2015 study, where equipment was continually fouled by aquatic vegetation, equipment during this 2016 study was kept clean, suggesting that the results of this study offer more accurate readings for DO experienced in the west channel during the late summer period.

DO levels in 2016 were generally greater than those observed during 2015, reaching higher levels, and not reaching minimum levels observed during 2015. Equipment was kept clean in 2016 through frequent site visits, and by placing equipment in locations where fouling was less likely to occur. Conversely, equipment in 2015 had spirogyra wrapped around it on several occasions, which likely affected those results. DO levels in the upper and middle west channel did experience increased daily spikes in DO levels as August progressed, which may be due to the increased amount of aquatic vegetation that was observed during the latter half of 2016. While some vegetation, particularly spirogyra, was observed during 2015, an abundance of Hydrilla was observed during 2016. Hydrilla was not observed during the 2015 study and is a new exotic species for the area that will influence the west channel habitat conditions in the future. Further, the large unplanned spillway releases that occurred early in the 2016 study may have influenced the study results by retarding the dominance of aquatic vegetation in the west channel.

Overall, water quality in the west channel seems to be most impacted during the later summer months, when stream flows are typically lower, temperatures are warmer, and vegetation growth is at a higher level. The planned smaller spillway pulses appeared to have had a positive effect on DO levels in the west channel, as observed DO levels were measurably increased with each of the planned pulse events. The pulses of approximately 25 acre-feet, in combination with the unplanned spills, were able to maintain higher levels of water quality in the West channel.

The study also determined that water levels in the west channel are strongly influenced by flows from the powerhouse and indicate that tailrace flows enter the west channel. An increase in the amount of water passing through the powerhouse will increase the amount of water in the west channel and should help to improve DO levels in the west channel.

It is possible that the higher DO levels observed during 2016 were a result of both the flows to the west channel from the tailrace combined with periodic spills of approximately 25 acre feet. More data over several years may be needed to fine tune the frequency and amount of spills that are needed to boost west channel DO levels during the late summer.

6.0 REFERENCES

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PARR SHOALS DAM TURBINE VENTING REPORT

PARR HYDROELECTRIC PROJECT

FERC NO. 1894

Prepared for:

South Carolina Electric & Gas Company
Cayce, South Carolina

Prepared by:

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SOUTH CAROLINA ELECTRIC & GAS COMPANY

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PARR SHOALS DAM TURBINE VENTING REPORT

PARR HYDROELECTRIC PROJECT
FERC NO. 1894

SOUTH CAROLINA ELECTRIC & GAS COMPANY

1.0 INTRODUCTION

South Carolina Electric & Gas Company (SCE&G) is the Licensee for the Parr Hydroelectric Project (FERC No. 1894) (Project). The Project consists of the Parr Shoals Development and the Fairfield Pumped Storage Development. Both developments are located along the Broad River in Fairfield and Newberry Counties, South Carolina.

The Project is currently involved in a relicensing process which involves cooperation and collaboration between SCE&G, as licensee, and a variety of stakeholders including state and federal resource agencies, state and local government, non-governmental organizations (NGO), and interested individuals. SCE&G has established several Technical Working Committees (TWC's) comprised of members from the interested stakeholders. The TWC's objectives include the evaluation of relicensing issues and making recommendations to address these issues in the new license.

Following the completion of the Parr Hydroelectric Project Baseline Water Quality Report, there were questions regarding occasional low dissolved oxygen (DO) in the tailrace downstream of Parr Shoals Dam. At a Water Quality TWC meeting on February 4, 2014, the TWC noted that the Baseline Water Quality Report identified periodic excursions of DO levels less than 4.0 mg/L in the Parr Shoals Dam tailrace, as reported by the USGS station 02160991. In an effort to understand these excursions better, SCE&G consolidated historic USGS data to examine these excursions and issued an addendum to the Baseline Water Quality Report in June 2014. At the request of the Water Quality TWC, SCE&G collected additional water quality data in the summer of 2014 in the tailrace and forebay of Parr Shoals Dam in an attempt to determine whether project operations are causing these excursions. These results were summarized in a memo issued on March 2, 2015 (Appendix A). SCE&G followed up this effort by collecting another series of water quality data in the Parr forebay from May through mid-October 2015. The results of this data collection effort are summarized in this report.

In addition, SCE&G proposed to test all of the Parr turbines for their ability to self-vent and potentially increase the dissolved oxygen in the tailrace during specific periods of the year. An initial test of the turbines' capacity to vent was performed August 2014; a second test to determine which turbines had the most significant impact on increasing dissolved oxygen was performed in July 2015. The results of the testing, along with the findings published in the Baseline Water Quality Report, were used to develop a Turbine Venting Plan, which is also included in this report.

2.0 OBJECTIVES

Parr forebay data was collected from May through mid-October, 2015 in an effort to determine if low DO in the tailrace was caused by low DO in the forebay as it passed downstream through the powerhouse and turbines. Additionally, the turbine vent testing was performed in the summer of 2015 to determine if turbine venting had a positive impact on DO in the tailrace. The results of the turbine vent testing were used to develop a Turbine Venting Plan for use during periods of the low DO season.

3.0 METHODS

3.1 METHODS USED FOR TURBINE VENTING TESTING

During the 2014 test, the primary objective was to determine the turbines' physical capacity to self-vent. This requires both the presence of vacuum breakers (which are used during dewatering operations) (Photo 3-1), as well as the proper turbine vertical setting and sufficient gross head to draw air into the turbine during operation. With a turbine operating, the vacuum breaker valve is opened, and venting can be audibly determined. Aeration of the water can also be visually observed in the tailrace (Photo 3-2).

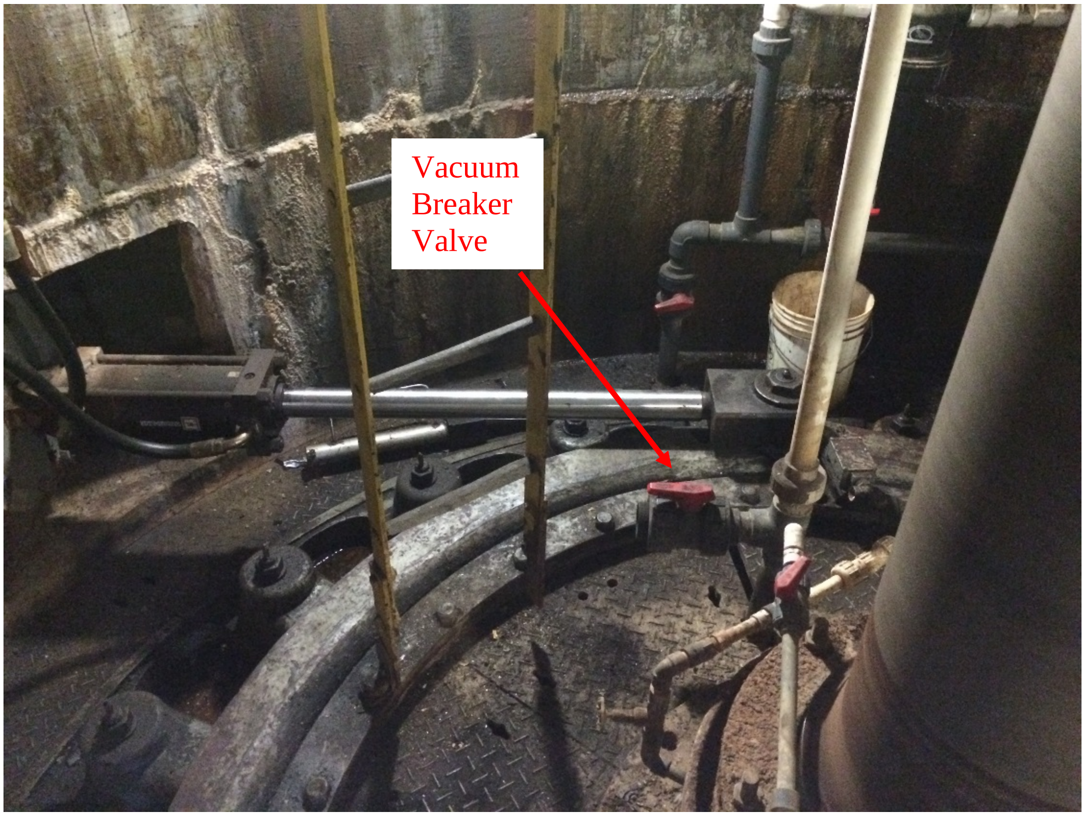

PHOTO 3-1 PIPING FOR VACUUM BREAKERS IN HEADCOVER

PHOTO 3-2 TURBINE DISCHARGE WITH VENTS OPEN

Water quality measurements (dissolved oxygen, temperature and percent saturation) were taken using a Hydrolab Surveyor 4a (Photo 3-3). Measurements were made immediately downstream of each turbine both prior to and after the vent was opened. It was verified that the crest gates had not operated within the past several hours, therefore no mechanical aeration influence from spilling was present. Hydrolab readings were allowed to stabilize for several minutes before water quality parameters were recorded.

PHOTO 3-3 MEASURING DO LEVELS DURING TESTING

During the 2014 test, several of the turbines were undergoing maintenance, and testing of all units was not possible. In addition, the tailrace dissolved oxygen and total saturation levels were high prior to opening the vents, which likely reduced the effectiveness of venting. Given these limitations, an effectiveness venting test was planned for summer 2015 when additional turbines could be evaluated. Prior to the 2015 testing date, DO levels were monitored via the downstream USGS Gage No. 02160991, Broad River near Jenkinsville, SC to identify a test period with lower DO conditions.

3.2 METHODS USED FOR FOREBAY DO SAMPLING

Water quality data, including DO and temperature, was collected in the forebay of the Parr Shoals Dam using two HOBO data loggers, with one logger located approximately one foot above the bottom of the reservoir and the other located approximately one foot below the surface of the reservoir. The HOBO data loggers were suspended from the log boom located in the forebay. Data was logged on an hourly basis from May 4, 2015 through October 16, 2015. Hourly data was also collected from the USGS gage at Jenkinsville (02160991), which is located immediately downstream of Parr Shoals Dam near the powerhouse.

4.0 RESULTS

4.1 RESULTS OF TURBINE VENTING

The Parr Shoals powerhouse contains six vertical turbines, five of which have vacuum breakers to facilitate dewatering the draft tube. It was discovered that unit 6, which is nearest the shoreline, does not have a vacuum breaker. During the 2014 test, units 1, 3 and 4 were operable, and the admittance of air was audible when the vacuum breakers were opened. In addition, the tailrace observation clearly indicated the water was being aerated. With the high saturation levels (above 70%), the measured increases in dissolved oxygen were 0.16 and 0.17 mg/L between the initial measurement and the end of the venting test (Appendix A – 2014 report).

During the 2015 test, all turbines were tested except unit 4, which was inoperable due to ongoing maintenance; however, unit 4 had been tested in 2014. Results of the 2015 testing (data included as Appendix B) indicate that unit 3 venting had the most significant increase in dissolved oxygen, followed by units 1, 5 and 2. The increases are shown in Table 4-1.

TABLE 4-1 DISSOLVED OXYGEN MEASUREMENTS (MG/L)

Unit No.	Vent Closed	Vent Open	Increase in DO
1	4.65	5.04	0.39
2	4.60	4.80	0.20
3	4.70	5.15	0.45
4*	5.66	5.82	0.16
5	4.84	5.20	0.36
6**	5.10	N/A	N/A

*test data from 2014
**Unit 6 is not equipped with a vacuum breaker.

While the 2014 test indicated a dissolved oxygen increase of 0.16 mg/L induced by venting unit 4, the increase was hindered by the starting saturation level compared to the testing in 2015. It can be assumed that the lower levels in 2015 would have resulted in better uptake, but the exact level of increase is not known. Operating priority for the Turbine Venting Plan was not modified to arbitrarily place unit 4 above other turbines that have a better demonstrated uptake capacity.

4.2 RESULTS OF FOREBAY SAMPLING

Due to the fluctuations of the reservoir, periods of low inflows, and the general location of the HOBO loggers in the forebay of the dam, the loggers were highly susceptible to fouling due to debris, sediment, and algae. It appears that after approximately one week of data collection in the reservoir, the HOBO loggers became severely compromised and no longer collected accurate data. Likewise, as the study season progressed, the accuracy of the HOBO loggers decreased due to overgrowth with algae and other aquatic debris. At each download, which occurred on a monthly basis, HOBO loggers were freed of obvious debris as they were removed from the water, making the accuracy of the logger slightly increase for a short period of time, but then fouling quickly afterwards. For that reason, each week after the monthly download is considered to be the most accurate representation of the DO in the Parr forebay. However, the data was compromised during the collection period and is therefore not considered a completely reliable representation of DO in the Parr forebay. Regardless, the one week period following each download is presented in graphs below (Figure 4-1 through Figure 4-6), along with the corresponding data from the Jenkinsville gage. Data collected during October is not included in this report, as severe flooding occurred in early October resulted in abnormally high flows and irregular DO levels.

Throughout the month of May, DO levels in the forebay, both from the top and bottom of the reservoir, and in the tailrace were consistent with each other, and well above the SCDHEC instantaneous standard of 4.0 mg/L (Figure 4-1 and Figure 4-2) (SCDHEC 2012).

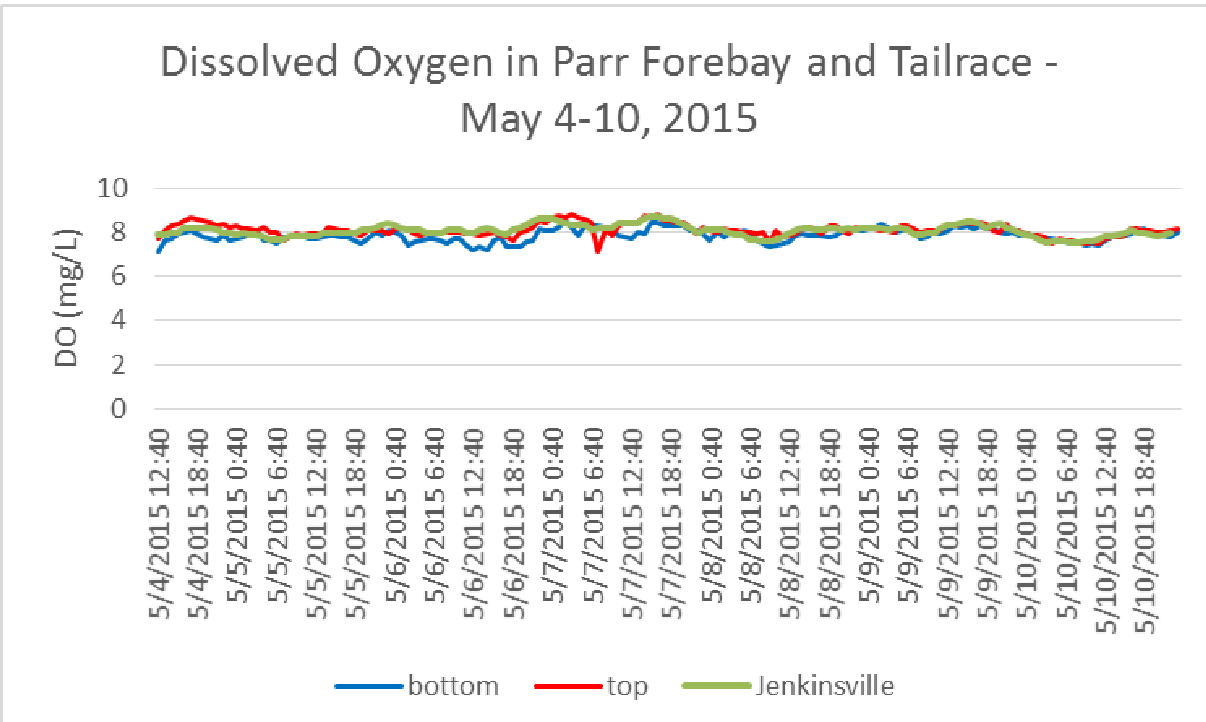

FIGURE 4-1 DISSOLVED OXYGEN IN THE PARR FOREBAY AND TAILRACE – MAY 4-10, 2015

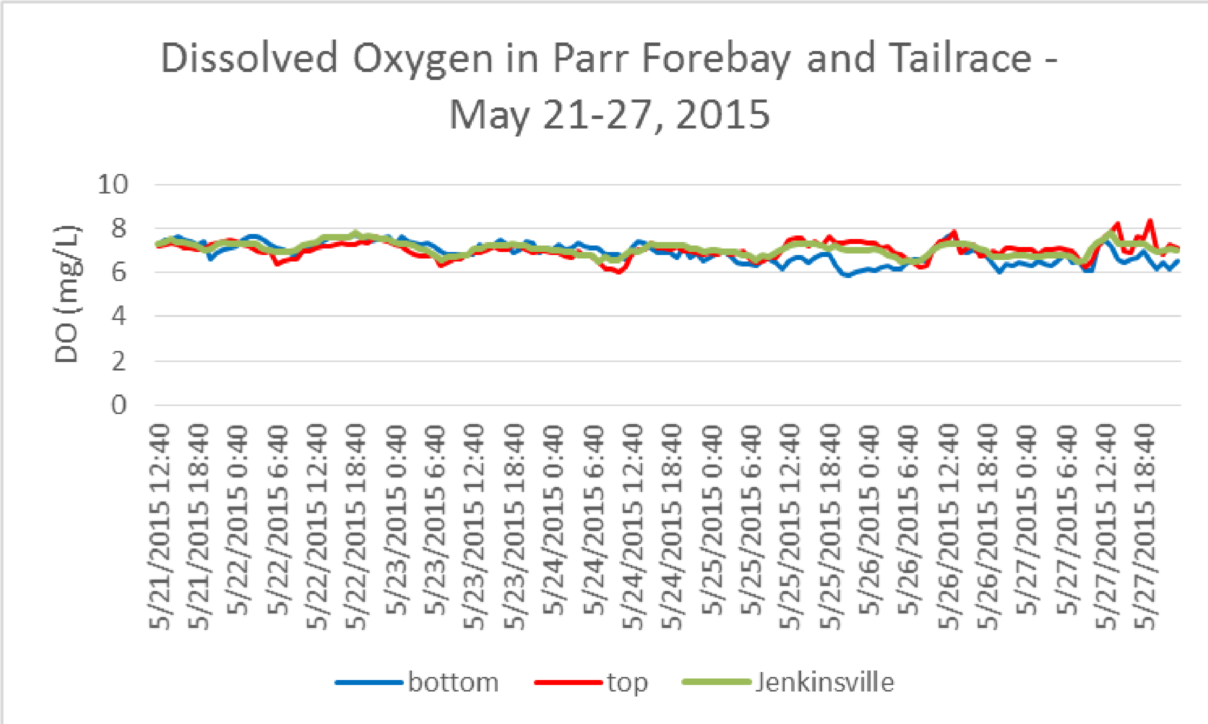

FIGURE 4-2 DISSOLVED OXYGEN IN THE PARR FOREBAY AND TAILRACE – MAY 21-27, 2015

In late June and early July, DO levels began to drop slightly in the forebay and tailrace (Figure 4-3). While the DO levels followed the same general pattern in the forebay as they did in the tailrace, the logger located near the bottom of the reservoir appeared to be affected by algal growth and debris. DO readings collected by the gage at Jenkinsville remain above the standard of 4.0 mg/L.

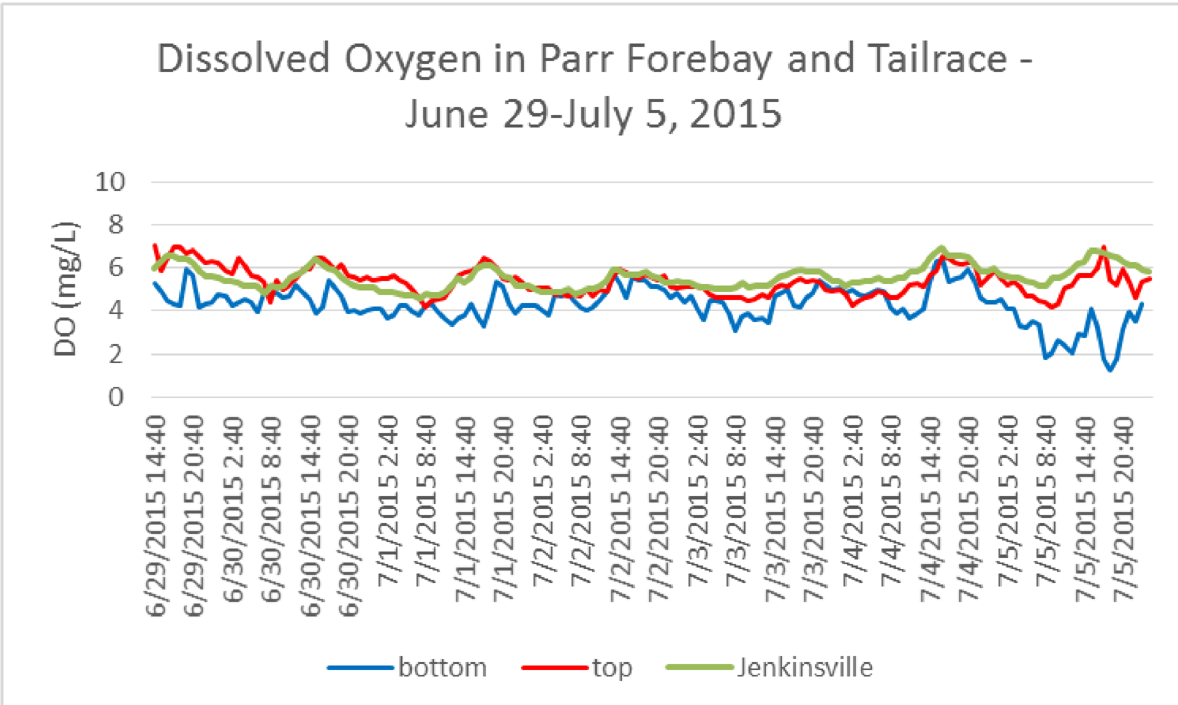

FIGURE 4-3 DISSOLVED OXYGEN IN THE PARR FOREBAY AND TAILRACE – JUNE 29-JULY 5, 2015

In mid-July, DO levels in the tailrace remained constant near 6.0 mg/L (Figure 4-4). DO readings collected in the forebay ranged from near 6.0 mg/L to 0.0 mg/L. Both loggers appeared to be affected by fouling from algae, sediment and other debris located in the forebay, but loggers began to detect a diel pattern typical of day and night shifts in DO levels associated with reservoirs and production and consumption of DO.

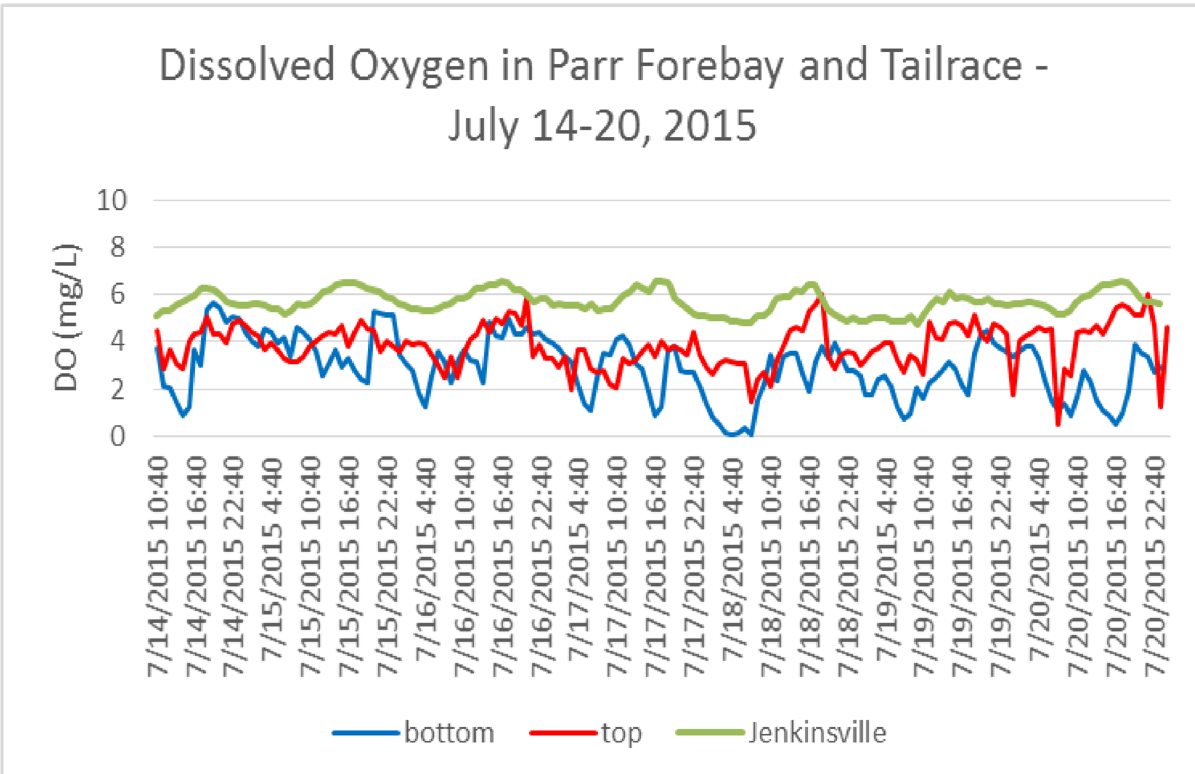

FIGURE 4-4 DISSOLVED OXYGEN IN PARR FOREBAY AND TAILRACE – JULY 14-20, 2015

In mid-August, DO levels in the tailrace continued to remain constant near 6.0 mg/L (Figure 4-5). DO readings collected in the forebay at the top of the reservoir again sporadically range from near 6.0 mg/L to 0.0 mg/L. It is likely that the top HOBO logger became wrapped with debris, causing the unusually low readings. The DO readings collected in the forebay at the bottom of the reservoir were less sporadic, however, they show a downward deterioration of fouling as time progresses, indicating that the longer the loggers were in the water, the more affected they became by algal growth, sediment, and debris.

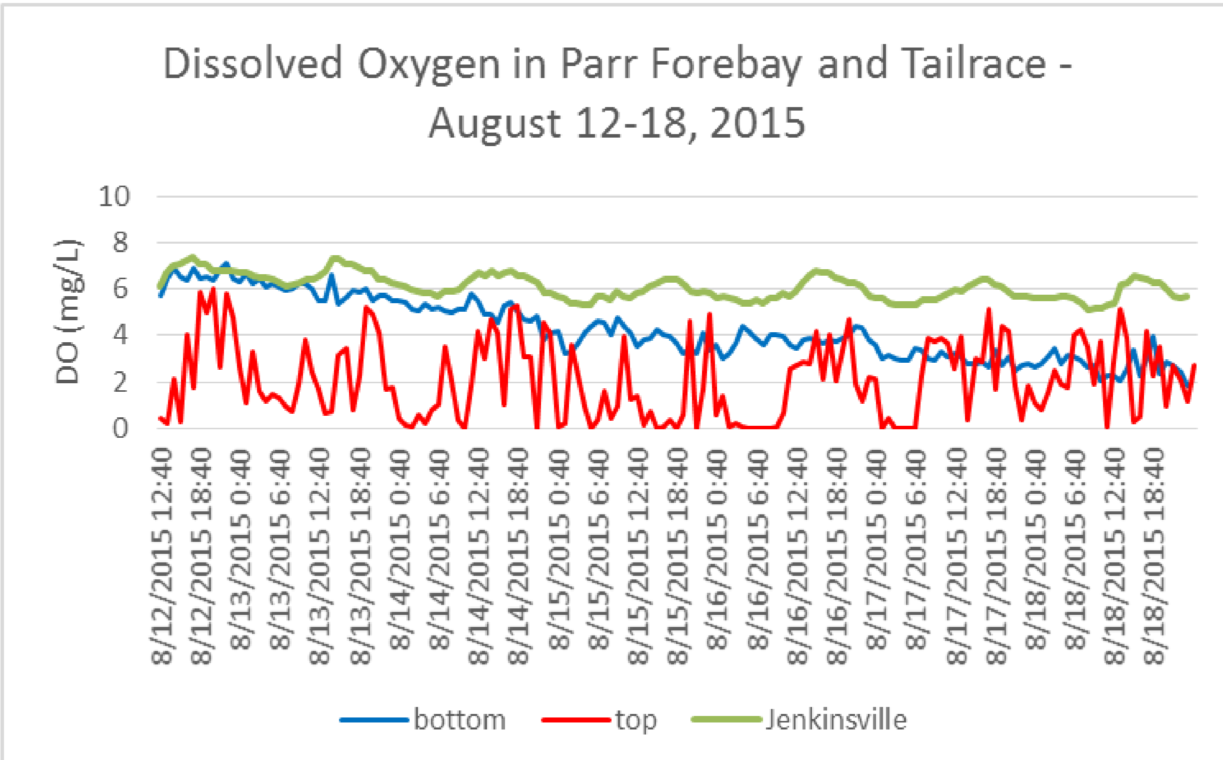

FIGURE 4-5 DISSOLVED OXYGEN IN PARR FOREBAY AND TAILRACE – AUGUST 12-18, 2015

During mid-September, DO levels in the tailrace rose from approximately 6.0 mg/L up to approximately 8.0 mg/L (Figure 4-6). DO readings collected in the forebay range from near 6.0 mg/L to 2.0 mg/L. The loggers again appear to be affected somewhat by algae, sediment and other debris located in the forebay. River flows during this period increased slightly with reoccurrence of rain events in the fall.

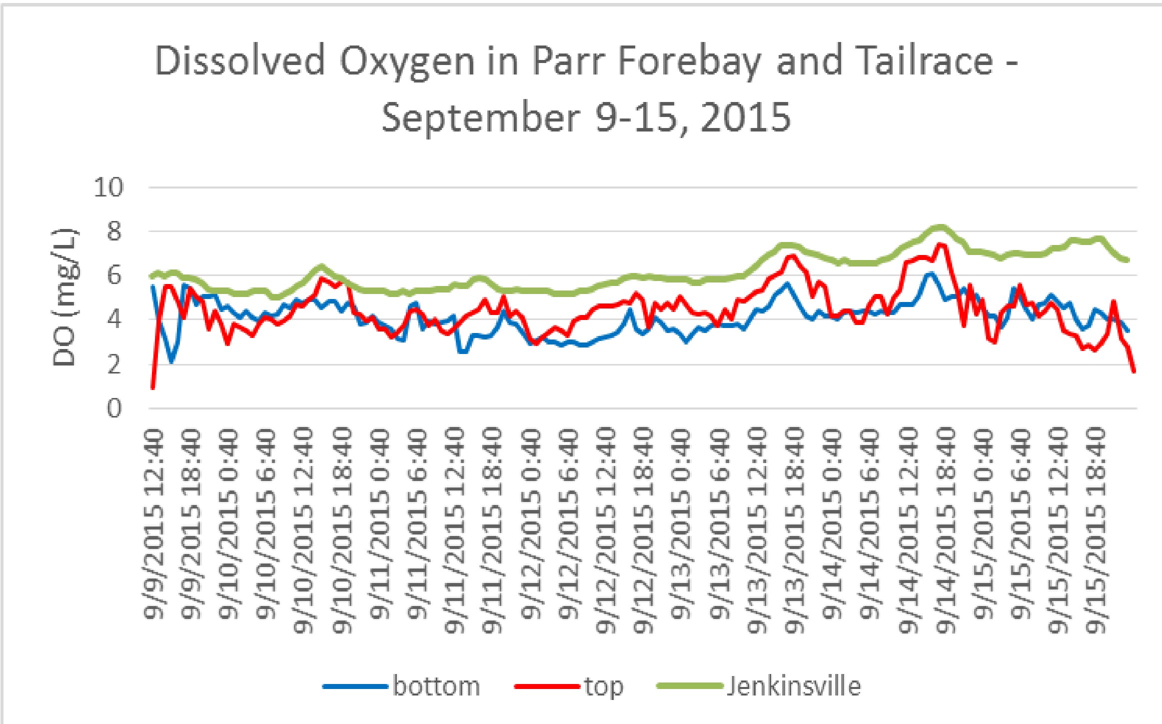

FIGURE 4-6 DISSOLVED OXYGEN IN PARR FOREBAY AND TAILRACE – SEPTEMBER 9-15, 2015

5.0 TURBINE VENTING PLAN

5.1 OPERATING PROCEDURES

Turbine venting shall occur continuously during a “venting period” for each calendar year, with vents opened as turbines are started up and brought online. During the venting period, the turbines will be operated with vents opened in a first-on / last-off order as follows: 3, 1, 5, 2, 4, and 6. Exceptions to this operating order shall occur due to equipment maintenance that results in unit outages, or emergency conditions.

SCE&G shall follow the venting procedures from June 15 through July 31 of each year. This period captures all of the excursions recorded by the nearby USGS Gage No. 02160991, Broad River near Jenkinsville, SC since the current probe was installed in 2011.

5.2 DOCUMENTATION

SCE&G shall provide documentation to DHEC of dissolved oxygen excursions below the standard within ten days of occurrence. Upon request from a consulting agency, SCE&G shall provide hourly records to agency representatives to demonstrate adherence to the order of turbine operating during a venting period. Documentation of maintenance activities to justify deviation from the turbine operating order will also be provided, should a deviation occur.

6.0 DISCUSSION

During two turbine tests at Parr Hydro, it was demonstrated that five of the six turbines have a demonstrated capacity to self-aerate by opening vacuum breaker valves. Effectiveness of the venting appears to vary between turbines, and the results of testing conducted with dissolved oxygen below 5.0 mg/L were used to prioritize an operating sequence. Observations of downstream data trends were used to determine trigger mechanisms for venting, which was combined with the operating sequence for a venting plan.

During 2015, there were no DO levels below 4.2 mg/L detected at the USGS tailrace DO gage. After July 31, there was only one DO reading lower than 5.0 mg/l and that was 4.9 mg/l on August 2. Fouling of DO monitor probes in the Parr forebay made it more difficult to see clear trends in the DO levels experienced in the forebay, but they did detect lower DO levels and a diel shift in DO levels starting at the end of June and extending through the end of September.

This report will be used as part of the 401 water quality certification application for the Parr Hydroelectric Project to demonstrate that the Project will meet the state standards as described by SCDHEC under the new FERC license.

7.0 REFERENCES

SCDHEC. 2012. Water Classifications and Standards (R. 61-68). [Online] URL: https://www.scdhec.gov/Agency/docs/lwm-regs/r61-68.pdf. Accessed December 29, 2015.

APPENDIX A

PARR HYDROELECTRIC PROJECT WATER QUALITY BASELINE MEMORANDUM – WATER QUALITY REPORT – SUPPLEMENTAL DISSOLVED OXYGEN DATA

Parr Hydroelectric Project – FERC No. 1894
Water Quality Baseline – Memorandum

TO: Parr/Fairfield Relicensing Water Quality Technical Working Committee (TWC)

FROM: Kelly Miller and Henry Mealing – Kleinschmidt Associates

DATE: March 2, 2015

RE: Water Quality Report – Supplemental Dissolved Oxygen Data

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The Parr Hydroelectric Project Baseline Water Quality Report includes analysis of both upstream and downstream water quality associated with the Parr Shoals Development and concluded that project operations could affect water quality downstream of Parr Shoals Dam. At the Water Quality TWC meeting on February 4, 2014, the TWC noted that the Baseline Water Quality Report identified periodic excursions of dissolved oxygen (DO) levels below 4.0 mg/l in the Parr Shoals Dam tailrace, as reported by the USGS station 02160991. In an effort to understand these excursions better, SCE&G contacted USGS and asked if they had any further information on this station. In June of 2011, the USGS installed a new sensor at the station 02160991. From January 2011 through December 2014, there have been approximately 13 hourly excursions in DO below the 4.0 mg/l SCDHEC standard which is approximately 0.04 percent of that period of time. At the request of the Water Quality TWC, SCE&G collected additional water quality data in the tailrace and forebay of Parr Shoals Dam to attempt to determine whether project operations are causing these excursions, and if so, how SCE&G might prevent them from occurring.

Tailrace Data – July – September 2014

Methods

From July through September of 2014, SCE&G collected temperature and DO data at seven sites along the downstream face of the Parr Shoals Dam, adjacent to the USGS station 02160991, and at a location approximately 400 feet downstream of Parr Shoals Dam. Data was collected on a weekly basis, three times per day including one hour before sunrise, at sunrise, and one hour after sunrise. To see if unit location had an effect on DO, the turbine(s) running during collections and the number of any lowered flashboard was also recorded.

Results

SCE&G collected data in the tailrace for two main reasons: (1) to verify the accuracy of the USGS gage station 02160991 and (2) to determine if DO could be correlated to an early morning DO sag or related to which turbine units were running at the time of data collection. During the sampling period, DO levels consistently stayed above 4.0 mg/l. No excursions were recorded by SCE&G or on the USGS gage (Table 1). Data collected by SCE&G at the site of the USGS station 02160991 was consistent with the USGS gage.

TABLE 1 DISSOLVED OXYGEN DATA AT USGS STATION 02160991 AND PARR SHOALS TAILRACE JULY – SEPTEMBER 2014.

	USGS Data		SCE&G Data	
Date	**Time**	**DO mg/l**	**Time**	**DO mg/l**
7/2/14	5:00 AM	6.2	5:35 AM	6.12
	6:00 AM	6.0	6:37 AM	5.95
	7:00 AM	6.0	7:42 AM	5.86
	8:00 AM	6.0		
7/10/14	5:00 AM	6.0	5:32 AM	6.24
	6:00 AM	5.9	6:27 AM	6.16
	7:00 AM	5.7	7:33 AM	6.08
	8:00 AM	5.5		
7/15/14	5:00 AM	5.5	5:34 AM	5.62
	6:00 AM	5.4	6:32 AM	5.32
	7:00 AM	4.9	7:42 AM	4.91
	8:00 AM	5.0		
7/24/14	5:00 AM	5.2	5:41 AM	5.15
	6:00 AM	5.2	6:51 AM	5.03
	7:00 AM	5.1	7:50 AM	5.49
	8:00 AM	5.3		
7/31/14	5:00 AM	5.8	5:43 AM	5.66
	6:00 AM	5.7	6:42 AM	5.55
	7:00 AM	5.7	7:54 AM	5.53
	8:00 AM	5.7		
8/7/14	5:00 AM	6.0	5:39 AM	5.90
	6:00 AM	6.0	6:48 AM	5.84
	7:00 AM	5.9	7:49 AM	5.74
	8:00 AM	5.9		
8/13/14	5:00 AM	5.9	5:30 AM	5.83
	6:00 AM	5.9	6:33 AM	5.86
	7:00 AM	5.9	7:33 AM	5.83
	8:00 AM	5.9		
8/20/14	5:00 AM	5.8	5:48 AM	5.90
	6:00 AM	5.8	6:46 AM	5.97
	7:00 AM	5.7	7:56 AM	5.86
	8:00 AM	5.7		
8/26/14	5:00 AM	6.3	5:41 AM	6.26
	6:00 AM	6.4	6:51 AM	6.51
	7:00 AM	6.4	7:48 AM	6.35
	8:00 AM	6.3		
9/3/14	5:00 AM	5.7	5:29 AM	6.02
	6:00 AM	5.8	6:40 AM	5.73
	7:00 AM	5.4	7:53 AM	5.46
	8:00 AM	5.4		
9/10/14	6:00 AM	5.6	6:30 AM	5.62
	7:00 AM	5.7	7:46 AM	5.78
	8:00 AM	5.7	8:46 AM	5.71
	9:00 AM	5.7		
9/16/14	6:00 AM	5.0	6:22 AM	4.94

	7:00 AM	5.0	7:24 AM	4.98
	8:00 AM	5.0	8:24 AM	4.92
	9:00 AM	5.0		
9/25/14	6:00 AM	7.3	6:33 AM	7.10
	7:00 AM	7.3	7:34 AM	7.65
	8:00 AM	7.3	8:29 AM	7.62
	9:00 AM	7.3		

Results did not detect a clear correlation between DO readings and the units running at the time of data collection. See Appendix A for a complete list of the data collected during this effort.

Forebay Data – October & November 2014

Methods

Water quality data, including DO and temperature, were collected in the forebay of the Parr Shoals Dam to determine if low DO water is being released through the turbines, causing the DO in the tailrace to drop. The data was collected using two HOBO data loggers, with one logger located approximately one foot above the bottom of the reservoir and the other located approximately one foot below the surface of the reservoir. Data was logged on an hourly basis from October 16, 2014 through December 3, 2014. We had planned to begin collections earlier but did not receive the data loggers until mid-September.

Results

Results showed the expected correlations between DO and temperature and natural diel fluctuations (Figure 1 through Figure 4). DO levels at the bottom of the forebay are consistently slightly lower than those at the top of the forebay, and there was no evidence of stratification in the forebay area of the reservoir. There were no low DO events observed in the tailrace during the monitoring effort.

FIGURE 1 DO AND TEMPERATURE AT BOTTOM OF PARR SHOALS DAM FOREBAY

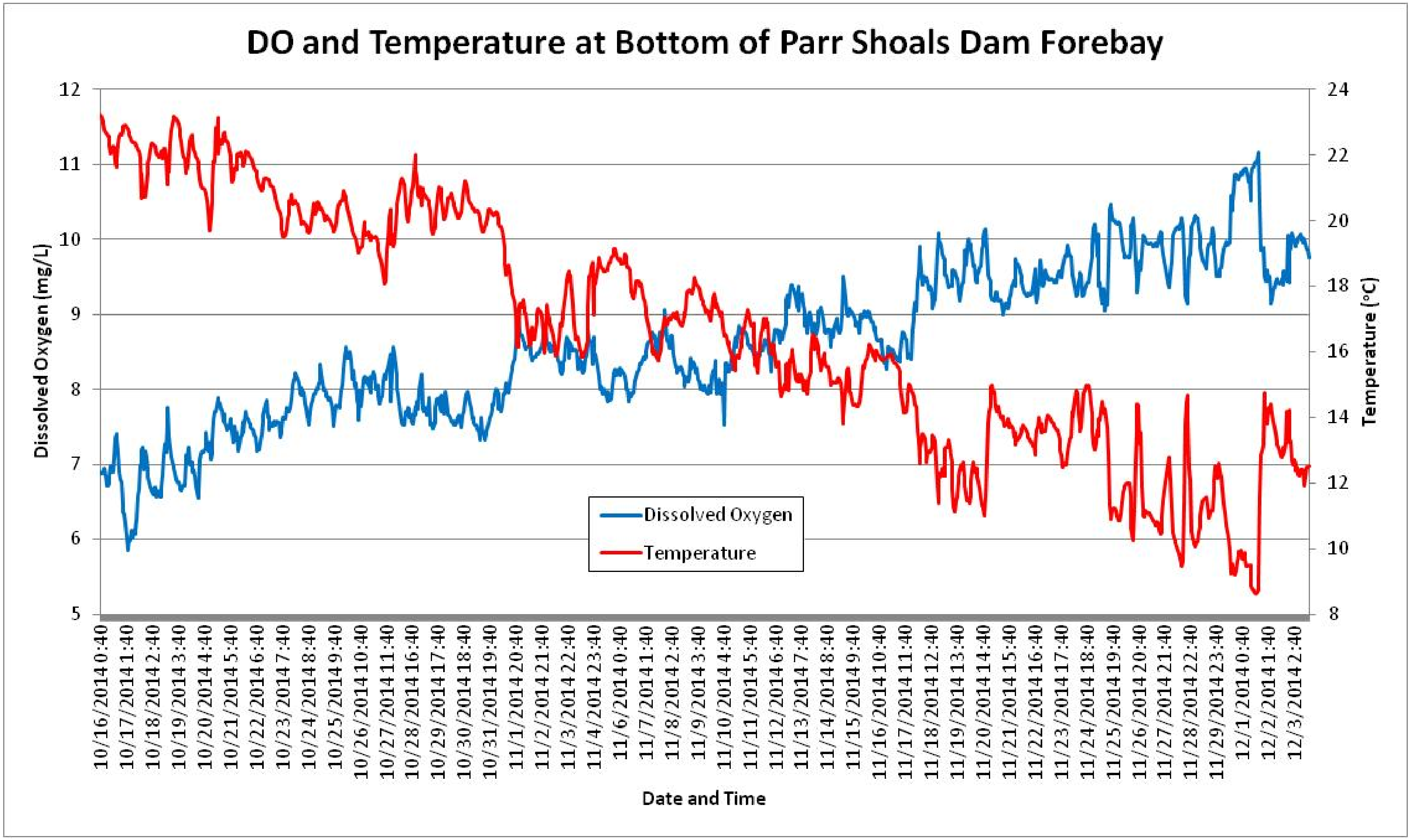


FIGURE 2 DO AND TEMPERATURE AT THE TOP OF PARR SHOALS DAM FOREBAY

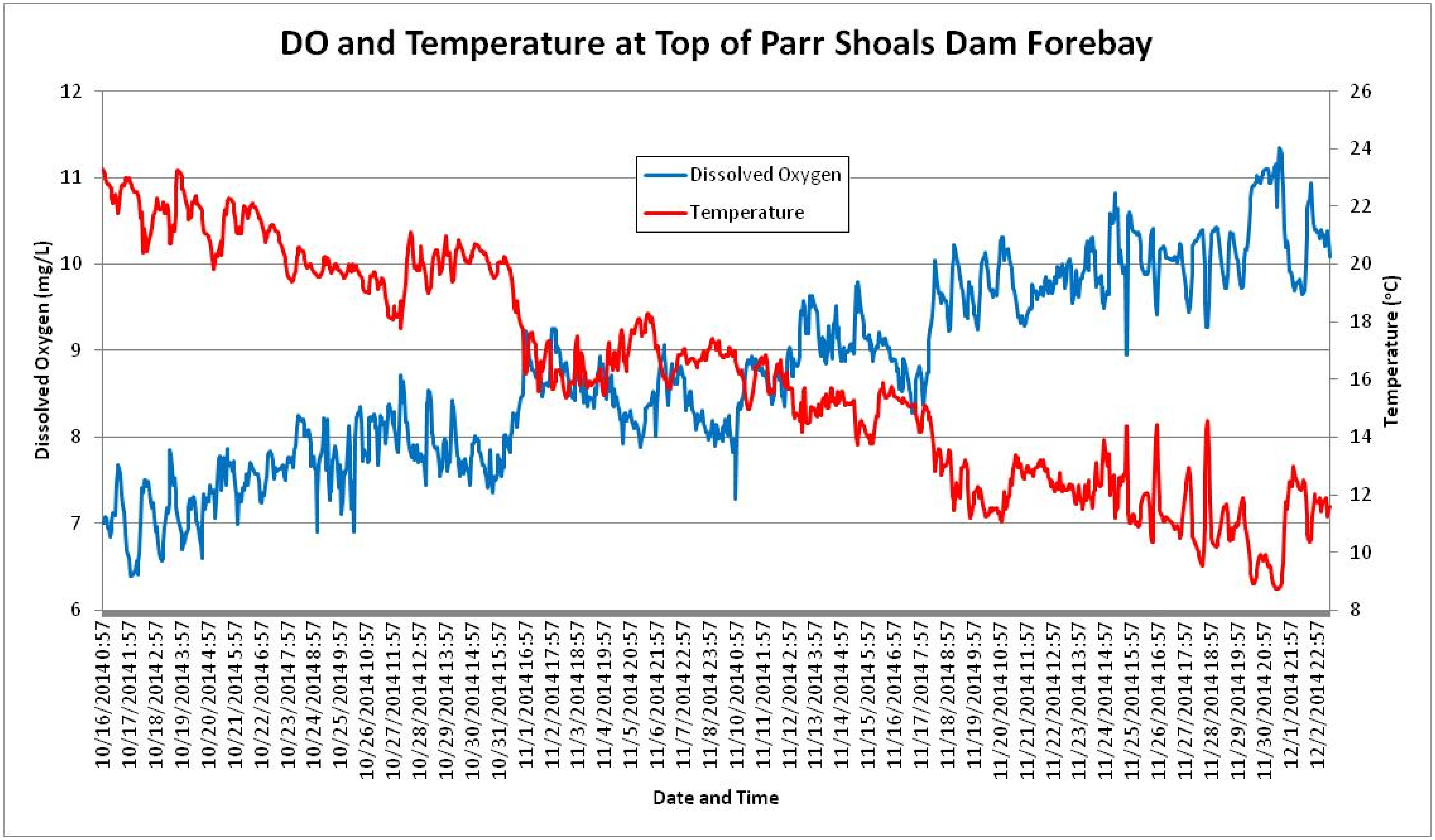


FIGURE 3 PARR SHOALS DAM FOREBAY DISSOLVED OXYGEN

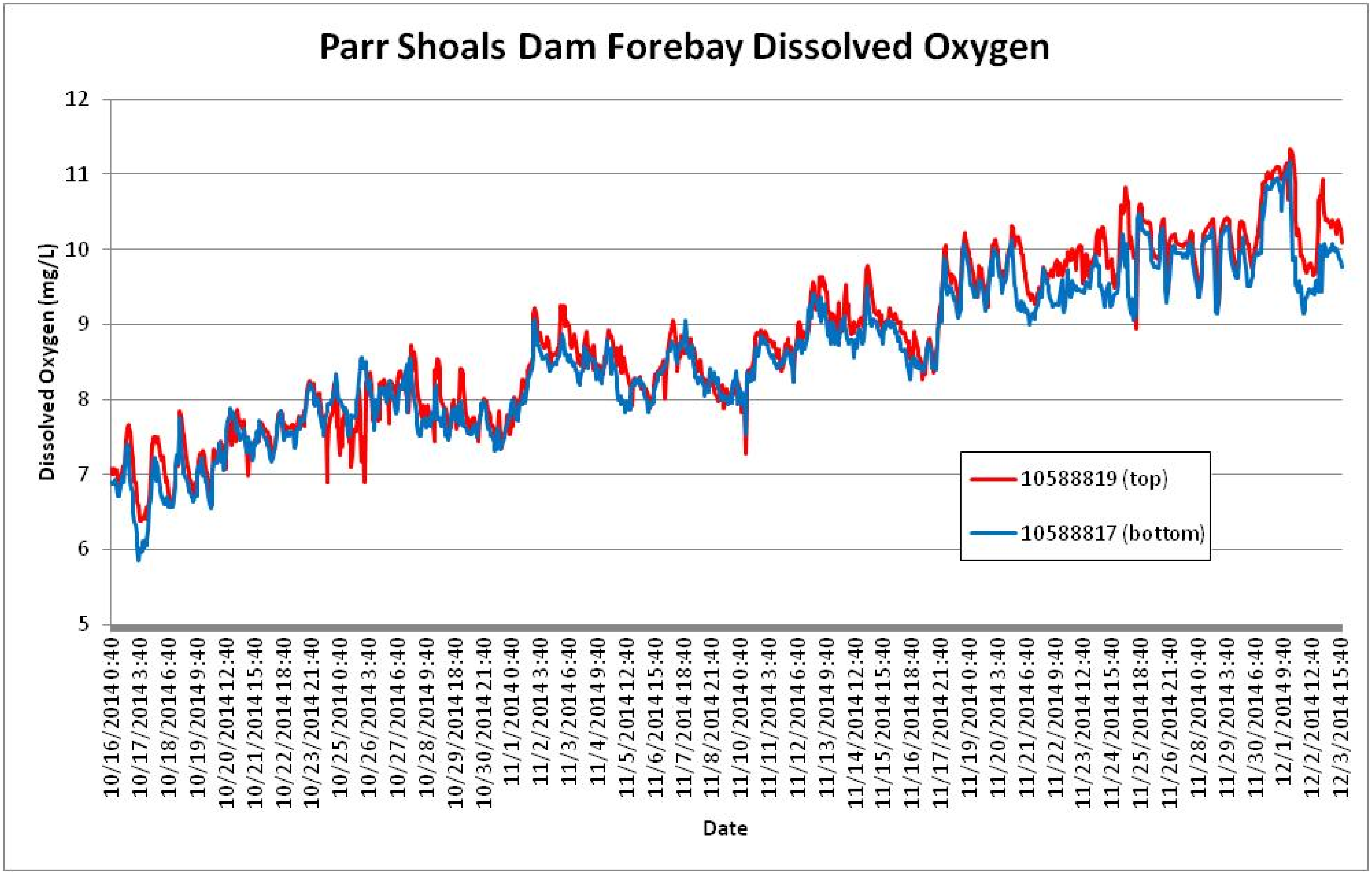
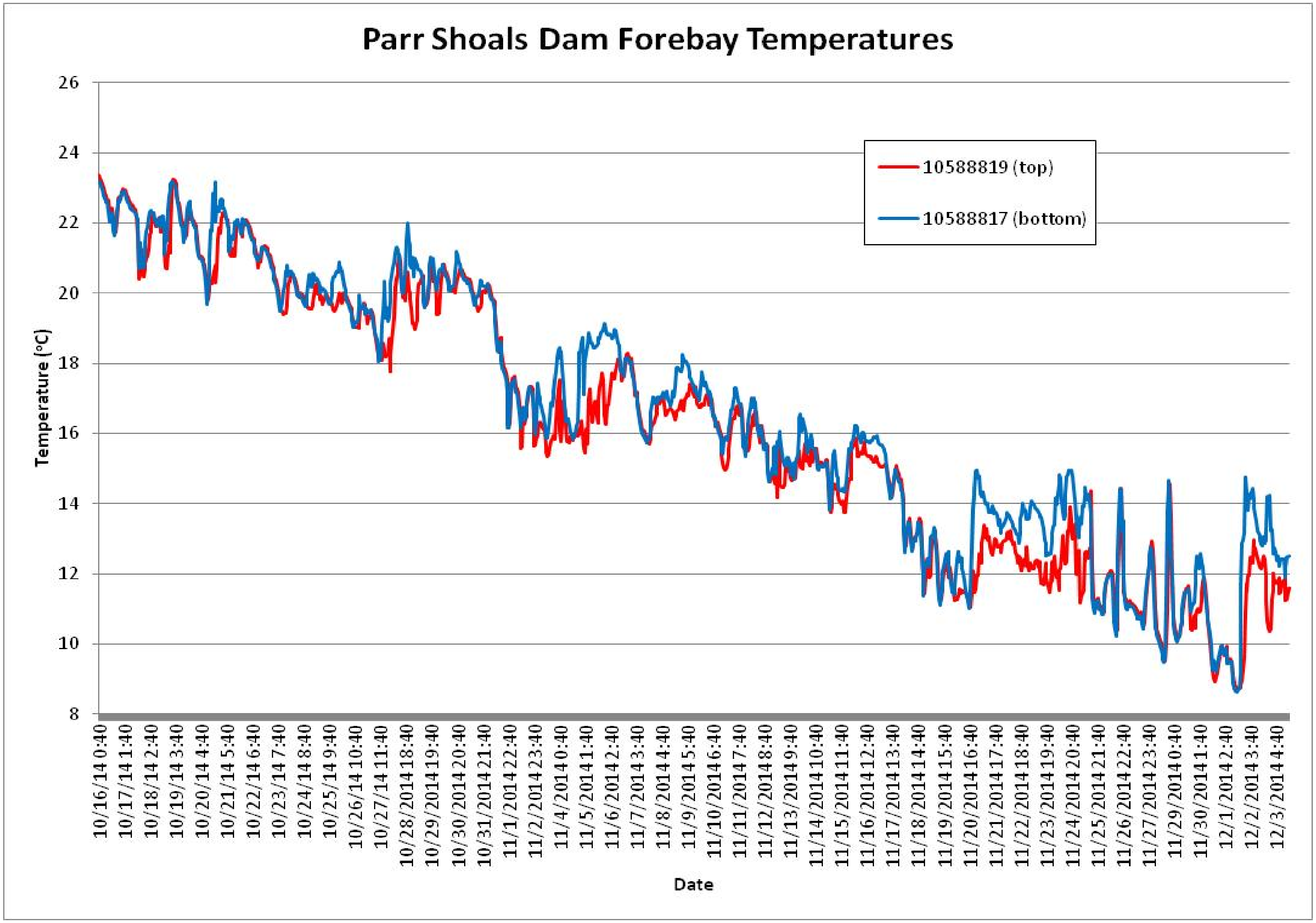


FIGURE 4 PARR SHOALS DAM FOREBAY TEMPERATURES



<u>Parr Aeration Investigation – August 2014</u>

Because of the success with turbine self-venting (or self-aerating) at the Saluda Hydro Project, SCE&G performed some initial investigations to determine if turbine aerating at the Parr Shoals Development was feasible for periodically increasing the tailrace DO levels. Bret Hoffman (Kleinschmidt), Amy Bresnahan (SC&EG), Milton Quattlebaum (SCE&G), and Mike Hall (USGS) performed some initial onsite turbine venting tests at the Parr Shoals Development on the morning of August 20, 2014. The results of their investigation are included below.

During each test run, water quality measurements (DO, temperature, and % DO saturation) were recorded with handheld meters (independent of the permanently installed USGS gage station equipment) in the tailrace at the bay 7 location (which is between the six turbine bays and the shore) and along the shoreline adjacent to the USGS gage. These measurements provided a cursory examination of the ability of the Units to aerate by opening the existing vacuum breaker valves located on the turbine head cover. Only Units 1, 3, and 4 were available for operation testing as the other units were out of service for repair, and Unit 4 could not be shut down because of equipment issues. During testing all river flow was passed through the turbine units and the spillway gates were in the closed (raised) position. Test runs for the water quality measurements were conducted in combinations of turbine operations as described below and were partially dictated by the requirement that Unit 4 could not be shut down. The headpond and tailwater elevations were also recorded, as were individual generator kW and kVar outputs.

<u>Unit 4 - Test</u>

Initially, tailrace readings were collected with only Unit 4 operating, and the vacuum breaker valve closed. Then, the vacuum breaker valve was fully opened to allow aeration, and audibly drew in air. The effects of the introduced air were clearly visible in the tailrace. The initial tailrace reading collected with the valve closed was 5.66 mg/l, the reading at bay 7 with the valve open was 5.82 mg/l. Upon closing the valve, the DO at bay 7 dropped to 5.78 mg/l, although the aerated water may not have had time to flush out from the tailrace area. The USGS measurements on the shore were 5.58 mg/l prior to opening any turbine vents, and 5.75mg/l with the vent open for 25 minutes. The USGS reading did not drop after the valve was closed, and matched the bay 7 reading of 5.78 mg/l, supporting the theory that residual aerated water remained in the immediate tailrace area. Initial saturation was 71% (valve closed), and with the valve open the saturation increased to 74.9%. Saturation levels reported near the USGS gage were within a tenth of a percent of those recorded at bay 7.

<u>Units 1 and 4</u>

Unit 1 was started (valve closed) and allowed to stabilize for 15 minutes. DO readings were collected with Unit 1 valve closed and Unit 4 valve open. The USGS reading increased to 5.84 mg/l, while the bay 7 reading increased from 5.82 mg/l to 5.86 mg/l. The Unit 1 valve was opened and readings were collected after 15 minutes of stabilization. The measurement near the USGS gage was 5.80 mg/l, while the bay 7 reading was 5.88 mg/l. Saturation with Unit 1 (valve closed) and Unit 4 (valve open) was 73%, which increased to 75.4% with both units' valves open.

Units 1, 3, and 4

Unit 3 was started and operated for 15 minutes with no valve open, while the valves for Units 1 and 4 were left open. The measurements from the USGS site and at bay 7 were both 5.80 mg/l, and the saturation at bay 7 was 74.8%. When the valve was opened on Unit 3, the bay 7 reading was 5.76 mg/l and the USGS reading was 5.75 mg/l with a saturation level of 74.3% - with all three units aerating. USGS took an additional measurement at bay 2 (between units 1 and 3) with all units aerating, which ranged from 6.08 mg/l to 6.15 mg/l; at 6.08 mg/l, saturation was 79%.

One final measurement was taken with all units 1, 3 and 4 operating but all three valves closed. The reading near the USGS gage was 5.71 mg/l while the bay 7 reading was 5.73 mg/l, indicating very minimal reduction from aerating. It is likely that the aerated water in the tailrace area did not flush out and resulted in higher readings. The USGS handheld meter was used to re-sample water quality at bay 2 and the DO dropped to 5.89 mg/l and 75% saturation.

Discussion

The three units tested will aerate with their current valve configurations. The inability to shut down unit 4 likely prevented the aerated flows from units 1 and 3 from reaching the shore, as they are located further toward the middle of the river. While the DO readings with various combinations of valves open for all three units was fairly stable, the initial increase from Unit 4 indicates there is an ability to increase dissolved oxygen by aerating. Saturation was between 71% initial reading (prior to any aeration), and 75% after the valve was opened, indicating an increase in saturation. Saturation levels were near 75% for all readings following the initial valve opening.

Saturation was calculated for all the DO excursions (below 4.0 mg/L) during the past three years as recorded by the USGS gage. While the saturation levels during the aeration testing ranged from 71% (without aerating) up to 76%, the levels calculated for the excursions varied between 44.8% and 51.18%. Water temperatures during the testing ranged between 27.5 and 28.1 ^{o}C, while temperature during the excursions was measured at 29.3 to 30.1 ^{o}C.

The initial increase in DO measured during testing was approximately 0.17 mg/l. This indicates the turbines have some ability to increase DO by aerating, although the saturation percentage and water temperatures were significantly different during the historic DO excursions. A better determination of effectiveness could be made under lower DO and saturation conditions during the summer. Also, testing during a period when all of the turbine units can be manipulated (turned on/off and aerating on/off) would give more precise information on the performance of each unit.

APPENDIX A

TAILRACE DATA

Parr/Fairfield Relicensing Dissolved Oxygen Study 2014

Date: 7/2/14

Samplers: Milton Quattlebaum and Kelly Miller

Time	Location	DO (mg/L)	Temp (°C)	Units Running
5:11 AM	Unit 1	5.79	27.30	on
5:16 AM	Unit 2	5.92	27.45	off
5:20 AM	Unit 3	5.90	27.44	on
5:23 AM	Unit 4	6.01	27.69	on
5:26 AM	Unit 5	6.18	27.94	off
5:29 AM	Unit 6	6.14	27.94	off
5:35 AM	**At USGS gage**	**6.12**	**27.92**	
5:41 AM	DWNSTRM Plant	6.09	27.89	
6:16 AM	Unit 1	5.97	27.30	on
6:19 AM	Unit 2	5.89	27.40	off
6:21 AM	Unit 3	5.90	27.48	on
6:23 AM	Unit 4	6.06	27.74	on
6:26 AM	Unit 5	5.99	27.76	off
6:28 AM	Unit 6	5.98	27.79	off
6:33 AM	NPDES 001 sign	6.00	27.62	
6:37 AM	**At USGS gage**	**5.95**	**27.74**	
6:42 AM	DWNSTRM Plant	5.94	27.71	
7:17 AM	Unit 1	5.74	27.25	on
7:22 AM	Unit 2	5.82	27.36	off
7:25 AM	Unit 3	5.84	27.40	on
7:27 AM	Unit 4	6.03	27.64	on
7:30 AM	Unit 5	5.93	27.61	off
7:33 AM	Unit 6	5.89	27.63	off
7:36 AM	NPDES 001 sign	5.93	27.62	
7:42 AM	**At USGS gage**	**5.86**	**27.56**	
7:49 AM	DWNSTRM Plant	5.89	27.57	

Time	Jenkinsville 02160991	Parr Res. Level 02160990	Parr Crest Gate	**USGS DO data at Jenkinsville**	USGS Temp data at Jenkinsville
5:00 AM	221.37	261.52	258.50	**6.2**	27.8
6:00 AM	221.35	260.89	262.50	**6.0**	27.6
7:00 AM	221.65	260.44	258.50	**6.0**	27.5
8:00 AM				**6.0**	27.4

Parr/Fairfield Relicensing Dissolved Oxygen Study 2014

Date: 7/10/14

Samplers: Milton Quattlebaum and Kelly Miller

Time	Location	DO (mg/L)	Temp (^oC)	Units Running
5:04 AM	Unit 1	5.73	27.40	on
5:08 AM	Unit 2	5.75	27.45	off
5:11 AM	Unit 3	5.86	27.48	on
5:15 AM	Unit 4	6.09	27.53	on
5:18 AM	Unit 5	6.28	27.69	off
5:21 AM	Unit 6	6.24	27.66	off
5:24 AM	NPDES 001 sign	6.26	27.67	
5:32 AM	**At USGS gage**	**6.24**	**27.61**	
5:35 AM	DWNSTRM Plant	6.24	27.65	
6:07 AM	Unit 1	5.75	27.44	on
6:10 AM	Unit 2	5.82	27.47	off
6:13 AM	Unit 3	5.89	27.51	on
6:15 AM	Unit 4	6.27	27.64	on
6:18 AM	Unit 5	6.24	27.65	off
6:20 AM	Unit 6	6.20	27.64	off
6:22 AM	NPDES 001 sign	6.19	27.65	
6:27 AM	**At USGS gage**	**6.16**	**27.63**	
6:32 AM	DWNSTRM Plant	6.16	27.59	
7:14 AM	Unit 1	5.87	27.50	on
7:16 AM	Unit 2	5.84	27.51	off
7:19 AM	Unit 3	5.91	27.51	on
7:21 AM	Unit 4	6.19	27.59	on
7:23 AM	Unit 5	6.15	27.60	off
7:25 AM	Unit 6	6.16	27.62	off
7:27 AM	NPDES 001 sign	6.13	27.61	
7:33 AM	**At USGS gage**	**6.08**	**27.61**	
7:40 AM	DWNSTRM Plant	6.15	27.50	
				*lowered crest gates 5 and 6 at 7:20 am

Time	Jenkinsville 02160991	Parr Res. Level 02160990	Parr Crest Gate	**USGS DO data at Jenkinsville**	USGS Temp data at Jenkinsville
5:00 AM	221.36	260.89	266.00	**6.0**	27.6
6:00 AM	221.35	260.57	266.00	**5.9**	27.5
7:00 AM	221.93	260.59	258.00	**5.7**	27.5
8:00 AM				**5.5**	27.4

Parr/Fairfield Relicensing Dissolved Oxygen Study 2014

Date: 7/15/14

Samplers: Milton Quattlebaum and Kelly Miller

Time	Location	DO (mg/L)	Temp (°C)	Units Running
5:10 AM	Unit 1	5.30	28.19	on
5:14 AM	Unit 2	5.29	28.25	off
5:17 AM	Unit 3	5.30	28.29	on
5:19 AM	Unit 4	5.70	28.42	on
5:22 AM	Unit 5	5.63	28.45	off
5:25 AM	Unit 6	5.54	28.48	off
5:28 AM	NPDES 001 sign	5.64	28.41	
5:34 AM	**At USGS gage**	**5.62**	**28.34**	
5:39 AM	DWNSTRM Plant	5.57	28.41	
6:13 AM	Unit 1	4.77	28.18	on
6:15 AM	Unit 2	4.81	28.21	off
6:18 AM	Unit 3	4.92	28.22	on
6:20 AM	Unit 4	5.19	28.25	on
6:22 AM	Unit 5	5.40	28.16	off
6:25 AM	Unit 6	5.35	28.24	off
6:27 AM	NPDES 001 sign	5.31	28.34	
6:32 AM	**At USGS gage**	**5.32**	**28.30**	
6:36 AM	DWNSTRM Plant	5.33	28.29	
7:22 AM	Unit 1	4.98	28.18	on
7:25 AM	Unit 2	4.94	28.15	off
7:27 AM	Unit 3	4.94	28.11	on
7:30 AM	Unit 4	5.00	28.12	on
7:32 AM	Unit 5	5.18	28.18	off
7:35 AM	Unit 6	5.02	28.19	off
7:37 AM	NPDES 001 sign	5.03	28.16	
7:42 AM	**At USGS gage**	**4.91**	**28.08**	
7:47 AM	DWNSTRM Plant	5.00	28.18	
7:55 AM	Unit 1	4.86	28.12	on
				*not spilling while monitoring

Time	Jenkinsville 02160991	Parr Res. Level 02160990	Parr Crest Gate	**USGS DO data at Jenkinsville**	USGS Temp data at Jenkinsville
5:00 AM	221.34	258.63	266, except 5&6 at 264	**5.5**	28.3
6:00 AM	221.31	258.40	266, except 5&6 at 264	**5.4**	28.2
7:00 AM	221.34	258.68	266, except 5&6 at 264	**4.9**	28
8:00 AM				**5.0**	28

Parr/Fairfield Relicensing Dissolved Oxygen Study 2014

Date: 7/24/14

Samplers: Milton Quattlebaum and Kelly Miller

Time	Location	DO (mg/L)	Temp (^oC)	Units Running
5:10 AM	Unit 1	5.23	27.34	off
5:15 AM	Unit 2	5.26	27.32	off
5:17 AM	Unit 3	5.21	27.30	off
5:21 AM	Unit 4	5.43	27.35	on
5:24 AM	Unit 5	5.15	27.32	off
5:29 AM	Unit 6	4.81	27.21	off
5:35 AM	NPDES 001 sign	5.11	27.29	
5:41 AM	**At USGS gage**	**5.15**	**27.28**	
5:46 AM	DWNSTRM Plant	4.70	27.19	
6:27 AM	Unit 1	5.27	27.29	off
6:33 AM	Unit 2	5.26	27.23	off
6:35 AM	Unit 3	5.28	27.28	off
6:38 AM	Unit 4	5.19	27.30	on
6:41 AM	Unit 5	5.09	27.29	off
6:43 AM	Unit 6	4.97	27.27	off
6:46 AM	NPDES 001 sign	5.05	27.21	
6:51 AM	**At USGS gage**	**5.03**	**27.27**	
6:56 AM	DWNSTRM Plant	4.72	27.09	
7:22 AM	Unit 1	5.18	27.24	off
7:32 AM	Unit 2	5.68	27.24	off
7:33 AM	Unit 3	5.68	27.27	off
7:37 AM	Unit 4	5.83	27.26	on
7:40 AM	Unit 5	5.49	27.25	off
7:42 AM	Unit 6	5.43	27.11	off
7:45 AM	NPDES 001 sign	5.50	27.21	
7:50 AM	**At USGS gage**	**5.49**	**26.68**	
7:55 AM	DWNSTRM Plant	5.47	27.06	
8:00 AM	Unit 1	5.63	27.25	off

Time	Jenkinsville 02160991	Parr Res. Level 02160990	Parr Crest Gate	**USGS DO data at Jenkinsville**	USGS Temp data at Jenkinsville
5:00 AM	220.47	260.11	Gates 1, 2, 3, 4: 264	**5.2**	27.2
6:00 AM	220.47	259.41	Gates 5, 6, 7, 8: 266	**5.2**	27.2
7:00 AM	220.46	258.97		**5.1**	27.1
8:00 AM				**5.3**	27.1

Parr/Fairfield Relicensing Dissolved Oxygen Study 2014

Date: 7/31/14

Samplers: Milton Quattlebaum

Time	Location	DO (mg/L)	Temp (°C)	Units Running
5:18 AM	Unit 1	5.72	27.49	on
5:21 AM	Unit 2	5.73	27.52	off
5:24 AM	Unit 3	5.73	27.50	off
5:27 AM	Unit 4	5.78	27.51	on
5:30 AM	Unit 5	5.65	27.49	off
5:33 AM	Unit 6	5.60	27.48	off
5:37 AM	NPDES 001 sign	5.67	27.46	
5:43 AM	**At USGS gage**	**5.66**	**27.32**	
5:50 AM	DWNSTRM Plant	5.54	27.39	
6:22 AM	Unit 1	5.71	27.42	on
6:25 AM	Unit 2	5.71	27.47	off
6:28 AM	Unit 3	5.73	27.48	off
6:31 AM	Unit 4	5.81	27.46	on
6:33 AM	Unit 5	5.61	27.42	off
6:36 AM	Unit 6	5.59	27.41	off
6:38 AM	NPDES 001 sign	5.64	27.43	
6:42 AM	**At USGS gage**	**5.55**	**27.32**	
6:47 AM	DWNSTRM Plant	5.61	27.22	
7:32 AM	Unit 1	5.64	27.41	on
7:36 AM	Unit 2	5.69	27.37	off
7:39 AM	Unit 3	5.69	27.42	off
7:41 AM	Unit 4	5.73	27.41	on
7:44 AM	Unit 5	5.63	27.39	off
7:46 AM	Unit 6	5.66	27.38	off
7:49 AM	NPDES 001 sign	5.68	27.38	
7:54 AM	**At USGS gage**	**5.53**	**27.36**	
7:59 AM	DWNSTRM Plant	5.61	27.32	
8:07 AM	Unit 1	5.60	27.49	on *no gates spilling

Time	Jenkinsville 02160991	Parr Res. Level 02160990	Parr Crest Gate	**USGS DO data at Jenkinsville**	USGS Temp data at Jenkinsville
5:00 AM	220.97	260.44	Gates 1, 2, 5, 6, 9, 10: 266	**5.8**	27.4
6:00 AM	220.99	259.66	Gates 3, 4:264	**5.7**	27.3
7:00 AM	220.95	259.00	Gates 7, 8: 263	**5.7**	27.3
8:00 AM				**5.7**	27.3

Parr/Fairfield Relicensing Dissolved Oxygen Study 2014

Date: 8/7/14

Samplers: Milton Quattlebaum

Time	Location	DO (mg/L)	Temp (°C)	Units Running
5:14 AM	Unit 1	5.90	27.37	off
5:14 AM	Unit 2	5.92	27.30	off
5:20 AM	Unit 3	6.02	27.32	on
5:23 AM	Unit 4	5.99	27.29	on
5:26 AM	Unit 5	5.92	27.34	off
5:29 AM	Unit 6	5.92	27.33	off
5:33 AM	NPDES 001 sign	5.88	27.30	
5:39 AM	**At USGS gage**	**5.90**	**27.30**	
5:48 AM	DWNSTRM Plant	5.80	27.18	
6:25 AM	Unit 1	5.94	27.33	off
6:29 AM	Unit 2	5.94	27.33	off
6:31 AM	Unit 3	6.02	27.34	on
6:34 AM	Unit 4	5.95	27.32	on
6:36 AM	Unit 5	5.90	27.32	off
6:39 AM	Unit 6	5.86	27.28	off
6:42 AM	NPDES 001 sign	5.90	27.30	
6:48 AM	**At USGS gage**	**5.84**	**27.27**	
6:58 AM	DWNSTRM Plant	5.68	27.13	
7:27 AM	Unit 1	5.82	27.34	off
7:30 AM	Unit 2	5.92	27.29	off
7:33 AM	Unit 3	5.97	27.36	on
7:36 AM	Unit 4	5.95	27.32	on
7:39 AM	Unit 5	5.90	27.27	off
7:42 AM	Unit 6	5.85	27.26	off
7:45 AM	NPDES 001 sign	5.90	27.28	
7:49 AM	**At USGS gage**	**5.74**	**27.21**	
7:56 AM	DWNSTRM Plant	5.73	27.15	
8:03 AM	Unit 1	5.83	27.27	off
				*no gates spilling

Time	Jenkinsville 02160991	Parr Res. Level 02160990	Parr Crest Gate	**USGS DO data at Jenkinsville**	USGS Temp data at Jenkinsville
5:00 AM	220.76	258.89	Gates 1, 2, 9, 10:266	**6.0**	27.2
6:00 AM	220.75	258.17	Gates 3, 4, 5, 6, 7, 8: 264	**6.0**	27.2
7:00 AM	220.72	258.02		**5.9**	27.2
8:00 AM				**5.9**	27.2

Parr/Fairfield Relicensing Dissolved Oxygen Study 2014

Date: 8/13/14

Samplers: Milton Quattlebaum and Kelly Miller

Time	Location	DO (mg/L)	Temp (^{o}C)	Units Running
5:09 AM	Unit 1	5.87	26.18	on
5:13 AM	Unit 2	5.85	26.24	off
5:15 AM	Unit 3	5.89	26.26	on
5:18 AM	Unit 4	5.93	26.26	on
5:20 AM	Unit 5	5.80	26.28	off
5:23 AM	Unit 6	5.81	26.27	off
5:25 AM	NPDES 001 sign	5.82	26.27	
5:30 AM	**At USGS gage**	**5.83**	**26.24**	
5:35 AM	DWNSTRM Plant	5.85	26.23	
6:13 AM	Unit 1	5.85	26.20	on
6:16 AM	Unit 2	5.87	26.19	off
6:18 AM	Unit 3	5.85	26.21	on
6:20 AM	Unit 4	5.93	26.19	on
6:23 AM	Unit 5	5.83	26.18	off
6:25 AM	Unit 6	5.81	26.18	off
6:28 AM	NPDES 001 sign	5.83	26.18	
6:33 AM	**At USGS gage**	**5.86**	**26.15**	
6:38 AM	DWNSTRM Plant	5.87	26.14	
7:17 AM	Unit 1	5.86	26.14	on
7:19 AM	Unit 2	5.86	26.15	off
7:21 AM	Unit 3	5.88	26.15	on
7:23 AM	Unit 4	5.94	26.12	on
7:25 AM	Unit 5	5.86	26.10	off
7:27 AM	Unit 6	5.88	26.09	off
7:29 AM	NPDES 001 sign	5.89	26.08	
7:33 AM	**At USGS gage**	**5.83**	**26.07**	
7:37 AM	DWNSTRM Plant	5.90	26.06	
7:41 AM	Unit 1	5.90	26.12	on
				*no gates spilling

Time	Jenkinsville 02160991	Parr Res. Level 02160990	Parr Crest Gate	**USGS DO data at Jenkinsville**	USGS Temp data at Jenkinsville
5:00 AM	221.33	259.89	1, 2, 9, 10: 266	**5.9**	26.1
6:00 AM	221.33	259.5	3, 4, 5, 6, 7, 8: 261	**5.9**	26.0
7:00 AM	221.07	259.57		**5.9**	26.0
8:00 AM				**5.9**	26.0

Parr/Fairfield Relicensing Dissolved Oxygen Study 2014

Date: 8/20/14

Samplers: Milton Quattlebaum

Time	Location	DO (mg/L)	Temp (°C)	Units Running
5:24 AM	Unit 1	5.53	27.54	on
5:27 AM	Unit 2	5.88	27.68	off
5:30 AM	Unit 3	5.91	27.65	off
5:33 AM	Unit 4	5.99	27.67	on
5:36 AM	Unit 5	5.92	27.68	off
5:39 AM	Unit 6	5.91	27.64	off
5:42 AM	NPDES 001 sign	5.91	27.64	
5:48 AM	**At USGS gage**	**5.90**	**27.47**	
5:53 AM	DWNSTRM Plant	5.90	27.55	
6:26 AM	Unit 1	5.63	27.70	on
6:29 AM	Unit 2	5.87	27.68	off
6:31 AM	Unit 3	5.86	27.67	off
6:33 AM	Unit 4	5.91	27.66	on
6:35 AM	Unit 5	5.87	27.63	off
6:38 AM	Unit 6	5.86	27.60	off
6:41 AM	NPDES 001 sign	5.93	27.65	
6:46 AM	**At USGS gage**	**5.97**	**27.21**	
6:50 AM	DWNSTRM Plant	5.86	27.48	
7:32 AM	Unit 1	5.67	27.64	on
7:34 AM	Unit 2	5.96	27.57	off
7:38 AM	Unit 3	5.92	27.66	off
7:41 AM	Unit 4	6.02	27.65	on
7:43 AM	Unit 5	5.97	27.64	off
7:45 AM	Unit 6	5.87	27.53	off
7:48 AM	NPDES 001 sign	5.93	27.61	
7:56 AM	**At USGS gage**	**5.86**	**27.47**	
8:00 AM	DWNSTRM Plant	5.83	27.50	
8:09 AM	Unit 1	5.73	27.61	on
				*no gates spilling

Time	Jenkinsville 02160991	Parr Res. Level 02160990	Parr Crest Gate	**USGS DO data at Jenkinsville**	USGS Temp data at Jenkinsville
5:00 AM	220.97	258.50	1, 2, 9, 10: 265	**5.8**	27.6
6:00 AM	220.96	258.37	3, 4, 5, 6, 7, 8: 266	**5.8**	27.6
7:00 AM	220.94	258.42		**5.7**	27.5
8:00 AM				**5.7**	27.5

Parr/Fairfield Relicensing Dissolved Oxygen Study 2014

Date: 8/26/14

Samplers: Milton Quattlebaum

Time	Location	DO (mg/L)	Temp (°C)	Units Running
5:17 AM	Unit 1	7.05	28.08	off
5:20 AM	Unit 2	7.02	28.08	off
5:23 AM	Unit 3	7.09	28.07	on
5:26 AM	Unit 4	6.41	28.08	on
5:28 AM	Unit 5	6.29	28.06	off
5:31 AM	Unit 6	6.25	28.03	off
5:34 AM	NPDES 001 sign	6.30	28.04	
5:41 AM	**At USGS gage**	**6.29**	**27.90**	
5:46 AM	DWNSTRM Plant	6.20	27.95	
6:26 AM	Unit 1	7.00	28.02	off
6:29 AM	Unit 2	7.06	28.00	off
6:32 AM	Unit 3	7.03	27.98	on
6:35 AM	Unit 4	6.64	27.90	on
6:38 AM	Unit 5	6.43	27.86	off
6:41 AM	Unit 6	6.41	27.82	off
6:45 AM	NPDES 001 sign	6.50	27.87	
6:51 AM	**At USGS gage**	**6.51**	**27.82**	
6:56 AM	DWNSTRM Plant	6.36	27.61	
7:30 AM	Unit 1	6.74	27.81	off
7:32 AM	Unit 2	6.81	27.79	off
7:34 AM	Unit 3	6.80	27.84	on
7:36 AM	Unit 4	6.68	27.71	on
7:38 AM	Unit 5	6.45	27.74	off
7:42 AM	Unit 6	6.47	27.66	off
7:44 AM	NPDES 001 sign	6.50	27.74	
7:48 AM	**At USGS gage**	**6.35**	**27.71**	
7:53 AM	DWNSTRM Plant	6.29	27.60	
8:01 AM	Unit 1	6.67	27.79	off
				*no gates spilling

Time	Jenkinsville 02160991	Parr Res. Level 02160990	Parr Crest Gate	**USGS DO data at Jenkinsville**	USGS Temp data at Jenkinsville
5:00 AM	221.10	261.50	1, 2, 9, 10: 266	**6.3**	27.9
6:00 AM	221.10	261.33	3, 4, 5, 6, 7, 8: 265	**6.4**	27.8
7:00 AM	221.08	261.01		**6.4**	27.6
8:00 AM				**6.3**	27.5

Parr/Fairfield Relicensing Dissolved Oxygen Study 2014

Date: 9/03/14

Samplers: Milton Quattlebaum and Kelly Miller

Time	Location	DO (mg/L)	Temp (°C)	Units Running
5:01 AM	Unit 1	5.88	28.45	on
5:04 AM	Unit 2	5.74	28.41	off
5:10 AM	Unit 3	5.61	28.40	on
5:14 AM	Unit 4	5.75	28.42	on
5:17 AM	Unit 5	5.67	28.49	off
5:19 AM	Unit 6	5.63	28.48	off
5:24 AM	NPDES 001 sign	5.82	28.35	
5:29 AM	**At USGS gage**	**6.02**	**28.86**	
5:35 AM	DWNSTRM Plant	6.11	28.43	
6:19 AM	Unit 1	5.56	28.41	on
6:21 AM	Unit 2	5.58	28.41	off
6:25 AM	Unit 3	5.53	28.42	on
6:27 AM	Unit 4	5.62	28.44	on
6:30 AM	Unit 5	5.73	28.46	off
6:33 AM	Unit 6	5.69	28.47	off
6:35 AM	NPDES 001 sign	5.71	28.46	
6:40 AM	**At USGS gage**	**5.73**	**28.46**	
6:45 AM	DWNSTRM Plant	5.69	28.13	
7:31 AM	Unit 1	5.57	28.61	on
7:36 AM	Unit 2	5.62	28.60	off
7:39 AM	Unit 3	5.63	28.59	on
7:41 AM	Unit 4	5.61	28.57	on
7:44 AM	Unit 5	5.63	28.54	off
7:47 AM	Unit 6	5.56	28.54	off
7:49 AM	NPDES 001 sign	5.53	28.55	
7:53 AM	**At USGS gage**	**5.46**	**28.51**	
7:59 AM	DWNSTRM Plant	5.56	28.30	
8:05 AM	Unit 1	5.55	28.51	on
				*no gates spilling

Time	Jenkinsville 02160991	Parr Res. Level 02160990	Parr Crest Gate	**USGS DO data at Jenkinsville**	USGS Temp data at Jenkinsville
5:00 AM	221.43	259.43	all @ 266	**5.7**	28.4
6:00 AM	221.38	259.1		**5.8**	28.4
7:00 AM	221.38	258.74		**5.4**	28.4
8:00 AM				**5.4**	28.4

Parr/Fairfield Relicensing Dissolved Oxygen Study 2014

Date: 9/10/14

Samplers: Milton Quattlebaum

Time	Location	DO (mg/L)	Temp (^{o}C)	Units Running
6:02 AM	Unit 1	5.90	27.12	on
6:04 AM	Unit 2	5.82	27.11	off
6:07 AM	Unit 3	5.71	27.09	off
6:10 AM	Unit 4	5.77	27.09	on
6:13 AM	Unit 5	5.62	27.08	off
6:17 AM	Unit 6	5.61	27.04	off
6:20 AM	NPDES 001 sign	5.65	27.01	
6:30 AM	**At USGS gage**	**5.62**	**27.04**	
6:35 AM	DWNSTRM Plant	5.64	26.98	
7:22 AM	Unit 1	5.82	26.95	on
7:26 AM	Unit 2	5.76	26.94	off
7:29 AM	Unit 3	5.83	26.92	off
7:32 AM	Unit 4	5.81	26.92	on
7:35 AM	Unit 5	5.66	26.93	off
7:38 AM	Unit 6	5.74	26.67	off
7:41 AM	NPDES 001 sign	5.69	26.90	
7:46 AM	**At USGS gage**	**5.78**	**26.64**	
7:50 AM	DWNSTRM Plant	5.72	26.72	
8:27 AM	Unit 1	5.78	26.81	on
8:30 AM	Unit 2	5.80	26.87	off
8:33 AM	Unit 3	5.79	26.85	off
8:36 AM	Unit 4	5.85	26.85	on
8:38 AM	Unit 5	5.80	26.86	off
8:40 AM	Unit 6	5.76	26.83	off
8:42 AM	NPDES 001 sign	5.78	26.84	
8:46 AM	**At USGS gage**	**5.71**	**26.75**	
8:50 AM	DWNSTRM Plant	5.80	26.80	
9:00 AM	Unit 1	5.65	26.82	on
				*no gates spilling

Time	Jenkinsville 02160991	Parr Res. Level 02160990	Parr Crest Gate	**USGS DO data at Jenkinsville**	USGS Temp data at Jenkinsville
6:00 AM	221.07	259.38	all @ 266	**5.6**	26.9
7:00 AM	221.05	259.44		**5.7**	26.8
8:00 AM	221.06	259.43		**5.7**	26.8
9:00 AM				**5.7**	26.8

APPENDIX B

Parr/Fairfield Relicensing Dissolved Oxygen Study 2014

Date: 9/16/14

Samplers: Milton Quattlebaum

Time	Location	DO (mg/L)	Temp (^{o}C)	Units Running
6:01 AM	Unit 1	5.13	26.99	off
6:04 AM	Unit 2	5.37	26.73	off
6:07 AM	Unit 3	5.36	27.06	off
6:09 AM	Unit 4	5.25	27.06	on
6:12 AM	Unit 5	4.95	27.01	off
6:15 AM	Unit 6	4.97	26.96	off
6:18 AM	NPDES 001 sign	4.95	26.84	
6:22 AM	**At USGS gage**	**4.94**	**26.81**	
6:26 AM	DWNSTRM Plant	4.87	26.77	
7:03 AM	Unit 1	5.16	26.99	off
7:05 AM	Unit 2	5.20	26.96	off
7:08 AM	Unit 3	5.34	26.98	off
7:11 AM	Unit 4	5.10	26.99	on
7:13 AM	Unit 5	5.00	26.92	off
7:16 AM	Unit 6	4.97	26.93	off
7:19 AM	NPDES 001 sign	4.81	26.85	
7:24 AM	**At USGS gage**	**4.98**	**26.80**	
7:30 AM	DWNSTRM Plant	4.95	26.83	
8:02 AM	Unit 1	5.18	26.91	off
8:05 AM	Unit 2	5.15	26.92	off
8:08 AM	Unit 3	5.30	26.88	off
8:11 AM	Unit 4	5.24	26.93	on
8:13 AM	Unit 5	4.99	26.93	off
8:15 AM	Unit 6	4.96	26.91	off
8:18 AM	NPDES 001 sign	5.04	26.80	
8:24 AM	**At USGS gage**	**4.92**	**26.87**	
8:28 AM	DWNSTRM Plant	5.12	26.67	
8:39 AM	Unit 1	5.26	26.89	

Time	Jenkinsville 02160991	Parr Res. Level 02160990	Parr Crest Gate	**USGS DO data at Jenkinsville**	USGS Temp data at Jenkinsville
6:00 AM	220.54	259.57	1, 2, 9, 10 @266	**5.0**	26.9
7:00 AM	220.54	259.73	3, 4, 5, 6, 7, 8@262	**5.0**	26.8
8:00 AM	221.44	259.81		**5.0**	26.9
9:00 AM				**5.0**	26.8

Parr/Fairfield Relicensing Dissolved Oxygen Study 2014

Date: 9/25/14

Samplers: Milton Quattlebaum

Time	Location	DO (mg/L)	Temp (°C)	Units Running
6:09	Unit 1	7.80	21.40	off
6:11	Unit 2	7.76	21.42	off
6:15	Unit 3	7.81	21.44	on
6:17	Unit 4	7.85	20.90	on
6:21	Unit 5	7.70	21.39	off
6:24	Unit 6	7.65	21.42	off
6:27	NPDES 001 sign	7.66	21.43	
6:33	**At USGS gage**	**7.10**	**21.40**	
6:40	DWNSTRM Plant	7.61	21.36	
7:17	Unit 1	7.69	21.68	off
7:19	Unit 2	7.71	21.67	off
7:21	Unit 3	7.80	21.67	on
7:23	Unit 4	7.70	21.61	on
7:25	Unit 5	7.58	21.57	off
7:27	Unit 6	7.62	21.62	off
7:29	NPDES 001 sign	7.60	21.62	
7:34	**At USGS gage**	**7.65**	**21.61**	
7:39	DWNSTRM Plant	7.31	21.59	
8:13	Unit 1	7.67	21.75	off
8:15	Unit 2	7.65	21.72	off
8:17	Unit 3	7.71	21.75	on
8:19	Unit 4	7.66	21.62	on
8:21	Unit 5	7.65	21.51	off
8:23	Unit 6	7.58	21.59	off
8:25	NPDES 001 sign	7.63	21.60	
8:29	**At USGS gage**	**7.62**	**21.42**	
8:34	DWNSTRM Plant	7.59	21.47	
8:39	Unit 1	7.68	21.65	off
				*no gates spilling

Time	Jenkinsville 02160991	Parr Res. Level 02160990	Parr Crest Gate	**USGS DO data at Jenkinsville**	USGS Temp data at Jenkinsville
6:00 AM	221.06	259.18	all @ 266	**7.3**	21.5
7:00 AM	221.05	259.2		**7.3**	21.5
8:00 AM	221.05	259.24		**7.3**	21.5
9:00 AM				**7.3**	21.5

Appendix B

2015 Turbine Venting Test Results

Parr Aeration Investigation – July 2015

SCE&G initially performed turbine venting testing at the Parr Shoals Development during 2014. Based on the initial success of that testing for periodically increasing dissolved oxygen (DO) levels in the tailrace, SCE&G performed additional turbine venting testing on July 9, 2015. The results of this testing will be used to develop a Turbine Venting Plan for the Parr Shoals Development and submitted as part of the 401 Water Quality Certification application process for the Parr Hydroelectric Project.

During each test run, water quality measurements (DO, temperature, and % DO saturation) were recorded with handheld meters in the tailrace outflow of each unit being tested. Units 1, 2, 3, 5 and 6 were available for testing. Unit 4 was under repair and could not be tested. Unit 6 does not have a vacuum breaker installed on the headcover and cannot be vented, but was tested to determine its aerating capability. During testing all river flow was passed through the turbine units and the crest gates were in the closed (raised) position. The headpond and tailwater elevations were also recorded, as were individual generator kW and kVar outputs (Table 1).

At the beginning of each turbine test, tailrace readings were collected with the unit running and the vacuum breaker closed. After approximately 5 to 10 minutes, the vacuum breaker valve was fully opened to allow aeration. The effects of the introduced air were clearly visible in the tailrace for each unit tested. The unit was allowed to run for another 5 to 10 minutes until tailrace readings stabilized before data was recorded. Each unit was tested in sequence using this same scenario. Unit 6 data was collected to see the DO levels that occurred on that unit with no venting available. Surprisingly, Unit 6 DO levels were fairly high without venting which may be an artifact of its location near the shoreline. Unit 6 may pull water from closer to the surface than the other units located further away from the shoreline.

Discussion

Each of the units 1, 2, 3, and 5 tested will aerate with their current valve configurations and each increased DO levels at a different amounts. Testing showed that the units vent from highest to lowest as follows: 3, 1, 5, 2, 4, and 6. SCE&G will use this information to develop a Turbine Venting Plan for the Parr Shoals Development that will be submitted to South Carolina Department of Health and Environmental Control for discussion and approval.

Table B-1. Summary of Turbine Venting at Parr Shoals Dam July 9, 2015.

Unit Tested	Vent Open/Close	DO (mg/L)	DO Increase (mg/L)	Saturation %	Saturation Increase %	Temp (F)	Gate Setting %	Output (KW)	KVars
1	Close	4.65	------	59.8	------	82.9	45	1473	150
1	Open	5.04	0.39	64.3	4.5	83.0	45	1426	145
2	Close	4.60	------	58.8	------	82.9	43	1520	144
2	Open	4.80	0.20	61.2	2.4	82.9	43	1475	144
3	Close	4.70	------	60.0	------	82.9	45	1370	153
3	Open	5.15	0.45	65.2	5.2	82.9	45	1300	142
5	Close	4.84	------	62.4	------	82.9	45	1560	154
5	Open	5.20	0.36	65.6	3.2	82.9	45	1476	150
6	No Vent	5.10	------	65.2	------	83.0	39	1426	145

Unit 4 was not available for testing

Unit 6 does not have a vent

Headwater elevation remained stable between 258.1 – 257.9 msl during the test

Tailwater Elevation remained stable between 221.0 – 220.8 msl during the test

ROCKY SHOALS SPIDER LILY REPORT

PARR HYDROELECTRIC PROJECT
FERC PROJECT NO. 1894

Prepared for:

South Carolina Electric & Gas Company
Cayce, South Carolina

Prepared by:

Kleinschmidt

Lexington, South Carolina
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November 2015

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1.0 INTRODUCTION

The Parr Hydroelectric Project (FERC No. 1894) (Project), owned and operated by South Carolina Electric & Gas Company (SCE&G), is seeking a new license from the Federal Energy Regulatory Commission (FERC), as their current license is set to expire on June 30, 2020. The Parr Hydroelectric Project consists of two developments, Parr Shoals and Fairfield Pumped Storage, and is located on the Broad River in Fairfield and Newberry counties, South Carolina.

As part of relicensing, SCE&G has established a Rare, Threatened & Endangered Species Technical Working Committee (TWC) to address potential Project-related issues involving species that are of conservation concern. The TWC includes representatives from the U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), South Carolina Department of Health and Environmental Control (SCDHEC) and South Carolina Department of Natural Resources (SCDNR), among others. During issues scoping, the TWC identified the rocky shoals spider lily (*Hymenocallis coronaria*) as occurring in the Broad River downstream of the Parr Shoals Dam (Parr Dam) and requested a survey to document its occurrence in the area of Project influence. Accordingly, the objective of this study was to assess the number and spatial distribution of RSSL occurring in the study area of the Broad River extending from Parr Dam through Frost Shoals, near Boatwright Island (Figure 1-1).

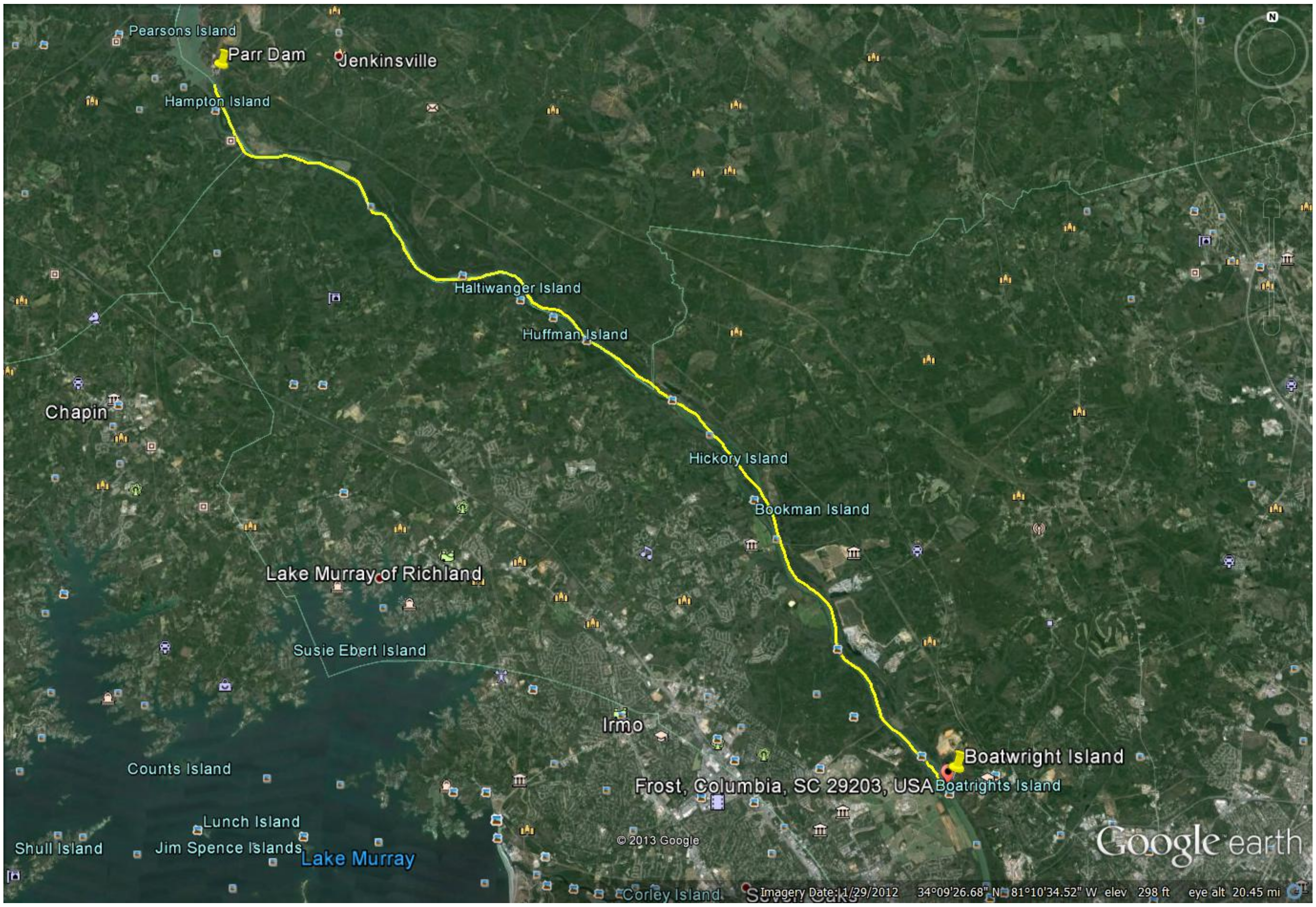


FIGURE 1-1 ROCKY SHOALS SPIDER LILY SURVEY REACH

1.1 RELEVANT LIFE HISTORY INFORMATION

Rocky shoals spider lily (RSSL), also referred to as Cahaba lily, is an aquatic perennial limited to large streams and rivers at or above the fall line in Georgia, South Carolina and Alabama (Davenport 1996). It is typically found on bedrock outcroppings or in large cobble or boulder substrates, which provide anchor points for the RSSL's roots and bulbs (Patrick et al. 1995). RSSL grows best in direct sunlight, with constantly flowing water, relatively low sediment loads, and water depths (to bulb) of 4 to 12 inches (Aulbach-Smith 1998). Blooming for this species occurs annually from late-April through mid-June, during which it is easily identified by it large white flowers (Photo 1-1). The decline of RSSL has historically been attributed to loss of shoals habitat due to construction of impoundments and other channel modifications (Davenport 1996).

While not state or federally listed as threatened or endangered, the RSSL is considered rare by the SCDNR and is among the species tracked by the agency's Heritage Trust Program (Julie Holling, SCDNR, Pers. Comm., April 14, 2014).

PHOTO 1-1 ROCKY SHOALS SPIDER LILY *HYMENOCALLIS CORONARIA* (A. CABE, 2004)

2.0 METHODS

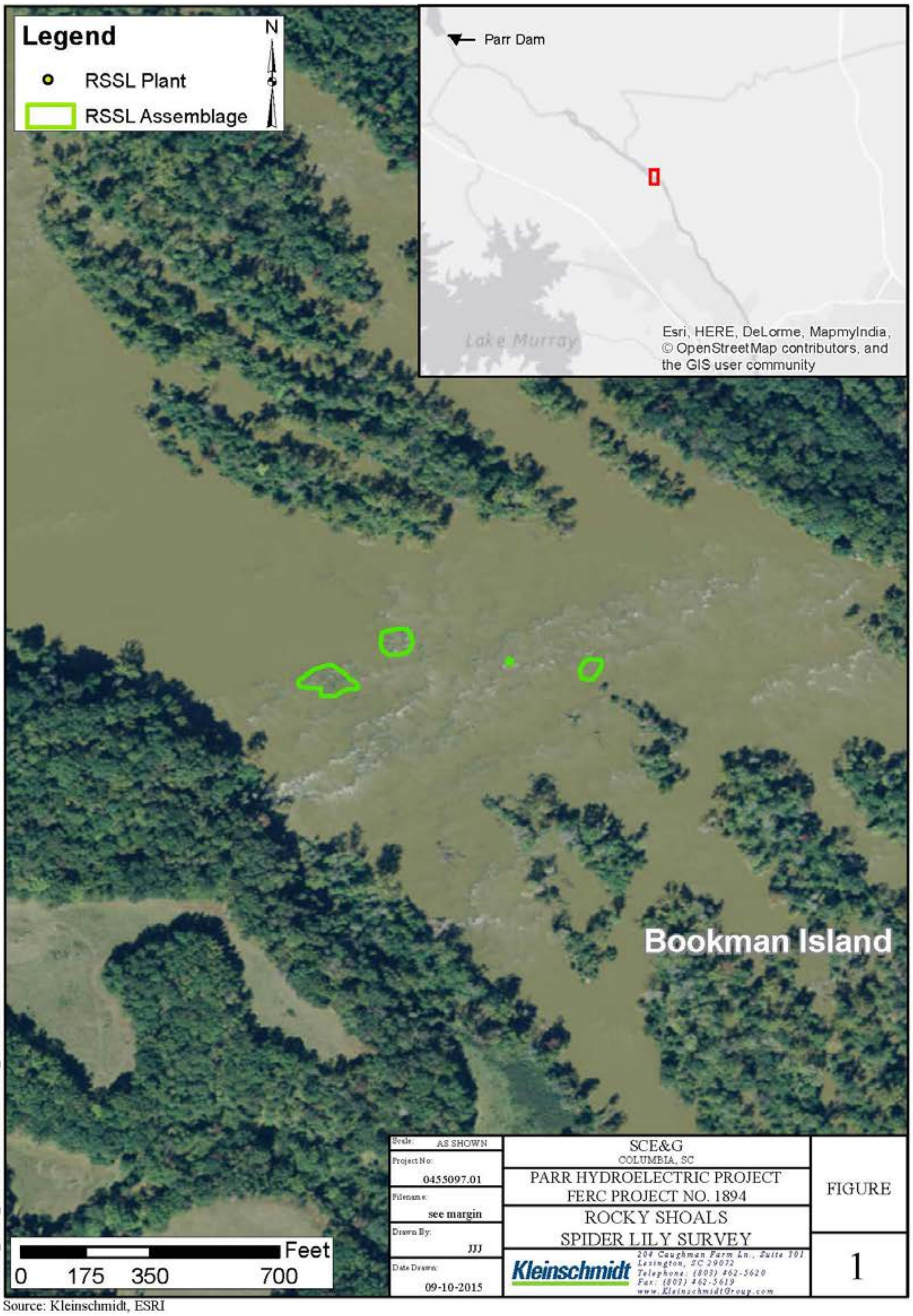
The entirety of the study area was surveyed via boat by two to three crews during the peak flowering season in 2015 (May 26-27). Each team was led by a Kleinschmidt scientist with experience in conducting RSSL surveys. Each RSSL encountered was documented using a handheld Global Positioning System (GPS) and photographed. Surveyors also recorded length and width of each plant or cluster (to allow for calculation of basal area) and noted whether plants were blooming and if there were any visible signs of herbivory. Based on the length and width measurement collected in the field, basal area was calculated using the formula:
$A = \pi (l/2 * w/2)$.

3.0 RESULTS AND DISCUSSION

A total of 81 RSSL plants or clumps of plants were documented during the survey. RSSL occurrences were limited to two primary areas: the Bookman Shoals complex and Frost Shoals, located just upstream of Boatwright Island (Figure 1-1). The majority of RSSL documented within the Bookman Shoals complex were located along a large bedrock ledge just upstream of Hickory Island, approximately 13 miles downstream of Parr Shoals Dam (Figure 3-1; Photo 3-1). Scattered additional RSSL were located in the braided channels downstream of the primary ledge in the Bookman Shoals complex (Figure 3-2). At Frost Shoals, RSSL occurrence was limited to the bedrock ledge located approximately 300 ft upstream of Boatwright Island and approximately 20 miles downstream of Parr Shoals Dam (Figure 3-3; Photo 3-2). RSSL occurrences ranged from single plants to assemblages of several hundred plants, and accordingly, basal area ranged from 0.05 m^2 to more than 20,000 m^2 within the study area (Table 3-1 and Table 3-2). Herbivory was noted at only 2 clusters observed during the survey. Plants were documented at water depths ranging from zero to 30 inches. Essentially all of the plants observed were extremely vigorous, with 96% (78 of 81) in full bloom at the time of the survey.

PHOTO 3-1 ROCKY SHOALS SPIDER LILY ASSEMBLAGE AT BOOKMAN SHOALS

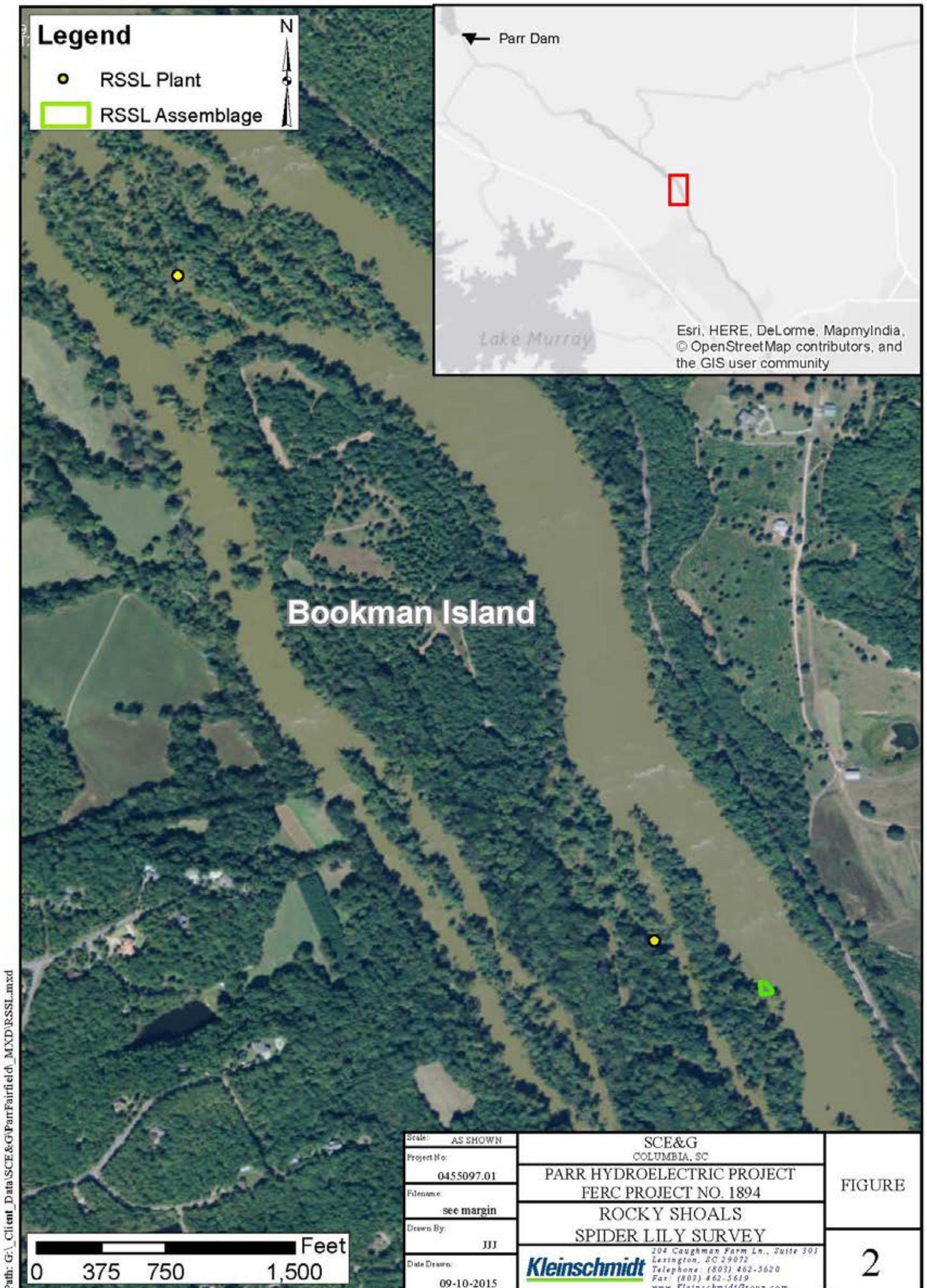
PHOTO 3-2 LARGE ROCKY SHOALS SPIDER LILY ASSEMBLAGE AT FROST SHOALS



Path: G:_Client_Data\SCE&G\ParrFairfield_MXD\RSSL.mxd

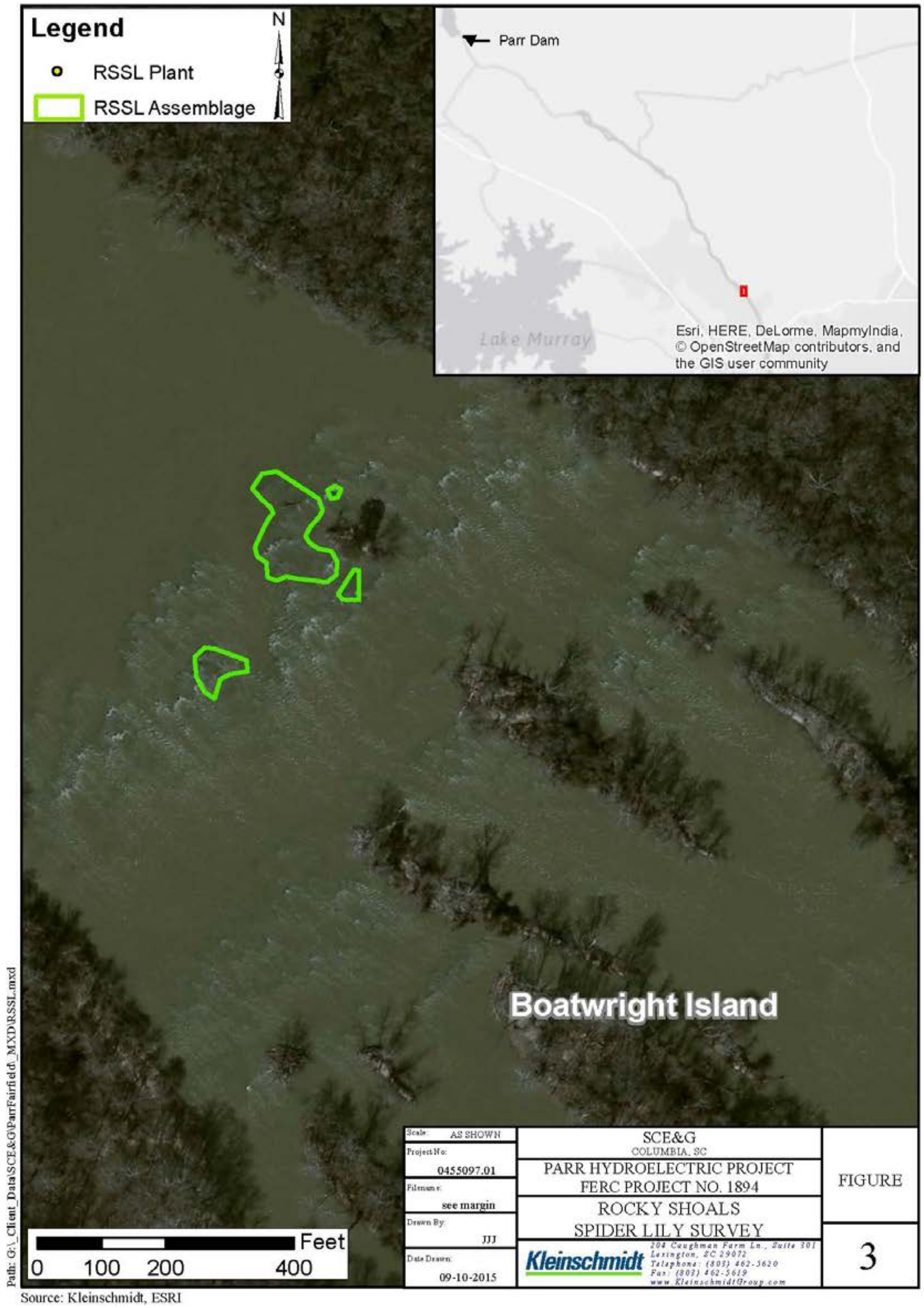
Source: Kleinschmidt, ESRI

FIGURE 3-1 ROCKY SHOALS SPIDER LILIES – UPPER BOOKMAN SHOALS



Source: Kleinschmidt, ESRI

FIGURE 3-2 ROCKY SHOALS SPIDER LILIES – LOWER BOOKMAN SHOALS



Source: Kleinschmidt, ESRI

FIGURE 3-1 ROCKY SHOALS SPIDER LILIES – BOATWRIGHT ISLAND

TABLE 3-1 ROCKY SHOALS SPIDER LILY DATA – BOOKMAN SHOALS

ID	Length (cm)	Width (cm)	Basal Area (m^2)	Blooming (y/n)	Herbivory (y/n)	Water Depth (cm)
T1-1	68.58	27.94	15.05	y	y	5.1
T1-2	162.56	119.38	15.24	y	n	25.4
T1-3	81.28	81.28	51.88	y	n	30.5
T1-4	129.54	129.54	131.79	y	n	17.8
T1-5	121.92	96.52	92.42	y	n	27.9
T1-6	15.24	22.86	2.73	y	n	15.2
T1-7	111.76	45.72	40.13	y	n	22.9
T1-8	205.74	114.30	184.69	y	n	7.6
T1-9	68.58	66.04	35.57	y	n	5.1
T1-10	20574	91.44	147.75	y	n	12.7
T1-11	83.82	55.88	36.78	y	n	5.1
T1-12	165.10	111.76	144.91	y	n	12.7
T1-13	368.30	271.78	786.15	y	n	33.0
T1-14	33.02	33.02	8.56	y	n	33.0
T1-15	27.94	30.48	6.68	y	n	22.9
T1-16	304.80	129.54	310.10	y	n	35.6
T1-17	58.42	35.56	16.31	y	n	33.0
T1-18	30.48	38.10	9.12	y	n	27.9
T1-19	35.56	33.02	9.22	y	n	17.8
T1-20	200.66	144.78	228.17	y	n	15.2
T1-21	312.42	360.68	885.01	y	n	15.2
T1-22	114.30	121.92	109.44	y	n	22.9
T2-1	33.02	60.96	15.80	y	n	0.0
T2-2	58.42	15.24	6.99	y	n	0.0
T2-3	86.36	60.96	41.34	y	n	3.8
T2-4	96.52	66.04	50.06	y	n	12.7
T2-5	25.40	20.32	4.05	y	n	20.3
T2-6	78.74	66.04	40.84	y	n	10.2
T2-7	45.72	30.48	10.94	y	n	10.2
T2-8	10.16	7.62	60.80	n	n	2.5
T2-9	2.54	2.54	0.05	n	n	2.5
T2-10	53.34	38.10	15.96	y	n	76.2
T2-11	10.16	15.24	1.22	y	n	0.0
T2-12	43.18	38.10	12.92	y	n	0.0
T3-1	172.72	401.32	544.41	y	n	10.2
T3-2	157.48	350.52	433.54	y	n	20.3
T3-3	281.94	127.00	281.22	y	n	10.2
T3-3b	261.62	106.68	219.20	y	n	10.2
T3-4	116.84	109.22	100.23	y	n	15.2
T3-5	50.80	93.98	37.50	y	n	25.4
T3-6	284.48	264.16	590.21	y	n	35.6
T3-7	914.40	350.52	2517.32	y	n	0.0
T3-8	574.04	396.24	1786.45	y	n	0.0
T3-9	25.40	10.16	2.03	y	n	7.6
T3-9b	15.24	5.08	0.61	y	n	10.2
T3-10	35.56	10.16	2.84	y	n	2.5
T3-11	60.96	335.28	160.52	y	n	2.5
T3-12	213.36	662.94	1110.91	y	n	7.6

TABLE 3-2 ROCKY SHOALS SPIDER LILY DATA – BOATWRIGHT ISLAND

ID	Length (cm)	Width (cm)	Basal Area (m^2)	Blooming (y/n)	Herbivory (y/n)	Water Depth (cm)
T1-23	81.28	73.66	47.02	y	n	43.2
T1-24	93.98	91.44	67.49	y	n	17.8
T1-25	27.94	25.40	5.57	y	n	27.9
T1-26	149.86	421.64	496.27	y	n	15.2
T1-27	292.10	279.40	640.98	y	n	30.5
T1-28	35.56	22.86	6.38	y	n	35.6
T1-29	99.06	111.76	86.95	y	n	35.6
T1-30	269.24	167.64	354.49	y	n	30.5
T1-31	2377.44	1082.04	20204.25	y	n	22.9
T2-20	22.86	20.32	3.65	y	n	3.8
T2-21	48.26	17.78	6.74	y	n	5.1
T2-22	25.40	27.94	5.57	y	n	15.2
T2-23	81.28	81.28	51.89	y	n	25.4
T2-24	109.22	111.76	95.87	y	n	22.9
T2-25	586.74	215.90	994.92	y	n	15.2
T2-26	104.14	66.04	54.02	y	n	5.1
T2-27	104.14	86.36	70.64	y	n	25.4
T2-29	299.72	151.13	22624.89	y	n	12.7
T2-30	114.30	101.60	355.76	y	n	45.7
T2-31	63.50	53.34	91.21	y	n	30.5
T2-32	20.32	17.78	26.60	n	n	40.6
T2-33	55.88	60.96	2.84	y	n	12.7
T3-14	731.52	271.78	26.75	y	n	38.1
T3-15	1097.28	762.00	1561.47	y	n	25.4
T3-16	50.80	38.10	6566.93	y	n	33.0
T3-17	187.96	116.84	15.20	y	n	30.5
T3-18	121.92	101.60	172.48	y	n	43.2
T3-19	304.80	200.66	97.29	y	n	25.4
T3-20	1371.60	967.74	480.36	y	n	22.9
T3-21	53.34	60.96	10425.00	y	n	15.2
T3-22	325.12	127.00	25.54	y	n	10.2
T3-23	213.36	40.64	324.29	y	n	0.0
T3-24	86.36	50.80	68.10	y	n	7.6

4.0 REFERENCES

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PARR HYDROELECTRIC PROJECT

FERC NO. 1894

RARE, THREATENED AND ENDANGERED SPECIES DESKTOP ASSESSMENT

Prepared for:

South Carolina Electric & Gas Company
Cayce, South Carolina

Prepared by:

Kleinschmidt

Lexington, South Carolina
www.KleinschmidtGroup.com

December 2015
Revised March 2016

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RARE, THREATENED AND ENDANGERED SPECIES DESKTOP ASSESSMENT
SOUTH CAROLINA ELECTRIC & GAS COMPANY

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RARE, THREATENED AND ENDANGERED SPECIES DESKTOP ASSESSMENT
SOUTH CAROLINA ELECTRIC & GAS COMPANY

1.0 INTRODUCTION

The Parr Hydroelectric Project (Project) (FERC No. 1894) is located along the Broad River in Newberry and Fairfield counties, South Carolina and is owned and operated by South Carolina Electric & Gas Company (SCE&G). The Project consists of two developments, including the Parr Shoals Development and the Fairfield Pumped Storage Development. The Project location is depicted in Figure 2-1.

In preparation for relicensing, SCE&G consulted with local, state and Federal agencies and other interested stakeholders to identify potential impacts of Project operations on natural resources. A Rare, Threatened and Endangered Species Technical Working Committee ("RT&E TWC" or "TWC") was formed and is comprised of representatives from the United States Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), South Carolina Department of Natural Resources (SCDNR), South Carolina Department of Health and Environmental Control (SCDHEC), non-governmental organizations (NGOs), SCANA/SCE&G and other interested individuals. In addition to several field surveys for selected species, the TWC agreed upon a literature-based assessment to summarize the status of federally and state listed rare, threatened and endangered species (RT&E) occurring in the Parr Hydroelectric Project vicinity. As outlined in the RT&E Species Study Plan (Appendix A), the objective of this assessment was to identify those species potentially occurring in the Project vicinity, which includes habitats within the Project Boundary and in the downstream reach of the Broad River that is influenced by the Project (Richland County), based on review of occurrence data and habitat requirements. We also note that site-specific surveys are being conducted for American eel and Broad River spiny crayfish, and as such, only life history information is included for these species.

2.0 CONSULTATION HISTORY

During initial consultation, the USFWS provided county-level listings of RT&E species occurring in the two county regions surrounding the Project (Fairfield and Newberry counties; Appendix B). At the May 16, 2013 RT&E TWC meeting, the TWC discussed several species that should be addressed during relicensing (meeting notes are in Appendix C). SCDNR requested that the TWC add eight species to this analysis that are not state or federally-listed, but are considered state conservation priority species (Table 4-3). Based on a review of the initial draft of this report, two additional mussel species that are not state or federally listed but are state conservation priority species (yellow lampmussel and Roanoke slabshell) were also added to this analysis (Table 4-3). The TWC agreed that SCE&G would conduct a literature-based review to determine habitat requirements for each of these species and compare those requirements with typical habitat types known to occur in the study area for this report.

The RT&E TWC met again on October 22, 2013 to discuss the Rare, Threatened and Endangered Species Desktop Assessment Study Plan (study plan in Appendix A; meeting notes in Appendix C). At this meeting, the TWC agreed to extend the study area to include areas of the Broad River downstream of the Project Boundary. More specifically, they agreed that the study area would include habitats within the Project Boundary (Project Area) (Figure 2-1), as well as the reach of the Broad River from Parr Shoals Dam through Frost Shoals, near Boatwright Island (Figure 2-2). This area encompasses three counties in South Carolina: Newberry, Fairfield and Richland counties.

In addition, the USFWS revised their initial species list and included several Federal At-Risk species and several species of “Birds of Conservation Concern” for the southeast region (email dated August 24, 2015). We reviewed this list and updated this analysis to include all of the species requested by the USFWS.

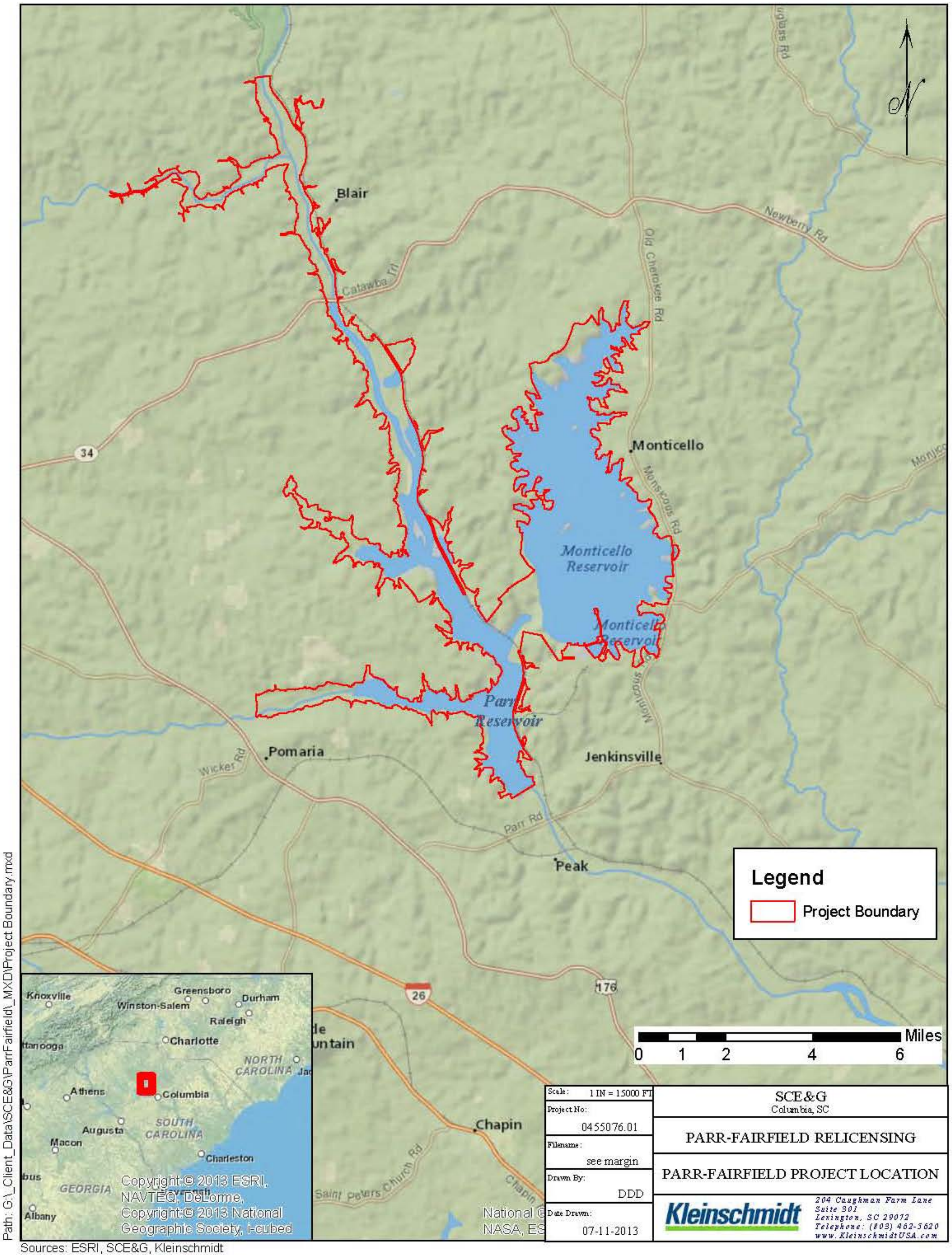
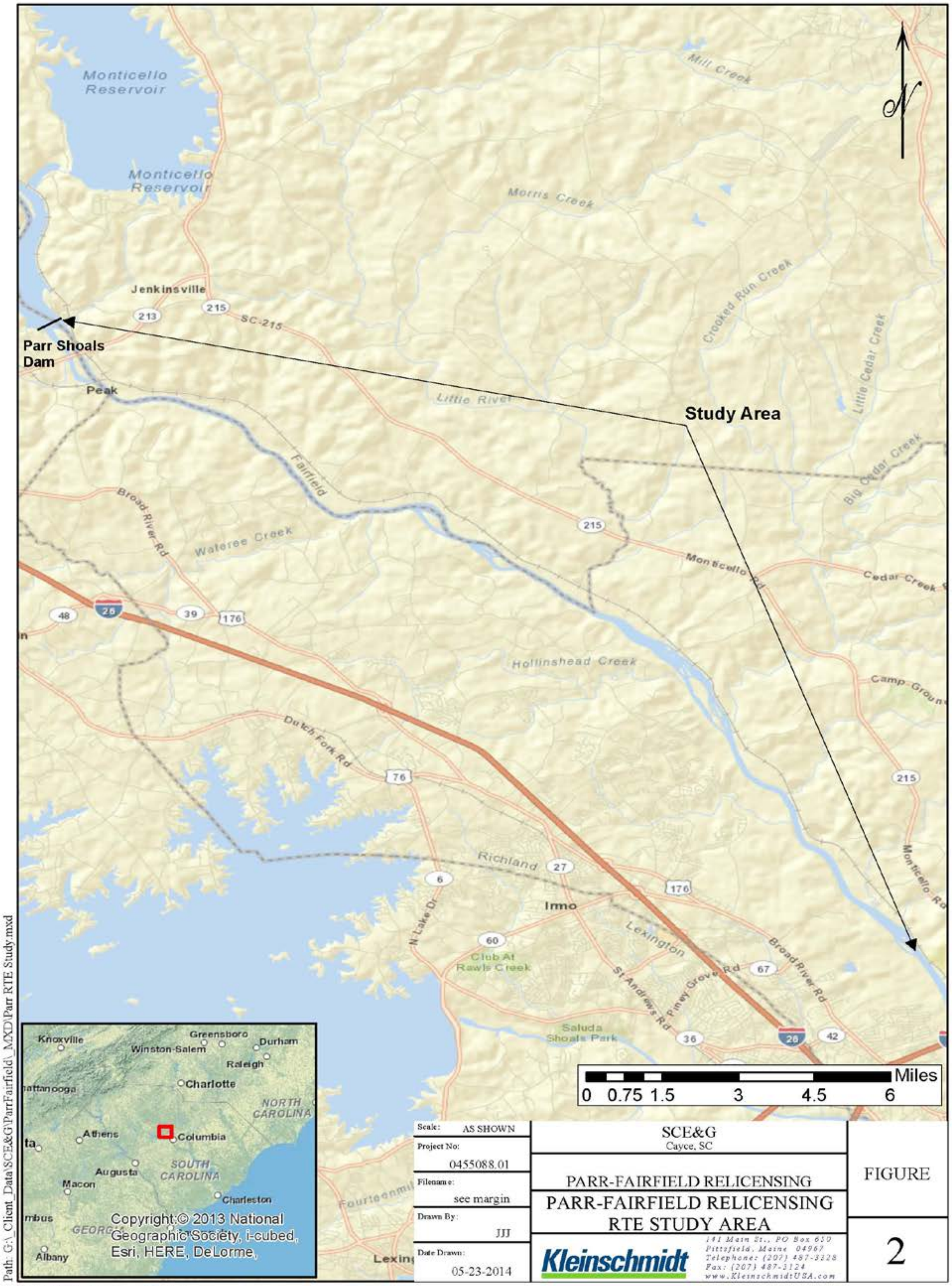


FIGURE 2-1 PARR HYDROELECTRIC PROJECT LOCATION MAP



Source: ESRI, Kleinschmidt

FIGURE 2-2 DOWNSTREAM RT&E STUDY AREA

3.0 METHODOLOGY

As an initial step, the USFWS county-level listings for Newberry, Fairfield and Richland counties were reviewed to identify species potentially occurring in the study area that are federally listed as threatened or endangered under the US Endangered Species Act of 1972 (ESA), or are candidates for such listing. Additionally, at the request of USFWS, county-level listings for Newberry, Fairfield and Richland counties were reviewed to identify species potentially occurring in the study area that are considered at-risk species. USFWS also requested that a number of birds that are included on the 2008 Birds of Conservation Concern list be included for review. SCDNR county-level listings for the three counties were also reviewed to identify species that are state listed under the South Carolina Nongame and Endangered Species Conservation Act of 1974. Bald eagle, which was removed from the federal endangered species list in 2007, was included in the assessment because of its continued protection under the Bald and Golden Eagle Protection Act of 1938. As previously noted, ten species that are considered priority species in the SCDNR's State Wildlife Action Plan (SCDNR 2015), and are documented as occurring in the three counties of interest, were also added to the analysis (Table 4-3). Known ranges, life history and habitat requirements for each of these species were then summarized and compared to conditions occurring in the study area to determine the potential for occurrence and to identify potential Project effects.

4.0 SPECIES DESCRIPTIONS AND ANALYSIS

4.1 FEDERALLY LISTED SPECIES – THREATENED OR ENDANGERED

Ten species that are federally listed as threatened or endangered, or are candidates for such listing, are included on the USFWS county-level listings for the three counties of interest (Table 4-1). None of the federally listed species on Table 4-1 have critical habitat designated in the study area. Life history information and habitat requirements for these species, as well as their status within the study area and potential to be affected by continued operation of the Project, are summarized below.

TABLE 4-1 FEDERALLY LISTED AND CANDIDATE SPECIES OCCURRING IN RICHLAND, FAIRFIELD, AND NEWBERRY COUNTIES, SOUTH CAROLINA (SOURCE: USFWS 2013A)

COMMON NAME	SCIENTIFIC NAME	FEDERAL STATUS[1]	STATE STATUS[2]	COUNTIES
Birds				
Bald eagle	*Haliaeetus leucocephalus*	P	T	Newberry, Fairfield, Richland
Red-cockaded woodpecker	*Picoides borealis*	E	E	Richland
Wood stork	*Mycteria americana*	T	E	Newberry, Richland
Fish				
Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	E	E	Richland
Shortnose sturgeon	*Acipenser brevirostrum*	E	E	Richland
Mammals				
Northern long-eared bat	*Myotis septentrionalis*	T		
Invertebrates				
Carolina heelsplitter	*Lasmigona decorata*	E		Newberry, Fairfield, Richland
Plants				
Canby's dropwort	*Oxypolis canbyi*	E		Richland
Rough-leaved loosestrife	*Lysimachia asperulaefolia*	E		Richland
Smooth coneflower	*Echinacea laevigata*	E		Richland

[1] Federal Status – E (listed as Endangered under ESA); T (listed as Threatened under ESA); C (Candidate for Federal listing); SC (Federal Species of Concern); P (Federally protected).

[2] State Status – E (state listed as endangered); T (state listed as threatened)

4.1.1 BALD EAGLE

The bald eagle was removed from the federal list of threatened species in 2007 (USFWS 2007a) but remains protected as a state endangered species under the South Carolina Nongame and Endangered Species Conservation Act, and federally under the Bald and Golden Eagle Protection Act and Migratory Bird Treaty Act (16 U.S.C.668-668d) (72 FR 37345-37372). Bald eagles are found throughout North America, typically around water bodies, where they feed primarily on fish and carrion. Studies suggest that reservoirs, especially those associated with hydroelectric facilities, are particularly attractive to foraging bald eagles (Brown 1996). Eagles nest in large trees near water and typically repair and use the same nest for several years, (Degraaf and Rudis 1986). In South Carolina, the distribution of eagle nesting has expanded from the coast to encompass more inland areas. This expansion has been attributed to the construction of approximately 491,000 acres of large reservoirs in the state since the early 1900s (Wilde et al. 2003). In South Carolina, the number of estimated nesting pairs has increased from 13 in 1977 to 181 in 2003 (Wilde et al. 2003).

Status in the Study Area

Bald eagles are commonly observed in the study area (SCE&G 2010), with Monticello and Parr reservoirs, as well as the lower Broad River, providing abundant foraging habitat.

Determination of Effect

Continued operation of the Project is not likely to result in negative effects on eagle foraging or nesting. SCE&G tracks bald eagle nesting in the Project Area and utilizes this information to minimize potential impacts of various shoreline management activities on eagle nests. Specifically, SCE&G refrains from issuing shoreline permits for activities within 660 ft of an active nest during the nesting season (September through May) and 330 ft during the non-nesting season. This policy is in adherence to the USFWS habitat guidelines for nesting bald eagles (USFWS 2007b). SCE&G also frequently consults with USFWS Ecological Services staff regarding proposed activities in the vicinity of known nests.

4.1.2 RED-COCKADED WOODPECKER

The red-cockaded woodpecker (RCW) is endemic to open, mature, and old growth pine ecosystems in the southeastern United States (USFWS 2003). Over 97% of the pre-colonial era RCW population has been eradicated, leaving only roughly 14,000 RCWs living in about 5,600 colonies scattered across eleven states, including South Carolina. RCW decline is generally attributed to a loss of suitable nesting and foraging habitats, including longleaf pine systems, due to logging, agriculture, fire suppression, and other factors (USFWS 2003). Suitable nesting habitat generally consists of open pine forests and savannahs with large, older pines and minimal hardwood midstory or overstory. Living trees, especially older trees that are susceptible to red-heart disease making them more easily excavated, provide the RCWs preferred nesting cavities. Suitable foraging habitat consists of open-canopy, mature pine forests with low densities of small pines, little midstory vegetation, limited hardwood overstory, and abundant bunchgrass and forb groundcover (USFWS 2003).

Status in the Study Area

There are no known reports of RCWs in areas surrounding the Project or along the lower Broad River. Further, there is no known longleaf pine savanna habitat in the study area.

Determination of Effect

Based on the lack of suitable habitat, it is very unlikely that this species occurs in the study area and thus would not be affected by continued operation of the Project.

4.1.3 WOOD STORK

The wood stork is a large, colonial wading bird and is the only stork species that breeds in the United States (USFWS 1996). It was federally listed as endangered in 1984, primarily due to loss of wetland habitat throughout its range, but recently its status has been changed from endangered to threatened due to significant population recovery (USFWS 2012b). It uses a variety of wetlands for nesting, feeding, and roosting. Nesting colonies (rookeries) in South Carolina are typically surrounded by extensive palustrine forested wetlands. Nests are usually located in the upper branches of large black gum or cypress trees, and several nests are typically located in each tree. Like most wading birds, storks feed primarily on small fish. Shallow, open water is required for successful foraging, and depressions where fish become concentrated during periods of falling water levels are particularly attractive sites. Currently, nesting of the species in the United States is thought to be limited to the coastal plain of South Carolina, North Carolina, Georgia, and Florida (Murphy and Hand 2013), which is consistent with recent survey work that found no nesting on the adjacent Saluda Hydroelectric Project (Kleinschmidt 2005).

Status in the Study Area

Periodic foraging of wood storks has been documented in the adjacent Saluda River Basin (Kleinschmidt 2005). Shallow backwaters in the study area, particularly in the upper reaches of the Parr Reservoir, may provide foraging habitat for transient wood storks. Although habitat is present, wood stork use of these areas has not been documented.

Determination of Effect

Project operations are expected to result in no effects on wood storks or their habitat. In fact, fluctuating water levels in Parr Reservoir could enhance foraging habitat by periodically trapping fish in shallow pool areas.

4.1.4 ATLANTIC STURGEON

The Atlantic sturgeon is a large (up to 5.5m in length), long-lived (up to 60 years) anadromous species that was historically present in the Santee Basin at least as far inland as the fall line (Newcomb and Fuller 2001). The Carolina Distinct Population Segment of Atlantic sturgeon, which includes the Santee Basin population, is federally listed as endangered (77 FR 5914), primarily due to overharvesting for flesh and eggs (caviar) during the early to mid-20th Century, as well as habitat degradation and blockage of access to historical spawning grounds (NMFS1998a).

The Atlantic sturgeon is considered estuarine anadromous, spending most of it life in estuarine and ocean environments and undertaking spawning migrations into riverine systems during late-winter and spring months (NMFS 1998a; Marcy et al. 2005). Spawning typically occurs over hard bottoms of clay, rubble, or gravel, with flowing water and temperatures of 14 - 24°C. After spawning, females typically return to estuarine environments within 4 to 6 weeks, while males may remain in the river through the fall. Juveniles of this species remain in the natal rivers for three to five years before migrating to the ocean (Marcy et al. 2005).

Status in the Study Area

Atlantic sturgeon were historically present at least as far inland as the fall line (Newcomb and Fuller 2001). Current upstream distribution in the Santee Basin is thought to be limited by the lack of passage for Atlantic sturgeon at the Santee Cooper Dams[1]. This information indicates that this species does not occur in the Project study area.

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species due to a likely lack of occurrence in the study area.

4.1.5 SHORTNOSE STURGEON

The shortnose sturgeon is federally listed as endangered and is thought to have occurred historically in the reach of the Broad River encompassed by the Project (Welch 2000, Newcomb and Fuller 2001). Shortnose sturgeon are amphidromous (semi-anadromous) spending portions of their life cycle in low salinity estuaries and portions in freshwater rivers (NMFS 1998b; Kynard 1997; Buckley and Kynard 1985). Shortnose sturgeon begin migrating to spawning areas of inland riverine reaches in the spring (typically mid-February through March in South Carolina) when water temperatures rise above 9 °C (Kynard 1997, Hall et al. 1991). Shortnose sturgeon spawning has been documented in the Congaree River near the City of Columbia over substrates of sand, gravel and rock, at temperatures ranging from 9.7-15.6°C, and dissolved oxygen concentrations of 10.6-12.5 mg/L (Collins et al. 2003).

[1] Bill Post (SCDNR), personal communication, April 24, 2014.

Status in the Study Area

Population groups of shortnose sturgeon are known from downstream of the Santee-Cooper dams in the lower Santee and Cooper rivers (Collins et al. 2003). An additional dam-locked spawning population of shortnose sturgeon has been documented in the Santee-Cooper lakes (with Lake Marion and its tributaries harboring the most significant number of fish) and upstream in the Congaree River. Radio-telemetry studies have documented migration of shortnose sturgeon as far upstream on the Congaree as the Blossom Street Bridge adjacent to the City of Columbia (Finney et al. 2006). However, consultation with SCDNR Diadromous Fish Program staff suggests that this occurrence was based on a small number of observations (2 fish) and that their radiotelemetry data suggest that shortnose sturgeon activity is primarily limited to areas downstream of Granby Lock and Dam[2]. Granby Lock and Dam is located approximately one mile downstream of the Blossom Street Bridge and approximately five miles downstream of the Columbia Hydroelectric Project Fishway (fishway). The fishway was designed to provide passage of blueback herring and American shad to historic spawning grounds in the Broad River downstream of Parr Shoals Dam and was intended to be “sturgeon friendly”. Shortnose sturgeon have not been documented upstream of the Blossom Street Bridge in recent history, nor have any been documented passing into the study area through the fishway since annual monitoring began in 2007. In August of 2015, the Water Quality, Fish, and Wildlife Resource Conservation Group (RCG) identified that peaking flows from the Project could impact spawning habitat for shortnose sturgeon downstream in the Congaree River. SCE&G is examining this issue and will include those results in the Determination of Effect for this species prior to filing the Final License Application.

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species within the study area due to a likely lack of occurrence. It should be noted, however, that SCE&G is currently performing a study to determine if peaking flows from the Project influence a documented shortnose sturgeon spawning area downstream of the study area in the Congaree

[2] Bill Post (SCDNR), personal communication, April 24, 2014.

River. As previously noted, this Determination of Effect will be updated prior to issuance of the Final License Application, pending results of the aforementioned study.

4.1.6 NORTHERN LONG-EARED BAT

The northern long-eared bat is a species federally listed as threatened (USFWS 2015b). The full range of this species spans much of the eastern and north central United States as well as the majority of Canada. The main cause of their population decline is disease; specifically white-nose syndrome (USFWS 2015b). White-nose syndrome has spread rapidly since its first occurrence throughout the northeastern and midwestern United States.

Northern long-eared bats exhibit “delayed fertilization,” in which the female stores the male’s sperm after mating through the hibernation period (USFWS 2015b). In spring, after hibernation has ended, the stored sperm fertilizes a female’s egg. The females migrate south and roost in small communities of 30 to 60 bats (USFWS 2015b). The northern long-eared bat gives birth to one pup that is able to fly 18 to 21 days after birth. This bat hibernates in the winter in humid caves with a constant air temperature and spends summers roosting in trees and snags (USFWS 2015b). Males and non-reproductive females may roost in cooler areas such as caves.

Status in the Study Area

As of April 2015, the USFWS lists the following South Carolina counties within the range of the Northern long-eared bat: Laurens, Anderson, Pickens, Greenville, Spartanburg, Oconee, Abbeville, Cherokee, Union, and York (USFWS 2015b). Currently, the species is not known to occur within the study area, although there is the possibility it could migrate further down in the state.

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species due to a likely lack of occurrence in the study area. If northern long-nose bat does occur, but has not been documented, its presence would likely be limited to the hibernation period. There are no known hibernation caves located within the Project Boundary and SCE&G does not plan to alter the shoreline classifications to accommodate extensive development.

4.1.7 CAROLINA HEELSPLITTER

The Carolina heelsplitter is the only South Carolina freshwater mussel currently listed as federally endangered (Price 2006). Although it was once found in large rivers and streams, the Carolina heelsplitter is now restricted to cool, clean, shallow, heavily shaded streams of moderate gradient. Stable streambanks and channels, with pool, riffle and run sequences, little or no fine sediment, and periodic natural flooding, appear to be required for the Carolina heelsplitter.

Status in the Study Area

Carolina heelsplitter is known to occur in isolated populations distributed in the Savannah, Pee Dee, and Catawba drainages and is not known to occur in the Broad River Basin (Price 2006) or within the study area.

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species due to a likely lack of occurrence in the study area.

4.1.8 CANBY'S DROPWORT

Canby's dropwort is a perennial plant that grows in coastal plain habitats including wet meadows, wet pineland savannas, ditches, sloughs, and around the edges of cypress-pine ponds (USFWS 2010). The healthiest populations seem to occur in open bays or ponds, which are wet most of the year and have little or no canopy cover. Ideal soils for Canby's dropwort have a medium to high organic content and a high water table. They are also acidic, deep, and poorly drained.

Status in the Study Area

Canby's dropwort is a coastal plain species and thus would not be expected to occur in the portion of Richland County occupied by the study area. This assumption is consistent with result of surveys by Nelson (2006, 2007), which failed to document the species on the adjacent V.C. Summer Nuclear Station site.

Determination of Effect

Because Canby's dropwort is not expected to occur in the study area, continued operation of the Project would likely result in no effect on the species.

4.1.9 ROUGH-LEAF LOOSESTRIFE

Rough-leaf loosestrife generally occurs in the ecotones or edges between longleaf pine uplands and pond pine pocosins (areas of dense shrub and vine growth usually on a wet, peaty, poorly drained soil), on moist to seasonally saturated sands, and on shallow organic soils overlaying sand (NatureServe 2013). Rough-leaf loosestrife has also been found on deep peat in the low shrub community of large Carolina bays (shallow, elliptical, poorly drained depressions of unknown origin). The grass-shrub ecotone, where rough-leaf loosestrife is found, is fire-maintained, as are the adjacent plant communities (longleaf pine-scrub oak, savanna, flatwoods, and pocosin). Suppression of naturally occurring fire in these ecotones, results in shrubs increasing in density and height and expanding to eliminate the open edges required by this plant.

Status in the Study Area

The pine pocosin and Carolina bay environments required by this species do not occur in the Piedmont; therefore, rough-leaf loosestrife is extremely unlikely to occur in the study area.

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species due to a likely lack of occurrence in the study area.

4.1.10 Smooth Coneflower

Smooth coneflower is typically found in open woods, cedar barrens, roadsides, clearcuts, dry limestone bluffs, and power line rights-of-way, usually on magnesium and calcium rich soils associated with amphibolite, dolomite or limestone (in Virginia), gabbro (in North Carolina and Virginia), diabase (in North Carolina and South Carolina), and marble (in South Carolina and Georgia) (USFWS 2012a). Smooth coneflower occurs in plant communities that have been described as xeric hardpan forests, diabase glades, or dolomite woodlands. Optimal sites are characterized by abundant sunlight and little competition in the herbaceous layer. Natural fires, as well as large herbivores, historically influenced the vegetation in this species' range. Many of the herbs associated with smooth coneflower are also sun-loving species that depend on periodic disturbances to reduce the shade and competition of woody plants.

Status in the Study Area

The diabase glade habitat required by this species is not known to occur in areas around Monticello and Parr reservoirs or along the lower Broad River. Although no site-specific surveys have been performed, surveys by Nelson (2006, 2007) failed to document smooth coneflower on the adjacent V. C. Summer Nuclear Station Project area and concluded that appropriate habitat for the species does not occur on the site.

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species due to a likely lack of occurrence in the study area.

4.2 Federally Listed Species – At-Risk Species

The USFWS lists an additional seventeen species as At-Risk Species for the three counties of interest (Table 4-2). Only life history information is included in this section for Broad River spiny crayfish and the American eel, since site-specific surveys are being performed. Rafinesque’s big-eared bat is not discussed in this section, as it is also a South Carolina state-listed species, and is discussed under section 4.3. The Newberry burrowing crayfish and the robust redhorse are state conservation priority species, and are discussed under section 4.4. Life history information and habitat requirements for the twelve remaining species, as well as their status within the study area and potential to be affected by continued operation of the Project, are summarized below.

TABLE 4-2 FEDERALLY LISTED AT-RISK SPECIES OCCURRING IN RICHLAND, FAIRFIELD, AND NEWBERRY COUNTIES, SOUTH CAROLINA

COMMON NAME	SCIENTIFIC NAME	COUNTIES
Amphibians		
Chamberlain's dwarf salamander	*Eurycea chamberlaini*	Richland
Crustaceans		
Broad River spiny crayfish	*Cambarus spicatus*	Fairfield, Richland
Newberry burrowing crayfish	*Distocambarus youngineri*	Newberry
Fish		
American eel	*Anguilla rostrata*	Newberry, Fairfield, Richland
Blueback herring	*Alosa aestivalis*	Newberry, Fairfield, Richland
Robust redhorse	*Moxostoma robustum*	Richland
Mammals		
Rafinesque's big-eared bat	*Corynorthinus rafinesquii*	Richland
Tri-colored bat	*Perimyotis subflavus*	Newberry, Fairfield, Richland
Mollusks		
Savannah lilliput	*Toxolasma pullus*	Newberry, Richland
Plants		
Bog spicebush	*Lindera subcoriacea*	Richland
Ciliate-leaf tickseed	*Coreopsis integrifolia*	Richland
Georgia aster	*Symphyotrichum georgianus*	Fairfield, Richland
Purple balduina	*Balduina atropurpurea*	Richland
Sandhills lily	*Lilium pyrophilum*	Richland
Spathulate seedbox	*Ludwigia spathulata*	Richland
Wire-leaved dropseed	*Sporobolus teretifolius*	Richland
Reptiles		
Southern hognose snake	*Heterdon simus*	Richland

4.2.1 CHAMBERLAIN'S DWARF SALAMANDER

Chamberlain's dwarf salamander is a distinct species similar to the more common dwarf salamander. Chamberlain's dwarf salamander varies from the more common species by being lighter in color, with a yellow underside that is void of markings. This species is very small, averaging approximately 2.5 cm in total length (SCDNR 2015).

Chamberlain’s dwarf salamander deposits eggs in aquatic habitats and has aquatic larvae that inhabit wetlands until metamorphosis. It is usually found in wet areas, such as seepages near small streams and wetlands, under leaf litter and small debris (SCDNR 2015).

Status in the Study Area

Although Chamberlain’s dwarf salamander is known to exist in Barnwell, Allendale and Pickens counties in South Carolina, little data exists on the population status of the species (SCDNR 2015). The full range of the species is not completely known.

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species due to a likely lack of occurrence in the study area and because no significant changes are proposed for Project operations. Wetland and stream areas will not negatively change under continued Project operations.

4.2.2 BROAD RIVER SPINY CRAYFISH

The Broad River spiny crayfish distribution is thought to be limited to lotic environments in the Broad River drainage (Eversole 1990). Although collections are limited, Broad River spiny crayfish have been found in association with leaf litter and other organic debris located along stream banks, primarily over unstable sandy substrates that lack rooted aquatic vegetation. In the Project Vicinity, this species has been collected in the Little River, a tributary to the Broad River, in Fairfield County (Eversole 1990).

4.2.3 AMERICAN EEL

The American eel, *Anguilla rostrata*, is a catadromous species known to occur within river systems in South Carolina. Mature American eels spawn in the ocean and the egg and pre-larval stages mature into the leptocephalus stage, where they drift with ocean currents for approximately a year before metamorphosing into the glass eel stage. Glass eels migrate across the continental shelf, eventually entering estuaries and tidal rivers, where they mature into elvers. Elvers migrate primarily at night and are able to overcome obstacles that often times prevent passage of other aquatic species. Vertical obstacles, such as a dam, can be traversed by small eels as long as the surface of the structure is textured and remains wet. As the small eels continue to mature into yellow eels, they may gradually move upstream over many years, with the greatest movement occurring during the moderate water temperatures of spring and fall (ASMFC 2000).

Although the American eel currently does not have special status under state or federal regulations, it has been identified by the South Carolina Department of Natural Resources (SCDNR) as a priority species (SCDNR 2005). The federal status of this species has been further reviewed by the U.S. Fish and Wildlife Service and National Marine Fisheries Service several times over the past decade and the species is considered "at risk". American eel are also listed as a target species in the Columbia Fishway Prescription. Currently, an area potentially conductive to eel passage exists along the west corner of the Columbia Dam.

4.2.4 BLUEBACK HERRING

The blueback herring is a diadromous fish that ranges along the Atlantic Coast from Nova Scotia to Florida. It can be found in the Atlantic Ocean as well as coastal rivers and streams (SCDNR 2013). As a diadromous fish, the blueback herring spends its adult life at sea and migrates up freshwater rivers and streams to spawn. Spawning area spans the tidal zone to as far upstream as 100 miles (SCDNR 2013).

During spawning the female releases as many as 250,000 eggs in shoreline areas of hard substrate (SCDNR 2013). The eggs are then fertilized by the male. After the spawning season of April and May, adult blueback herring return to the ocean. Freshly hatched blueback herring remain in the rivers for several months before moving to sea (SCDNR 2013).

Status in the Study Area

Blueback herring are known to occur in watersheds throughout South Carolina, including the Santee River Basin, where the Project is located. Currently, blueback herring do not occur in the Project Vicinity, however the construction of the Columbia Hydroelectric Project Fishway, completed in 2006, allows for the possibility of this species to occur in the Project Vicinity within the term of the new license.

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species due to a likely lack of occurrence in the study area. If blueback herring begin to use the Columbia Fishway to move upstream during the new Project license, SCE&G and USFWS will likely consult to determine potential impacts to the species.

4.2.5 TRI-COLORED BAT

The tri-colored bat is very small and exhibits delayed fertilization. In the spring, the female fertilizes an egg with stored sperm and gives birth in the fall to twins (NatureServe 2015l). The pups are able to fly within a month and remain with the mother for another week for foraging. Once young tri-colored bats learn how to forage for insects they leave their mothers and are independent (NatureServe 2015l).

This bat ranges throughout most of the eastern United States, southeastern Canada, and into eastern Mexico and Central America (NatureServe 2015l). Most tri-colored bats roost in trees during the summer and hibernate in cave, mines, and rock crevices during the winter (NatureServe 2015l).

Status in the Study Area

The tri-colored bat is considered common in South Carolina, and is found statewide (SCDNR 2015).

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species due to a likely lack of occurrence in the study area and because SCE&G does not plan to significantly change the Project shoreline uses. There are no known hibernation caves located within the Study Area and SCE&G does not plan to alter the shoreline classifications to accommodate extensive development.

4.2.6 SAVANNAH LILLIPUT

The Savannah lilliput, a freshwater mussel, is a long-term brooder, brooding in August with hybrid bluegill suitable as fish hosts (NatureServe 2015o). The Savannah lilliput tends to inhabit shallow water, usually at the edges of very shallow streams, rivers and lakes, and backwaters. This mussel is rarely found in deeper lake waters and tends to be found in mud or silty sand (NatureServe 2015o). It will move up and down as water levels fluctuate.

Historical records show the species living in the Ocmulgee and Altamaha Rivers in Georgia, Savannah River in South Carolina, Catawba River and Beaver Creek in North Carolina, Wateree River in South Carolina, University Lake (Cape Fear River system) in North Carolina, and Neuse River in North Carolina (NatureServe 2015o). Savannah lilliput is known to occur in Allendale, Calhoun, Clarendon, Orangeburg, and Saluda counties, South Carolina (NatureServe 2015o).

Status in the Study Area

Savannah lilliput has been found in the Saluda River Basin, in Lake Greenwood and in Cloud's Creek, and in the Savannah River. It has also been documented in the lower Congaree River, the upper Santee River, and upper Lake Marion (SCDNR 2015). The species has not been documented as occurring in the Broad River, or in Parr and Monticello reservoirs.

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species due to a likely lack of occurrence in the study area.

4.2.7 BOG SPICEBUSH

The bog spicebush is a recently described multi-stemmed deciduous shrub that can grow up to 4 meters tall (USFS 2015). Tiny yellow-green flowers are produced in clusters of three to four during mid-March and small bright red fruits mature during late summer. Plants are often clonal and spread by suckering (USFS 2015).

Bog spicebush occurs throughout the southeast Coastal Plain, from southeastern Virginia through the sandhills of the Carolinas; to Georgia, the Florida Panhandle, and south Alabama; and in south Mississippi and southeastern Louisiana (NatureServe 2015j). The plant inhabits permanently moist to wet, shrub-dominated seepage wetlands, open, quaking bogs in pinelands, shrub thickets of seepages, typically near the heads of streams and along the banks of small braided streams. It is usually not found outside of the wettest portions of rare sphagnous bog habitats, on very acidic soils that are high in organic matter and permanently saturated (NatureServe 2015j).

Status in the Study Area

Bog spicebush has been documented in Aiken, Barnwell, Lexington, and Richland counties, although it may currently be extirpated in Richland County (NatureServe 2015j).

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species due to a likely lack of occurrence in the study area and because SCE&G does not plan to significantly change Project operations or the Project shoreline uses. Currently wetland areas would stay in their current condition and any individuals would continue to exist there.

4.2.8 CILIATE-LEAF TICKSEED

The ciliate-leaf tickseed is a perennial herb with bright yellow ray flowers surrounding a purple-red disk (NatureServe 2015e). Blooming typically occurs from August through November, but occasionally occurs as early as July. Habitat for ciliate-leaf tickseed is generally described as forested wetlands (NatureServe 2015e). This species can be found along streambanks and floodplains of blackwater streams; edges of swamp forests bordering longleaf pinelands or bordering brackish marshes; moist sand banks and low flat floodplains of rivers and creeks; low, heavily wooded bluffs above rivers; wooded edge of parking area for boat ramp and edge of creek, surrounded by floodplain forest; in wet loam of shaded, roadside depressions; in moist, semi-shaded sandy loam along edge of mesic woods; and along forestry road adjacent to bottomland (NatureServe 2015e). Ciliate-leaf tickseed occurs from southeastern South Carolina south to the Panhandle of Florida.

Status in the Study Area

Historically, ciliate-leaf tickseed has been reported in only three counties in southeastern South Carolina, including Berkeley, Charleston and Horry counties (NatureServe 2015e).

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species due to a likely lack of habitat in the study area for this species. SCE&G does not plan to significantly change Project operations or the Project shoreline uses, so any current wetland areas would remain in their current condition and provide marginal habitat for this species.

4.2.9 GEORGIA ASTER

Georgia aster habitat consists of dry, rocky woodlands, woodland borders, roadbanks, and powerline rights-of-way (Weakley 2012). It is thought to be a relict species of the post oak-savanna communities that existed in the southeast prior to fire suppression.

Status in the Study Area

Although no site-specific occurrence data are available for the study area, Nelson (2006, 2007) found no Georgia aster on the adjacent V.C. Summer Nuclear Station but concluded that suitable habitat exists on the site. Georgia aster is also known from several locations on the nearby Sumter National Forest (USDA 2010).

Determination of Effect

Habitat for Georgia aster may exist within the Project study area; however, potential occurrences would be limited to terrestrial sites, which should not be affected by continued operation of the Project.

4.2.10 PURPLE BALDUINA

Purple balduina is an autumn-blooming perennial herb with yellow ray flowers surrounding a dark purple disk (NatureServe 2015c). Habitat for the species is classified as spring brook, forested wetland, herbaceous wetland, scrub/shrub wetland, forest/woodland, savanna, and woodland-conifer. The plant is often associated with longleaf pine or slash pine and is found in wet pine flatwoods, savannahs, peaty hillside seepage bogs, and pitcherplant bogs (NatureServe 2015c).

Purple balduina is distributed in southeastern and southcentral Georgia and northeast Florida. It has also historically been found in southeast North Carolina and northcentral South Carolina (NatureServe 2015c).

Status in the Study Area

Purple balduina is listed as occurring in Richland County, South Carolina.

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species due to a likely lack of occurrence in the study area. Further, SCE&G does not plan to significantly change Project operations or the Project shoreline uses. Wetland areas would stay in their current condition and any individuals would continue to exist there.

4.2.11 SANDHILLS LILY

Sandhills lily is a perennial herb with showy, pendant flowers that range in color from yellow to orange to dusky red and spotted with magenta (NatureServe 2015i). This plant flowers late July through mid-August and capsules mature in October. Habitat is almost exclusively restricted to narrow transition zones between dry longleaf pine uplands and wet, wooded creeks and streamheads (NatureServe 2015i). It can also occur on herb and shrub-dominated side slopes and floodplains in streamhead and small depression pocosins, sandhill seeps, Coastal Plain small stream swamps, and wet, maintained rights-of-way (NatureServe 2015i).

Sandhills lily ranges in distribution from southeastern Virginia to southcentral South Carolina, with most populations occurring in the Sandhills region on the interior Coastal Plain of southeastern North Carolina (NatureServe 2015i).

Status in the Study Area

Sandhills lily is known to occur in Chesterfield County, and possibly Richland County, in South Carolina (NatureServe 2015i). This species has not been documented within the Study Area.

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species due to a likely lack of occurrence in the study area and because SCE&G does not plan to significantly change Project operations or the Project shoreline uses.

4.2.12 SPATHULATE SEEDBOX

Spathulate seedbox is a perennial herb with soft-hairy herbage and prostrate, creeping stems that often intermingle, forming extensive mats (NatureServe 2015k). Small flowers, which lack true petals, emerge and last from June through October. This species is most likely self-pollinating and spreads vegetatively by rooting from the nodes of stems. Habitat includes bogs, forested wetlands, herbaceous wetlands, and riparian areas (NatureServe 2015k). Spathulate seedbox is often found along exposed shores and bottoms of sinkhole ponds, bogs and depression meadows. This species occurs in Georgia, Florida, Alabama, and South Carolina (NatureServe 2015k).

Status in the Study Area

Within South Carolina, this species is known to occur within Aiken, Barnwell, Lexington, Richland, and Saluda counties (NatureServe 2015k). There is a possibility this plant could occur downstream of Parr Shoals Dam, in Richland county.

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species due to a likely lack of occurrence in the study area and because SCE&G does not plan to significantly change Project operations or the Project shoreline uses. Wetland areas would stay in their current condition and any individuals would continue to exist there.

4.2.13 Wire-Leaved Dropseed

The wire-leaved dropseed is a densely tufted perennial grass that flowers from July through September (NatureServe 2015n). Habitat types include bog, forested wetland, herbaceous wetland, forest-conifer, forest/woodland, and savanna. Wire-leaved dropseed occurs in southeastern North Carolina and northeastern South Carolina, south to southern Georgia, and west to extreme southeastern Alabama (NatureServe 2015n).

Status in the Study Area

The species occurs in six counties in South Carolina, including Horry, Georgetown, Lexington, Kershaw, Richland and Chesterfield (NatureServe 2015n).

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species due to a likely lack of occurrence in the study area and because SCE&G does not plan to significantly change Project operations or the Project shoreline uses.

4.2.14 Southern Hognose Snake

Southern hognose snake is stocky with dark blotches and a sharply upturned snout (NatureServe 2015g). Females mature at two-three years and lay clutches of six-ten eggs. Some individuals have been known to live well into their second decade, and generation length is approximately five to ten years. Southern hognose snake inhabits open, dry habitats, with well-drained, sandy, or sandy-loam soils, such as those occurring at sand ridges, stabilized coastal sand dunes, pine flatwoods, mixed oak-pine woodlands and forests, scrub oak woods, old fields and river floodplains (NatureServe 2015g). This snake spends a majority of its time burrowed in the soil.

Southern hognose snake occurs on the Coastal Plain from eastern North Carolina to southern Florida, west to southeastern Mississippi (NatureServe 2015g).

Status in the Study Area

The southern hognose snake occurs in many counties throughout South Carolina, including Richland County, downstream of the Project (NatureServe 2015g).

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species even though it likely occurs in the study area. SCE&G does not plan to significantly change Project operations or the Project shoreline uses, therefore the current habitats of the Project should not change significantly.

4.3 STATE LISTED SPECIES

Three species that are state-listed as threatened or endangered are included on the SCDNR county-level listings for the three counties of interest (Table 4-3). Life history information and habitat requirements for these species, as well as their status within the study area and potential to be affected by continued operation of the Project, are summarized below.

TABLE 4-3 STATE-LISTED SPECIES OCCURRING IN RICHLAND, FAIRFIELD, AND NEWBERRY COUNTIES, SOUTH CAROLINA

COMMON NAME	*SCIENTIFIC NAME*	FEDERAL STATUS[1]	STATE STATUS[2]	COUNTIES
Amphibians				
Pine Barrens tree frog	*Hyla andersonii*		T	Richland
Mammals				
Rafinesque's big-eared bat	*Corynorhinus rafinesquii*	ARS	E	Richland
Fish				
Carolina darter	*Etheostoma collis*	SC	T	Fairfield, Richland

[1] Federal Status – E (listed as Endangered under ESA); T (listed as Threatened under ESA); C (Candidate for Federal listing); SC (Federal Species of Concern); P (Federally protected); ARS (At-risk species).
[2] State Status – E (state listed as endangered); T (state listed as threatened).

4.3.1 Pine Barrens Tree Frog

The pine barrens tree frog inhabits the swamps, bogs, and acidic brownwater streams of the New Jersey Pine Barrens, as well as the pocosins (shrub bogs) of the Carolinas (Conant and Collins 1991). This species is intolerant of closed-canopy conditions and is restricted to localized wetlands such as hillside seepage bogs within dry uplands, pine barrens, and headwater swamps and disperses along drainages within these areas (NatureServe 2013). Non-breeding habitat generally is in pine-oak areas adjacent to breeding habitat. Important egg-laying and larval habitats include open cedar swamps and sphagnaceous, shrubby, acidic, seepage bogs on hillsides below pine-oak ridges.

For southeastern populations, typical habitats are characterized by the topography, soils, and vegetation of the Carolina Sandhills, with pocosin or evergreen shrub swamps established along seeps and small streams within the surrounding longleaf pine-oak forest. Breeding habitat in South Carolina has been described as low vegetation with dense growth of Sphagnum mosses. Cely and Sorrow (1983) found that occurrences in South Carolina appeared to be restricted to the Fall Line Sandhills at elevations ranging between 61 and 122 m.

Status in Study Area

The area surrounding the Project lacks the Carolina sandhills habitat and associated bogs and pocosins required by this species; therefore it is extremely unlikely that Pine Barren tree frog would occur in the study area.

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species due to a likely lack of occurrence in the study area.

4.3.2 Rafinesque's Big-eared Bat

Rafinesque's big-eared bat is a colonial bat species native to the southeastern U.S. Two subspecies are recognized in South Carolina, *Corynorhinus rafinesquii rafinesquii* in the mountains and *Corynorhinus rafinesquii macrotis* along the Coastal Plain (Bunch et al. 2006).

Rafinesque’s big-eared bat is nocturnal, feeding primarily on moths by echolocation. Coastal plain and sandhills populations of the species utilize I-beam and T-beam bridges for roosting. Roosting in mountainous regions of the state occurs in large hollow trees (typically large tulip poplars), abandoned buildings and mines, rock shelters, and caves. Habitat in the Blue Ridge Mountains includes rock outcrops, mesic and cove hardwood forests, forested bottomlands, bottomland agricultural fields, dry deciduous forests, pine woodlands, and forested riparian areas. Coastal zone and sandhills habitats include black gum stands, bald cypress swap forests, maritime forests, and mature hardwood and mixed forests (Bunch et al. 2006).

Status in the Study Area

The range of Rafinesque’s big-eared bat in South Carolina includes the coastal plain and sandhills regions and the extreme northwestern Blue Ridge, with the piedmont representing a gap in the species’ distribution (Bunch et al. 2006). As such, it is extremely unlikely that this species would occur in the study area.

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species due to a likely lack of occurrence in the study area and because it is a terrestrial species. SCE&G does not propose to make major changes to shoreline classifications or encourage development within the Project.

4.3.3 CAROLINA DARTER

The Carolina darter exists only in the Piedmont region from south-central Virginia through North Carolina into north-central South Carolina (Hayes and Bettinger 2006); it is state-listed as threatened and a federal species of concern. It occurs in small to moderately sized streams in areas of low current velocity, typically in backwaters among submerged tree roots or under leaves, where it feeds primarily on Chironomid larvae and micro-crustaceans. Preferred substrates are usually characterized by mud, sand, and sometimes bedrock (Rohde et al. 2009).

Status in the Study Area

The Carolina darter has been collected at several locations in the lower Broad River, including one that appears to be a tributary to Parr Reservoir (Rohde et al. 2009). However, extensive sampling by SCE&G and SCDNR in both Parr and Monticello reservoirs and in the downstream reach have failed to document this species (Kleinschmidt 2013a), suggesting that it may not occur in the study area or occurs in extremely low numbers not detected by previous sampling.

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species due to a likely lack of occurrence in the study area.

4.4 SELECTED SOUTH CAROLINA CONSERVATION PRIORITY SPECIES

As previously noted, ten species that are considered state conservation priority species were also added to the analysis based on consultation with SCDNR and USFWS staff (Table 4-4). Life history information and habitat requirements for these species, as well as their status within the Project Vicinity and potential to be affected by continued operation of the Project, are summarized below.

TABLE 4-4 SELECTED STATE CONSERVATION PRIORITY SPECIES

COMMON NAME	SCIENTIFIC NAME	STATE PRIORITY LEVEL[1]	FEDERAL STATUS[2]
Newberry burrowing crayfish	*Distocambarus youngineri*	Highest	ARS
Robust redhorse	*Moxostoma robustum*	Highest	ARS
Piedmont darter	*Percina crassa*	High	
Seagreen darter	*Etheostoma thalassinum*	High	
Highfin carpsucker	*Carpiodes velifer*	Highest	
Quillback	*Carpiodes cyprinus*	High	
Santee chub	*Hybopsis zanema*	High	
Striped bass	*Morone saxatilis*	Moderate	
Yellow lampmussel	*Lampsilis cariosa*	Highest	
Roakoke slabshell	*Elliptio roanokensis*	High	

[1] Refers to conservation priority level as listed in SCDNR's State Wildlife Action Plan (SCDNR 2015).
[2] ARS – At-Risk-Species. Refers to species that the USFWS has been petitioned to list and for which a positive 90-day finding has been issued (listing may be warranted), yet no Federal protections currently exist.

4.4.1 NEWBERRY BURROWING CRAYFISH

The Newberry burrowing crayfish is a terrestrial crayfish of the genus *Distocambarus* and is endemic to South Carolina (Eversole and Welch 2006). Although knowledge of its habitat requirements is limited, Newberry burrowing crayfish has typically been found in poorly drained areas where the ground is saturated during the rainy season (November – March) (Eversole and Welch 2006; Hobbs and Carlson 1985). The species has been documented from a range of site types including low, moist woodlands, a machine-maintained powerline, and a manicured lawn. Sites are generally isolated from floodplains and streams, although some have been found in low moist areas near the headwaters of streams (colluvial valleys). Analyses performed by Welch and Eversole (2002) found a close association between occurrence of Newberry burrowing crayfish and the presence of a perched water-table, as well as presence of Chewacla, Worsham, Toccoa-Cartecay, Enon, and Sedgefield soil types (Eversole and Welch 2006).

Status in the Study Area

Currently, the Newberry burrowing crayfish is known from only 14 sites, all of which are located in Newberry County (Eversole and Welch 2006). The known range of the species encompasses portions of the Tyger, Enoree, Lower Broad, and Saluda River basins. Because this species is generally isolated from floodplains and streams, it is not expected to occur in the Project Area or in the downstream reach of the Broad River influenced by the Project.

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species due to a likely lack of occurrence in the study area.

4.4.2 ROBUST REDHORSE

The robust redhorse is a large, heavy-bodied sucker which was presumed extinct until being “rediscovered” during the initial stages of relicensing at Georgia Power’s Sinclair Hydroelectric Project (FERC No. 1951). Fisheries scientists knew little about its life history and habitat requirements. As a result, Georgia Power Company, along with state and federal resource agencies, other hydropower interests, and the Georgia Wildlife Federation, formed the Robust Redhorse Conservation Committee (RRCC) in 1995 to guide recovery efforts for the species in lieu of listing under the ESA. Subsequent research has produced valuable information about the robust redhorse and its habitat requirements. However, much research is still needed, as little is known about the habitat preferences of juvenile robust redhorse.

Based on recent studies, it appears that adult robust redhorse typically inhabit areas of the river where the current is moderately swift. Preferred habitat is riffle areas or in/near outside bends, where depths are greater and accumulations of logs and other woody debris are present (Evans 1997). Spawning typically occurs at water temperatures from 18 to 24° C, usually over gravel substrate in both deep and shallow water (Hendricks 1998).

Status in the Study Area

At this time, natural populations of robust redhorse are not known to exist in the Broad River (Lamprecht and Scott 2013). Stocking of fingerlings began in 2004 at sites both above and below the Parr Shoals Dam (Lamprecht and Scott 2013), and robust redhorse have since been documented in both Parr and Monticello reservoirs, as well as the reach of the Broad River downstream of Parr Shoals Dam (Table 4-5). In addition, robust redhorse use of the fishway at the Columbia Hydroelectric Project has been documented (Kleinschmidt 2009, 2010, 2012, 2013, 2014), suggested that robust redhorse from the Congaree and potentially other areas of the lower Santee Basin are utilizing habitat in the reach of the Broad downstream of Parr Shoals Dam during the spawning season.

Determination of Effect

Habitat for robust redhorse is potentially affected by Project flow releases and will be assessed as part of the proposed Instream Flow Incremental Methodology (IFIM) Study. Because it is listed as one of the key species for flow alterations, proposed changes to downstream flows should benefit the species.

4.4.3 Piedmont Darter

The piedmont darter is one of two species in the genus *Percina* found in South Carolina (Hayes and Bettinger 2006). It is typically found in cool to warm moderately-sized streams and rivers, usually in riffles with gravel or rock substrates (Rohde et al. 2009). Though a riffle dweller, this darter does not seem to favor extremely strong currents.

Status in the Study Area

The piedmont darter has been documented in the reach of the Broad River downstream of Parr Shoals Dam within the study area (Table 4-5).

Determination of Effect

Habitat for piedmont darter is potentially affected by Project flow releases and will be assessed as part of the proposed IFIM Study. This species is included in the IFIM analysis and proposed changes to downstream flows may benefit the species.

4.4.4 SEAGREEN DARTER

The seagreen darter is restricted to the Santee River drainage of the Carolinas (Hayes and Bettinger 2006). This species inhabits lower elevation tributaries in the mountain regions and is also found over a broad area of the upper piedmont in the Carolinas. It is less frequently found below the fall line in tributaries of the Congaree River. The seagreen darter favors a habitat of rock, rubble or gravel riffles in large creeks and rivers with moderate to swift currents, but has adapted to wide variations in temperature and water clarity.

Status in the Study Area

The seagreen darter has been documented in the reach of the Broad River downstream of Parr Shoals Dam within the study area (Table 4-5).

Determination of Effect

Habitat for seagreen darter is potentially affected by Project flow releases and will be assessed as part of the proposed IFIM Study. This species is included in the IFIM analysis and proposed changes to downstream flows may benefit the species.

4.4.5 HIGHFIN CARPSUCKER

The highfin carpsucker is distributed throughout the Lake Michigan drainage and Mississippi River Basin from Pennsylvania south to Louisiana (Self and Bettinger 2006). It also occurs on the Atlantic Slope from the Cape Fear River to Savannah River drainages and Gulf Slope drainages from Choctawhatchee River, Alabama and Florida to the Pearl River, Louisiana and Mississippi. The Atlantic Slope and Gulf Slope populations likely differ at the species level from those of the Mississippi and Lake Michigan drainages. In South Carolina, the highfin carpsucker occurs in the Broad and Congaree rivers in the upper Santee River Basin and the Savannah River. Historically the highfin carpsucker also occurred in the Pee Dee River; however, that population may have since been extirpated. The highfin carpsucker inhabits rivers in areas with moderate or swift current over sand or a gravel substrate (Rohde et al. 2009).

Highfin carpsucker population size and trends are not well known (Self and Bettinger 2006). There appear to be healthy populations with recruitment in the Broad River, Congaree River, and Savannah River. Preservation of populations in the Santee River is extremely important to the global preservation of the species given declining populations in the Cape Fear River and Pee Dee River (Self and Bettinger 2006).

Status in the Study Area

This species has been documented in both Parr Reservoir and the reach of the Broad River downstream of the Project (Table 4-5).

Determination of Effect

Habitat for highfin carpsucker is potentially affected by Project flow releases and will be assessed as part of IFIM Study. This species is included in the IFIM analysis and proposed changes to downstream flows may benefit the species.

4.4.6 QUILLBACK

The quillback is found in warm, low- to moderate-gradient reaches of most major rivers, including upper portions of associated reservoirs (Lamprecht and Bettinger 2006). Quillback occur over varied substrates in rivers, but seldom over mud. They tend to occupy calm water; however, quillback may shift to swifter and deeper depths during low water. Quillback reportedly spawn in riffles, calm stream reaches and in floodplain bayous, laying eggs on gravel, sand, mud and organic matter. Quillback feed on insect larvae and other benthic organisms.

The quillback is distributed from the Great Lakes region in the St. Lawrence River, Hudson Bay and Mississippi River basins from Quebec to Alberta, Canada; south to Louisiana and west to Wyoming in the United States (Lamprecht and Bettinger 2006). It also occurs on the Atlantic slope from the Delaware River, New York, to the Altamaha River, Georgia. In gulf slope drainages, it occurs from the Apalachicola River in Florida and Georgia to the Pearl River in Louisiana. The southern Atlantic slope populations in South Carolina are reported in the upper portions of the three major South Carolina drainages: the Pee Dee, Santee, and Savannah. Fish from these populations are likely distinct from those of the interior basin and gulf slope drainages (Lamprecht and Bettinger 2006).

Status in the Study Area

Quillbacks have been documented in both Parr and Monticello reservoirs, as well as the downstream reach of the Broad River (Table 4-5).

Determination of Effect

Habitat for quillback is potentially affected by Project flow releases and will be assessed as part of the proposed IFIM Study. This species is included in the IFIM analysis and proposed changes to downstream flows may benefit the species.

4.4.7 SANTEE CHUB

The Santee chub is restricted to the Santee River drainage within South Carolina, primarily in the piedmont and Blue Ridge foothills (Hayes and Bettinger 2006). A few populations of Santee chub found in the coastal plain represent an undescribed species known as the "thinlip" chub. Outside of South Carolina, "thinlip" chub is also found in the Cape Fear River drainage of North Carolina. The Santee chub inhabits small to medium sized streams with sand and rocky runs or current-swept pools. This species seems to be able to tolerate more turbid and warm waters than its close relative, the big-eye chub, *Hybopsis amblops*.

Status in the Study Area

Santee chub has been documented in the reach of the Broad River downstream of Parr Shoals Dam within the study area (Table 4-5).

Determination of Effect

Habitat for Santee chub is potentially affected by Project flow releases and will be assessed as part of the proposed IFIM Study. This species is included in the IFIM analysis and proposed changes to downstream flows may benefit the species.

4.4.8 STRIPED BASS

The striped bass is an anadromous species native to the Atlantic slope, with natural populations residing in saltwater and migrating to medium to large freshwater rivers annually to spawn. It has been widely introduced or has remnant populations in impounded river systems, with some systems, including the Santee River Basin, supporting naturally-reproducing, damlocked populations (Sessions et al. 2006). In freshwater, they prefer to occupy areas with clean sandy bottoms, fine gravel and rock. Adult striped bass have a thermal tolerance of six to 27° C, but seek temperatures between 18 to 25°C when available. During spawning, striped bass occupy shallow rocky and gravely areas with strong turbulent water flow. Striped bass eggs are semibouyant; they drift and sink slowly requiring moderate current to keep the eggs from settling to the bottom and dying before they are hatched in one to three days. Optimum water temperatures for successful striped bass egg hatching and survival is 17 to 18°C (Sessions et al. 2006).

Status in the Study Area

Striped bass are regularly observed passing through the Columbia Hydroelectric Project fishway into the reach of the Broad downstream of Parr Shoals Dam (Kleinschmidt 2009, 2010, 2011, 2012, 2013) and have been documented from the study area during electrofishing (Table 4-5).

Determination of Effect

Habitat for striped bass is potentially affected by Project flow releases and will be assessed as part of the proposed IFIM Study. This species is included in the IFIM analysis and proposed changes to downstream flows may benefit the species. The effect of downstream peaking flows on spawning habitat for this species is also being addressed as part of a downstream flow study.

4.4.9 YELLOW LAMPMUSSEL

The yellow lampmussel is a freshwater species that is found primarily in medium to large rivers and streams. Preferred habitat includes a variety of substrates such as silt or sand, gravel bars, and in the bedrock cracks of both large and small rivers and streams (Price 2006b). The range of this species extends from the Ogeechee River in Georgia to Nova Scotia, with distribution in South Carolina spanning the Savannah, Broad, Wateree, Congaree, and Pee Dee River basins (Bogan and Alderman 2008, Price et al. 2009, Kleinschmidt 2013b).

Gravid yellow lampmussels observed in the Congaree River in 2007 were reported to release their glochidia between June and July (Price et al. 2009). These animals are long-term brooders that attract piscivorous hosts with mantle lure display. Broad River host trials indicate that Moronids like striped bass and white bass are likely natural hosts for yellow lampmussel, though Centrarchids may also be viable hosts (Price et al. 2009).

Status in the Study Area

In 2007, 60 sites were surveyed for mussels on the Broad and Congaree rivers from Cayce on the Congaree to five river miles south of the North Carolina border on the Broad. Six sites were surveyed between Parr Dam and Columbia Dam, and seven sites were sampled in the Parr Reservoir. However, only nine individuals were collected from three sites located two-three river miles downstream of the confluence of the Broad and Saluda rivers (Price *et al*. 2009). Alderman (2006) documented similar numbers of yellow lampmussels from the upper Congaree River, with 3 live individuals documented at five sites between the Broad/Saluda confluence and the Cayce Boat Landing.

In 2012, 13 sites just downstream from the Parr Shoals Dam were surveyed on the northeast side of Hampton Island (Alderman and Alderman 2012). This survey reported two sites where yellow lampmussel was present (CPUE ranging from 0.5-0.57 mussels/surveyor-hour). This location represents the uppermost extent of yellow lampmussel’s known range in the Broad River (Table 4-5).

Determination of Effect

Alderman and Alderman (2012) reported that the mussel assemblage directly downstream of the Parr Shoals Dam represents the highest freshwater mussel diversity recorded in the Broad River Sub-basin in North and South Carolina upriver from the Columbia Hydroelectric Project. Further, the tailrace is the only location above the Columbia Hydroelectric Project where yellow lampmussel appears to have persisted. Although densities of yellow lampmussel were low, the overall abundance and diversity of mussels observed suggests that the tailrace may actually be serving as a sanctuary for freshwater mussels.

4.4.10 ROANOKE SLABSHELL

The Roanoke slabshell is found in large rivers, but can occasionally be found in small creeks. The Roanoke slabshell is able to tolerate large variations in flow levels and higher water temperatures, making it able to survive in some locations near dams and hydroelectric plants. It has experienced large die offs when the plants generate extremely low flows and cause levels of oxygen to drop (Price 2006).

The host fish for this species are still somewhat speculative, but it is thought that it parasitizes a diadromous fish host. Moreover, host studies conducted for Roanoke slabshell only showed successful transformation on blueback herring (most successful), gizzard shad, and white perch although a suite of taxa (ictalurids, cyprinids, centrarchids, catastomids, and anguillids) were considered (Price et al. 2009).

Status in the Study Area

In 2007, 60 sites were surveyed for mussels on the Broad and Congaree rivers from Cayce to five river miles south of the North Carolina border. Six sites were surveyed between Parr Shoals Dam and Columbia Dam seven in Parr Reservoir, and 13 sites below the Columbia Dam near the confluence of the Broad and Saluda rivers. Of these 60 sites, Roanoke slabshell was restricted to 194 live individuals from eight sites below the Columbia Dam (CPUE ranging from 1-62 mussels/surveyor-hour) and one individual from one site in Cherokee County, SC (Price et al. 2009).

In 2012, 13 sites just downstream from the Parr Shoals Dam were surveyed on the northeast side of Hampton Island (Alderman and Alderman 2012). This survey reported nine sites where Roanoke slabshell were present (CPUE ranging from 4-18 mussels/surveyor-hour), representing the healthiest, upper-most, extent of its presently known range in the Broad River (Alderman 2009) (Table 4-5).

Determination of Effect

As previously noted, Alderman and Alderman (2012) reported that the mussel assemblage found in the Parr tailrace represents the highest freshwater mussel diversity recorded in the Broad River Sub-basin in North and South Carolina upriver from the Columbia Hydrelectric Project. Further, the tailrace was the only location upstream of Columbia Hydroelectric Project dam where Roanoke slabshell has been documented (Alderman and Alderman 2012, Price 2010). Finally, juvenile Roanoke slabshell were documented by Alderman and Alderman (2012), suggesting that reproduction and recruitment are occurring in the tailrace area. These data suggest that the Project is unlikely to be resulting in any negative effects to the Roanoke slabshell population in the tailrace, but rather may be serving as a refuge for this and other mussel species.

TABLE 4-5 DOCUMENTED OCCURRENCE OF SELECTED STATE CONSERVATION PRIORITY FISH SPECIES IN MONTICELLO RESERVOIR, PARR RESERVOIR AND THE DOWNSTREAM REACH OF THE BROAD RIVER (SOURCE: NORMANDEAU 2007, 2008, 2009; SCANA 2013; BETTINGER ET AL. 2003; KLEINSCHMIDT 2013A; ALDERMAN AND ALDERMAN 2012)

COMMON NAME	SCIENTIFIC NAME	PARR	MONTICELLO	BROAD RIVER
Robust redhorse	*Moxostoma robustum*	x	x	x
Piedmont darter	*Percina crassa*			x
Seagreen darter	*Etheostoma thalassinum*			x
Highfin carpsucker	*Carpiodes velifer*	x		
Quillback	*Carpiodes cyprinus*	x	x	x
Santee chub	*Hybopsis zanema*			x
Striped bass	*Morone saxatilis*			x
Yellow lampmussel	*Lampsilis cariosa*			x
Roanoke slabshell	*Elliptio roanokensis*			x

4.5 BIRDS OF CONSERVATION CONCERN

In 2008, the USFWS published a report entitled *Birds of Conservation Concern 2008*, with the goal of accurately identifying the migratory and non-migratory bird species (beyond those already designated as federally threatened or endangered) that represent the USFWS' highest conservation priorities. The USFWS requested that birds from the Piedmont Bird Conservation Region (BCR), (Table 4-6) be included in this assessment, as this is where the Project is located. Life history information and habitat requirements for these species, as well as their status within the Project Vicinity and potential to be affected by continued operation of the Project, are summarized below. Table 4-6 also includes the state priority level (SCDNR 2015) for the species presented.

TABLE 4-6 BIRDS OF CONSERVATION CONCERN IN THE PIEDMONT BIRD CONSERVATION REGION

COMMON NAME	SCIENTIFIC NAME	STATE PRIORITY LEVEL
Peregrine falcon	*Falco peregrinus*	Moderate
Black rail	*Laterallus jamaicensis*	Highest
Short-eared owl	*Asio flammeus*	Not listed
Whip-poor-will	*Caprimulgus vociferous*	High
Loggerhead shrike	*Lanius ludovicianus*	Highest
Brown-headed nuthatch	*Sitta pusilla*	Moderate
Bewick's wren	*Thryomanes bewickii*	Moderate
Sedge wren	*Cistothorus platensis*	Highest
Wood thrush	*Hylocichla mustelina*	High
Blue-winged warbler	*Vermivora cyanoptera*	Moderate
Prairie warbler	*Setophaga discolor*	High
Cerulean warbler	*Setophaga cerulean*	Highest
Swainson's warbler	*Limnothlypis swainsonii*	Highest
Kentucky warbler	*Geothlypis formosa*	High
Bachman's sparrow	*Aimophila aestivalis*	Highest
Henslow's sparrow	*Ammodramus henslowii*	Highest
Rusty blackbird	*Euphagus carolinus*	Highest

4.5.1 PEREGRINE FALCON

Peregrine falcon, a medium-sized bird of prey, is slate-grey on the head and back, barred and spotted on the chest and belly, with distinctive black "sideburns" (USFWS 2015c). Birds acquire adult plumage in their second year, but do not reproduce until age three. Nesting starts in late

March, when females lay three to five eggs, which are identified by a pale rose color with brown blotches (USFWS 2015c). Incubation lasts approximately 33-34 days. If the first clutch of eggs is destroyed, a second clutch may be laid. Chicks remain in the nest six to seven weeks after hatching and are cared for by both parents (USFWS 2015c).

Historically the peregrine falcon ranged throughout the eastern United States from the Great Lakes and eastern Maine, south to Georgia and Alabama (USFWS 2015c). Peregrines usually nest on high, remote cliff ledges, with the nest site, or "eyrie" consisting of a shallow depression in the rocks and soil, sometimes surrounded with twigs and grass.

Status in the Study Area

The peregrine falcon is only known to occur within Greenville and Pickens counties, South Carolina (SCDNR 2015). Typically, peregrines are only seen in South Carolina during the winter season or during their migration.

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species because SCE&G does not propose to significantly change the shoreline classification or encourage development in the Project Area.

4.5.2 BLACK RAIL

The black rail is a small, blackish marshbird with a black bill, red eyes and a distinct white-speckled back (Cornell 2015c). The black rail nests in high portions of salt marshes, shallow freshwater marshes, wet meadows, and flooded grassy vegetation. Eggs are usually laid in clutches of six to ten and are a creamy white with brown spots. Incubation lasts approximately 16 to 20 days (Cornell 2015c).

Black rails range from southern New England to the Gulf States, and spend winters throughout the southern Atlantic coast states to Central America (Cornell 2015c).

Status in the Study Area

In South Carolina, there is only one confirmed nesting record, from 1903 (SCDNR 2015). Calling locations are spotty, with Bear Island WMA in Colleton County supporting the most significant population to date. SCDNR counted a total of 38 black rails in 1991-1992 along the coast of South Carolina, during an extensive marsh bird survey (SCDNR 2015). Black rails have also been reported in isolated wetlands in the Upstate (SCDNR 2015).

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species because the species and its preferred habitats are not present within the Project Area.

4.5.3 SHORT-EARED OWL

The short-eared owl is found throughout North America, South America, Europe and Asia, and on many oceanic islands (Cornell 2015d). Preferred habitat includes open country, such as prairie, meadows, tundra, moorlands, marshes, savanna, and open woodland (Cornell 2015d). Nests are scratched out on the ground and surrounded by grass. Clutch size ranges from one to eleven eggs and incubation lasts from 26-29 days (Cornell 2015d).

Status in the Study Area

The short-eared owl resides within South Carolina during the winter months, and not during breeding season (SCDNR 2015).

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species because SCE&G does not propose to significantly change the shoreline classification or encourage development in the Project Area.

4.5.4 WHIP-POOR-WILL

The whip-poor-will has a very distinctive call and is more commonly heard than seen. It is most active at dawn and dusk and spends the day roosting in trees. While roosting, the whip-poor-will prefers lower limbs of trees so as to be better camouflaged and sits with its body parallel to the limbs, unlike most birds (NatureServe 2015b).

The whip-poor-will's clutch size is 2 eggs on a nest of leaf litter directly on the ground. Eggs incubate for 19 to 21 days and chicks leave the nest at 17 to 20 days of age (NatureServe 2015b). Whip-poor-will chicks are downy and capable of feeding themselves at hatching. Females typically leave the nest at 7 to 9 days to start a second nest (NatureServe 2015b). The range of the whip-poor-will spans Central Canada to the Atlantic Coast and south to Oklahoma and Georgia; wintering in the Southeast United States and Central America (NatureServe 2015b).

Status in the Study Area

The whip-poor-will is a winter resident along the South Carolina coast and migrates northward to the middle and eastern sections of the state in April (SCDNR 2015). The bird has also been documented in Spartanburg, Union, Chesterfield, Lee, Dorchester, and Richland counties, South Carolina (SCDNR 2015).

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species because SCE&G does not propose to significantly change the shoreline classification or encourage development in the Project Area.

4.5.5 LOGGERHEAD SHRIKE

The loggerhead shrike averages 23 cm long with a coloring similar to mocking birds; upper side gray with a white underside (NatureServe 2015h). In late April to early May, the bird begins building its nest made of thick twigs woven together and padded by feathers, hair, or cotton. A typical clutch consists of 4 to 6 eggs and incubation usually lasts 16-18 days. The young fledge in about 17-20 days and are independent in 36 days (NatureServe 2015h).

The loggerhead shrike is a fairly common bird throughout most of North America ranging from southern Canada to Mexico and from the Pacific to Atlantic coast (NatureServe 2015h). It typically winters from Virginia to Florida, but is common in these areas year-round as well.

Status in the Study Area

The loggerhead shrike is a permanent resident throughout South Carolina, except at higher elevations (SCDNR 2015). It is most abundant in the Coastal Plain, especially within the "farm belt" area of the Inner Coast Plain (SCDNR 2015).

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species because SCE&G does not propose to significantly change the shoreline classification or encourage development in the Project Area.

4.5.6 BROWN-HEADED NUTHATCH

The brown-headed nuthatch has a brown crown with blue-gray wings and back. The average size is 10 to 11 cm in length (NatureServe 2015m). During nesting season, the brown-headed nuthatch uses holes or snags in trees, usually dead, but rely on nesting boxes when dead trees are unavailable. The brown-headed nuthatch is monogamous for the breeding season, and sometimes for several consecutive seasons. The female typically lays three to nine eggs and the male protects the nest (NatureServe 2015m).

Brown-headed nuthatch is a non-migratory species and primarily exist in the southeast region of the United States and the Bahamas (NatureServe 2015m). The brown-headed nuthatch's habitat consists of mature forests and are pine specialists. Currently, the brown-headed nuthatch is not Federally listed, but populations are declining due to habitat loss from logging and fire prevention (NatureServe 2015m).

Status in the Study Area

The brown-headed nuthatch commonly breeds in western South Carolina, utilizing the loblolly-shortleaf pine forests of the Upper Coastal Plain and the longleaf-slash pine forests of the Lower Coastal Plain (SCDNR 2015). This species spends a majority of its time in open, mature old-growth forest, especially where natural fire patterns have been maintained (SCDNR 2015).

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species because SCE&G does not propose to significantly change the shoreline classification or encourage development in the Project Area.

4.5.7 BEWICK'S WREN

Bewick's wren is a medium sized wren with a long tail and long, slender bills (Cornell 2015a). Nests are usually built in cavities in trees or on ledges. Females usually lay three to eight eggs per brood sometimes producing as many as three broods in a breeding season (Cornell 2015a).

Bewick's wren prefers brushy and scrub type habitat and are often found in thickets in open country or open woodlands near streams (Cornell 2015a). This species is flourishing in western North America, but its populations have steadily declined in the east. A possible cause for population decline is the increase in the house wren, which typically remove eggs from existing nests (Cornell 2015a).

Status in the Study Area

Bewick's wren was historically found in central South Carolina, although it is likely extirpated from the state (SCDNR 2015).

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species due to a likely lack of occurrence in the study area.

4.5.8 Sedge Wren

The sedge wren is a small wren measuring 10 to 12 cm with a short, thin bill. Male sedge wrens are very territorial and build multiple nests within their territory for females (NatureServe 2015d). Nests consist of round balls of grasses and sedges with an entrance on the side. After selecting her nest, the female sedge wren pads the nest with feathers and fur (NatureServe 2015d). A female sedge wren typically lays four to eight eggs per brood. Females incubate the eggs alone for approximately 14 days and continues to care for young alone. Young typically leave the nest after 12 to 14 days (NatureServe 2015d).

As the name suggests, the sedge wren prefers wet fields and marshes with tall grasses and sedges (NatureServe 2015d). The sedge wren typically breeds in central northern United States and central Canada and winters in the southeast region of the United States (NatureServe 2015d).

Status in the Study Area

The sedge wren is a common winter resident of the Coastal Plain region (SCDNR 2015).

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species because its preferred wintering habitats are not present within the Project Area.

4.5.9 Wood Thrush

The wood thrush has brown upper parts with a spotted white breast and are typically 19 to 21 cm in length with a short tail and straight bill. During nesting season, the female initiates the nest building by developing a platform of grass will walls of woven grass, leaves, or stems (Cornell 2015e). Nests are usually located in shrubs for support from branches as well as coverage from foliage. A female wood thrush typically lays three to four eggs per brood and will usually have two broods in a breeding season (Cornell 2015e). A new nest will be made for the second brood, and wood thrush pairs generally remain monogamous throughout the season (Cornell 2015e).

The wood thrush prefers mature deciduous forests with large trees and a moderate understory and is a fairly common bird throughout the eastern region of the United States (Cornell 2015e). However, its populations have been steadily declining for several years, possibly due to nest parasitism from the brown-headed cowbird (Cornell 2015e).

Status in the Study Area

The wood thrush is distributed statewide with higher concentrations of breeding in the Piedmont and Mountain regions of the state (SCDNR 2015).

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species because SCE&G does not propose to significantly change the shoreline classification or encourage development in the Project Area.

4.5.10 BLUE-WINGED WARBLER

The Blue-winged warbler is a small songbird commonly found in the eastern United States. Nests are generally built on the ground and well concealed by tall grasses and vines (NAS 2015). A usual clutch for the blue-winged warbler is four to seven eggs. The female incubates the eggs for 10 to 11 days and then both male and female feed the young (NAS 2015). Chicks remain in the nest for eight to 11 days. The blue-winged warbler often cross breeds with the golden-winged warbler resulting in fertile offspring (NAS 2015).

Blue-winged warblers spend their breeding season in the northeast and occupy the southeast during the winter (NAS 2015). They prefer the overgrown pastures of abandoned farmlands and forest clearings. Currently, they are suffering parasitism from brown-headed cowbirds, but populations appear stable (NAS 2015).

Status in the Study Area

The blue-winged warbler occurs in low densities as a breeding bird in South Carolina's Appalachian Mountains (SCDNR 2015). It is migratory along the coastal areas, and overwinters in Central America and the Caribbean (SCDNR 2015).

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species because SCE&G does not propose to significantly change the shoreline classification or encourage development in the Project Area.

4.5.11 PRAIRIE WARBLER

The prairie warbler is a medium sized warbler commonly found throughout the eastern United States (USFS 2001). Nests are an open cup shape of woven plants located between 1 and 10 feet from the ground (USFS 2001). Birds are monogamous for the breeding season, but typically select new mates each year. Females incubate three to five eggs for 11 to 15 days. The hatchlings fledge after 8 to 10 days, but remain dependent upon both parents for another month. Prairie warblers produce one brood per year (USFS 2001).

Preferred habitat includes open, brushy areas, fields, and Christmas tree farms (USFS 2001). Prairie warblers are also found in disturbed areas which are deemed suitable five years after the disturbance of fire or clearing. An absence of a high canopy is important for this species of warbler (USFS 2001).

Status in the Study Area

The prairie warbler is found throughout the state of South Carolina (SCDNR 2015).

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species because the species and its preferred habitats are not present within the Project Area.

4.5.12 CERULEAN WARBLER

The cerulean warbler is a small bird that prefers the tall trees of deciduous hardwood forests of the eastern United States (USFWS 2006). Female cerulean warblers will typically lay three to four eggs per brood and incubate for 11 to 13 days (USFWS 2006). Once hatched, both parents assist in feeding and care of the young until they leave the nest after nine to 11 days. Cerulean warblers generally produce only one brood per year, however if the original nest is destroyed, a second attempt may be made (USFWS 2006).

Cerulean warblers breed in the northeast and then migrate southeast for the winters (USFWS 2006). Populations are in a steady decline due to habitat loss. Much of the historical forest habitat has been cleared for human development (USFWS 2006).

Status in the Study Area

The cerulean warbler's breeding distribution includes the northwest corner of the South Carolina Mountain Ecoregion. Otherwise, it is only found throughout South Carolina as a passage migrant (SCDNR 2015).

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species because its preferred breeding habitats are not located in the Project Area. Also, SCE&G does not propose to significantly change the shoreline classification or encourage development in the Project Area.

4.5.13 SWAINSON'S WARBLER

Female Swainson's warblers build bulky nests at an average height of six feet in various vegetation, typically near dense vines or shrubs (Meyer 2006). Females lay an average of three eggs per brood. One brood per year is typical, though renesting in the event of a failed first attempt is common. The female Swainson's warbler incubates the eggs for 13 to 15 days and chicks leave the nest after 10 to 12 days (Meyer 2006).

Swainson’s warbler is commonly found in bottomland hardwood forests. In the breeding season, they prefer the southeastern United States and migrate south to the Caribbean for the winter. Preferred habitat includes forests near rivers, swamps, or floodplains (Meyer 2006). Coniferous and deciduous forests with canebreaks are also desirable locations.

Status in the Study Area

Swainson’s warbler is an uncommon breeder in South Carolina, inhabiting bottomlands in the Coastal Plain and rhododendron thickets in the mountains (SCDNR 2015). It is known to occur in Abbeville, Beaufort, Berkeley, Charleston, Chesterfield, Dorchester, Greenville and Pickens counties (SCDNR 2015).

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species because its preferred habitats are not present in the study area.

4.5.14 KENTUCKY WARBLER

During nesting season, the female Kentucky warbler builds her nest on or near the ground hidden and supported by shrubs or fallen branches (Cornell 2015b). A typical clutch size consists of three to six eggs which are incubated solely by the female for 12 to 13 days. Once hatched, the young are cared for by both parents for the eight to ten days before they fledge as well as another week after leaving the nest (Cornell 2015b).

The Kentucky warbler’s range spans from the Great Plains to the Atlantic Coast, wintering in Central America (Cornell 2015b). Preferred habitat for this species of warbler include woods with dense, humid thickets, areas near rivers and edges of swamps (Cornell 2015b). Currently suffering from habitat loss, the Kentucky warbler is also prone to parasitism by the brown-headed cowbird.

Status in the Study Area

The Kentucky warbler is a common breeder found throughout South Carolina, with breeding activity confirmed in all but a few counties of the state (SCDNR 2015).

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species because SCE&G does not propose to significantly change the shoreline classification or encourage development in the Project Area.

4.5.15 BACHMAN'S SPARROW

Bachman's sparrow, distinguished by "buffy" brownish-gray under plumage that is tinged with reddish streaks, is monogamous throughout the year, typically yielding two broods each breeding season (USFWS 2015a). A female sparrow build a nest of grasses at, or just above, ground level and lays a clutch of three to four eggs and incubates for 12 to 14 days. After hatching, both parents care for the young until they leave the nest after nine to ten days (USFWS 2015a).

Bachman's sparrow spans the Coastal Plain and Piedmont of the southeastern United States. This species historically preferred mature pine forests, the majority of which have been logged (USFWS 2015a). Today, pine forests with a more open understory are the usual habitat for this sparrow. Populations have been seen to increase in the year immediately after a fire and decline after three years post-fire. The Bachman's sparrow southern populations are non-migratory while the northern populations have a short migration in the winter (USFWS 2015a).

Status in the Study Area

Bachman's sparrow can be found throughout the Piedmont and Coastal Plain regions of the state, specifically Charleston, Georgetown and Jasper counties (SCDNR 2015).

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species because SCE&G does not propose to significantly change the shoreline classification or encourage development in the Project Area.

4.5.16 HENSLOW'S SPARROW

Henslow's sparrow is believed to be monogamous for the breeding season and produces two broods each year (NatureServe 2015a). The male sparrow suggests several different locations in areas of dense, tall grass in open fields and meadows. The female selects the site she prefers and begins building a nest on or near the ground and well hidden in the dense grasses and weeds (NatureServe 2015a). Typical clutch size is three to five eggs per brood and is incubated by the female for nine to 11 days. Once hatched, both male and female parents care for the young. The Henslow's sparrow remains in the nest for nine to ten days after hatching (NatureServe 2015a).

Henslow's sparrow is a rare bird whose populations are in decline. Historically, the habitat preferred by this species included open, moist meadows, coastal plains, and salt marshes, but in recent years they have been less frequently observed in coastal areas (NatureServe 2015a). The Henslow's sparrow breeds in the Central and Northeast United States and migrates to the Southeast, primarily the Gulf Coast, for winter (NatureServe 2015a).

Status in the Study Area

Henslow's sparrows winter throughout the Coastal Plain, extending inland from the coast through the Sandhills (SCDNR 2015). This species is unlikely to be found within the study area, as it is generally limited to areas below the fall line in South Carolina.

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species because its preferred habitats are not present in the study area.

4.5.17 RUSTY BLACKBIRD

The female rusty blackbird is in charge of building the nest. Nests are typically a bulky cup shape of sticks and coarse grasses (NatureServe 2015f). They are placed in the mid to upper sections of small conifer trees. Rusty blackbird nests are often in or near wetlands. The female lays three to five eggs and she alone incubates the eggs for roughly two weeks (NatureServe 2015f). While the female incubates the eggs, the male will often feed her in the nest or on a nearby branch. Both parents care for and feed the hatchlings. Rusty blackbird chicks remain in the nest for 10 to 12 days (NatureServe 2015f).

Rusty blackbirds winter in the southeastern United States in flooded forests, wooded wetlands, and swamps (NatureServe 2015f). Breeding occurs in the boreal forests of Canada, specifically in patchy wetland areas with small coniferous trees (NatureServe 2015f).

Status in the Study Area

The rusty blackbird is a fairly common winter visitor to the Piedmont and Coastal Plain, with lesser numbers occurring in the Mountain region of South Carolina (SCDNR 2015).

Determination of Effect

Continued operation of the Project is expected to result in no effect on this species because SCE&G does not propose to significantly change the shoreline classification or encourage development in the Project Area.

5.0 SUMMARY

The original approved Study Plan for this Rare, Threatened, and Endangered Species Desktop Assessment (October 2014) was expanded based on an August 24, 2015 USFWS request to include several bird species considered to be of conservation concern for Piedmont Bird Conservation Region, as well as several Federal At-Risk Species. We addressed the potential project effects on each of those species in the report. Some of the species could occur in the Project boundary, but none of those species should be impacted by Project operations and are not protected by state or federal law.

Of the 10 state- and federally-listed and candidate species originally identified by the USFWS, habitat requirements and known occurrence data suggest that only the bald eagle likely occurs in the study area with any regularity. Wood storks may periodically utilize portions of the study area of seasonal foraging (primarily by post-dispersal migrants during the summer months); however, this usage is expected to be sporadic and ephemeral. Habitat for Georgia aster has been noted on the adjacent V.C. Summer Nuclear Station site and on nearby U.S. Forest Service lands, suggesting that habitat may also exist within the Project study area. Potential occurrences of Georgia aster would be limited to terrestrial sites, which would not be affected by continued operation of the Project. Finally, several fish species that are not state- or federally-listed, but are classified as priority conservation species have been documented from the study area. Habitat requirements for these species will be assessed as part of the proposed IFIM study. Information from this study will be considered in developing Protection, Mitigation, and Enhancement measures.

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APPENDIX A
RT&E SPECIES STUDY PLAN

PARR HYDROELECTRIC PROJECT
(FERC NO. 1894)

RARE, THREATENED AND ENDANGERED SPECIES STUDY PLAN

Prepared for:

South Carolina Electric & Gas Company
Cayce, South Carolina

Prepared by:

Kleinschmidt

Lexington, South Carolina
www.KleinschmidtUSA.com

October 2013

PARR HYDROELECTRIC PROJECT
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(FERC NO. 1894)

RARE, THREATENED AND ENDANGERED SPECIES STUDY PLAN

SOUTH CAROLINA ELECTRIC & GAS COMPANY

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PARR HYDROELECTRIC PROJECT
(FERC NO. 1894)

RARE, THREATENED AND ENDANGERED SPECIES STUDY PLAN

SOUTH CAROLINA ELECTRIC & GAS COMPANY

1.0 INTRODUCTION

South Carolina Electric & Gas Company (SCE&G) is the Licensee of the Parr Fairfield Hydroelectric Project (FERC No. 1894) (Project). The Project consists of the Parr Hydro Development and the Fairfield Pumped Storage Development. Both developments are located along the Broad River in Fairfield and Newberry Counties, South Carolina (Figure 1).

The Project is currently involved in a relicensing process which involves cooperation and collaboration between SCE&G as the licensee and a variety of stakeholders including state and federal resource agencies, state and local government, non-governmental organizations (NGOs), and interested individuals. Collaboration and cooperation of stakeholders is essential to the identification of and treatment of operational, economic, and environmental issues associated with a new operating license for the Project. SCE&G has established several Technical Working Committees (TWCs), including members from among the interested stakeholders, with the objective of achieving consensus regarding the identification and proper treatment of these resource issues in the context of a new license.

In preparation for relicensing, SCE&G formed a Rare, Threatened and Endangered Species Technical Working Committee (“RT&E TWC” or “TWC”), which is comprised of interested stakeholders who are working with SCE&G to identify potential issues, make biological study recommendations, and provide technical and experience-based input related to rare, threatened and endangered (RT&E) species potentially residing in the Project area. SCE&G is planning to conduct a literature-based study to compile existing information on federally and state listed RT&E species in the immediate project area. SCE&G will use this information in developing their license application for Federal Energy Regulatory Commission (FERC).

2.0 STUDY OBJECTIVES

The objective of this study is to characterize the present status of RT&E species at the Parr Fairfield Hydroelectric Project by providing information regarding the availability of RT&E habitat and characterize the known status of RT&E species within the Project boundary and Project vicinity. The presence or absence of select species will be verified through targeted field studies, including the Rocky Shoals Spider Lily Study, the Spiny Crayfish Study, and the Monticello Mussel Study.

3.0 GEOGRAPHIC AND TEMPORAL SCOPE

This study will focus on all areas within the FERC Project boundary, including Parr and Monticello reservoirs, the immediate vicinity of the Project in Fairfield and Newberry counties, and the area downstream of Parr Shoals Dam extending to and including Frost Shoals in Richland County. RT&E species that are deemed as potentially occurring within the Project Area and from Parr Shoals Dam extending to and including Frost Shoals, near Boatwright Island, along with the known presences of available RT&E habitat, will be evaluated. As this study is a desktop exercise, no field reconnaissance will be implemented. The study is scheduled to commence in 2015.

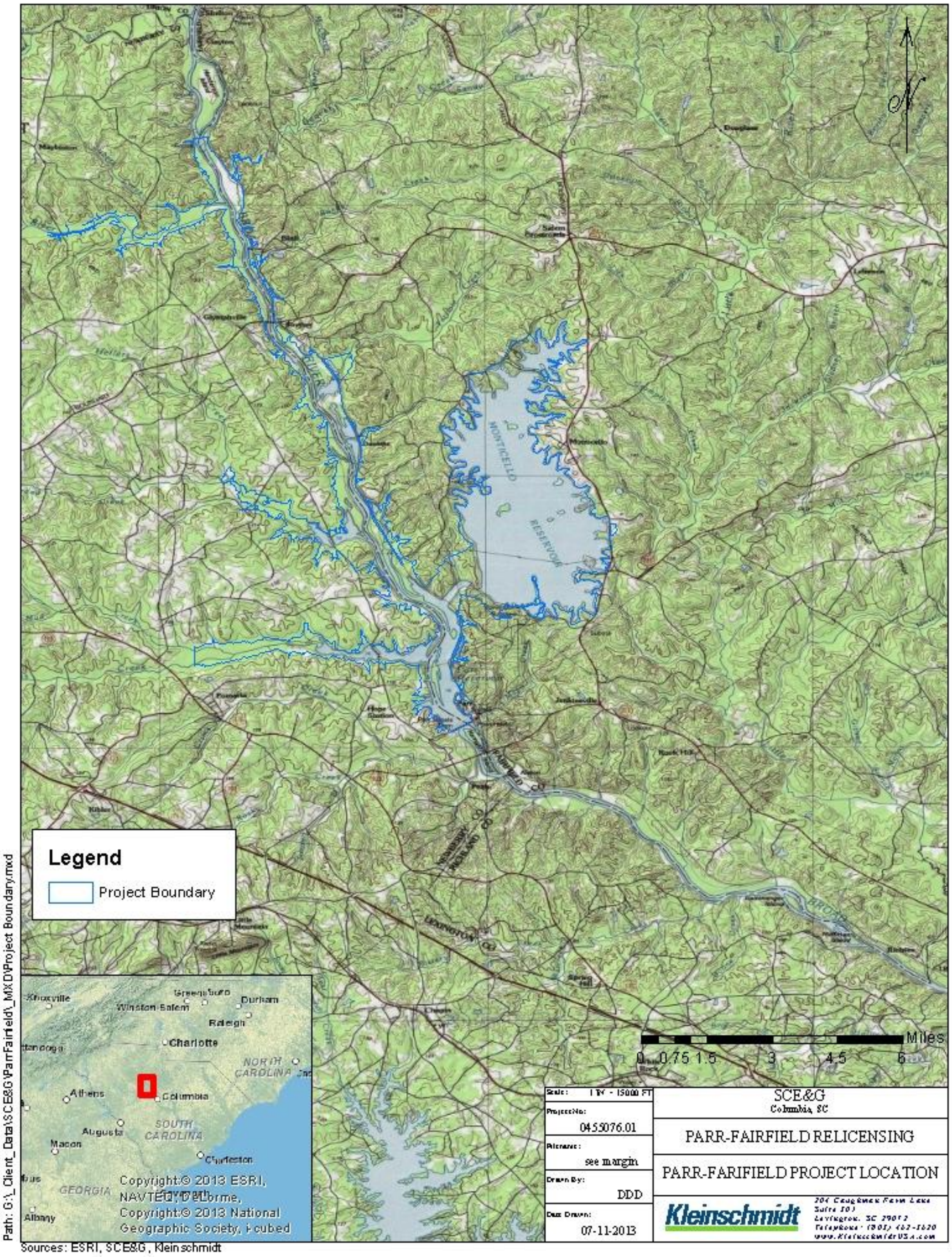

FIGURE 1 PARR-FAIRFIELD PROJECT LOCATION MAP

4.0 COLLECTION METHODS AND ANALYSIS

In order to appropriately characterize the present status of RT&E species in the Project vicinity, information will be collected from various sources, including the South Carolina Department of Natural Resources (SCDNR) and the U.S. Fish and Wildlife Service (USFWS) RT&E databases.

As an initial step, a list of RT&E species documented as occurring in the counties surrounding the Project and downstream (Newberry, Fairfield and Richland) will be compiled based on the USFWS and SCDNR county level listings. Additional key species may be added at the request of TWC members, if agreed to be appropriate. The federal, state and global status of each of these species will be summarized, along with counties of occurrence. As a second step, known ranges of these species, along with occurrence data from the SCDNR Natural Heritage Program and other survey data, will then be used to eliminate species occurring in the counties but not in the Broad River Basin. Habitat requirements of each of the remaining species will then be summarized and compared to available habitat within the Project boundary and the area downstream of the Parr Shoals Dam extending to and including Frost Shoals, near Boatwright Island. This analysis will yield a list of species that potentially occur within the Broad River Basin, and that have suitable habitat within the Project Boundary and downstream of the Parr Shoals Dam extending to and including Frost Shoals, near Boatwright Island.

5.0 SCHEDULE

Research and data collection efforts will begin no later than the spring of 2015. A final report summarizing the study findings including the compiled spreadsheets will be issued within 120 days of the completion of data collection. Study methodology and timing may be adjusted based on consultation with resource agencies and interested stakeholders.

6.0 USE OF STUDY RESULTS

Study results will be used as an information resource during discussion of relicensing issues and developing potential Protection, Mitigation and Enhancement measures with the SCDNR, USFWS, RT&E TWC and other relicensing stakeholders.

APPENDIX B
USFWS COUNTY LEVEL LISTING FOR FAIRFIELD, NEWBERRY AND RICHLAND COUNTIES

South Carolina List of At-Risk, Candidate, Endangered, and Threatened Species - Fairfield County

*	Contact National Marine Fisheries Service (NMFS) for more information on this species
**	The U.S. Fish and Wildlife Service (FWS) and NMFS share jurisdiction of this species
ARS	At-Risk Species - Species that the FWS has been petitioned to list and for which a positive 90-day finding has been issued (listing may be warranted); information is provided only for conservation actions as no Federal protections currently exist.
BGEPA	Federally protected under the Bald and Golden Eagle Protection Act
C	FWS or NMFS has on file sufficient information on biological vulnerability and threat(s) to support proposals to list these species
CH	Critical Habitat
E	Federally Endangered
P - CH	Proposed critical habitat in the Federal Register
S/A	Federally protected due to similarity of appearance to a listed species
T	Federally Threatened

COUNTY	CATEGORY	COMMON NAME	SCIENTIFIC NAME	STATUS
Fairfield	Amphibian		None Found	
	Bird	Bald eagle	*Haliaeetus leucocephalus*	BGEPA
	Crustacean	Little River (Broad River spiny) crayfish	*Cambarus spicatus*	ARS
	Fish	Blueback herring	*Alosa aestivalis*	ARS
	Insect		None Found	
	Mammal		None Found	
	Mollusk	Carolina heelsplitter	Lasmigona decorata	E
	Plant	Georgia aster	*Symphyotrichum georgianum*	C
	Reptile		None Found	

These lists should be used only as a guideline, not as the final authority. The lists include known occurrences and areas where the species has a high possibility of occurring. Records are updated as deemed necessary and may differ from earlier lists.

For a list of State endangered, threatened, and species of concern, please visit https://www.dnr.sc.gov/species/index.html.

South Carolina List of At-Risk, Candidate, Endangered, and Threatened Species - Newberry County

*	Contact National Marine Fisheries Service (NMFS) for more information on this species
**	The U.S. Fish and Wildlife Service (FWS) and NMFS share jurisdiction of this species
ARS	At-Risk Species - Species that the FWS has been petitioned to list and for which a positive 90-day finding has been issued (listing may be warranted); information is provided only for conservation actions as no Federal protections currently exist.
BGEPA	Federally protected under the Bald and Golden Eagle Protection Act
C	FWS or NMFS has on file sufficient information on biological vulnerability and threat(s) to support proposals to list these species
CH	Critical Habitat
E	Federally Endangered
P - CH	Proposed critical habitat in the Federal Register
S/A	Federally protected due to similarity of appearance to a listed species
T	Federally Threatened

COUNTY	CATEGORY	COMMON NAME	SCIENTIFIC NAME	STATUS
Newberry	Amphibian	None Found		
	Bird	Bald eagle	*Haliaeetus leucocephalus*	BGEPA
	Bird	Wood stork	*Mycteria americana*	E
	Crustacean	Newberry burrowing crayfish (Saluda)	*Distocambarus youngineri*	ARS
	Fish	None Found		
	Insect	None Found		
	Mammal	None Found		
	Mollusk	Savannah lilliput	*Toxolasma pullus*	ARS
	Mollusk	Yellow lance	*Elliptio lanceolata*	ARS
	Plant	None Found		
	Reptile	None Found		

These lists should be used only as a guideline, not as the final authority. The lists include known occurrences and areas where the species has a high possibility of occurring. Records are updated as deemed necessary and may differ from earlier lists.

For a list of State endangered, threatened, and species of concern, please visit https://www.dnr.sc.gov/species/index.html.

South Carolina List of At-Risk, Candidate, Endangered, and Threatened Species - Richland County

*	Contact National Marine Fisheries Service (NMFS) for more information on this species
**	The U.S. Fish and Wildlife Service (FWS) and NMFS share jurisdiction of this species
ARS	At-Risk Species - Species that the FWS has been petitioned to list and for which a positive 90-day finding has been issued (listing may be warranted); information is provided only for conservation actions as no Federal protections currently exist.
BGEPA	Federally protected under the Bald and Golden Eagle Protection Act
C	FWS or NMFS has on file sufficient information on biological vulnerability and threat(s) to support proposals to list these species
CH	Critical Habitat
E	Federally Endangered
P or P - CH	Proposed for listing or critical habitat in the Federal Register
S/A	Federally protected due to similarity of appearance to a listed species
T	Federally Threatened

COUNTY	CATEGORY	COMMON NAME	SCIENTIFIC NAME	STATUS
Richland	Amphibian	Chamberlain’s dwarf salamander	*Eurycea chamberlaini*	ARS
	Bird	Bald eagle	*Haliaeetus leucocephalus*	BGEPA
	Bird	Red-cockaded woodpecker	*Picoides borealis*	E
	Crustacean	Little River (Broad River spiny) crayfish	*Cambarus spicatus*	ARS
	Fish	American eel	*Anguilla rostrata*	ARS
	Fish	Atlantic Sturgeon*	*Acipenser oxyrinchus**	E
	Fish	Blueback herring	*Alosa aestivalis*	ARS
	Fish	Robust redhorse	*Moxostoma robustum*	ARS
	Fish	Shortnose sturgeon*	*Acipenser brevirostrum**	E
	Insect	None Found		
	Mammal	None Found		
	Mollusk	Savannah lilliput	*Toxolasma pullus*	ARS
	Plant	Bog spicebush	*Lindera subcoriacea*	ARS
	Plant	Canby's dropwort	*Oxypolis canbyi*	E
	Plant	Carolina-birds-in-a-nest	*Macbridea caroliniana*	ARS
	Plant	Ciliate-leaf tickseed	*Coreopsis integrifolia*	ARS
	Plant	Georgia aster	*Symphyotrichum georgianum*	C
	Plant	Purple balduina	*Balduina atropurpurea*	ARS
	Plant	Rough-leaved loosestrife	*Lysimachia asperulaefolia*	E
	Plant	Smooth coneflower	*Echinacea laevigata*	E
	Plant	Spathulate seedbox	*Ludwigia spathulata*	ARS
	Reptile	Southern hognose snake	*Heterdon simus*	ARS

These lists should be used only as a guideline, not as the final authority. The lists include known occurrences and areas where the species has a high possibility of occurring. Records are updated as deemed necessary and may differ from earlier lists.

For a list of State endangered, threatened, and species of concern, please visit https://www.dnr.sc.gov/species/index.html.

APPENDIX C
STAKEHOLDER CONSULTATION

From:	Vivianne Vejdani
To:	Kelly Miller
Cc:	Bill Marshall; "Richard Christie"
Subject:	RE: draft RT&E Species Desktop Assessment
Date:	Wednesday, July 09, 2014 4:37:08 PM

Hi Kelly,

The plan looks good but I would offer perhaps one general suggestion...the phrase "does not occur within the study area/project area" be replaced by something like "is not likely to occur," in cases where on the ground surveys have not been conducted.

From: Kelly Miller [mailto:Kelly.Miller@KleinschmidtGroup.com]
Sent: Monday, June 23, 2014 4:34 PM
To: Alison Jakupca; BARGENTIERI@scana.com; Bill Marshall; Bill Stangler (CRK@congareeriverkeeper.org); Byron Hamstead (Byron_hamstead@fws.gov); Chad Altman (altmankc@dhec.sc.gov); David Eargle (eargleda@dhec.sc.gov); Gerrit Jobsis (gjobsis@americanrivers.org); Henry Mealing; Jay Maher; Jim Glover (gloverjb@dhec.sc.gov); Karla Reece (Karla.Reece@noaa.gov); Kelly Miller; QUATTLEBAUM, MILTON; rammarell@scana.com; Randy Mahan (randolph.mahan@scana.com); randy mahan (rmahan@sc.rr.com); Sam Stokes Jr.; Scott Castleberry (castlews@dhec.sc.gov); Shane Boring; Steve Summer; Tom McCoy (thomas_mccoy@fws.gov); Vivianne Vejdani
Subject: draft RT&E Species Desktop Assessment

All,

Attached is the draft Rare, Threatened and Endangered Species Desktop Assessment. Please review and submit any comments or edits to me by Wednesday, July 9th. Please note that the appendices will be included with the final report.

Thanks!
Kelly

Kelly Miller
Regulatory Coordinator
Kleinschmidt
Office: 803.462.5633
www.KleinschmidtGroup.com

From:	Hamstead, Byron
To:	Kelly Miller
Cc:	Alison Jakupca; BARGENTIERI@scana.com; Bill Marshall (marshallb@dnr.sc.gov); Bill Stangler (CRK@congareeriverkeeper.org); Chad Altman (altmankc@dhec.sc.gov); David Eargle (eargleda@dhec.sc.gov); Gerrit Jobsis (gjobsis@americanrivers.org); Henry Mealing; Jay Maher; Jim Glover (gloverjb@dhec.sc.gov); Karla Reece (Karla.Reece@noaa.gov); QUATTLEBAUM, MILTON; rammarell@scana.com; Randy Mahan (randolph.mahan@scana.com); randy mahan (rmahan@sc.rr.com); Sam Stokes (stokess@dnr.sc.gov); Scott Castleberry (castlews@dhec.sc.gov); Shane Boring; Steve Summer; Tom McCoy (thomas_mccoy@fws.gov); Vivianne Vejdani
Subject:	Re: draft RT&E Species Desktop Assessment
Date:	Wednesday, July 09, 2014 4:39:38 PM
Attachments:	20140709_Parr_RTE_TWC_proposal_to_include_two_mussels_for_consideration.docx

All,

The Service proposes that two additional species be included for consideration by the RT&E TWC, *Lampsilis cariosa* and *Elliptio roanokensis*. Attached is a document that aims to provide our basis for this proposal, and information relevant to the objectives of the desktop assessment. Please let me know if you have any questions regarding this information. Additionally, I can send along the 2007 mussel survey data (from Price *et al*. 2009) in GIS file format if you request it. The Service appreciates the opportunity to participate on this Committee.

Thanks,
Byron

Byron Hamstead
Fish and Wildlife Biologist
USFWS Charleston Field Office
176 Croghan Spur Rd., Suite 200
Charleston, SC, 29407

843-727-4707 ext. 205

On Mon, Jun 23, 2014 at 4:33 PM, Kelly Miller <Kelly.Miller@kleinschmidtgroup.com> wrote:

> All,
>
> Attached is the draft Rare, Threatened and Endangered Species Desktop Assessment. Please review and submit any comments or edits to me by Wednesday, July 9th. Please note that the appendices will be included with the final report.
>
> Thanks!
>
> Kelly

From:	Hamstead, Byron
To:	Kelly Miller
Cc:	Alison Jakupca; BARGENTIERI@scana.com; Bill Marshall (marshallb@dnr.sc.gov); Bill Stangler (CRK@congareeriverkeeper.org); Chad Altman (altmankc@dhec.sc.gov); David Eargle (eargleda@dhec.sc.gov); Gerrit Jobsis (gjobsis@americanrivers.org); Henry Mealing; Jay Maher; Jim Glover (gloverjb@dhec.sc.gov); Karla Reece (Karla.Reece@noaa.gov); QUATTLEBAUM, MILTON; rammarell@scana.com; Randy Mahan (randolph.mahan@scana.com); randy mahan (rmahan@sc.rr.com); Sam Stokes (stokess@dnr.sc.gov); Scott Castleberry (castlews@dhec.sc.gov); Shane Boring; Steve Summer; Tom McCoy (thomas_mccoy@fws.gov); Vivianne Vejdani
Subject:	Re: draft RT&E Assessment in track changes
Date:	Sunday, August 24, 2014 1:36:04 PM
Attachments:	20140824_USFWS Comments_Parr RTE Desktop Assessment.docx

Hi Kelly,

Please see comments from the USFWS on the RTE desktop assessment. Many thanks for your efforts to include the yellow lampmussel and Roanoke slabshell in your assessment. Please let me know if you have any questions regarding these comments. I will be away from the office for the next two weeks, but I am available via email or my cell: 919.946.0874.

Thanks,
Byron

Byron Hamstead
Fish and Wildlife Biologist
USFWS Charleston Field Office
176 Croghan Spur Rd., Suite 200
Charleston, SC, 29407

843-727-4707 ext. 205

On Wed, Aug 13, 2014 at 10:01 AM, Kelly Miller <Kelly.Miller@kleinschmidtgroup.com> wrote:

> Good morning!
>
> The draft Rare, Threatened and Endangered Species Desktop Assessment has been revised to address comments received by Byron Hamstead and Vivianne Vejdani. These revisions are included in track changes in the attached document. Please review the revised report and if everyone approves of the changes, I will attach the appendices and finalize the document.
>
> Thanks!

Kelly

Kelly Miller

Regulatory Coordinator

Kleinschmidt

Office: 803.462.5633

www.KleinschmidtGroup.com

From:	Shane Boring
To:	Hamstead, Byron
Cc:	Henry Mealing; BARGENTIERI@scana.com; Kelly Miller
Subject:	Final Parr/FF Rare, Threatened and Endangered Species Assessment
Date:	Wednesday, September 24, 2014 4:15:20 PM
Attachments:	20140924 Parr RTE Desktop Assessment.docx USFWS comment responses 9-18-2014- revised.doc

Byron,

Thanks for your comments on the revised RT&E report; they were very constructive. We have addressed the majority of your comments, which you will find in track changes in the attached final version of the report. There were a few comments that we did not agree with for inclusion in the final report, but we believe needed further clarification with you specifically. For those items, we prepared and attached a separate document with our rationale on these items. When we file the RTE report in the Final License Application, we will include your official comments and correspondence as part of the report.

Thanks again for your continued commitment to the relicensing process.

C. Shane Boring
Environmental Scientist
Kleinschmidt
Office: 803.462.5625
www.KleinschmidtGroup.com

From:	Hamstead, Byron
To:	Henry Mealing
Cc:	ARGENTIERI, WILLIAM R; Shane Boring; Kelly Miller
Subject:	Re: Delivery delayed:County Species List
Date:	Tuesday, September 01, 2015 7:19:27 AM
Attachments:	image001.png

Apologies Henry. I included the Union County list b/c the PBL includes the confluence of the Broad and Enoree Rivers. I mistook the Union county line to extend down to the Enoree-Broad River confluence.

Byron

____

Byron Hamstead
Fish and Wildlife Biologist
USFWS Charleston Field Office
176 Croghan Spur Rd., Suite 200
Charleston, SC, 29407

843-727-4707 ext. 205

On Mon, Aug 31, 2015 at 7:14 PM, Henry Mealing <Henry.Mealing@kleinschmidtgroup.com> wrote:

> Byron,
>
> I took a closer look at all of the items you sent me and I noticed that you included Union County as one of the counties in the project influence. The project doesn't touch Union County and we will remove any species from the list that are associated with that specific county list. The major inclusions of species to evaluate are the At Risk Species (ARS). We will add an additional section to cover these species including a short write up – known presence within the PBL – if the project will affect the species.
>
> Thanks again for the complete list. We will get started on this right away.
>
> Henry
>
> **Henry Mealing**

Fisheries Biologist / Project Manager

Kleinschmidt

204 Caughman Farm Lane

Suite 301

Lexington, SC 29072

706-339-3209

www.KleinschmidtGroup.com

From: Hamstead, Byron [mailto:byron_hamstead@fws.gov]
Sent: Monday, August 24, 2015 10:05 AM
To: ARGENTIERI, WILLIAM R <BARGENTIERI@scana.com>
Cc: Henry Mealing <Henry.Mealing@KleinschmidtGroup.com>
Subject: Re: Delivery delayed:County Species List

Hi Bill,

Per Henry's request, attached is a .xlsx list of federal priority species that may be impacted by the Parr Project. These species were pulled from the USFWS's county lists (Union, Fairfield, Newberry, and Richland Counties), Birds of Conservation Concern (2008) for Bird Conservation Region 29 (Table 27), and our July 9, 2014 proposal to include two mussels for consideration by the RT&E TWC. County lists and other reference documents are attached for your records. Please let me know if you have any questions.

Thanks,

Byron

Byron Hamstead

Fish and Wildlife Biologist

USFWS Charleston Field Office

176 Croghan Spur Rd., Suite 200

Charleston, SC, 29407

843-727-4707 ext. 205

This email correspondence an any attachments to and from this sender is subject to the Freedom of Information Act and may be disclosed to third parties.

On Mon, Jun 29, 2015 at 1:08 PM, ARGENTIERI, WILLIAM R <BARGENTIERI@scana.com> wrote:

> Done
>
> His new email address is Henry.Mealing@KleinschmidtGroup.com.
>
> ---
>
> **From:** Thomas McCoy [mailto:thomas_mccoy@fws.gov]
> **Sent:** Friday, June 26, 2015 3:13 PM
> **To:** ARGENTIERI, WILLIAM R
> **Subject:** FW: Delivery delayed:County Species List
>
> ***This is an EXTERNAL email. Please do not click on a link or open any attachments unless you are confident it is from a trusted source.
>
> ---

Hi Bill,

??

Can you send to Henry the species list?

It bounced back.

Tom

??

NOTE: This email correspondence and any attachments to and from this sender are subject to the Freedom of Information Act and may be disclosed to third parties. ??

??

From: Microsoft Outlook [mailto:postmaster@doi.gov]
Sent: Friday, June 26, 2015 2:55 PM
To: thomas_mccoy@fws.gov
Subject: Delivery delayed:County Species List

??

Delivery is delayed to these recipients or groups:

Henry Mealing (HMealing@kassociates.com)

Subject: County Species List

This message hasn't been delivered yet. Delivery will continue to be attempted.

The server will keep trying to deliver this message for the next 1 days, 19 hours and 55 minutes. You'll be notified if the message can't be delivered by that time.

RECREATION USE AND NEEDS STUDY REPORT

PARR HYDROELECTRIC PROJECT

(FERC NO. 1894)

Prepared for:

South Carolina Electric & Gas Company
Cayce, South Carolina

Prepared by:

Kleinschmidt

Lexington, South Carolina
www.KleinschmidtGroup.com

November 2016

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(FERC NO. 1894)

SOUTH CAROLINA ELECTRIC & GAS COMPANY

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RECREATION USE AND NEEDS STUDY REPORT

PARR HYDROELECTRIC PROJECT
(FERC NO. 1894)

SOUTH CAROLINA ELECTRIC & GAS COMPANY

1.0 INTRODUCTION

South Carolina Electric & Gas Company ("SCE&G") is the Licensee of the Parr Hydroelectric Project (FERC No. 1894) ("Project"). The Project consists of the Parr Shoals Development ("Parr Development") and the Fairfield Pumped Storage Development ("Fairfield Development"). Both Developments are located along the Broad River in Fairfield and Newberry counties, South Carolina.

The Parr Development creates the Parr Reservoir along the Broad River. The Development consists of a 37-foot-high, 200-foot-long concrete gravity spillway dam with a powerhouse and generating units with a combined licensed capacity of 14.9 MW. The Parr Development operates in a modified run-of-river mode and normally operates to continuously pass Broad River flow. The 13-mile-long Parr Reservoir has a surface area of 4,400 acres at full pool and serves as the lower reservoir for pumped-storage operations. Recreation opportunities at Parr Reservoir include hunting, boating, fishing, hiking and picnicking opportunities.

The Fairfield Development is located directly off of the Broad River and forms the 6,800-acre Monticello Reservoir, with four earthen dams. Monticello Reservoir serves as the upper reservoir and, as noted, Parr Reservoir serves as the lower reservoir for pumped storage operations. The Fairfield Development has a licensed capacity of 511.2 MW and is primarily used for peaking operations, reserve generation, and power usage. Recreation opportunities at Monticello Reservoir include hunting, boating, fishing, camping, hiking and picnicking opportunities.

In addition to the Monticello and Parr Reservoirs, the Recreation Lake, which was constructed by SCE&G solely for recreational use, is located adjacent to Monticello Reservoir and has a surface area of 300 acres. The Recreation Lake is maintained at a stable water level and is not affected by the operation of the pumped storage facility. The Recreation Lake encompasses approximately 10.2 miles of shoreline and offers opportunities for fishing and picnicking.

Approximately 9,000 acres of land and water within the Project are part of the statewide Wildlife Management Area ("WMA") Program, managed by the South Carolina Department of Natural Resources ("SCDNR") (SCE&G, 2002).

1.1 Study Purpose and Objectives

South Carolina Electric & Gas is currently in the process of obtaining a new federal operating license for the Project from the Federal Energy Regulatory Commission ("FERC"). This process involves cooperation and collaboration between SCE&G, as licensee, and a variety of stakeholders including state and federal resource agencies, state and local government, non-governmental organizations ("NGOs"), and interested individuals. SCE&G has established several Resource Conservation Groups ("RCGs") and Technical Working Committees ("TWCs") composed of interested stakeholders with the objective of achieving consensus regarding the identification and proper treatment of these issues in the context of a new license.

As part of this process, SCE&G performed an assessment of existing and future recreational use, opportunities, and needs for the Project. The assessment was designed to collect and provide information pertinent to the current and future availability and adequacy of SCE&G owned and managed recreation sites as well as specific informal recreation areas at Monticello Reservoir and Parr Reservoir. The overall study objective was to identify current and potential recreational use, opportunities, and needs at the Project by addressing the following goals and objectives:

<u>Goal 1</u>: *Characterize the existing recreational use of SCE&G's recreation sites on Monticello Reservoir and Parr Reservoir. This was accomplished by focusing on the following objectives:*

i. Identifying recreation points, inventorying the services and facilities offered at each, and assessing the general condition of each site, including whether the site provides barrier free access.

ii. Identifying the patterns of recreation use at each site (type, volume, and daily patterns of use).

<u>Goal 2</u>: *Characterize existing use of waterfowl areas (Broad River Waterfowl Area, Enoree River Waterfowl Area) and SCE&G recreation lands by hunters during designated hunting seasons. This was accomplished by focusing on the following objectives:*

i. Identifying the patterns of recreation use within the Project boundary (type, volume, and daily/seasonal patterns of use).

Goal 3: *Identify future recreational needs relating to public recreation sites on Monticello Reservoir and Parr Reservoir. This was accomplished by focusing on the following objectives:*

i. Identifying existing recreation user needs and preferences, including perceptions of crowding at recreation sites.
ii. Estimating future recreational use of existing recreation sites.
iii. Identifying future needs for new recreation sites and facilities.

1.2 STUDY DEVELOPMENT AND CONSULTATION

Preceding submittal of the Pre-Application Document ("PAD") for the Project, stakeholders requested additional information on the Project through the implementation of several studies, one of which was a Recreation Use and Needs Study ("RUNS"). At a meeting with the Lake and Land Management and Recreation RCG on October 16, 2013, stakeholders discussed the proposed draft RUNS Study Plan. The study plan was revised based on comments received at that meeting, and a finalized study plan was filed with the PAD on January 5, 2015. A copy of the study plan, along with meeting notes from the RCG meetings on February 19, 2013, and October 16, 2013, are included in Appendix A. This RUNS report provides the results of the study.

2.0 METHODOLOGY

This section describes data collection and analysis efforts used for this study. Data collection focused on obtaining information related to existing public recreation sites and facilities owned by SCE&G[1], estimating recreational use of those sites, and learning recreation user perceptions and site capacities. Analysis was performed to support study objectives, to characterize existing and potential future recreational use at SCE&G's public access sites, and to assess future requirements necessary to support adequately, public recreational use of the Project resources.

2.1 STUDY AREA

Eleven recreation sites and informal recreation areas on Monticello Reservoir and Parr Reservoir were included in this assessment, with five on Monticello Reservoir and five on Parr Reservoir, and one, Enoree River Bridge Informal Access Area, upstream of Parr Reservoir and outside of the Project boundary. Table 1 summarizes the sites for which data was collected at each reservoir, which sites are considered Project recreation facilities, and the general type of data collected at each site. More specific and detailed descriptions of the data collection methods are provided in the following section. Figure 1 identifies the location of each recreation site for Monticello Reservoir and Parr Reservoir included in this study.

TABLE 1 RECREATION SITES ASSESSED

Recreation Sites and Informal Areas	Parr Project Facility	Site Inventory	Vehicle Counts	Exit Interviews	Mail-in Surveys	Spot Counts
Monticello Reservoir						
Scenic Overlook (SCE&G-maintained portion)	●	●	●	●		●
Highway 215 Boat Ramp	●	●	●	●	●	●
Highway 99 Boat Ramp	●	●	●	●	●	●
Recreation Lake Access Area	●	●	●	●		●
Highway 99 Informal Fishing Area	●	●	●	●		●
Parr Reservoir						
Cannon's Creek Public Access Area	●	●	●	●	●	●

[1] At the request of the RCG, the RUNS also assessed recreation use at the Enoree River Bridge Informal Access Area, which is outside of the Project Boundary, and the Enoree and Broad River Waterfowl Areas which are within the Project boundary, but managed by South Carolina Department of Natural Resources.

Recreation Sites and Informal Areas	Parr Project Facility	Site Inventory	Vehicle Counts	Exit Interviews	Mail-in Surveys	Spot Counts
Heller's Creek Public Access Area	●	●	●	●	●	●
Highway 34 Primitive Ramp	●	●	●			
Broad River Waterfowl Area		●				
Enoree River Waterfowl Area		●	●		●	
Enoree River Bridge Informal Access Area		●	●			

2.2 DATA COLLECTION

A variety of data collection techniques were used to obtain the information necessary to meet the study objectives. Table 2 identifies the information collected to address each objective as well as the data collection methods. Primary data collection included site inventories, user counts, and use surveys (exit interviews). Secondary data included information from the U.S. Bureau of Census data, the South Carolina Statewide Comprehensive Outdoor Recreation Plan (SCORP), the South Carolina Recreation Participation & Preference Study, data provided by the South Carolina Department of Natural Resources ("SCDNR") and other relevant, readily available literature. Additional input was obtained from the Lake & Land Management and Recreation RCG, Recreation TWC, and target "focus groups" offering "in the field" knowledge of the recreation resources and needs of the lake and river.

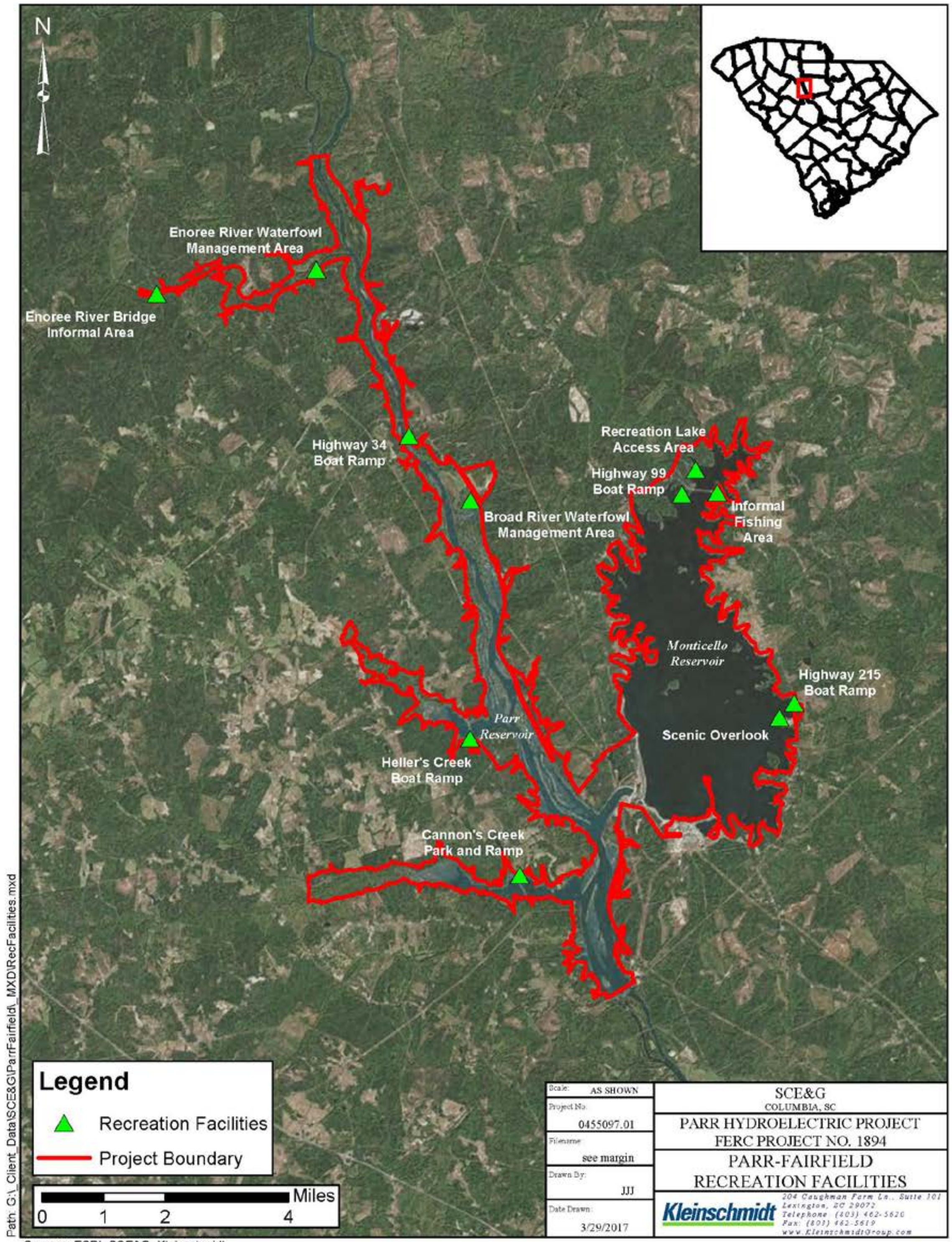

FIGURE 1 RECREATION FACILITIES AT PARR PROJECT

TABLE 2 RECREATION USE AND NEEDS STUDY OBJECTIVES AND EFFORTS

Objectives	Information Needed	Source
Goal 1: Characterize existing recreational use of recreation sites on Monticello Reservoir and the Parr Reservoir		
Identify formal recreation sites, inventory the services and facilities offered at each, and assess the general condition and ADA compliance of each site	• Physical inventory of all boat ramps, grills, shelters, restrooms, parking capacity, etc., at each site • General assessment of site condition to include maintenance, basic rehabilitation needs, etc. • Visitors' assessment of site conditions • Identification of activities that occur at each site • ADA compliance assessment	• Recreation Site Inventory • Survey of Recreation Site Users
Identify the patterns of use at each site (type, volume, and daily patterns of use)	• Utilize vehicle counts as an estimation of people • Estimate of number people/vehicle • Estimate of number vehicles/site • Parking capacity	• Traffic Counter Data • Surveyor Counts of Vehicles at Recreation Sites • Survey of Recreation Site Users - number of people per vehicle and length of visit • Recreation Site Inventory - number of parking spaces • County data from Scenic Overlook
Goal 2: Characterize existing use of waterfowl areas (Broad River Waterfowl Area, Enoree River Waterfowl area) and SCE&G recreation lands by hunters during designated hunting seasons.		
Identify the patterns of use within the Project boundary (type, volume, and daily/seasonal patterns of use).	• Estimate number of hunters/site or waterfowl area	• Counts of Vehicles at Recreation Sites/waterfowl areas • Mail-in questionnaire specific to hunting use at the Project • SCDNR waterfowl use data • SCDNR hunting permit data

TABLE 2 RECREATION USE AND NEEDS STUDY OBJECTIVES AND EFFORTS (CONTINUED)

Objectives	Information Needed	Source
Goal 3: Identify future recreational needs relating to public recreation sites on Monticello Reservoir and Parr Reservoir		
Identify existing user needs and preferences, including perceptions of crowding at recreation sites	• User preferences and opinions of needs and crowding at sites • Condition assessment	• Survey of Recreation Site Users • Recreation Site Inventory
Estimate future recreational use of existing recreation sites	• Current inventory and use data from Goals 1 and 2 • Population projections for the project area • Recreational use trends	• Results of Goals 1 and 2 • U.S. Bureau of Census Data • SC Division of Research & Statistics (Budget and Control Board) • SCORP, SC Recreation Participation & Preference Study, or other readily available literature
Identify future needs for new recreation sites and facilities	• Population projections • Recreation use trends • "focus group" (stakeholders) knowledge of recreation resources and needs	• SC Div. of Research & Statistics • SCORP, SC Recreation Participation & Preference Study, Palmetto Conservation Foundation trail use data, or other literature • Recreation TWC and Lake and Land Management & Recreation RCG

2.2.1 STUDY SEASON

Primary interview activities occurred during the April 1 through September 7 (Labor Day), 2015 period. Additional interviews were conducted from February 1 through March 31, 2016, on the Monticello Reservoir in order to capture recreational activity on the reservoir during early crappie season. Specific targeted survey activities with mail-in surveys were implemented at both reservoirs during the migratory waterfowl seasons, including the Canada geese hunting season. The 2015 and 2016 waterfowl seasons extended as follows:

- September 1- September 30, 2015: Early Canada Geese Season
- September 11- September 26, 2015: Early Teal Season
- November 21- November 28, 2015, December 12, 2015 - January 31, 2016: Duck and Canada Geese Seasons
- February 14- February 29, 2016: Canada Geese Season

2.2.2 RECREATION SITE INVENTORY

Site inventories were completed at recreation sites on Monticello and Parr Reservoirs (see Table 1). Data on the types of activities supported, parking capacity, the type, number, and size of facilities (bathhouses/restrooms, boat ramps, picnic shelters and tables, etc.) were collected for each location.

2.2.3 VEHICLE COUNTS

Traffic counters were installed to record the number of vehicles entering and exiting the public recreation areas. Vehicle counts were conducted at ten[2] study sites during the recreation season and at the five Monticello Reservoir recreation sites during the crappie season. The data collected was summarized by day type (weekdays, weekends, and holidays) for each site location. The traffic counters were configured to divide the number of vehicles counted by two, in order to account for the same vehicle entering and exiting the recreation site. Two access areas on Monticello Reservoir have two separate entrance/exit locations: the Highway 99 Informal Fishing Area, and the Highway 215 Boat Ramp. A traffic counter was installed at each entrance/exit location in order to count all vehicles entering or exiting the site. Vehicle counts provided by each counter were divided by two, consistent with the other recreation sites.

[2] After communication with SCDNR, a vehicle counter was not placed at the Broad River Waterfowl Management Area, as it is a draw-hunt site and SCDNR is well-apprised of use at that site.

Additionally, the vehicle counts for both entrances/exits were added together to account for total vehicle use at that site.

2.2.4 Public Recreation Area Visitor Exit Interviews

The preferences and perceptions of people using SCE&G's recreation sites and informal areas are important inputs in management decisions regarding the adequacy and availability of existing recreation sites. Information from recreation site users was obtained via onsite exit interviews during the prime recreation season at both the Monticello and Parr Reservoirs during April 1 through September 7 (Labor Day), 2015. In addition, exit interviews were conducted during the crappie fishing seasons from February 1 through March 31, 2016, on Monticello Reservoir.

The surveys were designed to collect user characteristics (origin, gender, age, number of people per vehicle, total group size, etc.), the type of land-based and water-based recreation activities being participated in, length of stay, perceptions of crowdedness, conditions of recreation sites, and additional recreation facility needs at the Project. Exit interviews were conducted at all five of the Monticello Reservoir sites, and at the Parr Reservoir, Cannon's Creek and Heller's Creek Public Access Areas. Surveys were not conducted at the remaining Parr Reservoir sites due to the seasonal usage of these areas or the rural and informal nature of these areas.

Two survey versions were implemented, one for Monticello Reservoir and one for Parr Reservoir. The two survey versions were similar to each other and contained similar questions (see Appendix A). The survey was pre-tested in the field, prior to implementation. All survey clerks were trained as a means of quality control and were provided detailed information on the study purpose, schedule, data collection protocols and data sheet chain of custody, and direction on appropriate interviewing techniques and attire. Clerks were monitored regularly during the entire study period.

A sampling plan was prepared in consultation with the TWC utilizing stratified random sampling to target conducting at least 30 days of interviewing at each recreation site. Sampling days included weekends, weekdays and holidays. Weekends were sampled at a greater rate than weekdays to account for the heavier use that typically occurs during those periods. All major national holidays that fell within the recreation season were included in the sampling plan (see Table 3).

TABLE 3 LIST OF HOLIDAYS INCLUDED IN THE 2015 RUNS EXIT INTERVIEW SAMPLING PLAN

Date	Holiday
May 23, 2015	Saturday before Memorial Day
May 24, 2015	Sunday before Memorial Day
May 25, 2015	Memorial Day
July 3, 2015	Friday before Independence Day
July 4, 2015	Independence Day
July 5, 2015	Sunday after Independence Day
September 5, 2015	Saturday before Labor Day
September 6, 2015	Sunday before Labor Day
September 7, 2015	Labor Day

A total of 710 surveys were distributed at the Project area, and a total of 681 useable surveys were completed. Interviewers provided an incentive of a floating keychain for survey respondents to complete the survey. Table 4 provides a summary of the response rates.

TABLE 4 SURVEY RESPONSE RATES

	Monticello Reservoir	Parr Reservoir	Total Project
Total Number Attempted	480	230	710
Individual did not speak English	8	1	9
Refusals	18	2	20
Total Number Completed	**454**	**227**	**681**
Survey Response Rate	95%	99%	96%

2.2.5 SPOT COUNTS

Spot counts were conducted at the public recreation sites where the exit interviews were conducted once per interview period, concurrent with exit interview period. Information recorded during spot counts included: date, time, and weather; amount of vehicle and vehicle/trailer parking capacity in use; number and type of activities observed at the site; and state license plate data. Spot count data was used in parallel with traffic counter data to document the number of visitors and/or vehicles present at that visit and to characterize site use.

2.2.6 WATERFOWL MANAGEMENT AREAS FOCUS GROUP AND SURVEYS

Waterfowl hunting typically occurs during the fall and winter months outside of the typical recreation season. Waterfowl hunters represent a unique group of users whose preferences and perceptions may differ from those using recreation sites during the summer months. Therefore, in order to capture the preferences and perceptions of waterfowl hunters a panel of waterfowl hunters were asked to serve as an expert panel, or focus group, to provide information about waterfowl hunting at the Project.

SCE&G, in consultation with stakeholders, formed a Waterfowl Focus Group to aid in gathering this information, and conducted a focus group of waterfowl hunters in December of 2014. The focus group was comprised of 9 individuals, which included unaffiliated waterfowl hunters, Tyger Enoree River Alliance members, and SCDNR representatives. Similar to the recreation survey, the purpose of conducting the focus group of waterfowl hunters was to obtain information about:

- hunting preferences to understand how waterfowl hunters use public access sites and areas in the Project area (identify access sites used, time and locations on the lake where hunting occurs);
- waterfowl hunting seasonal trends and distribution of activities;
- waterfowl hunting Project area preferences and needs to identify perceptions of the adequacy and condition of existing recreation sites and identify needs for additional public access for waterfowl hunting.

In addition to this focus group, mail-in surveys similar to the access site survey were distributed at the Enoree River Waterfowl Area and on Parr and Monticello reservoirs during appropriate waterfowl hunting seasons. On Monticello Reservoir, mail-in surveys were distributed on vehicles parked at the Hwy 215 boat ramp and the Hwy 99 boat ramp during the Canada Geese hunting season. A total of 18 completed surveys were returned, with 6 individuals indicating that they were waterfowl hunting at the time the survey was distributed. On Parr Reservoir, mail-in surveys were distributed on vehicles parked at Heller's and Cannon's Creek Public Access Areas during Early Teal and Duck hunting seasons. A total of 43 completed surveys returned with 40 individuals indicating that they were waterfowl hunting at the time the survey was distributed. Additionally, a survey box was placed at the Enoree River Waterfowl Area containing mail-in surveys. An unknown number of surveys were distributed at that site with only 1 completed survey returned.

2.3 ANALYSIS

The following sections provide a description of the approach for estimating existing and future recreational use, recreation site capacity and use density percentages, and recreation needs.

2.3.1 CURRENT RECREATIONAL USE ESTIMATES

Estimates of recreation use were developed for weekdays, weekends, and holidays for each public access site at the Monticello and Parr Reservoirs utilizing the traffic counters and recreation site survey data. The reported estimates of recreation are presented in "recreation days". The FERC defines a recreation day as one visit by a person to a development for purposes of recreation during any 24-hour period[3]. The average number of people at each site within the morning and afternoon periods were estimated within each day type and converted to a daily estimate. Daily estimates for each day type were expanded to represent the study period and summed for a total estimate for each recreation site. Recreational use data at the Enoree River and Broad River waterfowl areas was provided by SCDNR, including annual use estimate and harvest data.

2.3.2 FUTURE RECREATIONAL USE ESTIMATES

Estimated projections of future recreation use at Monticello Reservoir and Parr Reservoir were developed using the average annual increase in population growth over the past 10 years, as reported by the Census Bureau or the State Division of Research and Statistics, for Newberry, Fairfield and Richland counties[4]. The estimates were augmented with discussion of trends reported in the SCORP (2014) and the SC Recreation Participation & Preference Study (2005). Estimated projections are provided in 5 year intervals for the anticipated term of the license up to 50 years into the future (through year 2070).

While it is acknowledged that future changes in the supply of recreation resources, either in their quantity, accessibility, and/or quality may influence future demand and use, the demand analysis undertaken for this study does not attempt to predict what these future changes might consist of or how they might specifically affect levels of use at Project facilities. Therefore, the demand

[3] Recreation use estimates are provided in recreation days, which the Federal Energy Regulatory Commission (FERC) defines as "each visit by a person to a development for recreational purposes during any portion of a 24-hour period." Providing use estimates in this fashion allows for comparisons between sites, as well as between FERC projects around the country.
[4] Although Richland County is not within the FERC Project boundary, it is believed that a significant number of those who recreate at the Project reside within Richland County.

analysis results should be viewed as a general, data supported projection of potential future recreation pressure developed for planning purposes only.

2.3.3 Recreation Site Capacity

For purposes of this study, the carrying capacity for a recreation site is defined as the number of vehicles and boat trailers that can be parked at a recreation site at one time, based on the number of available parking spaces associated with each site. For paved parking areas, capacity was estimated by counting the number of designated parking spaces available at the recreation site. For gravel parking areas, the number of available parking spaces for each recreation site was estimated by measuring the area (sq. ft.) available for parking and estimating the number of vehicles that could be parked at the location, if optimal space were utilized. These estimates were based on parking capacity standards for vehicle length, width, and available turn around space.

2.3.4 Recreation Site Use Density

The use density of recreation sites was estimated by comparing the estimated peak number of vehicles at the sites during a specific time period with the available parking capacity for the recreation sites. Use densities were calculated for the sites at which a survey clerk was present, as the other necessary data input (i.e. initial spot count and average length of stay) was gathered through clerk data and exit interviews. One weekend day and one week day per month was randomly selected from the sampling period for each site at which a clerk performed exit interviews. Recreation capacity should be considered for typical weekday and weekend use in management and site design decisions. Therefore, holidays were not used to estimate recreation site use density as they are regarded as special circumstances, with use levels that are experienced only a few times a year.

Recreation clerk spot count data was used to determine the amount of vehicles occupying spaces at the start of a shift. The total number of vehicles entering a site per hour during a shift was obtained from traffic counters. The average trip length in hours (from survey results) was used to estimate the length of time vehicles were occupying spaces at each site. For example, if the average length of stay was 3 hours, vehicles entering the site at 1:00 pm were assumed to remain at the site and exit at 4:00 pm. Total hourly vehicle counts from the initial spot count and from traffic counters were then estimated for each hour during the selected sample day for each site. The maximum number of vehicles at the site at a given time (peak hour) was then derived from the totals. The maximum number of vehicles was then divided by the parking capacity to provide an estimated use density for each site.

It should be noted that use density should be considered an *over-estimate*, as traffic counter data also includes those individuals that drive through the site, but do not stay to recreate. Moreover, vehicles observed by clerks performing initial spot counts at the beginning of their shift were assumed to have stayed for the entire average length of stay estimated for the site. Therefore, this should also be considered an over-estimate as these vehicles may have departed soon after the initial count.

An example of how this analysis was performed is shown in Table 5, and explained as follows. Fictitious numbers are used for this explanation. Suppose a recreation site had 250 parking spaces, and survey results show that people using that site spent an average of 3 hours there. Initial spot count data indicated that there were 24 vehicles parked at the site when the clerk arrived. If 56 vehicles arrive from 7:00 to 8:00 AM, 50 arrive from 8:00 AM to 9:00 AM, and 64 arrive from 9:00 AM to 10:00 AM, then the parking area would be at 78 percent capacity until the first vehicle departed around 10:00 AM. If 56 additional vehicles arrive before 10:00 AM, then there may not be enough parking spaces (capacity) to accommodate demand (number of vehicles).

TABLE 5 HYPOTHETICAL CALCULATION OF ESTIMATED AVERAGE DEMAND FOR PARKING SPACES

Methods	Example Calculation
On average, length of time that individuals spend at the recreation site	Average Length of Stay 3 hours
Vehicle counts by hour from spot count and traffic counter for recreation clerk shift	Initial Spot Count: 24 at 7 AM (assume vehicles stay the 3 hour length of stay) 56 vehicles traffic counter from 7:00 AM to 8:00 AM 50 vehicles traffic counter from 8:00 AM to 9:00 AM 64 vehicles traffic counter from 9:00 AM to 10:00 AM 48 vehicles traffic counter from 10:00 AM to 11:00 AM 62 vehicles traffic counter from 11:00 AM to 12:00 PM 50 vehicles traffic counter from 12:00 PM to 1:00 PM
Vehicle counts are summed across the average length of stay	Vehicles at the site from 7:00 AM to 10:00 AM = 24+56+50+64=194 Vehicles at the site from 8:00 AM to 11:00 AM = 50+64+48=162 Vehicles at the site from 9:00 AM to 12:00 PM = 64+48+62=174 Vehicles at the site from 10:00 AM to 1:00 PM = 48+62+50=160 Vehicles at the site from 11:00 AM to 2:00 PM = 62+50+50=162 Vehicles at the site from 12:00 AM to 3:00 PM = 50+50+50=150 Vehicles begin departing at 10:00 AM, resulting in a maximum estimate of 194 vehicles at the recreation site.
Ratio of maximum vehicles at site to parking capacity	Site parking capacity = 250 spaces Maximum vehicles = 194 Capacity at which the site is used = 194/250 = 78%

2.3.5 RECREATION NEEDS ASSESSMENT

The need for recreation and site development or modification of existing recreation resources will be assessed based on the inventory, condition, capacity, and exit interview survey results. The needs assessment will focus on the existing condition and user opinions of recreation sites, whether a particular site provides "barrier free" access, and the ability of sites to meet current and anticipated future recreation demand pressures. Consideration will also be given to site opportunities and constraints, as well as support facilities such as signage and maintenance. The need for new recreational sites and facilities will be determined through assessment of the information collected and summarized within this report and the input of stakeholders on the Recreation and Lake & Land Management RCG. Final protection mitigation and enhancement measures relating to recreation resources will be included in a Settlement Agreement and proposed Recreation Management Plan.

3.0 RECREATION RESOURCES

This section provides an overview of regional recreational resources available in the Project vicinity. Additionally, detailed information is summarized regarding the recreation facilities located at Parr and Monticello reservoirs included in this study.

3.1 REGIONAL RECREATION RESOURCES

The Project is located within Newberry and Fairfield Counties and situated in the Piedmont Region of South Carolina. The Piedmont Region is the largest geographic region in the State and is home to Kings Mountain National Military Park, Sumter National Forest, and major tourist attractions such as Lake Keowee, Lake Hartwell, Lake Wylie, the Catawba River, and the Saluda River (StudySC.org, 2014). The Project is not located on a designated wild and scenic river segment. In addition, no Project lands are being considered for inclusion in the National Trails System or as a Wilderness Area.

Regionally and nationally recognized recreation opportunities within the Project vicinity include Dreher Island State Park, Chester State Park, Kings Mountain National Military Park, Sumter National Forest, Lake Greenwood State Park, and Lake Wateree State Park. These areas provide opportunities for hunting, boating, fishing, hiking, picnicking, swimming, and camping in the Project vicinity (StudySC.org, 2014).

Sumter National Forest is a 371,000-acre national forest providing walking, riding, and camping opportunities. Lake Greenwood State Park provides access to the 11,400-acre Lake Greenwood along the southwestern border of Newberry County with several miles of shoreline and public access. Lake Wateree State Park is a 72-acre state park containing outdoor and water-oriented facilities, a campground, picnic areas, and a boat ramp. Lynch's Woods Park is a 260-acre woodland area in the city of Newberry which has 7.5 miles of hiking and biking trails, 3.5 miles of equestrian trails, a primitive camp site, and picnic tables. Lake Monticello Park is a 25-acre park containing tennis courts, ball field, basketball court, picnic facilities, fishing pier, and walking trail.

Lake Murray is a 79.5 square-mile hydropower reservoir located in Newberry, Saluda, Lexington and Richland Counties. Lake Murray supports numerous on-water recreation opportunities through 15 public access sites situated around the reservoir. Lake Murray also hosts several national and local fishing tournaments. The lower Saluda River, which extends 10 miles downstream of the Lake Murray Dam, supports an active recreational fishery and provides a variety of paddling experiences, from flatwater to whitewater.

Fairfield and Newberry Counties encompass several municipal recreation areas. Fairfield County has 16 public parks and recreation facilities encompassing approximately 90 acres, and Newberry County has 45 public parks and recreation facilities encompassing more than 530 acres. These facilities (Table 6) provide the following amenities: playgrounds, picnic areas, softball fields, horseback riding, hand-carried and trailered boat launches, basketball courts, swimming pools, birding and wildlife watching opportunities, and multi-use trails that support hiking.

TABLE 6 RECREATION FACILITIES IN FAIRFIELD AND NEWBERRY COUNTIES

Fairfield County	Newberry County
Lake Monticello	Brick House Recreation Area
Feasterville Mini Park	Broad River Canoe Access
Mitford Mini Park	Cannon's Creek Public Access Area
Sheldon Mini Park	Dreher Island State Park
Eunice Shelton Trail	Heller's Creek Access Area
Adger Park	Little Mountain Reunion Park
Blair Park/Willie Lee Recreation Center	Lynch's Woods Park
Garden St. Park	Peak-to-Prosperity Rail Trail
Middle Six Mini Park	Wells Japanese Garden
Chappelltown Mini Park	Little Mountain Explorer Bicycling Route
Centerville Mini Park	
Horeb Glenn Park	
Alton Trail	
Fortunes Spring Park	

The South Carolina State Comprehensive Outdoor Recreation Plan (SCORP) provides information on the supply and demand for outdoor recreation facilities in South Carolina, creates policies for meeting that demand, and to qualify South Carolina for funding from the federal Land and Water Conservation Fund (LWCF) for acquiring or developing lands for public outdoor recreation (SCPRT 2008). The SCORP offers no recommendations specific to the

Project, but the recreation goals outlined in the SCORP may be applied by governments at the state, county, or municipal levels, including Newberry and Fairfield Counties and the city of Newberry. The following goals of the SCORP may be relevant to the Project: promote the state's tourist attractions; provide for the preservation and perpetuation of South Carolina's rich historical heritage; lease or convey lands to local governments for parks and recreation facilities; and, study the state's park and outdoor recreational resources and facilities, the current and projected needs for these resources, and the extent to which these needs are being met (SCPRT, 2008).

3.2 PROJECT AREA RECREATION RESOURCES

SCE&G permits public use of the Project land and waters for recreation. Monticello and Parr Reservoirs are popular recreational sites in western Fairfield County. SCE&G maintains six public access sites on Monticello and Parr reservoirs that are considered Project recreational facilities. In addition to the Project recreation sites, there are two informal recreation sites at the Project and one informal recreation site located primarily outside of the Project boundary. Sites are not regularly staffed, but are frequented by managing personnel and/or law enforcement to check on site and safety conditions. Table 7 lists recreation sites and associated facilities provided at these sites at Monticello and Parr Reservoirs. The location of these sites are shown in Figure 1.

On Monticello Reservoir, Project and non-Project recreation access sites include the Scenic Overlook, the Highway 215 Boat Ramp, the Highway 99 Public Access Area, the Recreation Lake Access Area, and the Highway 99 Informal Fishing Area. Monticello Reservoir recreation sites provide boating and fishing access and scenic viewing opportunities. The Scenic Overlook is managed in conjunction with the Fairfield County Recreation Commission, and includes a multiple-use recreational area at Monticello Reservoir, that includes a scenic overlook, baseball field, tennis courts, basketball court, picnic facilities, and fishing facilities. The Highway 99 Informal Fishing Area is available for bank fishing only.

On the Parr Reservoir, there are two Project boat ramps maintained by SCE&G and one informal boat ramp. Cannon's Creek and Heller's Creek provide boat launches, courtesy docks, and picnic facilities. The Highway 34 Primitive Ramp provides primitive boat access to the upper portions of Parr Reservoir. Additionally, two waterfowl management areas, the Broad River and the

Enoree River waterfowl areas were included in this study. These facilities provide public waterfowl hunting access and are under management jurisdiction of SCDNR under its WMA Program. These waterfowl areas are located within the Project boundary adjacent to the Parr Reservoir (Broad River Waterfowl Sub-impoundment) and the Enoree River (Enoree River Waterfowl Sub-impoundment). The RCG also requested that the study include collecting use information for the Enoree River Bridge Informal Access area which is located outside of the Project boundary, on U.S. Forest Service lands.

TABLE 7 PUBLIC RECREATION SITE INVENTORY SUMMARY FOR MONTICELLO AND PARR RESERVOIRS

Site Name	$ Fee	Barrier Free/ADA Amenities [a]	Picnicking	# Shelters	# of Tables	# of Grills	Trail Length (Mi)	Camping	Swimming	Bank Fishing	Dock Fishing	# Ramps	# Docks	Parking Spaces	Restrooms	Playground and Sport Facilities	Owned by SCE&G	Operated by SCE&G	Leased to Other Entity
Monticello Reservoir																			
Scenic Overlook	$0	●	●	5	12		1	●	●	●	●		1	100	●	●	●	Partial	Partial
Highway 215 Boat Ramp	$0		●	1	2					●		2	1	30			●	●	
Highway 99 Public Access Area	$0		●	2	5	1		●		●		3	1	80	●		●	●	
Recreation Lake Access Area	$0	●	●	2	26	7	0.3		●	●		1		105	●		●	●	
Highway 99 Informal Fishing Area	$0									●				20			●	●	
TOTALS	$0			**10**	**45**	**8**	**1.3**					**6**	**3**	**335**					
Parr Reservoir																			
Cannon's Creek Public Access Area	$0		●	2	2	1		●	●	●		1		30	●		●	●	
Heller's Creek Public Access Area	$0		●	2	2			●		●		1		25	●		●	●	
Highway 34 Primitive Ramp	$0							●		●		1		5			●	●	
TOTALS	$0			**4**	**4**	**1**						**3**		**60**					

[a] Although a recreation site may not be entirely ADA-compliant, this column indicates that the facility provides some level of barrier free amenities. Barrier free access at Project recreation sites is discussed further in Section 6.0.

3.2.1 PROJECT RECREATION FACILITIES - MONTICELLO RESERVOIR

SCENIC OVERLOOK

PHOTO 1 SCENIC OVERLOOK

Scenic Overlook Park (Photo 1) is located on the eastern shore of the reservoir and can be accessed from Highway 215. This is a day use site, managed in conjunction with Fairfield County. The site is designed primarily for dock fishing, bank fishing, and picnicking. The site provides one picnic shelter and eight picnic tables, a fishing pier, a scenic overlook, gravel parking areas and restrooms. In addition to these amenities, the portion of the site maintained by Fairfield County includes tennis courts, a baseball field, a playground area, additional picnic shelters, a 1-mile hiking trail, and a community center. The site is unstaffed and free to visitors year round.

Based on a scale of 1 to 5, with 5 being excellent, 2015 exit interview survey respondents rated the overall site condition of the Scenic Overlook Park as 4.42 (n=132).

HIGHWAY 215 BOAT RAMP

PHOTO 2 HIGHWAY 215 BOAT RAMP

The Highway 215 Boat Ramp (Photo 2) is located on the eastern side of the reservoir, off of Highway 215. The site is primarily used as a boat launch, and offers a dock and two boat ramps. There are 30 parking spaces for vehicles with trailers. The site also provides a picnic shelter with two tables. There are no restrooms at the site. The site is unstaffed, and use of the boat ramp is free to visitors year round.

Based on a scale of 1 to 5, with 5 being excellent, 2015 exit interview survey respondents rated the overall site condition of the Highway 215 Boat Ramp as 4.44 (n=134).

HIGHWAY 99 PUBLIC ACCESS AREA

PHOTO 3 HIGHWAY 99 PUBLIC ACCESS AREA

The Highway 99 Public Access Area (Photo 3) is a medium sized recreation area that is open for both day use and primitive tent camping. It is located on the northern side of the reservoir off of Highway 99. The site is primarily used as a boat launch, and also provides opportunities for primitive tent camping, picnicking, bank fishing, and boating. The site offers three boat ramps and one dock, as well as 80 parking spaces for vehicles with trailers. The site also provides restrooms, two picnic shelters, five picnic tables, and one grill. The area is unstaffed and access is free to visitors year round.

Based on a scale of 1 to 5, with 5 being excellent, 2015 exit interview survey respondents rated the overall site condition of the Highway 99 Public Access Area as 4.17 (n=104).

RECREATION LAKE ACCESS AREA

PHOTO 4 RECREATION LAKE ACCESS AREA

The Recreation Lake Access Area (Photo 4) is adjacent to Lake Monticello, off of Highway 99. The site provides a boat launch that is open year-round and a beach area that is open from April 1 to September 30. The site provides a total of 2 picnic shelters, 26 tables, and 7 grills. There is a 0.3-mile-long hiking trail at the beach area, as well. The beach area provides a gravel parking area for approximately 95 vehicles, including designated ADA parking spaces (although unpaved). The boat launch provides parking for up to 10 vehicles with trailers. Restrooms are provided at both the beach area and the boat launch. Both areas are unstaffed and free to visitors.

Based on a scale of 1 to 5, with 5 being excellent, the average survey response rating the overall condition of the site was 4.0 (n=61).

3.2.2 PROJECT RECREATION FACILITIES - PARR RESERVOIR

CANNON'S CREEK PUBLIC ACCESS AREA

PHOTO 5 CANNON'S CREEK PUBLIC ACCESS AREA

Cannon's Creek Public Access Area (Photo 6) is located on the western side of Parr Reservoir off of Broad River Road. This site provides one boat launch, as well as amenities that include two shelters, two tables, a grill, and restrooms. There are parking spaces for up to 30 vehicles with trailers. Primitive camping is allowed at this site.

Based on a scale of 1 to 5, with 5 being excellent, 2015 exit interview survey respondents rated the overall site condition of this site as 3.95 (n=146).

<u>HELLER'S CREEK PUBLIC ACCESS AREA</u>

PHOTO 6 HELLER'S CREEK PUBLIC ACCESS AREA

Heller's Creek Public Access Area (Photo 7) is located on the western side of Parr reservoir, off of Broad River Road. This site provides one boat launch, as well as amenities that include two picnic shelters, two tables, and restrooms. There are parking spaces for up to 25 vehicles with trailers. Primitive camping is allowed at this site. The site is unstaffed and open year round to visitors with no fees required.

Based on a scale of 1 to 5, with 5 being excellent, 2015 exit interview survey respondents rated the overall site condition of this site as 3.81 (n=80).

BROAD RIVER WATERFOWL MANAGEMENT AREA

The Broad River Waterfowl Management Area is a Category I waterfowl area, meaning hunts are conducted on selected Saturdays during the waterfowl season, with hunters having been selected by the SCDNR through a lottery system. This site is closed to the public during waterfowl season, and it is open to the public from February 2 through October 31. Recreation opportunities outside of waterfowl season include bird watching, bank fishing, deer hunting, and small game hunting.

ENOREE RIVER WATERFOWL MANAGEMENT AREA

The Enoree River Waterfowl Management Area is a category II hunting area, meaning it is open to the general public for waterfowl hunting. Waterfowl hunting is permitted on Saturdays until 12 p.m. during the hunting season. Outside of the waterfowl season, the area is open to visitors for activities including bird watching, deer hunting, and small game hunting.

3.2.3 NON-PROJECT ACCESS AREAS

HWY 99 INFORMAL FISHING AREA

PHOTO 7 HIGHWAY 99 INFORMAL FISHING AREA

The Highway 99 Informal Fishing Area (Photo 5) is located on the north side of Monticello Reservoir, off of Highway 99. This small, day use recreation site is primarily designed for bank fishing. Swimming is prohibited at this site and there are no tables or other amenities. The site provides parking for up to 20 vehicles, as well as shoreline access for bank fishing. There are no fees at this site and it is open year round to visitors.

Based on a scale of 1 to 5, with 5 being excellent, 2015 exit interview survey respondents rated the overall site condition of the Highway 99 Informal Fishing Area as 4.24 (n=21).

ENOREE RIVER BRIDGE INFORMAL ACCESS AREA

PHOTO 8 ENOREE RIVER BRIDGE INFORMAL ACCESS AREA

At the request of the RCG, a traffic counter was placed at the Enoree River Bridge Informal Access Area. This area is located on U.S. Forest Service lands, outside of the Project boundary. The Project boundary extends to the high water mark in the vicinity of this access area. This site provides a primitive ramp, used primarily for small watercraft access to the Enoree River.

HIGHWAY 34 PRIMITIVE RAMP

PHOTO 9 HIGHWAY 34 PRIMITIVE RAMP

The Highway 34 Primitive Ramp (Photo 8) provides a gravel/earthen boat ramp and parking for up to five vehicles. The site provides boaters and shoreline anglers with access to the Broad River at the upper end of Parr Reservoir. Primitive camping is also permitted at the site. There are no fees at this site and it is open year round.

A site condition rating is not available for the Highway 34 Primitive Ramp, as exit interviews were not conducted at this site.

4.0 CHARACTERIZATION OF EXISTING RECREATION USE

The following sections characterize the existing recreation use at public access sites on Monticello Reservoir and Parr Reservoir during the study season. This section summarizes visitor characteristics at the recreation sites, as well as the patterns of recreational use at the sites including type of recreation activity.

4.1 PUBLIC ACCESS SITE USERS

Knowledge of who is using Project sites and why they are using them can be useful in understanding future needs and how best to accommodate them. In this section, the characteristics of public access site users and their reasons for recreating at the Project are described.

4.1.1 MONTICELLO RESERVOIR

Of the individuals interviewed at Monticello Reservoir sites, the majority were male (72 percent) and the average age was 48. Almost all of the visitors were from South Carolina (97 percent) with a large representation from the surrounding four (Fairfield, Lexington, Newberry and Richland) counties and the Columbia area (18 percent). Of those respondents interviewed, less than 2 percent indicated they owned a permanent or seasonal lakefront residence on Monticello.

In terms of why visitors chose to recreate at Monticello Reservoir, 17 percent indicated it was close to home, 15 percent indicated they visited the site to go fishing, and others indicated that the easy access and facilities were a motivating factor for recreating at the Reservoir. In addition, many visitors stated that it provided a place to recreate with friends and family.

Table 8 provides a summary of visitor characteristics at the recreation sites where visitor interviews were conducted. The average party size of visitors interviewed at Monticello sites was 2.7 visitors, with 2.3 being the average number of people in a vehicle when visiting the sites. The average length of stay was about 3 hours 20 minutes, with the Scenic Overlook having the shortest length of stay per visit and the two boat ramp access areas having the longest, at 5 hours for the average length of stay.

TABLE 8 SUMMARY OF VISITOR CHARACTERISTICS AT MONTICELLO RESERVOIR SITES

Site Name		Age	Number of People in Vehicle	Party Size	Length of Stay
Scenic Overlook	Mean	47	2.59	3.06	0:56:48
	Median	49	2.00	2.00	0:15:00
	N	*131*	*93*	*132*	*132*
Highway 215 Boat Ramp	Mean	51	2.23	2.26	4:50:36
	Median	53	2.00	2.00	4:26:00
	N	*134*	*107*	*134*	*133*
Highway 99 Boat Ramp	Mean	48	2.05	2.69	4:53:34
	Median	49	2.00	3.00	4:05:30
	N	*99*	*55*	*106*	*106*
Recreation Lake Access Area	Mean	41	2.05	3.03	2:33:30
	Median	42	2.00	3.00	2:35:00
	N	*53*	*20*	*61*	*61*
Highway 99 Informal Fishing Area	Mean	45	2.50	2.71	2:59:45
	Median	45	2.00	3.00	0:30:00
	N	*17*	*10*	*21*	*21*
Total	**Mean**	**48**	**2.31**	**2.72**	**3:19:34**
	Median	**49**	**2.00**	**2.00**	**2:40:00**
	N	***434***	***285***	***454***	***453***

4.1.2 PARR RESERVOIR

The average age of the individuals interviewed at the Parr Reservoir sites was 43 and 89 percent were male. Of those respondents interviewed, less than 2 percent indicated they owned a permanent or seasonal lakefront residence on Parr Reservoir. All except for one visitor interviewed were from South Carolina with a large representation from Newberry County (over 75 percent) and from the Columbia area (12 percent).

In terms of why visitors chose to recreate at Parr Reservoir, the majority of those individuals interviewed indicated good fishing (52 percent). Others indicated that they selected the site because it was not crowded, had easy access, and that the site was close to home. The average party size was 2.3 visitors, with the average number of people in a vehicle when visiting the sites of 2.1 people. The average length of stay was about 3 hours 30 minutes. Table 9 provides a summary of visitor characteristics at the recreation sites where visitor interviews were conducted.

TABLE 9 SUMMARY OF VISITOR CHARACTERISTICS AT PARR RESERVOIR SITES

Site Name		Age	Number of People in Vehicle	Party Size	Length of Stay
Cannon's Creek Public Access Area	Mean	44	2.19	2.46	3:13:55
	Median	41	2.00	2.00	3:10:00
	N	*139*	*124*	*147*	*148*
Heller's Creek Public Access Area	Mean	42	2.08	2.09	3:58:06
	Median	39	2.00	2.00	3:50:00
	N	*77*	*76*	*80*	*80*
Total	**Mean**	**43**	**2.15**	**2.33**	**3:29:25**
	Median	**41**	**2.00**	**2.00**	**3:31:30**
	N	***216***	***200***	***227***	***228***

4.2 CURRENT USE

Recreation use estimates and identification of recreation activities are provided below for the Project, followed by total and site-specific estimates for the Monticello Reservoir and the Parr Reservoir.

4.2.1 PROJECT

During the April through September 2015 recreation season, recreation site visitation at the Project was estimated at a total of 152,709 recreation days. About 52 percent of the total use occurred on weekdays, and 38 percent on weekends and 10 percent on holidays. The greatest amount of use occurred during May (23 percent) followed by June (19 percent) and July (18 percent) during this period. Monticello Reservoir sites received the greatest use of the developments at 126,525 recreation days (83 percent of the total use) and Parr Reservoir sites received 26,184 recreation days during this period. See Table 10 for the summary of the recreation visitation by reservoir and day type during the 2015 study period.

TABLE 10 ESTIMATED RECREATION DAYS FOR MONTICELLO RESERVOIR AND PARR RESERVOIR SITES

	Monticello Reservoir Sites	Parr Reservoir Sites	Total
April	**18,318**	**4,217**	**22,535**
Weekdays	11,503	2,703	14,206
Weekends	6,815	1,514	8,329
Holidays	-	-	-
May	**29,267**	**6,018**	**35,284**
Weekdays	10,895	2,799	13,695
Weekends	11,975	2,232	14,208
Holidays	6,396	986	7,382
June	**23,992**	**4,645**	**28,636**
Weekdays	12,216	3,031	15,247
Weekends	11,776	1,614	13,390
Holidays	-	-	-
July	**23,721**	**4,191**	**27,912**
Weekdays	12,571	2,417	14,988
Weekends	6,776	1,195	7,971
Holidays	4,374	579	4,953
August	**17,463**	**4,103**	**21,566**
Weekdays	9,481	2,169	11,650
Weekends	7,983	1,934	9,916
Holidays	-	-	-
September	**13,765**	**3,010**	**16,775**
Weekdays	8,042	1,763	9,805
Weekends	2,810	775	3,585
Holidays	2,913	472	3,386
Total			
Weekdays	**64,707**	**14,883**	**79,590**
Weekends	**48,135**	**9,263**	**57,398**
Holidays	**13,683**	**2,038**	**15,721**
TOTAL	**126,525**	**26,184**	**152,709**

4.2.2 MONTICELLO RESERVOIR

Overall, the public recreation sites at Monticello Reservoir supported an estimated 126,525 recreation days during the study period (Table 11). The most used site was the Scenic Overlook (30 percent of total use at Monticello Reservoir sites and 37,384 recreation days), followed by the Highway 99 Informal Fishing Area (21 percent of total use). The Recreation Lake Access Area (17 percent of total use) and the Highway 215 Boat Ramp (17 percent of total use) and the Highway 99 Boat Ramp (15 percent of total use) received fairly equal amounts of use across the recreation season. About 51 percent of the total use occurred on weekdays, about 38 percent on weekends and the remaining 11 percent on holidays. The month of May received the greatest use at 23 percent of the total use during the recreation study season, following by June (19 percent) and July (19 percent).

TABLE 11 ESTIMATED RECREATION DAYS FOR MONTICELLO RESERVOIR SITES

	Scenic Overlook	Highway 215 Boat Ramp	Highway 99 Boat Ramp	Recreation Lake Access Area	Highway 99 Informal Fishing Area	Total
April						**18,318**
Weekdays	3,362	2,110	1,894	947	3,190	**11,503**
Weekends	2,051	1,249	1,246	689	1,580	**6,815**
Holidays	-	-			-	**-**
May						**29,267**
Weekdays	3,108	2,185	1,763	1,189	2,650	**10,895**
Weekends	3,730	2,105	1,968	2,312	1,860	**11,975**
Holidays	1,756	1,244	990	1,581	825	**6,396**
June						**23,992**
Weekdays	3,362	1,864	1,759	2,481	2,750	**12,216**
Weekends	3,750	1,766	1,689	3,050	1,520	**11,776**
Holidays	-	-	-	-	-	**-**
July						**23,721**
Weekdays	3,476	2,011	1,939	2,120	3,025	**12,571**
Weekends	1,958	1,231	972	1,820	795	**6,776**
Holidays	1,368	549	640	1,285	533	**4,374**
August						**17,463**
Weekdays	2,883	1,639	1,248	1,033	2,678	**9,481**
Weekends	2,253	1,539	1,271	1,620	1,300	**7,983**
Holidays		-	-	-	-	**-**
September						**13,765**
Weekdays	2,448	1,218	947	1,119	2,310	**8,042**
Weekends	901	482	615	197	615	**2,810**
Holidays	979	468	406	603	458	**2,913**
Total						

	Scenic Overlook	Highway 215 Boat Ramp	Highway 99 Boat Ramp	Recreation Lake Access Area	Highway 99 Informal Fishing Area	Total
Weekdays	**18,638**	**11,027**	**9,551**	**8,889**	**16,603**	**64,707**
Weekends	**14,644**	**8,371**	**7,761**	**9,688**	**7,670**	**48,135**
Holidays	**4,103**	**2,261**	**2,036**	**3,469**	**1,815**	**13,683**
TOTAL	**37,384**	**21,660**	**19,348**	**22,046**	**26,088**	**126,525**

The primary recreation activities on Monticello Reservoir included boat fishing (42 percent), following by bank fishing, pier/dock fishing and swimming (Table 12). Visitors also indicated they participated in other activities while at the reservoir in addition to their primary activities, these included picnicking, sunbathing, sightseeing, and walking. In terms of the activity by day-type, visitors interviewed indicated participation in similar type of activities during weekdays and weekend periods. For holidays, visitors reported some increased activities for canoeing and kayaking, as compared to the non-holiday periods.

TABLE 12 PRIMARY ACTIVITIES AT MONTICELLO RESERVOIR

	Day Type			
Activity	**Weekday**	**Weekend**	**Holiday**	**Total**
Boat Fishing	42%	43%	34%	**42%**
Pier/Dock Fishing	13%	11%	9%	**11%**
Bank Fishing	14%	20%	16%	**18%**
Motor Boating	3%	1%	0%	**2%**
Pontoon/Party Boating	0%	0%	0%	**0%**
Sailing	1%	0%	0%	**0%**
Canoeing/Kayaking	0%	1%	11%	**2%**
Windsurfing	1%	0%	0%	**0%**
Paddleboarding	0%	0%	2%	**0%**
Bicycling	0%	0%	0%	**0%**
Tent/Vehicle Camping	2%	5%	2%	**4%**
Walking/Hiking/Backpacking	2%	1%	5%	**1%**
Sightseeing	5%	3%	2%	**4%**
Hunting	0%	0%	2%	**0%**
Swimming	10%	6%	14%	**8%**
Picnicking	3%	5%	2%	**4%**
Sunbathing	1%	1%	0%	**1%**
Other	3%	2%	0%	**2%**
Total	**100%**	**100%**	**100%**	**100%**
N	*127*	*282*	*44*	*453*

About 54 percent of exit interview respondents indicated they spent time on Monticello Reservoir and about 15 percent indicated they recreated on Monticello Reservoir Islands. Of those respondents that recreated on the islands, the primary activity was bank fishing on the islands at 53 percent followed by camping on the islands at 38 percent (see Table 13).

TABLE 13 PRIMARY ACTIVITIES AT MONTICELLO RESERVOIR ISLANDS

Activity [a]	Day Type			Total
	Weekday	Weekend	Holiday	
Island Sunbathing	0%	20%	0%	**13%**
Island Bank Fishing	43%	70%	0%	**53%**
Island Hunting	0%	10%	40%	**13%**
Island Camping	43%	45%	0%	**38%**
Island Walking/Hiking	0%	15%	20%	**13%**
Island Sightseeing	14%	30%	0%	**22%**
Island Nature Study/Wildlife Viewing/Photography	14%	20%	20%	**19%**
Island Swimming	29%	30%	40%	**31%**
Island Picnicking	14%	20%	20%	**19%**
N	*7*	*20*	*5*	*32*

[a] Respondents were asked what activities they participated in while on Monticello island(s). Many individuals provided more than one activity in response to this question. Therefore, percentages equal greater than 100 percent.

In addition to data collected during the primary recreation season (April 1 through September 7), recreation use data was collected at the Monticello Reservoir sites during early crappie fishing season (February 1 through March 31, 2016). Table 14 summarizes recreation use at each site. The Highway 99 Informal Fishing Area site visitation was estimated at the greatest use; at about 36 percent, following by the Scenic Overlook at 25 percent of the total use during this period. Weekdays during March comprised the most use with 45 percent of the total estimated use during this period.

TABLE 14 MONTICELLO RESERVOIR RECREATION USE DURING EARLY CRAPPIE SEASON, 2016

	Scenic Overlook	Highway 215 Boat Ramp	Highway 99 Boat Ramp	Recreation Lake Access Area	Highway 99 Informal Fishing Area	Total
February						
Weekdays	1,360	1,030	646	215	2,940	**6,191**
Weekends	767	785	656	180	860	**3,248**
Holidays	-	-	-	-	-	**-**
March						
Weekdays	2,919	2,103	2,027	660	4,313	**12,022**
Weekends	1,595	981	1,033	344	1,480	**5,434**
Holidays	-	-	-	-	-	**-**
TOTAL	**6,641**	**4,899**	**4,362**	**1,400**	**9,593**	**26,895**

4.2.3 PARR RESERVOIR

The public recreation sites at Parr Reservoir supported an estimated 26,184 recreation days during the study period (Table 15). The most used sites were the Cannon's Creek Public Access Area (14,452 recreation days and 55 percent of the total use at the Parr Reservoir sites), followed by Heller's Creek Public Access Area (29 percent), and Highway 34 Primitive Ramp (16 percent). About 57 percent of the total use occurred on weekdays, about 35 percent on weekends and the remaining 8 percent on holidays. The month of May received the greatest use at 23 percent of the total use during the recreation study season, following by June (18 percent), April (16 percent), July (16 percent) and August (16 percent).

TABLE 15 ESTIMATED RECREATION DAYS FOR PARR RESERVOIR SITES

	Cannon's Creek Public Access Area	Heller's Creek Public Access Area	Highway 34 Primitive Ramp	Total
April				**4,217**
Weekdays	1,638	686	378	**2,703**
Weekends	823	433	258	**1,514**
Holidays	-	-	-	**-**
May				**6,018**
Weekdays	1,621	749	430	**2,799**
Weekends	1,121	716	396	**2,232**
Holidays	519	312	155	**986**
June				**4,645**
Weekdays	1,734	824	473	**3,031**
Weekends	806	532	275	**1,614**
Holidays	-	-	-	**-**
July				**4,191**
Weekdays	1,349	595	473	**2,417**
Weekends	526	437	232	**1,195**
Holidays	302	200	77	**579**
August				**4,103**
Weekdays	1,242	612	316	**2,169**
Weekends	1,029	603	301	**1,934**
Holidays	-	-	-	**-**
September				**3,010**
Weekdays	1,012	480	271	**1,763**
Weekends	434	212	129	**775**
Holidays	296	112	65	**472**
Total				
Weekdays	**8,596**	**3,946**	**2,341**	**14,883**
Weekends	**4,739**	**2,933**	**1,591**	**9,263**
Holidays	**1,117**	**624**	**297**	**2,038**
TOTAL	**14,452**	**7,503**	**4,229**	**26,184**

The predominant recreation activity on Parr Reservoir was boat fishing (75 percent), followed by bank fishing at 12 percent of visitors indicating this as their primary recreation activity (Table 16). Other secondary activities reported included tent/vehicle camping, sightseeing and pier/dock fishing. In terms of the activity by day-type, visitors interviewed indicated participation in similar type of activities during weekdays and weekend periods. For holidays, visitors reported some increased activities for tent/vehicle camping, as compared to the non-holiday periods.

TABLE 16 PRIMARY ACTIVITIES AT PARR RESERVOIR SITES

Activity	Day Type			Total
	Weekday	Weekend	Holiday	
Boat Fishing	85%	73%	64%	**75%**
Pier/Dock Fishing	2%	2%	0%	**2%**
Bank Fishing	8%	15%	11%	**12%**
Motor Boating	0%	0%	3%	**0%**
Canoeing/Kayaking	0%	2%	0%	**1%**
Tent/Vehicle Camping	0%	5%	11%	**5%**
Sightseeing	2%	2%	3%	**2%**
Hunting	0%	0%	3%	**0%**
Swimming	0%	0%	3%	**0%**
Picnicking	0%	1%	0%	**0%**
Other	2%	0%	3%	**1%**
None	2%	0%	0%	**0%**
Total	**100%**	**100%**	**100%**	**100%**
N	*61*	*130*	*36*	*227*

4.2.4 ENOREE RIVER BRIDGE INFORMAL ACCESS AREA

In addition to the Project public access sites, the recreation visitation was collected at the Enoree River Bridge Informal Access Area, which is located mostly outside of the Project boundary. Visitation was estimated through vehicle counters, and no interviews were conducted at this non-Project facility. For the use estimates, the vehicle counts were estimated and then the average rating of 2.15 people per vehicle was applied based on the average visitor use estimates at Cannon’s and Heller’s Creek Public Access Areas. The total estimated recreation use during the study season (April through September) was estimated at 1,342 visitor days with 69 percent of this use occurring during weekdays, 27 percent during weekends and the remaining use during holiday periods. April had the greatest visitation with 370 recreation days at 28 percent, followed by May (17 percent), June (16 percent) and September (16 percent) of the total use during the study period (Table 17).

TABLE 17 ESTIMATED RECREATION DAYS FOR NON-PROJECT SITES – ENOREE RIVER BRIDGE INFORMAL ACCESS AREA

	Enoree Bridge
April	**370**
Weekdays	284
Weekends	86
Holidays	-
May	**234**
Weekdays	129
Weekends	86
Holidays	19
June	**211**
Weekdays	142
Weekends	69
Holidays	-
July	**181**
Weekdays	142
Weekends	26
Holidays	13
August	**133**
Weekdays	90
Weekends	43
Holidays	-
September	**213**
Weekdays	135
Weekends	52
Holidays	26
Total	
Weekdays	**922**
Weekends	**361**
Holidays	**58**
TOTAL	**1,342**

4.2.5 WATERFOWL MANAGEMENT AREAS

Waterfowl hunting remains an important recreation activity at the Project and was identified as a primary goal (Goal 2) of this study.

A variety of waterfowl hunting opportunities are available to Project recreators. The waters of Monticello Reservoir, excluding the Recreation Lake, are designated as a waterfowl management area under SCDNR's Waterfowl Management Area (WMA) program and are available for public waterfowl hunting to those individuals possessing a permit. Portions of Parr Reservoir are also designated under SCDNR's WMA program. The Broad River and Enoree River Waterfowl Areas, which are managed by SCDNR, are both located within the Project boundary, adjacent to Parr Reservoir and the Enoree River, respectively.

This study was constructed to gather waterfowl hunter use data by employing several different data collection methods: a waterfowl focus group; vehicle counts at recreation sites/waterfowl areas; mail-in questionnaires specific to hunting use at the Project; and, SCDNR waterfowl use data.

WATERFOWL FOCUS GROUP RESULTS

The waterfowl focus group meeting was held on December 9, 2014 and was attended by nine individuals with affiliations ranging from individual waterfowl hunters, to members of the Tyger Enoree River Alliance, to SCDNR resource managers. Information was gathered in three primary areas: personal hunting preferences, seasonal trends and distribution of activities, Project area preferences and needs. Personal hunting preferences, seasonal trends, and the distribution of activities is discussed below. Project area preferences and needs is discussed under Section 5.3 User Perceptions of Site Conditions and Needs.

Personal Hunting Preferences. Most of the focus group attendees indicated that they hunted in the Project area on a weekly basis during the hunting season. Attendees generally indicated that waterfowl hunting is more enjoyable as a group activity and that they prefer to hunt with 1 to 4 other people. Attendees noted that hunting was usually preferable in the morning; however the preferable time of day to hunt was highly weather dependent. Weekdays are preferred over Saturdays (no hunting allowable in the Project area on Sundays) due to less crowding during the weekdays. In general, all species of waterfowl are hunted, no particular species of interest is specifically sought. Attendees indicated that they hunt by both boat and by wading. Hunters generally boat in from a public launch facility and then wade to a particular hunting location. The recreation facilities most often utilized by waterfowl hunters were indicated as follows: the

Highway 99 Boat Ramp and the Highway 215 Boat Ramp on Monticello; the Highway 34 Primitive Ramp and the Enoree River Bridge Informal Access Area on Parr.

Seasonal Trends. Attendees noted that they generally begin hunting on or around Thanksgiving Day and hunt through the end of January (concurrent with the state and federal seasons). However, many indicated that they also hunt during the September teal and goose seasons and the February goose season. Holidays were indicated as being some of the best hunting days due to a lack of other hunters.

A meeting summary is included in Appendix B.

RECREATION USE ESTIMATES FOR THE ENOREE RIVER WATERFOWL MANAGEMENT AREA

Recreation days were estimated for the Enoree River Waterfowl Management Area using data from the vehicle counter placed at the site entrance, using the Parr Reservoir average of 2.15 people per vehicle.

Vehicle counter data indicated that the Enoree River Waterfowl Area supported an estimated 263 recreation days during the study period (Table 18). This total does not account for individuals who accessed the site by boat. SCDNR’s use data estimated that 131 people used the site during the study season. The difference between estimated recreation days, using an average of 2.15 people per vehicle, and SCDNR data may indicate that hunters are traveling to the site individually.

TABLE 18 ESTIMATED RECREATION DAYS FOR THE ENOREE RIVER WATERFOWL MANAGEMENT AREA

	Enoree River Waterfowl Management Area
November	
Weekends	13
Holidays	39
December	
Weekends	60
Holidays	22
January	
Weekends	120
Holidays	9
Total	
Weekends	**193**
Holidays	**70**
TOTAL	**263**

SURVEY RESULTS

Monticello Reservoir

A total of 18 surveys were returned from those distributed on vehicles parked at the Highway 215 Boat Ramp and at the Highway 99 Boat Ramp during waterfowl study seasons. Of those surveys that were returned, six individuals indicated that they were waterfowl hunting at the time the survey was distributed. All 6 respondents indicated that they hunt with at least one other person (2.17 people average), with 5 out of the 6 respondents (83 percent) indicating that they primarily hunt on Saturdays. Most respondents indicated that they traveled from Newberry County, SC. No respondents indicated that they had traveled from out-of-state. Five of the respondents provided additional comments regarding waterfowl hunting on Monticello Reservoir. All of the comments were positive, noting that limited hunting days and Wednesday and Saturday AM hunting times were favorable to provide good hunting opportunities on Monticello.

Parr Reservoir

A total of 43 surveys were returned from those distributed on vehicles parked at the Cannon's Creek Public Access Area and at the Heller's Creek Public Access Area during waterfowl study seasons. Of those surveys that were returned, 40 individuals indicated that they were waterfowl hunting at the time the survey was distributed. Approximately 90 percent of respondents indicated that they hunt with at least one other person (1.80 people average). Ninety-five percent[5] of respondents indicated that they hunt on Saturdays. Wednesdays (53 percent) and Fridays (48 percent) were also popular hunting days among respondents. All but one respondent indicated that they hunt in the morning (98 percent). All respondents indicated that they were from South Carolina. Forty-three percent of respondents indicated that they had traveled from Richland County. Lexington was the second highest county of origin (27 percent) and Newberry County was listed third-highest, at approximately 19 percent. Other counties of origin included: Union, Fairfield, Edgefield and Aiken. Twenty-eight of the respondents provided additional comments regarding waterfowl hunting on Parr Reservoir. Approximately one-half of respondents that commented indicated that there were too many hunters on Parr Reservoir or that waterfowl hunting days/times should be limited.

Enoree River Waterfowl Management Area

Only 1 survey was returned by a waterfowl hunter using the Enoree River Waterfowl Management Area. That individual indicated that they typically hunt with one other person and that they had traveled from Lexington County, SC.

SCDNR WATERFOWL MANAGEMENT AREA USE DATA

SCDNR provided the following use data for the Enoree River Waterfowl Management Area: 131 hunters harvested 90 ducks and 1 Canada goose and shot 839 times. The bag included 54 wood ducks, 12 hooded mergansers, 17 ring-necked ducks, 3 black ducks, 1 green-winged teal, 1 gadwall, 1 pintail and 1 mallard (personal communication with Willie Simmons, SCDNR, on April 5, 2016).

SCDNR provided the following use data for the Broad River Waterfowl Management area: 58 hunters killed 130 ducks during 7 lottery hunts. The bag included 33 mallards, 7 black ducks,

[5] Many respondents indicated that they hunt on more than one day of the week. As such, percentages add up to be greater than 100 percent.

5 gadwall, 1 American widgeon, 15 green winged teal, 1 northern pintail, 10 wood ducks, 1 redhead, 10 scaup, 35 ring-necked ducks, 6 ruddy ducks and 6 mergansers. Additionally, SCDNR hosted 1 youth hunt on February 6, 2016. Five youths participated and harvested 7 ducks (2 ring-neck ducks, 2 scaup, and 3 wood ducks (personal communication with Sam Stokes, Wildlife Coordinator, SCDNR, on April 5, 2016).

5.0 CHARACTERIZATION OF POTENTIAL FUTURE USE AND NEEDS

The third goal of this study was to identify future recreational needs for public recreation sites on Monticello and Parr reservoirs and to assess the ability of existing access sites to accommodate that projected need. This includes estimating potential future use, assessing site capacity and crowdedness levels, and assessing whether current sites and facilities are adequate for long term management needs.

5.1 FUTURE USE

National trends in outdoor recreation between 1999 and 2009 has generally increased with activities such as viewing and photographing nature (about 20 percent increase), warmwater fishing (increase of about 17 percent), day hiking (15 percent increase) and visiting developed sites for family gatherings (10.5 percent increase) (White, et al 2014). Projected national outdoor recreation trends for the period from 2008 to 2030 provided by the U. S Forest Service as part of the 2010 Resources Planning Act Assessment estimated an increase of about 26 percent for visiting at developed sites, and about 21 percent for fishing activities, 30 percent for motorized water use, and hiking at about 33 percent (White, et al 2014).

Recreation trends in South Carolina show walking for pleasure remains a top outdoor activity at 83.2 percent participation for individuals age 12 and older (USC 2005). Picnicking and swimming remain in the top 10 activities, and along with freshwater fishing have remained fairly constant in participation rates with less than 5 percent change between the 1999 and 2005 period (USC, 2005). The top 25 recreation activities for the Central Midlands Planning District, which includes the four counties surrounding the Project (Fairfield, Newberry, Lexington, and Richland), are provided in Table 19. Of the activities rated above 50 percent, walking for pleasure, beach swimming, and sunbathing, and picnicking are all activities that are available at the Project's public recreation access sites.

TABLE 19 RECREATION PARTICIPATION (2005), AGE 12 AND OLDER, FOR THE FOUR COUNTIES SURROUNDING THE PARR PROJECT

	Activity	District	State
1.	Walking for pleasure or exercise	82.8	83.2
2.	Attending outdoor sporting events	68.7	63.4
3.	Beach swimming/sunbathing	68.5	62.5
4.	Driving for pleasure	52.8	58.2
5.	Weights or exercise machines	70.7	57.1
6.	Picnicking	54.1	53.4
7.	Pool swimming	52.6	53.2
8.	Visiting historical sites	50.1	52.1
9.	Bicycling	50.6	42.8
10.	Visiting a museum	45.4	38.4
11.	Fresh water fishing	37.6	37.2
12.	Visiting an unusual natural feature	35.3	34.7
13.	Playing basketball	44.2	34.5
14.	Visiting a zoo	60.4	34.1
15.	Motorboating	33.0	34.1
16.	Jogging/running	42.6	33.9
17.	Watching wildlife	34.3	33.4
18.	Lake/river swimming	26.8	28.0
19.	Off-road vehicle riding	22.7	23.5
20.	Camping	20.2	23.1
21.	Playing football	28.9	22.4
22.	Golf	24.7	21.1
23.	Guided nature trail/study	28.9	20.2
24.	Bird watching	17.7	20.2
25.	Hiking	19.9	18.2

Source: USC, 2005; data for the Central Midlands Planning District which includes the four counties surrounding the Project Fairfield, Newberry, Lexington, and Richland.

The population of the counties within the Central Midlands Planning District (Fairfield, Newberry, Lexington, and Richland) increased by 4.7 percent between 2010 and 2015 and is projected to increase by about 12.9 percent from 2015 to the year 2030 (SCRFA, 2016). Lexington County is projected to have the fastest population growth of the area, at an average of 6.3 percent from 2015 to 2030. And Fairfield is projected to have the slowest population growth of these counties, at 0.5 percent for the same time period. If participation in recreation increases at a similar rate, one can expect to see increased demand for recreation opportunities in the future use at the Project sites. Table 20 summarizes the estimated population projections to 2030 for the four counties surrounding the Project.

TABLE 20 POPULATION PROJECTIONS FOR THE FOUR COUNTIES SURROUNDING THE PARR PROJECT

County	2010 Census	2015 Projection	2020 Projection	2025 Projection	2030 Projection
Fairfield	23,956	24,100	24,200	24,300	24,500
Lexington	262,391	277,100	291,800	312,500	333,200
Newberry	37,508	37,900	38,200	39,000	39,800
Richland	384,504	404,400	424,300	440,100	456,000
Four County Subtotal	**708,359**	**743,500**	**778,500**	**815,900**	**853,500**
Percent Change	0%	4.73%	4.50%	4.58%	4.41%
South Carolina	4,625,364	4,823,200	5,020,800	5,235,500	5,451,700
Percent Change	0	4.10%	3.94%	4.10%	3.97%

Source: http://www.sccommunityprofiles.org/census/proj_c2010.html
South Carolina Revenue and Fiscal Affairs Office, South Carolina State and County Population Projections 2000-2030. Accessed athttp://www.sccommunityprofiles.org/census/proj_c2010.html on July 12, 2016.

5.1.1 PROJECT

Overall future use at the Project is estimated at 174,241 recreation days in the year 2030, based on the estimated population projections for the four county region and existing recreation use estimates at the Project. This would result in an increase of about 21,532 recreation days or about a 12.4 percent increase as compared to the 2015 estimated use. Table 21 provides a summary of projected estimated use at the Project out to year 2070. These estimates are based on applying the average population increase from 2010 to 2030 of 4.55 percent and applying this average estimate for each 5-year period. Future use estimates extending out in time beyond the 2030 period are even more subject to change as various assumptions, such assumptions about future births, deaths, net international migration, and domestic migration, affect these population trends over time.

TABLE 21 ESTIMATED FUTURE RECREATION DAYS FOR THE PARR SHOALS PROJECT, 2020-2070

Year	Population Growth Rates	Monticello Reservoir Sites	Parr Reservoir Sites	Total Project
Use Estimates (2015)		126,525	26,184	**152,709**
2020	4.50%	132,213	27,361	**159,575**
2025	4.58%	138,274	28,615	**166,889**
2030	4.41%	144,365	29,876	**174,241**
2035	4.55%	150,938	31,236	**182,174**
2040	4.55%	157,810	32,658	**190,469**
2045	4.55%	164,995	34,145	**199,140**
2050	4.55%	172,507	35,700	**208,207**
2055	4.55%	180,361	37,325	**217,686**
2060	4.55%	188,573	39,025	**227,597**
2065	4.55%	197,158	40,801	**237,960**
2070	4.55%	206,135	42,659	**248,794**

5.1.2 MONTICELLO RESERVOIR

Table 22 summarizes the projected recreation use by activity for each 5-year increment out to the year 2050 at the Monticello Reservoir sites. Fishing and boating are anticipated to remain the dominant recreation activities at Monticello Reservoir sites.

5.1.3 PARR RESERVOIR

Table 23 summarizes the projected recreation use by activity for each 5-year increment out to the year 2050 at the Parr Reservoir sites. Boat fishing and bank fishing are anticipated to remain the dominant recreation activities at the Parr Reservoir sites.

TABLE 22 PROJECTED FUTURE RECREATION DAY ESTIMATES FOR MONTICELLO RESERVOIR BY ACTIVITY, 2020-2050

	Use Estimates (2015)	2020	2025	2030	2035	2040	2045	2050
Population Growth Rates		4.50%	4.58%	4.41%	4.55%	4.55%	4.55%	4.55%
Activity								
Boat Fishing	52,789	55,162	57,690	60,232	62,974	65,841	68,839	71,973
Pier/Dock Fishing	14,245	14,885	15,567	16,253	16,993	17,767	18,576	19,421
Bank Fishing	22,624	23,641	24,724	25,814	26,989	28,218	29,502	30,846
Motor Boating	2,234	2,335	2,442	2,550	2,666	2,787	2,914	3,046
Pontoon/Party Boating	279	292	305	319	333	348	364	381
Sailing	559	584	610	637	666	697	728	762
Canoeing/Kayaking	2,514	2,627	2,747	2,868	2,999	3,135	3,278	3,427
Windsurfing	279	292	305	319	333	348	364	381
Paddleboarding	559	584	610	637	666	697	728	762
Bicycling	279	292	305	319	333	348	364	381
Tent/Vehicle Camping	4,748	4,962	5,189	5,418	5,664	5,922	6,192	6,474
Walking/Hiking/Backpacking	1,676	1,751	1,831	1,912	1,999	2,090	2,185	2,285
Sightseeing	4,469	4,670	4,884	5,099	5,331	5,574	5,828	6,093
Hunting	559	584	610	637	666	697	728	762
Swimming	9,776	10,215	10,683	11,154	11,662	12,193	12,748	13,328
Picnicking	5,307	5,545	5,800	6,055	6,331	6,619	6,920	7,235
Sunbathing	838	876	916	956	1,000	1,045	1,093	1,142
Other	2,793	2,919	3,052	3,187	3,332	3,484	3,642	3,808
Total	**126,525**	**132,213**	**138,274**	**144,366**	**150,938**	**157,810**	**164,995**	**172,507**

TABLE 23 ESTIMATED FUTURE RECREATION DAYS FOR PARR RESERVOIR BY ACTIVITY, 2020-2050

	Use Estimates (2015)	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
Population Growth Rates		4.50%	4.58%	4.41%	4.55%	4.55%	4.55%	4.55%
Activity								
Boat Fishing	19,609	20,491	21,430	22,374	23,393	24,458	25,571	26,736
Pier/Dock Fishing	461	482	504	526	550	575	602	629
Bank Fishing	3,230	3,375	3,530	3,685	3,853	4,028	4,212	4,404
Motor Boating	115	121	126	132	138	144	150	157
Pontoon/Party Boating	-	-	-	-	-	-	-	-
Sailing	-	-	-	-	-	-	-	-
Canoeing/Kayaking	231	241	252	263	275	288	301	315
Windsurfing	-	-	-	-	-	-	-	-
Paddleboarding	-	-	-	-	-	-	-	-
Bicycling	-	-	-	-	-	-	-	-
Tent/Vehicle Camping	1,269	1,326	1,387	1,448	1,514	1,583	1,655	1,730
Walking/Hiking/Backpacking	-	-	-	-	-	-	-	-
Sightseeing	577	603	630	658	688	719	752	786
Hunting	115	121	126	132	138	144	150	157
Swimming	115	121	126	132	138	144	150	157
Picnicking	115	121	126	132	138	144	150	157
Sunbathing	-	-	-	-	-	-	-	-
Other	346	362	378	395	413	432	451	472
Total	**26,184**	**27,361**	**28,615**	**29,876**	**31,236**	**32,658**	**34,145**	**35,700**

5.2 RECREATION SITE USE DENSITY

Project recreation sites are well used throughout the recreation season with sites generally being used within their design capacities. For the purposes of this study, sites were considered to be utilized within their design capacities if parking areas are regularly less than 75 percent full. Use is considered to be approaching capacity if parking areas are regularly between 75 and 99 percent full. Use is considered to be exceeding capacity if parking areas are regularly greater than 99 percent full. It is important to note that high levels of use typically experienced on holidays are regarded as special circumstances, as these use levels are experienced only a few times a year. Recreation capacity should be considered for typical weekday and weekend use in management and site design decisions.

5.2.1 MONTICELLO RESERVOIR

Results suggest that 3 sites are being used within their design capacities for the typical weekdays and weekend days selected during the study season and may accommodate additional use: Scenic Overlook; Highway 99 Boat Ramp; Recreation Lake Access Area (Table 24). Estimates for the Highway 99 Informal Fishing Area are shown to be within their design capacities during weekdays, but approaching capacity on weekend days. Estimates for the Highway 215 Boat Ramp potentially exceeded capacities during peak hours on some weekend days throughout the study season.

While data suggest that public access sites on Monticello Reservoir are being very well used during the summer season, at times at rates at or above their intended capacities, additional information can help in interpreting these findings to better understand how sites are used. Traffic counter data often provide an over-estimate of site use, as it includes those individuals that drive through a site, but do not stay to recreate. Drive-through traffic was frequently observed by recreation clerks stationed at the Highway 99 Informal Fishing Area. Spot count data for this site also indicate that 0 to 1 vehicles were observed parked at the site approximately 90 percent of the time. Additionally, this recreation site has a double entrance/exit and is located directly adjacent to a main road. This allows for easy turn around/lake viewing access. The Highway 215 Boat Ramp is also located directly off of a main road and has a double entrance/exit. Spot count data alone indicate that this site may be consistently approaching design capacities during the summer season, to meeting design capacities on weekend days.

However, when combined with traffic counter data, estimated peak use is frequently above 100 percent on weekend days.

TABLE 24 MONTICELLO RESERVOIR RECREATION SITE USE PEAK DENSITY ESTIMATES

	Scenic Overlook	Highway 215 Boat Ramp	Highway 99 Boat Ramp	Recreation Lake Access Area	Highway 99 Informal Fishing Area [a]	Monticello Development Total
April						
Peak Capacity - Weekday	7%	92%	14%	7%	55%	**35%**
Peak Capacity - Weekend day	10%	145%	56%	20%	75%	**61%**
May						
Peak Capacity - Weekday	8%	80%	33%	7%	58%	**37%**
Peak Capacity - Weekend day	37%	235%	28%	46%	88%	**87%**
June						
Peak Capacity - Weekday	13%	55%	30%	45%	85%	**46%**
Peak Capacity - Weekend day	24%	205%	99%	95%	95%	**104%**
July						
Peak Capacity - Weekday	9%	32%	42%	4%	58%	**29%**
Peak Capacity - Weekend day	18%	87%	45%	32%	70%	**50%**
August						
Peak Capacity - Weekday	6%	85%	16%	2%	68%	**35%**
Peak Capacity - Weekend day	11%	115%	35%	26%	88%	**55%**
September						
Peak Capacity - Weekday	5%	25%	31%	8%	48%	**23%**
Peak Capacity - Weekend day	6%	40%	28%	8%	68%	**30%**
Total						**49%**
Average Peak Capacity - Weekday	**8%**	**62%**	**28%**	**12%**	**62%**	
Average Peak Capacity - Weekend day	**17%**	**138%**	**49%**	**38%**	**81%**	

[a] .Drive-through traffic was frequently observed by recreation clerks stationed at the Highway 99 Informal Fishing Area. Spot count data for this site indicate that 0 to 1 vehicles were observed parked at the site approximately 90 percent of the time.

Perceptions of crowding can influence a person's enjoyment of a recreation site and can be a useful tool for managers when making decisions about whether a site can accommodate additional use. Table 25 provides a summary of user perceptions of crowding at Monticello Reservoir by access site. Crowdedness was rated on a scale from 1 (light) to 5 (heavy).

Overall, Monticello Reservoir respondents indicated generally low perceptions of crowdedness during the weekday (1.56 average). Additionally, Monticello Reservoir respondents indicated a generally moderate crowdedness rating for weekends (2.56 average weekend) and with a slightly higher average for holidays (2.93 average). The Highway 99 Boat Ramp received the highest crowdedness rating, overall. However, all of the sites received low to very moderate crowdedness ratings by interview respondents.

Fifty percent of waterfowl hunter survey respondents reported Monticello Reservoir as being moderately crowded, with other responses being distributed evenly among light to heavy.

TABLE 25 CROWDEDNESS RATINGS FOR MONTICELLO RESERVOIR RECREATION SITES [a]

	Crowdedness Rating	
Site	**Average**	**Median**
Scenic Overlook Park	2.08	2.00
Highway 215 Boat Ramp	2.42	2.50
Highway 99 Boat Ramp	2.70	3.00
Recreation Lake Access Area	2.05	1.00
Highway 99 Informal Fishing Area	1.90	1.00
Monticello Reservoir Total	**2.31**	**2.00**

[a] Crowding at Project recreation sites was rated on a scale from 1 to 5, where a 1 equals “light” and a 5 equals “heavy”

5.2.2 PARR RESERVOIR

The capacity at which Parr Reservoir public access sites are being used was estimated for Cannon’s Creek and Heller’s Creek public access areas. Highway 34 primitive ramp does not have a substantial parking area and is mainly used by boaters accessing the upper portions of Parr Reservoir.

Results suggest that both Cannon’s Creek and Heller’s Creek Public Access Areas are being consistently used below their design capacities and can accommodate additional use (Table 26). An exception to this was observed for a weekend day in May where Cannon’s Creek peak estimates met design capacity.

TABLE 26 PARR RESERVOIR RECREATION SITE USE PEAK DENSITY ESTIMATES

	Cannon's Creek Public Access	Heller's Creek Public Access	Parr Development Total
April			
Peak Capacity - Weekday	30%	18%	**24%**
Peak Capacity - Weekend day	32%	16%	**24%**
May			
Peak Capacity - Weekday	45%	16%	**31%**
Peak Capacity - Weekend day	100%	58%	**79%**
June			
Peak Capacity - Weekday	35%	28%	**32%**
Peak Capacity - Weekend day	48%	34%	**41%**
July			
Peak Capacity - Weekday	18%	14%	**16%**
Peak Capacity - Weekend day	38%	32%	**35%**
August			
Peak Capacity - Weekday	27%	12%	**20%**
Peak Capacity - Weekend day	42%	54%	**48%**
September			
Peak Capacity - Weekday	10%	18%	**14%**
Peak Capacity - Weekend day	45%	18%	**32%**
TOTAL			**33%**
Average Peak Capacity - Weekday	**28%**	**18%**	
Average Peak Capacity - Weekend day	**51%**	**35%**	

Parr Reservoir interview respondents indicated generally low perceptions of crowdedness during the weekday (1.64 average), moderate crowdedness rating for weekends (2.25 average weekend) with slightly lower ratings for holidays (2.11 average). Lower crowdedness ratings for holidays is unusual, and could be due to the high availability of regional recreation opportunities. Table 27 provides a summary of user perceptions of crowding at Parr Reservoir by access site. Both Cannon’s Creek and Heller’s Creek Public Access Areas received moderate crowdedness ratings, overall. Heller’s Creek Public Access Area (2.31 average) was perceived as being slightly more crowded than Cannon’s Creek Public Access Area (1.93 average).

Fifty-three percent of waterfowl survey respondents on Parr Reservoir indicated Parr Reservoir as being moderately crowded (“3” rating) for waterfowl hunting, with 33 percent of respondents indicating a crowdedness rating of moderately heavy (“4” rating). Waterfowl focus group attendees indicated that there was over-crowding at the Enoree Waterfowl Management Area, and collectively rated that area as a “5” for crowdedness. Focus group attendees also indicated that Parr Reservoir, from the Monticello tailrace to the Hwy 34 boat ramp, was also moderately crowded (rated as a "4" on Saturday mornings).

Several options were suggested by Waterfowl Focus Group attendees to alleviate some of the crowding issues currently experienced at the Enoree Waterfowl Area. All of these options would need to be implemented by SCDNR and include: a SCDNR decision to categorize the Enoree Waterfowl Area as "Category 1" (currently "Category 2"); only allow a certain number of individuals to hunt the area at one time; require a hunting pass; only allow hunting on Wednesdays.

TABLE 27 CROWDEDNESS RATINGS FOR PARR RESERVOIR RECREATION SITES [a]

	Crowdedness Rating	
Site	**Average**	**Median**
Cannon’s Creek Public Access Area	1.93	2.00
Heller’s Creek Public Access Area	2.31	2.50
Parr Reservoir Total	**2.07**	**2.00**

[a] Crowding at Project recreation sites was rated on a scale from 1 to 5, where a 1 equals “light” and a 5 equals “heavy”

5.3 USER PERCEPTIONS OF SITE CONDITIONS AND NEEDS

This section addresses user perceptions of recreation site conditions, and their recommendations for additional facilities and site improvements.

5.3.1 MONTICELLO RESERVOIR

Site Conditions. Monticello Reservoir recreation sites were considered to be in very good condition by respondents (Table 28). On a scale of 1 to 5 where a 1 is “poor” and a 5 is “excellent,” all of the recreation sites received a 4, or above. The Highway 215 Boat Ramp and Scenic Overlook Park received the highest condition ratings with scores approaching “excellent.” Overall, the sites received the highest condition ratings during weekdays, with an average of 4.44

for all of the sites. Weekends and holidays rated only slightly lower, with averages of 4.25 and 4.27, respectively.

Waterfowl hunter survey respondents[6] considered Monticello Reservoir to be in “very good” condition, with an average condition rating of 4.17.

Need for Additional Facilities. Respondents were asked to indicate what, if any, additional facilities were needed at the site at which they were interviewed (Table 29). Approximately 57 percent of respondents indicated that the Monticello Reservoir recreation site at which they were interviewed was in need of additional facilities. Of those indicating a need for additional facilities, restrooms were identified as the most needed additional facility at Monticello Reservoir recreation sites, comprising approximately 70[7] percent of the responses. This was particularly true for the Highway 215 Boat Ramp and the Highway 99 Informal Fishing Area, where 93 and 89 percent of respondents, respectively, indicated the need for restroom facilities. Picnic tables and shelters (18 percent of responses), lighting (16 percent of responses), and the addition of a fishing pier or dock (14 percent of responses) were also requested at Monticello Reservoir recreation sites. Individuals interviewed at the Scenic Overlook Park, the Recreation Lake Access Area and at the Highway 99 Boat Ramp had varying suggestions for additional facilities. At the Scenic Overlook Park, the addition of a fishing pier/dock and picnic tables/shelter was frequently requested. An additional parking area and picnic tables/shelter comprised many of the responses at the Recreation Lake Access Area. Additional lighting was frequently requested at the Highway 99 Boat Ramp. However, overall, the majority of respondents at the Highway 99 Boat Ramp and the Recreation Lake Access Area indicated that no additional facilities were needed. Not surprisingly, a variety of additional facilities were recommended at the Highway 99 Informal Fishing Area.

Although only 6 surveys were received from individuals who were waterfowl hunting on Monticello Reservoir, 3 of those respondents indicated that no additional facilities or improvements were needed for waterfowl hunting at Monticello Reservoir. Additional lighting, bathrooms, and a deeper boat landing was requested by the remaining three waterfowl survey

[6] Eighteen total surveys were returned; of those, only six individuals indicated that they were waterfowl hunting.
[7] Because many respondents provided more than one recommended facility, total responses add up to greater than 100 percent.

respondents. No improvements to Monticello Reservoir recreation sites were recommended during the Waterfowl Focus Group meeting.

Need for Improvements. Thirty-five percent of respondents indicated that additional improvements were needed at Monticello Reservoir. The Scenic Overlook Park received the highest response for additional improvement recommendations, 47 percent of respondents, and responses varied greatly (Table 30). Additional grills/tables and restroom improvements/year-round restroom access were the most frequently requested by respondents interviewed at Scenic Overlook Park. Dock/Pier improvements or repairs was the most frequently requested improvement at the Highway 215 Boat Ramp (23 percent). Respondents requesting facility improvements at the Highway 99 Boat Ramp most often indicated that restroom improvements/year-round access were needed. Benches/seating was requested most often at the Highway 99 Informal Fishing Area. Responses varied greatly for the Recreation Lake Access Area; however, most respondents (74 percent) indicated that no additional improvements were needed at this site.

As noted, 3 of the Monticello Reservoir waterfowl survey respondents indicated that no additional facilities or improvements were needed for waterfowl hunting at Monticello Reservoir. Additional lighting, bathrooms, and a deeper boat landing was requested by the remaining three waterfowl survey respondents. Additionally, no improvements to Monticello Reservoir recreation sites were recommended during the Waterfowl Focus Group meeting.

TABLE 28 CONDITION RATINGS FOR MONTICELLO RESERVOIR RECREATION SITES [a]

	CONDITION RATING	
SITE	**AVERAGE**	**MEDIAN**
Scenic Overlook Park	4.42	5.00
Highway 215 Boat Ramp	4.44	5.00
Highway 99 Boat Ramp	4.17	4.00
Recreation Lake Access Area	4.00	4.00
Highway 99 Informal Fishing Area	4.24	5.00
Monticello Reservoir Total	**4.30**	**5.00**

[a] Condition ratings on a scale from 1 “poor” to 5 “excellent”

TABLE 29 ADDITIONAL FACILITIES RECOMMENDED FOR MONTICELLO RESERVOIR RECREATION SITES

Site	Additional Facilities Recommended? - No	Additional Facilities Recommended? - Yes	n- Total Respondents	Bank Fishing Area	Boat Dock	Boat Launch	Camping Area	Fish Cleaning Station	Fishing Pier/Dock	Lighting	Parking Lot	Picnic Tables/Shelter	Restrooms	Signs and Information	Swimming Area	Trails	Trash Cans	RV Camping	Bilingual Signs	n – Total Respondents [a]
Scenic Overlook Park	38%	62%	132	2%	0%	2%	5%	7%	25%	12%	5%	31%	54%	2%	3%	5%	8%	2%	0%	59
Highway 215 Boat Ramp	31%	69%	134	0%	0%	2%	1%	1%	6%	15%	3%	7%	93%	0%	0%	0%	1%	0%	0%	88
Highway 99 Boat Ramp	58%	42%	106	0%	15%	9%	6%	9%	9%	24%	0%	6%	36%	0%	3%	3%	6%	3%	0%	33
Recreation Lake Access Area	70%	30%	61	8%	0%	0%	16%	8%	8%	8%	25%	33%	42%	0%	0%	8%	0%	0%	8%	12
Highway 99 Informal Fishing Area	10%	90%	21	5%	0%	0%	0%	16%	26%	21%	0%	42%	89%	5%	0%	5%	32%	0%	0%	19

[a] Individuals that responded that additional facilities were needed at a particular recreation site may not have provided a recommendation on what type of facilities were needed. As such, fewer facility recommendation responses were gathered. Additionally, many individuals provided more than one recommendation. Therefore, facility recommendation percentages may equal greater than 100%.

TABLE 30 IMPROVEMENTS RECOMMENDED FOR MONTICELLO RESERVOIR SITES

Site	Improvements Recommended? - No	Improvements Recommended? - Yes	n- Total Respondents	Additional Tables/ Grills	Repair/Improve Docks/Piers	Ice/Vending/ Concessions	Restroom Improvements/Year-round Access	Benches/Seating	General Maintenance/Upkeep	Handicap Access	Electricity	Security	Lighting	Beach Area	Parking Area Improvements	Boat Launch Improvements	Water Fountains	Other	n – Total Respondents [a]
Scenic Overlook Park	53%	47%	132	16%	6%	2%	11%	6%	8%	2%	2%	3%	2%	5%	2%	0%	3%	21%	32
Highway 215 Boat Ramp	71%	29%	133	8%	23%	8%	5%	3%	3%	0%	0%	3%	15%	0%	3%	13%	3%	13%	39
Highway 99 Boat Ramp	69%	31%	106	3%	6%	0%	52%	0%	21%	0%	6%	3%	0%	0%	3%	0%	0%	6%	33
Recreation Lake Access Area	74%	26%	61	6%	0%	13%	19%	0%	13%	0%	6%	0%	0%	0%	0%	0%	0%	44%	16
Highway 99 Informal Fishing Area	67%	33%	21	0%	0%	0%	0%	29%	0%	0%	0%	0%	14%	0%	0%	0%	14%	43%	7

[a] Individuals that responded that improvements were needed at a particular recreation site may not have provided a recommendation on what type of improvements were needed. As such, fewer improvement recommendation responses were gathered. Additionally, many individuals provided more than one recommendation. Therefore, percentages may equal greater than 100%.

5.3.2 Parr Reservoir

Site Conditions. In general, respondents interviewed at recreation sites on Parr Reservoir considered them to be in “good” to “very good” condition, regardless of day-type. On a scale of 1 to 5 where a 1 is “poor” and a 5 is “excellent”, Cannon’s Creek Public Access Area received a 3.95 and Heller’s Creek Public Access Area received a 3.81 (Table 31). Waterfowl hunter survey respondents[8] considered Parr Reservoir to be in “average” condition, with an average condition rating of 2.58.

Need for Additional Facilities. Respondents were asked to indicate what, if any, additional facilities were needed at the site at which they were interviewed (Table 32). Seventy percent[9] of respondents interviewed at Parr Reservoir recreation sites indicated that additional facilities are needed. Individuals most often requested the addition of a boat launch (37 percent of respondents). This was particularly true for Heller’s Creek Public Access Area, where 44 percent of respondents indicated the need for additional boat launching facilities. Additional restrooms (30 percent of respondents) and the addition of a boat dock (30 percent of respondents) were also commonly requested. The addition of a boat dock was most often requested at Cannon’s Creek Public Access Area.

Eighty percent of waterfowl survey respondents indicated that additional facilities or improvements are needed for waterfowl hunting at Parr Reservoir. Additional lighting (30 percent) and food for waterfowl (30 percent) were the most common requests received by waterfowl survey respondents. Other common facility requests included the addition of a dock (13 percent), the addition or repair of a boat ramp (10 percent) and the provision of stable Parr Reservoir levels (10 percent). Only one survey was received from a respondent hunting at the Enoree River Waterfowl Management Area. This respondent recommended additional trash cans at this site.

Waterfowl Focus Group attendees indicated that maintaining a Parr Reservoir level of 260’ or above would be preferable, particularly during December and January. Attendees also indicated that they would like for SCE&G to maintain the Highway 34 Ramp in a “primitive” state. The

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[8] Forty-three total surveys were returned; of those, forty individuals indicated that they were waterfowl hunting on Parr Reservoir.

[9] Because many respondents provided more than one recommended facility, total responses add up to greater than 100 percent.

Waterfowl Focus Group attendees did not recommend any additions or improvements at Cannon's Creek or Heller's Creek public access areas. Focus Group attendees generally noted that waterfowl hunting opportunities could possibly be improved in the Project area through the creation of an additional waterfowl habitat/resting area (in particular, an area upstream of the Enoree Waterfowl Area, along the Enoree River).

Need for Improvements. Thirty-one percent of respondents indicated that improvements are needed at Parr Reservoir recreation sites. Boat ramp upgrades or improvements was most commonly requested by respondents (26 percent), and most often requested by those individuals interviewed at Heller's Creek Public Access Area (Table 33). Improved or expanded restroom facilities was also commonly requested among respondents interviewed at both Cannon's Creek and Heller's Creek public access areas. Respondents commonly requested a courtesy dock or fishing pier at Cannon's Creek Public Access Area.

The Enoree River Bridge informal access area (non-Project) was noted as being highly utilized by Waterfowl Focus Group attendees. Attendees noted that it is difficult to launch a boat at this site and attendees recommended gravel or other boat launching improvements.

TABLE 31 CONDITION RATINGS FOR PARR RESERVOIR RECREATION SITES [a]

	Condition Rating	
Site	**Average**	**Median**
Cannon's Creek Public Access Area	3.95	4.00
Heller's Creek Public Access Area	3.81	4.00
Total	**3.90**	**4.00**

[a] Condition ratings on a scale from 1 "poor" to 5 "excellent"

TABLE 32 ADDITIONAL FACILITIES RECOMMENDED FOR PARR RESERVOIR ACCESS SITES

Site	Additional Facilities Recommended? - No	Additional Facilities Recommended? - Yes	n- Total Respondents	Additional Access Road	Bank Fishing Area	Boat Dock	Boat Launch	Camping Area	Fishing Pier/Dock	Lighting	Parking Lot	Picnic Tables/Shelter	Restrooms	Signs and Information	Swimming Area	Trash Cans	Other	n – Total Respondents [a]
Cannon's Creek Public Access Area	32%	68%	147	6%	8%	34%	33%	2%	23%	21%	0%	9%	29%	2%	6%	0%	3%	100
Heller's Creek Public Access Area	26%	74%	80	5%	2%	24%	44%	0%	20%	29%	2%	8%	32%	0%	3%	2%	2%	59

[a] Individuals that responded that additional facilities were needed at a particular recreation site may not have provided a recommendation on what type of facilities were needed. As such, fewer facility recommendation responses were gathered. Additionally, many individuals provided more than one recommendation. Therefore, facility recommendation percentages may equal greater than 100%.

TABLE 33 IMPROVEMENTS RECOMMENDED FOR PARR RESERVOIR ACCESS SITES

Site	Improvements Recommended? - No	Improvements Recommended? - Yes	n- Total Respondents	Restroom Improvements	Repair/Improve Boat Ramps	Dredging/Low Water Level	Benches/Seating	Electricity	Lighting	Swimming/Beach Area	Courtesy dock/Fishing Piers	Grills	Other	n – Total Respondents [a]
Cannon's Creek Public Access Area	68%	32%	100	25%	25%	6%	3%	3%	3%	3%	16%	6%	9%	32
Heller's Creek Public Access Area	69%	31%	59	28%	50%	11%	0%	6%	6%	0%	0%	0%	0%	18

[a] Individuals that responded that improvements were needed at a particular recreation site may not have provided a recommendation on what type of improvements were needed. As such, fewer improvement recommendation responses were gathered. Additionally, many individuals provided more than one recommendation. Therefore, percentages may equal greater than 100%.

6.0 CONCLUSIONS

The objective of this study was to identify current and potential recreational use, opportunities, and needs at the Project. This was accomplished by identifying and inventorying existing Project recreation facilities, identifying patterns of recreation use and user needs and preferences at each site, and estimating future recreational use and needs at the Project over the anticipated new license term. In the following sections, study results are summarized in the context of the overall study goals and objectives and are intended to facilitate recreation planning and management discussions.

6.1 CHARACTERIZATION OF EXISTING USE

The Project is surrounded by a number of regionally and nationally recognized recreation resources; yet, study results indicate that the Project is well used, providing an estimated 152,709 recreation days during the 2015 recreation season. This is undoubtedly due to the unique recreation atmosphere created by the Project, which includes riverine and lacustrine environments, waterfowl hunting areas, and areas that support a number of day-use activities such as picnicking, hiking and beach swimming. The Project supports eight public access sites and two waterfowl hunting areas, which are well distributed around the Project area. Survey results suggest that the sites are in good to very good condition, overall. Results specific to each development are provided below.

6.1.1 MONTICELLO RESERVOIR

Five public access sites are available on Monticello Reservoir and were included in this study. Study results indicate that site users are predominately local residents, traveling to the Project from the surrounding four counties (Fairfield, Lexington, Newberry and Richland). Visitors indicated a variety of reasons why they chose to recreate on Monticello Reservoir, with most noting that they chose it due to its proximity to their home or because it provided good fishing opportunities. It was shown that visitors tend to recreate at Monticello Reservoir in parties of between 2 and 3 people, with an average length of stay of approximately 3.5 hours.

Individuals using Monticello Reservoir recreation sites primarily engage in water-based recreation activities. Boat fishing was the most popular activity observed, followed by bank and pier fishing. Boat fishing, pier fishing and bank fishing occur fairly consistently across day types, with bank fishing increasing slightly on weekends, and boat fishing decreasing slightly on holidays. Canoeing and kayaking was shown to increase significantly on holidays. Respondents indicating that they recreated on Monticello Reservoir islands primarily reported that they did so to bank fish, with camping also being reported as popular island activities.

All five of the Monticello Reservoir recreation sites provide angler access through boat launches or through bank or pier fishing, supporting the demand for fishing access. Not surprisingly, boat fishing was the most popular activity reported at Highway 99 and Highway 215 boat ramps, with bank fishing being the most popular activity reported at the Highway 99 Informal Fishing Area. Bank fishing and pier fishing were equally popular at the Scenic Overlook. The Highway 215 boat ramp was also shown to support a significant amount of bank fishing, at approximately 17 percent of the reported site use. The Recreation Lake primarily supports day-use activities such as swimming, picnicking, and sightseeing. However, boat fishing still accounted for approximately 30 percent of the reported use at the Recreation Lake.

Monticello Reservoir was also shown to support significant recreational use during early crappie season in 2016 (February 1 through March 31). Visitation data indicates that March weekdays comprise the greatest amount of use during this period, with visitors primarily recreating at the bank and pier fishing sites of Highway 99 Informal Fishing Area and the Scenic Overlook.

Study results indicate that recreation sites on Monticello Reservoir receive very similar levels of use, with most of the use occurring on the weekends. Data indicates that the Scenic Overlook accommodated the greatest numbers of patrons over the course of the 2015 study season, followed by the Highway 99 Informal Fishing Area. Additional data provided by spot counts and clerk observations indicates that use results for the Highway 99 Informal Fishing Area may be elevated, as this site was observed to receive a significant amount of drive-through traffic. This is also depicted through site density data which, in itself, indicates that the Highway 99 Informal Fishing Area is approaching site capacity, while this result is not supported by spot count data. Drive-through traffic also likely contributes to the high site density estimates calculated at the Highway 215 Boat Ramp. Data alone estimates peak use frequently above 100 percent capacity on weekend days. However, this site received very moderate crowdedness ratings (2.42), and also has a double entrance/exit which facilities lake viewing and drive-through visits. The Highway 99 Boat Ramp, which received the highest crowdedness rating out of all the Monticello Reservoir sites (2.93) had low to moderate site density ratings. However, this site has one entrance/exit road, and is not directly visible from, and adjacent to, the main road, which may otherwise facilitate a large number of drive-through visits. Site visitation during the 2015 recreation season may also be slightly elevated due to the construction of additional nuclear electric-generating units at the V.C. Summer Nuclear Station, located adjacent to Monticello Reservoir. Site expansion has resulted in the creation of an additional 3,000 to 3,500 jobs at that site.

Overall, perceptions of crowding at Monticello Reservoir sites are low to moderate and site conditions were rated very high, with no Monticello Reservoir recreation site receiving below a 4[10] rating. Restrooms were indicated as being the most needed additional facility at Monticello Reservoir, which is very typical for recreation use studies. Other facility and amenity recommendations included picnic tables, shelters, lighting, and fishing piers or docks.

The five public access sites on Monticello Reservoir were surveyed for compliance with ADA guidelines. The Highway 215 Boat Ramp and Highway 99 Boat Ramp are paved; however neither site contains designated ADA compliant parking spaces. Parking areas at the Scenic Overlook Park, Recreation Lake Access Areas, and Highway 99 Informal Fishing Area are gravel. The Recreation Lake Beach Access Area contains designated ADA parking; however, as noted, neither of the two designated spaces are paved. Access trails to the facilities and amenities offered at the various Lake Monticello access sites (i.e. picnic areas, camping areas, and bank fishing areas) are unpaved. The Scenic Overlook provides ADA compliant restrooms; however no other permanent restroom facilities at the Monticello Reservoir sites are entirely ADA compliant. This is primarily due to the lack of paved access to restroom facilities. Other common deficiencies with restroom facilities include the inability to operate restroom doors with a closed fist and thresholds greater than 0.25 inches high. The general layout of restrooms and stalls are ADA compliant across all of the sites, with the exception of the Highway 99 Boat Ramp where the lavatories do not have enough clearance beneath them. Boat docks located at the Highway 215 and Highway 99 Boat Ramps are not ADA compliant due to their ramp slopes, missing transition plates between the ramp and dock, lack of two-inch curbs at the dock edges, and lack of paved access. The fishing pier at the Scenic Overlook Park would not be considered ADA compliant due to the lack of paved access, lack of sections of railing that are 34 inches in height, and lack of two-inch curbs around the outside ramp edges of the pier. While the Monticello

[10] On a scale of 1 to 5 where a 1 is “poor” and a 5 is “excellent.”

Reservoir recreation sites are not entirely ADA compliant in their current state, the addition of paved surfaces to the various facilities and amenities offered would eliminate many of the current barriers.

6.1.2 PARR RESERVOIR

Two public boat launch sites, one primitive boat launch, and two waterfowl sub-impoundments are available within the Project boundary at the Parr development. Respondents interviewed at Parr sites were primarily local, with a large representation from Newberry County (over 75 percent). Over half of the individuals interviewed noted that they chose to recreate at Parr Reservoir due to the good fishing opportunities. It was shown that visitors tend to recreate at Parr Reservoir with one other person, on average, with an average length of stay of approximately 3.5 hours.

As with Monticello Reservoir, individuals recreating at Parr Reservoir recreation sites during the recreation season, from April to September, primarily engage in water-based recreation activities. Boat fishing was the most popular activity observed, accounting for 69 percent of the use at Cannon's Creek Public Access Area and 86 percent of the use at Heller's Creek Public Access Area. Bank fishing was the second most popular activity at the Parr development, accounting for 16 percent of the use at Cannon's Creek Public Access Area. Boat fishing increased slightly during weekdays as compared to weekends and holidays. Conversely, bank fishing increased on the weekends and holidays. For holidays, visitors reported some increased activities for tent/vehicle camping, as compared to the non-holiday periods.

Study results indicate that Cannon's Creek Public Access Area receives the greatest amount of use, followed by Heller's Creek Public Access Area and the Highway 34 primitive ramp. Data collected at the Enoree Bridge Informal Access Area, located outside of the Project boundary, indicates that it receives approximately 5 percent of the use experienced at the three SCE&G maintained access areas on Parr Reservoir.

Density estimates calculated for Cannon's and Heller's Creek Public Access Areas suggest that these areas are consistently being used below their design capacities and can accommodate additional use, with the exception of peak hours during the occasional weekend day. This was also reflected in the low to moderate crowdedness ratings for these sites.

User perceptions of site conditions at Cannon's and Heller's Creek Public Access Areas ranged from good to very good. Additional boat launching or docking facilities were some of the most requested additional facilities, along with lighting and additional restrooms.

The three public access on Parr Reservoir were surveyed for compliance with ADA guidelines. All three sites have gravel lots and none of the sites contain ADA compliant parking spaces. None of the sites have paved access to bathrooms, picnic areas, bank fishing areas, or camping areas. In addition to the lack of paved access, the bathrooms do not comply with ADA guidelines for toilet seat height, entrance threshold heights, or the ability to operate doors with a closed fist. While the Parr Reservoir recreation sites are not currently ADA compliant, the addition of paved surfaces at the site would eliminate many of the current barriers.

6.1.3 WATERFOWL MANAGEMENT AREAS

Goal 2 of this study is to characterize existing use of waterfowl areas and SCE&G recreation lands by hunters during designated hunting seasons. Data was gathered by employing several different data collection methods: a waterfowl focus group; vehicle counts at recreation sites/waterfowl areas; mail-in questionnaires specific to hunting use at the Project; and, SCDNR waterfowl use data. Collectively, the data helps to characterize existing use of lands and waters designated for waterfowl hunting within the Project boundary.

Results from surveys distributed on vehicles parked Monticello Reservoir recreation sites during Canada Geese hunting season indicated that the majority of hunters are local residents who prefer to hunt on Saturday mornings. Several survey respondents noted that they prefer Monticello as it is less crowded than other areas in the vicinity, although they noted that the number of people recreating on Monticello reservoir has increased in recent years.

Results from surveys distributed at Parr Reservoir indicate that the majority of hunters are residents of the surrounding counties, primarily Richland and Lexington, who hunt on Saturday mornings. Approximately one-half of the respondents cited crowding as an issue, noting that there were too many hunters on Parr Reservoir. Similarly, waterfowl focus group attendees noted that they prefer to hunt during weekday mornings, as there are less hunters on the Reservoir. Waterfowl focus group attendees also emphasized that they would prefer that the Highway 34 Boat Ramp remain a primitive site.

Data regarding recreation use at the Enoree River and Broad River Waterfowl Management Areas was primarily obtained from SCDNR and waterfowl focus group attendees. Traffic counter data from the Enoree River Waterfowl Management Area indicates that it is well used. Crowding at this site was a primary concern among waterfowl focus group attendees. Several attendees suggested that this site be re-categorized as "Category I", or that hunting pressure be otherwise limited by SCDNR management actions. Crowding is not an issue for the Broad River Waterfowl Management Area as this site is a draw-hunt site.

6.2 CHARACTERIZATION OF FUTURE USE

As described by Cordell et al. (2004), population growth in the surrounding counties will likely be the primary contributing factor to future use of Project recreation facilities. Study data shows that site users are primarily local residents that do not have shoreline access via private residences. As such, public access areas at the Project generally serve as community parks rather than tourist destinations. It is possible that the V.C. Summer Nuclear Station expansion and associated job growth is contributing to increased recreation use of Project facilities. Once the expansion is complete, it is unknown whether any increases in recreation that may be currently taking place will subside. Waterfowl hunters, both through the focus group sessions and target surveys noted significant increases in waterfowl hunting, and associated crowding, at the Project in recent years. Interestingly, while the majority of recreators on Parr Reservoir during the 2015 peak recreation season were from Newberry County, the majority of Parr Reservoir waterfowl survey respondents were from Richland and Lexington counties. As Richland and Lexington counties are anticipated to have the greatest growth rates from 2015 to 2030, one may also surmise that waterfowl hunting in the Project area may also increase.

It is projected that the population of the surrounding counties will increase by 12.9 percent from 2015 to the year 2030. Fishing and boating are anticipated to remain the dominant recreation activities at Monticello Reservoir sites, and boat fishing and bank fishing are anticipated to remain the dominant recreation activities at Parr Reservoir sites.

There are many uncertainties when predicting future recreation use, including new technologies, shifting demographic patterns, and economic growth. Study data shows that Project facilities are well used, and in good condition. While data indicates that some sites may be used at rates approaching or at capacity during peak periods, there are alternative sites in the vicinity that provide similar amenities with lower density ratings. Moreover, crowdedness ratings for all Project facilities were shown to be low to moderate. Data related to the need for additional facilities and amenities, as summarized in this report, will be assessed in coordination with stakeholders on the Recreation and Lake & Land Management RCG. Project stakeholders will collectively work to develop appropriate measures to enhance Project recreation resources over the anticipated license term. These measures will be included in a Settlement Agreement and proposed Recreation Management Plan to be filed with the Final License Application.

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APPENDIX A

PARR RECREATION USE AND NEEDS STUDY PLAN

RECREATION USE AND NEEDS STUDY PLAN

PARR HYDROELECTRIC PROJECT
(FERC NO. 1894)

Prepared for:

South Carolina Electric & Gas Company
Cayce, South Carolina

Prepared by:

Kleinschmidt

Lexington, South Carolina
www.KleinschmidtUSA.com

January 2014
Revised October 2014

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SOUTH CAROLINA ELECTRIC & GAS COMPANY

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RECREATION USE AND NEEDS STUDY PLAN

PARR HYDROELECTRIC PROJECT
(FERC NO. 1894)

SOUTH CAROLINA ELECTRIC & GAS COMPANY

1.0 INTRODUCTION

South Carolina Electric & Gas Company (SCE&G) is the Licensee of the Parr Hydroelectric Project (FERC No. 1894) (Project). The Project consists of the Parr Hydro Development and the Fairfield Pumped Storage Development. Both developments are located along the Broad River in Fairfield and Newberry Counties, South Carolina.

The Parr Hydro Development forms Parr Reservoir along the Broad River. The Development consists of a 37-foot-high, 200-foot-long concrete gravity spillway dam with a powerhouse housing generating units with a combined licensed capacity of 14.9 MW. Parr Hydro operates in a modified run-of-river mode and normally operates to continuously pass Broad River flow. The 13-mile-long Parr Reservoir has a surface area of 4,400 acres at full pool and serves as the lower reservoir for pumped-storage operations.

The Fairfield Pumped Storage Development is located directly off of the Broad River and forms the 6,800-acre upper reservoir, Monticello Reservoir, with four earthen dams. As noted, Parr Reservoir serves as the lower reservoir for pumped storage operations. The Fairfield Development has a licensed capacity of 511.2 MW and is primarily used for peaking operations, reserve generation, and power usage.

2.0 PURPOSE OF THE STUDY

The Project is currently involved in a relicensing process which involves cooperation and collaboration between SCE&G, as licensee, and a variety of stakeholders including state and federal resource agencies, state and local government, non-governmental organizations (NGO), and interested individuals. The collaboration and cooperation is essential to the identification of and treatment of operational, economic, and environmental issues associated with a new operating license for the Project. SCE&G has established several Technical Working Committees (TWC's) with members from among the interested stakeholders with the objective of achieving consensus regarding the identification and proper treatment of these issues in the context of a new license.

As a part of this process, SCE&G is proposing to perform an assessment of existing and future recreational use, opportunities, and needs for the Project. The assessment is designed to provide information pertinent to the current and future availability and adequacy of SCE&G owned and managed recreation sites and specific informal recreation areas at Monticello Reservoir and the Parr Reservoir. The overall study plan objective is to identify current and potential recreational use, opportunities, and needs at the Project by addressing the following goals and objectives:

Goal 1: *Characterize the existing recreational use of SCE&G's recreation sites on Monticello Reservoir and Parr Reservoir. This will be accomplished by meeting the following objectives:*

i. Identify recreation points, inventory the services and facilities offered at each, and assess the general condition of each site (including whether the site provides barrier free access).
ii. Identify the patterns of use at each site (type, volume, and daily patterns of use).

Goal 2: *Characterize existing use of waterfowl areas (Broad River Waterfowl Area, Enoree River Waterfowl area) and SCE&G recreation lands by hunters during designated hunting seasons. This will be accomplished by meeting the following objectives:*

i. Identify the patterns of use within the Project boundary (type, volume, and daily/seasonal patterns of use).

Goal 3: *Identify future recreational needs relating to public recreation sites on Monticello Reservoir and Parr Reservoir. This will be accomplished by meeting the following objectives:*

i. Identify existing user needs and preferences, including perceptions of crowding at recreation sites.
ii. Estimate future recreational use of existing recreation sites.
iii. Identify future needs for new recreation sites and facilities.

3.0 STUDY AREA

SCE&G designated recreation sites and informal recreation areas on Monticello Reservoir (Figure 1) and Parr Reservoir (Figure 2) that will be included in this assessment include the following:

TABLE 1 RECREATION SITES TO BE ASSESSED

MONTICELLO RESERVOIR RECREATION SITES & INFORMAL AREAS	PARR RESERVOIR RECREATION SITES & INFORMAL AREAS
1. Scenic Overlook (SCE&G-maintained portion)	1. Cannon's Creek Boat Ramp
2. Hwy 215 Boat Ramp	2. Heller's Creek Boat Ramp
3. Hwy 99 Boat Ramp	3. Broad River Waterfowl Area (vehicle counter only)
4. Recreation Lake Access Area	4. Hwy 34 Boat Ramp (vehicle counter only)
5. Informal fishing area, east side of Hwy 99	5. Enoree River Waterfowl Area (vehicle counter only)
	6. Enoree River Bridge Informal Access Area (vehicle counter only)

FIGURE 1 MONTICELLO RESERVOIR RECREATION STUDY SITES

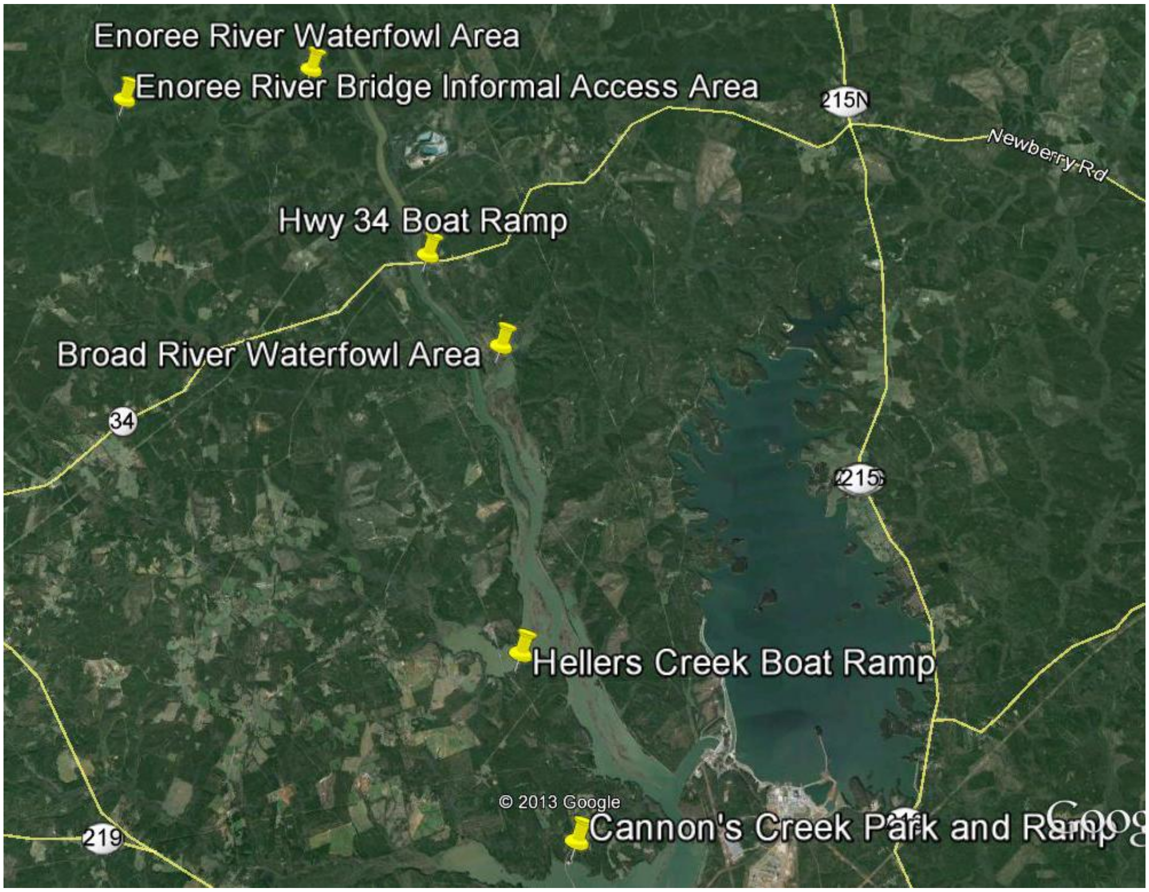

FIGURE 2 PARR RESERVOIR RECREATION STUDY SITES

4.0 STUDY SEASON

Study seasons will vary by study area based upon current knowledge of use patterns. Study seasons should capture specific seasonal activities, including hunting during legal seasons and on-water recreational use during the peak season (typically defined as Memorial Day to Labor Day). As hunting season dates vary annually based upon SCDNR board decisions, only approximate date ranges for specific targeted mail-in survey activities are provided within this study plan. Exact dates for waterfowl survey activities will be determined when study season dates are published, anticipated being mid-summer 2014. Study season specifics are further described below.

4.1 MONTICELLO RESERVOIR

Primary interview activities will occur from April 1 through Labor Day, 2015. Additional interviews will be conducted from February 1 through March 31, 2016 in order to capture recreational activity on the Reservoir during early crappie season. Specific targeted survey activities with mail-in surveys, as described in Section 5.5, will occur during the Canada Geese hunting season (approximately September 1 through September 30, depending on yearly SCDNR approved seasons).

4.2 PARR RESERVOIR

Primary interview activities, as described in Section 5.0, will occur from April 1 through Labor Day, 2015, to encompass turkey hunting season, as well as the peak recreation season. Specific targeted survey activities with mail-in surveys, as described in Section 5.5, will occur during Migratory Waterfowl Seasons, including Canada Geese hunting season (approximately September 2015 through January 2016, depending on yearly SCDNR approved seasons).

5.0 DATA COLLECTION METHODS

A variety of data collection techniques will be used to obtain the information necessary to meet the study objectives. Table 2 identifies the information needed to address each objective and the data collection methods to be used. Both primary and secondary data will be utilized. Primary data will entail site inventories, user counts, and use surveys (exit interviews). Secondary data will include U.S. Bureau of Census data, the South Carolina Statewide Comprehensive Outdoor Recreation Plan (SCORP), SC Recreation Participation & Preference Study, and other relevant, readily available literature. Additional input will be solicited from the Lake & Land Management and Recreation Resource Conservation Group (RCG), Recreation TWC, and target "focus groups" of especially knowledgeable individuals, offering knowledge of the recreation resources and needs of the lake and river.

TABLE 2 RECREATION USE AND NEEDS STUDY PLAN OBJECTIVES AND EFFORTS

OBJECTIVES	INFORMATION NEEDED	SOURCE
Goal 1: Characterize existing recreational use of recreation sites on Monticello Reservoir and the Parr Reservoir		
Identify formal recreation sites, inventory the services and facilities offered at each, and assess the general condition and ADA compliance of each site	• Physical inventory of all boat ramps, grills, shelters, restrooms, parking capacity, etc., at each site • General assessment of site condition to include maintenance, basic rehabilitation needs, etc. • Visitors' assessment of site conditions • Identification of activities that occur at each site • ADA compliance assessment	• Recreation Site Inventory • Survey of Recreation Site Users
Identify the patterns of use at each site (type, volume, and daily patterns of use)	• Utilize vehicle counts as an estimation of people • Estimate of # people/vehicle • Estimate of # vehicles/site • Parking capacity	• Traffic Counter Data • Surveyor Counts of Vehicles at Recreation Sites • Survey of Recreation Site Users - # of people per vehicle and length of visit • Recreation Site Inventory - # of parking spaces • County data from Scenic Overlook

OBJECTIVES	INFORMATION NEEDED	SOURCE
Goal 2: Characterize existing use of waterfowl areas (Broad River Waterfowl Area, Enoree River Waterfowl area) and SCE&G recreation lands by hunters during designated hunting seasons.		
Identify the patterns of use within the Project boundary (type, volume, and daily/seasonal patterns of use).	• Estimation of # hunters/site or waterfowl area	• Counts of Vehicles at Recreation Sites/waterfowl areas • Mail-in questionnaire specific to hunting use at the Project • SCDNR waterfowl use data • SCDNR hunting permit data

OBJECTIVES	INFORMATION NEEDED	SOURCE
Goal 3: Identify future recreational needs relating to public recreation sites on Monticello Reservoir and Parr Reservoir		
Identify existing user needs and preferences, including perceptions of crowding at recreation sites	• User preferences and opinions of needs and crowding at sites • Condition assessment	• Survey of Recreation Site Users • Recreation Site Inventory
Estimate future recreational use of existing recreation sites	• Current inventory and use data from Goals 1 and 2 • Population projections for the project area • Recreational use trends	• Results of Goals 1 and 2 • U.S. Bureau of Census Data • SC Division of Research & Statistics (Budget and Control Board) • SCORP, SC Recreation Participation & Preference Study, or other readily available literature
Identify future needs for new recreation sites and facilities	• Population projections • Recreation use trends • "focus group" (stakeholders) knowledge of recreation resources and needs	• SC Div. of Research & Statistics • SCORP, SC Recreation Participation & Preference Study, Palmetto Conservation Foundation trail use data, or other literature • Recreation TWC and Lake and Land Management & Recreation RCG

The capacity, availability, and overall condition of existing recreation sites will be assessed through review of existing information and an on-site inventory (Section 5.1). Recreational use of SCE&G's public recreation sites (Table 2) during the appropriate recreation season (as described in 4.0) will be estimated using a combination of data including traffic count, survey data, spot counts, and additional collection methods as described in Section 5.2, 5.3, 5.4, and 5.5. Methods for estimating recreational use are described in Section 6.0.

5.1 RECREATION SITE INVENTORY

Data on the types of amenities, activities supported, and the parking capacity of recreation sites at the Project, and the land area each site encompasses will be obtained from two sources. First, existing information regarding recreation sites such as FERC Form 80's and existing GIS data layers will be referenced. Second, a site visit will be made to collect data on the type, number, and size of facilities (restrooms, parking areas, boat ramps, picnic shelters and tables, etc.) located at each site. The general condition of recreation facilities will be recorded along with a qualitative assessment of whether the site is considered "barrier free". A copy of the inventory form is provided in Appendix A.

Upon completion of the inventory, all data will be uploaded into a database; anticipated to be a GIS database. The database will be structured so that it can be used in a variety of formats (brochure, maps, web pages, etc.) and can be updated as recreation sites are modified, added, or changed in any way.

5.2 TRAFFIC COUNTS

Traffic counters will be installed to record the number of vehicles that enter and exit the public recreation areas. Traffic count data will be collected for an entire year in order to capture the various hunting seasons. On Monticello Reservoir, traffic counters will be installed at the lake access point of the Scenic Overlook, the Hwy 215 Boat Ramp, the Hwy 99 Boat Ramp, Recreation Lake Access Area, and the Hwy 99 informal fishing area. At Parr Reservoir, traffic counters will be installed at Cannon's Creek Boat Ramp, Heller's Creek Boat Ramp, Broad River Waterfowl Area, Hwy 34 Boat Ramp, Enoree River Waterfowl Area, and the Enoree River Bridge informal area.

5.3 PUBLIC RECREATION AREA VISITOR EXIT INTERVIEWS

The preferences and perceptions of people using SCE&G's recreation sites and informal areas are important inputs in management decisions regarding the adequacy and availability of existing recreation sites. Information from recreation site users will be obtained via an onsite survey from April 1 through Labor Day, 2015, and from February 1 through March 31, 2016, on Monticello Reservoir and from April 1 through Labor Day, 2015, for Parr Reservoir.

Exit surveys will be administered to collect user characteristics (origin, gender, age, group size, etc.), the type of land-based and water-based recreation activities individuals are participating in, length of stay, perceptions of crowdedness, and conditions of recreation sites at the Project. Visitor demographic information will also be collected. Surveys will be conducted at the following locations:

Monticello Reservoir

- Scenic Overlook
- Hwy 215 Boat Ramp
- Hwy 99 Boat Ramp
- Recreation Lake Access Area
- Hwy 99 informal Fishing Area

Parr Reservoir

- Cannon's Creek Boat Ramp
- Heller's Creek Boat Ramp

The data collected will be used to provide a general pattern of recreation use and assist in the development of recreation use estimates at access sites. The data will also provide recreation user inputs on "crowdedness" and potential facility needs. The survey will be pre-tested in the field prior to implementation and revisions will be incorporated, as necessary. If any significant revisions to the survey or study protocol are deemed necessary subsequent to field pre-testing, the TWC will be notified.

Two survey versions will be implemented – one for Monticello Reservoir and one for Parr Reservoir. The two survey versions will be very similar to each other and will contain similar questions. Draft questionnaires are provided in Appendix B.

A draft sampling plan (Appendix C) has been prepared in consultation with the TWC utilizing stratified random sampling in order to complete at least 30 days of interviewing at each recreation site. Sampling days are made up of weekends, weekdays and holidays. Weekends will be sampled at a greater rate than weekdays, to account for the heavier use that typically occurs during those periods. Moreover, all major national holidays that fall within the recreation season have been included in the sampling plan (i.e., Memorial Day weekend, July 4th weekend, and Labor Day weekend)(Table 3). Furthermore, as the sampling season approaches, the TWC will be consulted on the potential for including special event days with the holidays.

TABLE 3 LIST OF HOLIDAYS TO BE INCLUDED IN THE 2015 RUNS EXIT INTERVIEW SAMPLING PLAN

DATE	HOLIDAY
May 23, 2015	Saturday before Memorial Day
May 24, 2015	Sunday before Memorial Day
May 25, 2015	Memorial Day
July 3, 2015	Friday before Independence Day
July 4, 2015	Independence Day
July 5, 2015	Sunday after Independence Day
September 5, 2015	Saturday before Labor Day
September 6, 2015	Sunday before Labor Day
September 7, 2015	Labor Day

All survey clerks will be trained thoroughly as a means of quality control. Survey clerks will be provided with detailed information on the study schedule, appropriate materials to aid in data collection, and direction on appropriate interviewing techniques and attire. Interviewers will also be provided with an incentive for survey respondents to complete the survey.

5.4 SPOT COUNTS

Spot counts will be conducted at the public recreation sites identified in Section 5.3 once per interview period, concurrent with exit interviews. Specifically, spot counts will document the number of visitors and/or vehicles present at that visit and help to characterize site use. Information recorded during spot counts will include: date, time, and weather; amount of vehicle and vehicle/trailer parking capacity in use; number and type of activities observed at the site; and state license plate data. Spot count data will be used in parallel with traffic counter data.

5.5 ADDITIONAL USER DATA COLLECTION EFFORTS

Waterfowl hunting typically occurs during the fall and winter months. Waterfowl hunters represent a unique group of users whose preferences and perceptions may differ from those using recreation sites during the summer months. The preferences and perceptions of waterfowl hunters will be identified through use of a panel of waterfowl hunters.

Kleinschmidt will work with the Recreation TWC to identify waterfowl organizations whose hunters use the Project. A panel will be assembled from willing participants of the respective organizations. Should not enough participants be available from the organizations, additional individual hunters may be sought out to serve on the panel. A small group of hunters will be invited to participate in a group meeting, similar to a focus group, to identify the opportunities and needs of waterfowl hunters using Project access areas. The information collected will be similar to that of the access site survey. Kleinschmidt will recruit the hunters, develop a meeting format and materials, and will conduct the meeting. It is anticipated that the meeting will occur during the waterfowl hunting season.

Additionally, mail-in surveys similar to the access site survey will be distributed at the Broad River[1] and Enoree River Waterfowl Areas, on Parr Reservoir during waterfowl hunting season. On Monticello Reservoir, mail-in surveys will be distributed on vehicles parked at the Hwy 215 boat ramp and the Hwy 99 boat ramp during Canada Geese season. The study seasons for Monticello Reservoir and Parr Reservoir, as discussed in Section 4.0, will capture the turkey hunting season through exit interview activities.

Representation of those utilizing the Project during local fishing tournaments are anticipated to be represented during access site exit interviews, as registration, check-in and weigh-in typically occurs at access areas.

[1] In lieu of distributing mail-in surveys on parked vehicles at the Broad River Waterfowl Area, mail-in surveys may be provided to SCDNR to distribute to hunters winning the opportunity to hunt at this site through the SCDNR Public Lottery Hunt program.

6.0 ANALYSIS

The following sections provide a description of the approach for estimating existing and future recreational use, recreation site capacity and use density percentages, and recreation needs.

6.1 CURRENT RECREATION USE ESTIMATES

The reported estimates of recreation will be presented in "recreation days". The FERC defines a recreation day as one visit by a person to a development for purposes of recreation during any 24-hour period. The weekday, weekend, and holiday average recreation days will be calculated for each Monticello Reservoir and Parr Reservoir recreation site utilizing the traffic counters and recreation site survey data. The average number of people at each site within the morning and afternoon periods will be estimated within each day type and converted to a daily estimate. Daily estimates for each day type will be expanded to represent the study period and summed for a total estimate for each recreation site.

6.2 FUTURE RECREATION USE ESTIMATES

Estimated projections of future recreation use at Monticello Reservoir and Parr Reservoir will be developed using the average annual increase in population growth over the past 10 years, as reported by the Census Bureau or the State Division of Research and Statistics, for Newberry, Fairfield and Richland counties[2]. The estimates will be augmented with discussion of trends reported in the SCORP (2014) and the SC Recreation Participation & Preference Study (2005). Estimated projections will be provided in 5 year intervals for the anticipated term of the license up to 50 years into the future (through year 2070).

While it is acknowledged that future changes in the supply of recreation resources, either in their quantity, accessibility, and/or quality may influence future demand and use, the demand analysis undertaken for this study does not attempt to predict what these future changes might consist of or how they might specifically affect levels of use at Project facilities. Therefore, the demand analysis results should be viewed as a general guide of potential future recreation pressure developed for planning purposes only.

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[2] Although Richland County is not within the FERC Project boundary, it is believed that a significant number of those who recreate at the Project reside within Richland County.

6.3 RECREATION SITE CAPACITY

For purposes of this study, the carrying capacity for a recreation site is defined as the number of vehicles and boat trailers that can be parked at a recreation site at one time, based on the number of available parking spaces associated with each site. For paved parking areas, this will be achieved by counting the number of designated parking spaces available at the recreation site. For gravel parking areas, the number of available parking spaces for each recreation site will be estimated by measuring the area (sq ft) available for parking and estimating the number of vehicles that could be parked at the location, if optimal space were utilized. These estimates will be based on parking capacity standards for vehicle length, width, and available turn around space.

6.4 RECREATION SITE USE DENSITY

The use density of recreation sites will be estimated by comparing the average observed number of vehicles at the sites on sampled weekday, weekend, and holiday days with the available parking capacity for each recreation site. The average observed number of vehicles divided by the parking capacity will provide an estimated use density for each site.

6.5 RECREATION NEEDS ASSESSMENT

The need for recreation and site development or modification of existing recreation resources will be assessed based on the inventory, condition, capacity, and exit interview survey results. The needs assessment will focus on the existing condition and user opinions of recreation sites, whether a particular site provides "barrier free" access, and the ability of sites to meet current and anticipated future recreation demand pressures. Consideration will also be given to site opportunities and constraints, as well as support facilities such as signage and maintenance. The need for new recreational sites, facilities, and shoreline will be determined through assessment of the information collected and the input of stakeholders on the Recreation TWC and Lake & Land Management RCG.

7.0 SCHEDULE

The proposed schedule for completion of the Recreation Use and Needs Study is as follows:

TASK	DATE
Mobilization for field work (includes field clerk hiring, training, etc.)	March 2015
Survey development and pre-testing	March 2015
Installation of Traffic Counters	March 31, 2015
Interview survey collection (Monticello Reservoir)	April 1-September 7 (Labor Day, 2015); and February 1 - March 31, 2016[3]
Interview survey collection (Parr Reservoir)	April 1 -September 7 (Labor Day, 2015)
Waterfowl survey activities	Throughout 2015 and early 2016 during appropriate seasons.
Early data entry, cleaning, and processing	Early October 2015
Determine if additional data collection is needed	December 2015[4]
Conduct analyses	April - July 2016
Submit draft report	July 2016
Finalize report	July/August 2016

8.0 REFERENCES

South Carolina Department of Parks, Recreation and Tourism, Recreation, Planning and Engineering Office. 2008. South Carolina Statewide Comprehensive Outdoor Recreation Plan.

University of South Carolina. 2005. South Carolina Recreation Participation & Preference Study. Prepared for the South Carolina Department of Parks, Recreation and Tourism. (Online) [URL]: http://www.scprt.com/files/RPE/2005%20Rec%20Study.pdf

[3] The recreation season has been extended into 2016 on Monticello Reservoir in order to capture use data during the early crappie season, from February 1 through March 31, 2016.

[4] If additional data collection is required, data collection methods, results and analyses, developed and assessed in cooperation with the Recreation RCG, will be provided in an addendum to the report.

APPENDIX A

SITE INVENTORY FORM

SOUTH CAROLINA ELECTRIC & GAS COMPANY

RECREATION ASSESSMENT STUDY PLAN

PARR HYDROELECTRIC PROJECT
(FERC NO. 1894)

SCE&G Public Site Inventory Form

Inspected by: ________ Date: _______

Site Name: ___________________________

Site Address: ____

City: _____________________ State: _SC_ Zip Code: ___________

Facility Type:

_____ Primitive Camp _____ Picnic Area ____ Day Use

_____ Overlook Site _____ Informal Site ____ Launch Ramp

Road Access:

_____ Paved access......................................______ # of lanes

_____ Unpaved access..................................______ # of lanes – (Circular entrance/exit)

Operations:

_____ Manned _____ Seasonal (From_____To_____)

_____ Unmanned _____ Year Round

_____ Fee ($) .... (Site_____; Parking;_____)

Site Amenities:

#	Type	#	Type
_____	Picnic Tables	_____	Potable Water
_____	Grills	_____	Boat Fuel
_____	Firepit/ring	_____	Trash Cans
_____	Boat Pump Out	_____	Docks
_____	Trails (specify use_____________: Miles_____)	_____	Playground
_____	Shelter	_____	Showers
_____	Designated Swim Area	_____	Concession
_____	Store	_____	Marina (# of slips_____)
_____	Dumping Station		

Parking Lots:

Type	Estimated # Paved	Estimated # Gravel		
ADA Spaces	_____	_____	_____	Spaces delineated?
Regular Spaces	_____	_____	_____	Curbs?
Vehicle & trailer spaces	_____	_____		

Sanitation Facilities:

	Flush	(BF*?)	Portable	(BF?)	Showers	(BF?)
Unisex	_____	(_____)	_____	(_____)	_____	(_____)
Women	_____	(_____)	_____	(_____)	_____	(_____)
Men	_____	(_____)	_____	(_____)	_____	(_____)

**BF - Barrier Free*

Campground/Campsite:

	RV sites	Cabins	Tent sites	Primitive sites
# of sites	______	______	______	______
On site parking	______	______	______	______
Water front	______	______	______	______
Barrier Free	______	______	______	______

Boat Launch Facilities:

_____ Hard surface _____ Unimproved (informal) _____ # of Lanes

_____ Gravel _____ Carry In _____ Boat Prep Area?

Courtesy/Fishing Docks:

Courtesy/Fishing	Dimensions	Barrier Free
________________	__________________________	____________________________________
________________	__________________________	____________________________________
________________	__________________________	____________________________________
________________	__________________________	____________________________________
________________	__________________________	____________________________________

Notes:

____

____

____

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____

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____

____

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____

____

Picture Number From _____ To ____

APPENDIX B

RECREATION SITE QUESTIONNAIRES

Monticello Reservoir Public Access Site Questionnaire

Clerk:_______________ **Site:** _______________ **Date:** ______________ **Time:** __________ **am/pm**

Weather: ☐ **Sunny** ☐ **Partly Cloudy** ☐ **Cloudy** ☐ **Light Rain** ☐ **Heavy Rain**

RESPONDENT GENDER: ☐ **Male** ☐ **Female** **RESPONDENT REFUSED INTERVIEW:** ☐
NUMBER OF PEOPLE IN VEHICLE: **RESPONDENT DOES NOT SPEAK ENGLISH:** ☐
VEHICLE HAS A BOAT TRAILER: ☐ **RESPONDENT IS NOT 18 YEARS OR OLDER:** ☐
RESPONDENT HAS BEEN INTERVIEWED AT THIS SITE PREVIOUSLY: ☐

THE FIRST FEW QUESTIONS ASK ABOUT YOUR EXPERIENCE HERE TODAY

1. Including yourself, how many people are in your party today? *(Fill in blank.)*

   _____ people in party

2. What time did you arrive ***at Monticello Reservoir*** today? *(Fill in blank.)*

   __________ am / pm

3. What is the primary recreation activity that you participated in today ***at Monticello Reservoir***? *(Please read the list to respondents. Check only one main activity in the first column.)*

What other activities did you participate in today ***at Monticello Reservoir***? *(Check all that apply in the second column.)*

Check only one main activity	*Check all other activities*	*Types of Activities*
		FISHING:
☐	☐	***boat fishing***
☐	☐	***pier/dock fishing***
☐	☐	***bank fishing***
		BOATING:
☐	☐	***motor boating***
☐	☐	***pontoon/party boating***
☐	☐	***sailing***
☐	☐	***canoeing/kayaking***
☐	☐	***windsurfing***
☐	☐	***paddleboarding***
		OTHER:
☐	☐	***bicycling***
☐	☐	***tent or vehicle camping***
☐	☐	***horseback riding***
☐	☐	***walking/hiking/backpacking***
☐	☐	***sightseeing***
☐	☐	***hunting***
☐	☐	***nature study/wildlife viewing/photography***
☐	☐	***swimming***
☐	☐	***picnicking***
☐	☐	***sunbathing***
☐	☐	***other:***___________________________________

Check only <u>one</u> main activity	*Check all other activities*	*Types of Activities*
	☐	***None***

4. Did you spend any time ***on the water on Monticello Reservoir*** today? *(Check one box.)*

☐ YES
☐ NO *(If no, skip to Question 6.)*

5A. Did you recreate on any of the ***islands on Monticello Reservoir*** today?

☐ YES
☐ NO *(If no, skip to Question 6.)*

5B. What activities did you participate in ***while on the island(s)***? *(Do not read this list. Allow respondent to answer and check all that apply and/or fill in the blanks.)*

☐ sunbathing	☐ bank fishing	☐ hunting
☐ camping	☐ walking/hiking	☐ sightseeing
☐ nature study/wildlife viewing/photography	☐ swimming	☐ picnicking
☐ other (please specify: ________________________________)		

6. On a scale from 1 to 5, with 1 being light, 3 being moderate, and 5 being heavy, how would you rate the crowdedness ***at this recreation site*** today? *(Circle one number.)*

Light ***Moderate*** ***Heavy***

1 2 3 4 5

7A. On a scale from 1 to 5, with 1 being poor and 5 being excellent, how would you rate the overall condition ***of this recreation site*** today? *(Circle one number.)*

Poor ***Excellent***

1 2 3 4 5

7B. Why did you choose to come to ***this recreation site*** today? (*Fill in the blank.)*

____

____

____

____

7C. Are there any additional facilities needed ***at this recreation site***? *(Check one box.)*

☐ YES
☐ NO *(If no, skip to Question 8.)*

7D. What do you recommend? *(Do not read this list. Allow respondent to answer and check all that apply and/or fill in the blanks.)*

☐ access road	☐ bank fishing area	☐ boat dock
☐ boat launch	☐ camping area	☐ fish cleaning station
☐ fishing pier/dock	☐ lighting	☐ parking lot
☐ picnic tables/shelter	☐ restrooms	☐ signs & information
☐ swimming area	☐ trails	☐ trash cans
☐ RV camping	☐ tent camping	☐ bilingual signs & information
☐ other (please specify: ______________________________)		

7E. Are there any other improvements that you would recommend for this site?

☐ YES
☐ NO *(If no, skip to Question 8.)*

7F. What improvements do you recommend? *(Fill in the blank.)*

____

____

____

____

8. What was your primary reason for choosing to recreate ***at Monticello Reservoir*** today verses another lake or area? *(Fill in blank.)*

____

____

____

9. What ***other lakes*** do you recreate at? *(Fill in blank.)*

____

____

____

____

I HAVE JUST A FEW MORE QUESTIONS

10. Do you own a permanent or seasonal lakefront residence ***on Monticello Reservoir***? What is your zip code? *(Check one box and fill in the blank for zip code.)*

- ☐ YES – Permanent Home→ ZIP CODE: ____________
- ☐ YES – Seasonal Home → ZIP CODE: ____________
- ☐ NO - Non-lakefront resident → ZIP CODE: ____________

11. In what year were you born? *(Fill in blank.)*

___________ YEAR

12. Do you have any additional comments about the recreation facilities at ***Monticello Reservoir***? (*Please fill in blank and be as specific as possible.*)

____

____

____

____

____

____

THANK YOU FOR YOUR HELP! WE APPRECIATE YOUR TIME TODAY!

Parr Reservoir/Broad River Public Access Site Questionnaire

Clerk:________________ **Site:** ________________ **Date:** _______________ **Time:** ___________ **am/pm**

Weather: ☐ **Sunny** ☐ **Partly Cloudy** ☐ **Cloudy** ☐ **Light Rain** ☐ **Heavy Rain**

RESPONDENT GENDER: ☐ **Male** ☐ **Female**
NUMBER OF PEOPLE IN VEHICLE:
VEHICLE HAS A BOAT TRAILER: ☐
RESPONDENT REFUSED INTERVIEW: ☐
RESPONDENT DOES NOT SPEAK ENGLISH: ☐
RESPONDENT IS NOT 18 YEARS OR OLDER: ☐
RESPONDENT HAS BEEN INTERVIEWED AT THIS SITE PREVIOUSLY: ☐

THE FIRST FEW QUESTIONS ASK ABOUT YOUR EXPERIENCE HERE TODAY

1. Including yourself, how many people are in your party today? *(Fill in blank.)*

   _____ people in party

2. What time did you arrive ***at Parr Reservoir*** today? *(Fill in blank.)*

   __________ am / pm

3. What is the primary recreation activity that you participated in today ***at Parr Reservoir***? *(Please read the list to respondents. Check only one main activity in the first column.)*

   What other activities did you participate in today ***at Parr Reservoir***? *(Check all that apply in the second column.)*

Check only one main activity	*Check all other activities*	*Types of Activities*
		FISHING:
☐	☐	***boat fishing***
☐	☐	***pier/dock fishing***
☐	☐	***bank fishing***
		BOATING:
☐	☐	***motor boating***
☐	☐	***canoeing/kayaking***
		OTHER:
☐	☐	***tent or vehicle camping***
☐	☐	***horseback riding***
☐	☐	***walking/hiking/backpacking***
☐	☐	***Sightseeing***
☐	☐	***Hunting***
☐	☐	***nature study/wildlife viewing/photography***
☐	☐	***Swimming***
☐	☐	***Picnicking***
☐	☐	***Sunbathing***
☐	☐	***other:***_____________________________________ _
	☐	***None***

4. On a scale from 1 to 5, with 1 being light, 3 being moderate, and 5 being heavy, how would you rate the crowdedness ***at this recreation site*** today? *(Circle one number.)*

Light		***Moderate***		***Heavy***
1	2	3	4	5

5A. On a scale from 1 to 5, with 1 being poor and 5 being excellent, how would you rate the overall condition ***of this recreation site*** today? *(Circle one number.)*

Poor				***Excellent***
1	2	3	4	5

5B. Why did you choose to come to ***this recreation site*** today? (*Fill in the blank.)*

____

____

____

____

5C. Are there any additional facilities needed ***at this recreation site***? *(Check one box.)*

☐ YES
☐ NO *(If no, skip to Question 6.)*

5D. What do you recommend? *(Do not read this list. Allow respondent to answer and check all that apply and/or fill in the blanks.)*

☐ access road	☐ bank fishing area	☐ boat dock
☐ boat launch	☐ camping area	☐ fish cleaning station
☐ fishing pier/dock	☐ lighting	☐ parking lot
☐ picnic tables/shelter	☐ restrooms	☐ signs & information
☐ swimming area	☐ trails	☐ trash cans
☐ RV camping	☐ tent camping	☐ bilingual signs & information
☐ other (please specify: ____)		

5E. Are there any other improvements that you would recommend for this site?

☐ YES
☐ NO *(If no, skip to Question 6.)*

5F. What improvements do you recommend? *(Fill in the blank.)*

____

____

____

____

I HAVE JUST A FEW MORE QUESTIONS

6. Do you own a permanent or seasonal residence ***on the Broad River***? What is your zip code? *(Check one box and fill in the blank for zip code.)*

☐ YES – Permanent Home→ ZIP CODE: ____________

☐ YES – Seasonal Home → ZIP CODE: ____________

☐ NO - Non-lakefront resident → ZIP CODE: ____________

7. In what year were you born? *(Fill in blank.)*

___________ YEAR

8. Do you have any additional comments about the recreation facilities on ***Parr Reservoir***? (*Please fill in blank and be as specific as possible.*)

____

____

____

____

____

____

THANK YOU FOR YOUR HELP! WE APPRECIATE YOUR TIME TODAY!

Appendix B

2014 Waterfowl Focus Group Meeting Summary

Parr Shoals Hydroelectric Project Relicense – FERC No. 1894

Waterfowl Hunters Focus Group Meeting Summary

December 9, 2014

Kleinschmidt Offices – Lexington, SC

Waterfowl Focus Group - Purpose Statement

Waterfowl hunting is a recreation activity that occurs within the Parr Hydroelectric Project boundary. As part of the relicensing of the Parr Hydroelectric Project, stakeholders identified the need to gather information from waterfowl hunters that use the Parr Project Area for hunting in order to learn about their use and perceptions regarding the adequacy of existing resources and opportunities within the Project boundary. SCE&G, in consultation with stakeholders, has formed a Waterfowl Focus Group to aid in gathering this information. The resulting Focus Group information will be used to help SCE&G identify ways to support waterfowl hunting and balance waterfowl hunters' needs with other demands at the Project.

Session Details

Facilitators: Alison Jakupca, Henry Mealing, Kelly Miller - Kleinschmidt Associates

Date of Session: December 9, 2014

Participant Information:

Organization/Affiliation	Number Attending
• Individual Waterfowl Hunters	3
• SCDNR	3
• Tyger Enoree River Alliance (TERA) Members	3
• SCE&G Personnel	3
• Kleinschmidt Personnel	3

Results:

SCE&G conducted a focus group of waterfowl hunters in December of 2014. Information was gathered in 3 primary areas: *personal hunting preferences, seasonal trends and distribution of activities, Project Area preferences and needs*. Individual waterfowl hunters and TERA members are collectively referred to as "attendees" in the following notes.

Personal Hunting Preferences:

- Most of the focus group attendees indicated that they hunted in the Project Area on a weekly basis during the hunting season, noting that they would hunt whenever time and personal commitments allow.
- Attendees generally indicated that waterfowl hunting is more enjoyable as a group activity and that they prefer to hunt with 1 to 4 other people.
- Attendees noted that hunting was usually preferable in the morning; however the preferable time of day to hunt was highly weather dependant.
- Weekdays are preferred over Saturdays (no hunting allowable in the Project Area on Sundays) due to less crowding during the weekdays.
- In general, all species of waterfowl are hunted, no particular species of interest is specifically sought.
- Attendees indicated that they hunt by both boat and by wading. Hunters generally boat in from a public launch facility and then wade to a particular hunting location.
- The Project area launch facilities most often utilized by waterfowl hunters are as follows: Hwy 99 and the site at Hwy 215 on Monticello; Hwy 34 primitive site, the Dawkins access (primitive boat ramp and cross over RR tracks); and the Maybinton (Keitts Bridge[1]) landing on Parr.

Seasonal Trends:

- Attendees noted that they generally begin hunting on or around Thanksgiving Day and hunt through the end of January (concurrent with the state and federal seasons). However, many indicated that they also hunt during the September teal and goose seasons and the February goose season.
- Holidays were indicated as being some of the best hunting days due to a lack of other hunters.
- Attendees noted an observed decrease in wood duck populations in the Project Area in the last 3 to 4 years. It was noted that snow geese are beginning to be observed in the Project Area.

[1] Please see clarification submitted subsequent to the meeting located at the end of this document.

Project Area Preferences and Needs:

- Parr Reservoir and associated waterfowl areas seems to be preferred to Monticello Reservoir. This may be due to the fact that Monticello Reservoir is only open to waterfowl hunting on Wednesday and Saturday, while Parr is open 6 days a week.
- Attendees indicated that there was over-crowding at the Enoree Waterfowl Area.
- It was noted that people drive from long distances to hunt at the Enoree Waterfowl Area due to the fact that it is a Category 2[2] waterfowl area (appears "attractive" on paper).
- Attendees also indicated that they have been stranded a few times on the reservoir, as lake levels drop. Additionally, attendees indicated that maintaining a Parr Reservoir level of 260' or above would be preferable, particularly during December and January.
- A bridge may be needed in the Enoree River Waterfowl Area to allow people to hunt at the far side of the area. This would, however, allow more public into this area, which may be a negative impact to serious hunters who wade to that area[3].
- Attendees indicated that they would like for SCE&G to maintain Hwy 34 in a primitive state.
- The Maybinton site is difficult to get in and out of and could use some gravel or other boat launching improvements.
- No improvements were recommended at Monticello recreation sites or at Heller's or Cannon's creek sites.
- Enoree Waterfowl Area was indicated as being the most used site, being rated by attendees as a "5" (with "1" being light and "5" being heavy).
- Focus group attendees indicated that the mainstem of the Broad River, from the Monticello tailrace to the Hwy 34 boat ramp, was also fairly crowded (rated as a "4" on Saturday mornings).
- Attendees noted that hunting opportunities could possibly be improved in the Project Area through the creation of an additional waterfowl habitat/resting area (in particular, an area upstream of the Enoree Waterfowl Area, along the Enoree River)[4].

[2] SCDNR defines a "Category 1" Waterfowl Area as one where hunting is permitted only by means of a special permit obtained from SCDNR through an annual drawing. Hunting is permitted on an "Category 2" Waterfowl Area only during SCDNR specified days and times during state waterfowl seasons.
[3] Please see clarification submitted subsequent to the meeting located at the end of this document.
[4] Please see clarification submitted subsequent to the meeting located at the end of this document.

Other points and issues raised by focus group attendees:

- Attendees indicated that there are general issues regarding disrespectful and inexperienced hunters in the Project Area; however, they also noted that this seems to be an issue present at any public hunting area and has been compounded by the new-found popularity of waterfowl hunting due to a popular TV show.
- An increase in the number of private impoundments was indicated as potentially attracting ducks away from Project Area waters.
- The VC Summer nuclear station service water pond also provides a good sanctuary for waterfowl.
- Attendees indicated that they general do not experience conflicts with other types of hunting in the Project Area (small game, large game, etc.). They indicated that they occasionally experience conflicts with fisherman in the Project Area.
- Several options were suggested by attendees to alleviate some of the crowding issues currently experienced at the Enoree Waterfowl Area. All of these options would need to be implemented by S.C. Department of Natural Resources (SCDNR) and include:
    - A SCDNR decision to categorize the Enoree Waterfowl Area as "Category 1" (currently "Category 2").
    - Only allow a certain number of individuals to hunt the area at one time.
    - Require a hunting pass.
    - Only allow hunting on Wednesdays.
- SCDNR indicated the desire to work with SCE&G on an annual basis to facilitate SCDNR management of waterfowl areas during planting and hunting seasons. In particular, was the discussion of SCE&G maintaining Parr Reservoir at levels that would assist with either flooding or draining of waterfowl areas.

Conclusions:

There were many common themes expressed during the focus group meeting. Over-crowding at the Enoree Waterfowl Area was a main concern. Some improvements were suggested at the Hwy 34 boat ramp and the Maybinton Landing. However, it was emphasized that improvements/maintenance should continue to focus on keeping these areas primitive. Focus group attendees expressed satisfaction with the Monticello Reservoir access areas as well as the developed access areas at Parr (Cannons and Hellers Creek). Attendees noted that desire to work with SCDNR to alleviate some of the crowding issues in the Project Area. Potential opportunities for SCE&G and SCDNR to work together in the future for the management of waterfowl areas were also identified.

Comments and Clarifications Submitted Subsequent to the Meeting

The following comments were provided subsequent to the focus group meeting to clarify the preceding meeting summary:

- In the "Personal Preferences" bullet points, Keitts Bridge appears to be referenced as being on Parr Reservoir. That landing is on the Enoree, upriver of the Enoree Waterfowl Area.

- In the "Project Area Preference and Needs" bullet points, there is a reference to the foot bridge in the Enoree Waterfowl Area. That bridge already exists. The conversation was about the fact that the bridge may be contributing to the over - crowding issue in the area. It does provide easier access to the far side of the area. Previously, that area was a long *walk* around the impoundment. Now wading to that area is possible because the foot bridge gets you over the creek channel out in the middle of the water.

- In the "Project Area Preference and Needs" bullet points, there is mention of "improving hunting opportunities" regarding the SCE&G property upstream of the Enoree Waterfowl Area. To be clear, the intent of the suggested enhancements to the area is to restore wetland habitat for waterfowl and other wetland dependant organisms.... critters. With its proximity to the Enoree Waterfowl Area, it is possible that the improved area would be a sanctuary. While this would contribute to overall habitat, I am not sure it directly contributes to "hunting opportunities". Waterfowl hunters have long correlated habitat conservation and restoration with sustaining populations conducive to hunting, but the two efforts are distinct.

Appendix: Focus Group Discussion Questions

1. When was the last time you hunted waterfowl in the Project Area (refer to map)?

2. When you hunt waterfowl in the Project Area, how many people do you usually hunt with?

3. What time of day do you usually hunt in the Project Area?

4. Is there a specific month that you tend to hunt most frequently? Why? Are there any months during the season that you generally avoid? Why?

5. What species or group (geese, wood ducks, puddle ducks, diving ducks) of waterfowl do you typically hunt for in these areas?

6. How many times a season do you typically hunt in these areas?

7. Do you typically hunt on weekends, weekdays or both?

8. Have you seen any changes in the species of ducks harvested over the last 5 years?

9. Looking at this map, I'd like you to show me areas where you typically hunt waterfowl in the Project Area. Why do you choose to hunt waterfowl here?

10. Do you typically hunt waterfowl by wading, from a boat, or both?

11. For those of you who typically hunt from a boat, do you usually launch from private property or a public launch facility? If either of the latter responses, which ones? (looking for specific names here)

12. I'd like to focus on the public access sites you use for launching on the lake for waterfowl hunting. Are there any additional facilities needed at these sites? [By "facilities" I mean

parking spaces, restrooms, launch lanes, lighting, etc.] Are there any improvements that you would recommend for this site?

13. On a scale from 1 to 5, with 1 being light, 3 being moderate, and 5 being heavy, how would you rate the crowdedness overall in the Project Area when you go waterfowl hunting?

14. Do you experience conflicts with other types of hunting (small game, large game, etc.) or recreation activities (fishermen) in the Project Area?

15. How do you think waterfowl hunting in the Project Area could be improved?

MEMORANDUM

TO: Parr/Fairfield Hydro Relicensing Fisheries and Instream Flow TWC

FROM: Shane Boring and Milton Quattlebaum

DATE: April 29, 2014

RE: Robust Redhorse Spawning Areas

An assessment of spawning habitat for robust redhorse (*Moxostoma robustum*) was requested by stakeholders during the study scoping phase of relicensing. Stakeholders agreed that a qualitative assessment of the Instream Flow Incremental Methodology (IFIM) study reach downstream of Parr Shoals Dam would be conducted concurrently with the mesohabitat assessment and other field efforts during the fall of 2013 and winter of 2014. This memorandum summarizes the assessment results.

Methods

The reach of the Broad River extending from Parr Shoals through the Bookman Island complex was observed by biologists (Milton Quattlebaum (SCANA), Ron Ahle (South Carolina Department of Natural Resources), and Shane Boring (Kleinschmidt Associates)) in October and November 2013 during the mesohabitat assessment conducted in support of the proposed IFIM Study. A follow up visit was made by Quattlebaum and Scott Lamprecht (South Carolina Department of Natural Resources) in February 2014. During the assessment, the group utilized published habitat suitability criteria to identify areas along the river reach they believed were potential robust redhorse (RRH) spawning sites. According to Freeman and Freeman (2001), RRH spawning habitat is characterized as being mid-channel gravel bars dominated by medium to coarse gravel with less that 30% sand and minimal fine particles. Spawning sites are also characterized as containing gravel small enough to be moved for egg deposition, but large enough to offer interstitial space for the eggs. Water depths are typically between 1 and 3.6 feet, with an average water column velocity of 0.85 to 2.20 ft/s. Sites encountered during the assessment that appeared to display these characteristics were noted on the field datasheets, their locations were documented with Global Positioning System (GPS), and in some instances, the sites were photographed.

Results

Four potential RRH spawning sites were examined during the assessment. The upstream-most site is located in the tailrace of the Parr development powerhouse within IFIM Study Site 3 (Figure 1). Fisheries Technical Working Committee (TWC) members have noted that RRH activity is well documented at that site, including observed potential spawning behavior. Three new sites were located during the assessment: one just upstream of Haltiwanger Island and two in the Bookman Shoals complex (IFIM Study Site 10) in the vicinity of Hickory Island (Figure 2). Results of PHABSIM and 2-D modeling conducted as part of the IFIM study will develop weighted usable area (WUA) estimates of spawning habitat under various flow scenarios, which will be taken into consideration by the TWC in developing a downstream flow recommendation that is best for multiple species, including RRH spawning.

FIGURES

FIGURE 1 POTENTIAL ROBUST REDHORSE SPAWNING AREA DOWNSTREAM OF PARR DAM

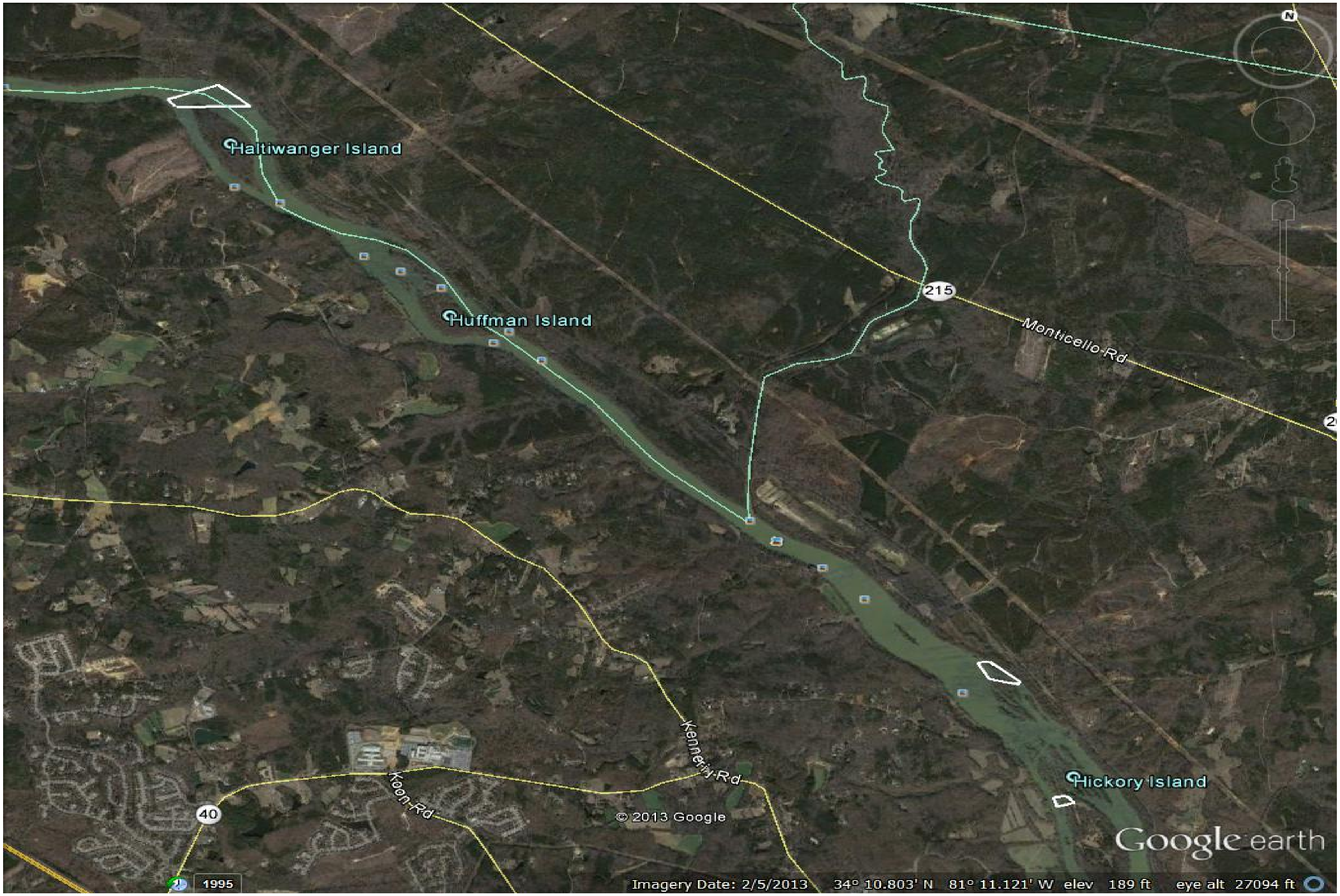

FIGURE 2 POTENTIAL ROBUST REDHORSE SPAWNING SITE AT HALTIWANGER ISLAND AND IN BOOKMAN SHOALS COMPLEX

MEMORANDUM

TO: Parr/Fairfield Hydro Relicensing Instream Flow TWC

FROM: Shane Boring

DATE: January 8, 2014

RE: Mesohabitat Assessment

A mesohabitat assessment of the Broad River downstream of Parr Shoals Dam was completed by biologists from Kleinschmidt (Shane Boring), SCANA (Milton Quattlebaum) and the South Carolina Department of Natural Resources (Ron Ahle) during October and November of 2013. The assessment was conducted in support of the ongoing Parr/Fairfield Hydroelectric Project relicensing effort, and more specifically, in preparation for the upcoming Instream Flow Incremental Methodology (IFIM) and other studies. The purpose of the assessment was to classify and determine the quantity and spatial distribution of different mesohabitat types within the study area previously outlined by the Instream Flow Technical Working Committee (TWC) (Figure 1). These data will be used to weight the Weighted Usable Area (WUA) output from individual representative transects and study sites according to the relative abundance and distribution of the mesohabitat types throughout the study area.

“Mesohabitats” are generalized habitat types that are commonly used to describe stream habitat (i.e. riffle, run, pool). Acceptable mesohabitat definitions were determined in consultation with the Instream Flow TWC (See July 30, 2013 meeting notes), and include the following:

RIFFLE	Shallow, with moderate velocity, turbulent, high gradient, moderate to large substrates (cobble/gravel). Typically > 1% gradient.
GLIDE	Moderately shallow, well-defined non-turbulent laminar flow, transition from low to moderate velocity, lacking a definite thalweg, typically flat stream geometry, typically finer substrates, transitional from pool.
RUN	Moderately deep, well-defined non-turbulent laminar flow, range from low to moderate velocity, well-defined thalweg, typically concave stream geometry, varying substrates, gently downstream slope (<1%).
POOL	Deep, low to no velocity, well-defined hydraulic control at outlet.
RAPID/SHOAL	Shallow, with moderate to high velocity, turbulent, with chutes and eddies, high gradient, large substrates or bedrock. Typically >2% gradient.
BACKWATER	Varying depth, no or minimal velocity, off the primary channel flow.

ASSESSMENT METHODS

For purposes of the mesohabitat assessment, the approximately 18 mile-long study area was broken into the two reaches agreed upon during the June 2013 field reconnaissance: Reach One – extending from the Parr Shoals dam downstream to the Palmetto Trail trestle crossing and Reach Two – extending from the trestle to the downstream end of Bookman Island (Figure 1). The study area was traversed by canoe/kayak or on foot at flows ranging from approximately 1,000 to 2,200[1] cubic feet per second (cfs), and mesohabitats occurring in each reach were classified into one of the six categories described above.

Upstream and downstream boundaries of each mesohabitat segment were documented using a Garmin 60cs Global Position System (GPS). Although not included in this report, field observations regarding dominant substrate, overall cover quality[2], and approximate channel width were recorded should this information be needed at a later date (e.g., during IFIM modeling efforts). Reference photos for each mesohabitat type were also taken at selected locations. GPS data were incorporated into a Geographic Information System (ArcGIS) and area polygons constructed and calculated for each mesohabitat segment (Figure 2).

RESULTS

Area and proportion of mesohabitats occurring in each reach are illustrated below in Figures 2-6 and summarized in Table 1. Reach One is dominated by run habitats, with an abundance of shoal habitat associated primarily with the bedrock outcroppings at the base of the Parr Shoals Dam (Table 1; Figure 3). Reach Two, which is depicted as Reaches 2a, 2b and 2c for illustration purposes (Figures 4-6), is dominated by pool habitats, with the remainder primarily consisting of nearly equal proportions of shoals, riffle and run habitats (Table 1). No significant backwaters were observed during the survey.

Table 1. Proportions of Mesohabitats Occurring Downstream of Parr Shoals Dam

	Glide	**Pool**	**Riffle**	**Shoal**	**Run**
Reach One	**4%**	**18%**	**0%**	**31%**	**47%**
Reach Two	**6%**	**28%**	**21%**	**25%**	**20%**

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[1] Small portions of Reach One were also observed at approximately 4000 cfs during wrap-up of field work in late-November 2013.
[2] Refers to the relative density of object cover such as boulders, logs, etc.

FIGURES

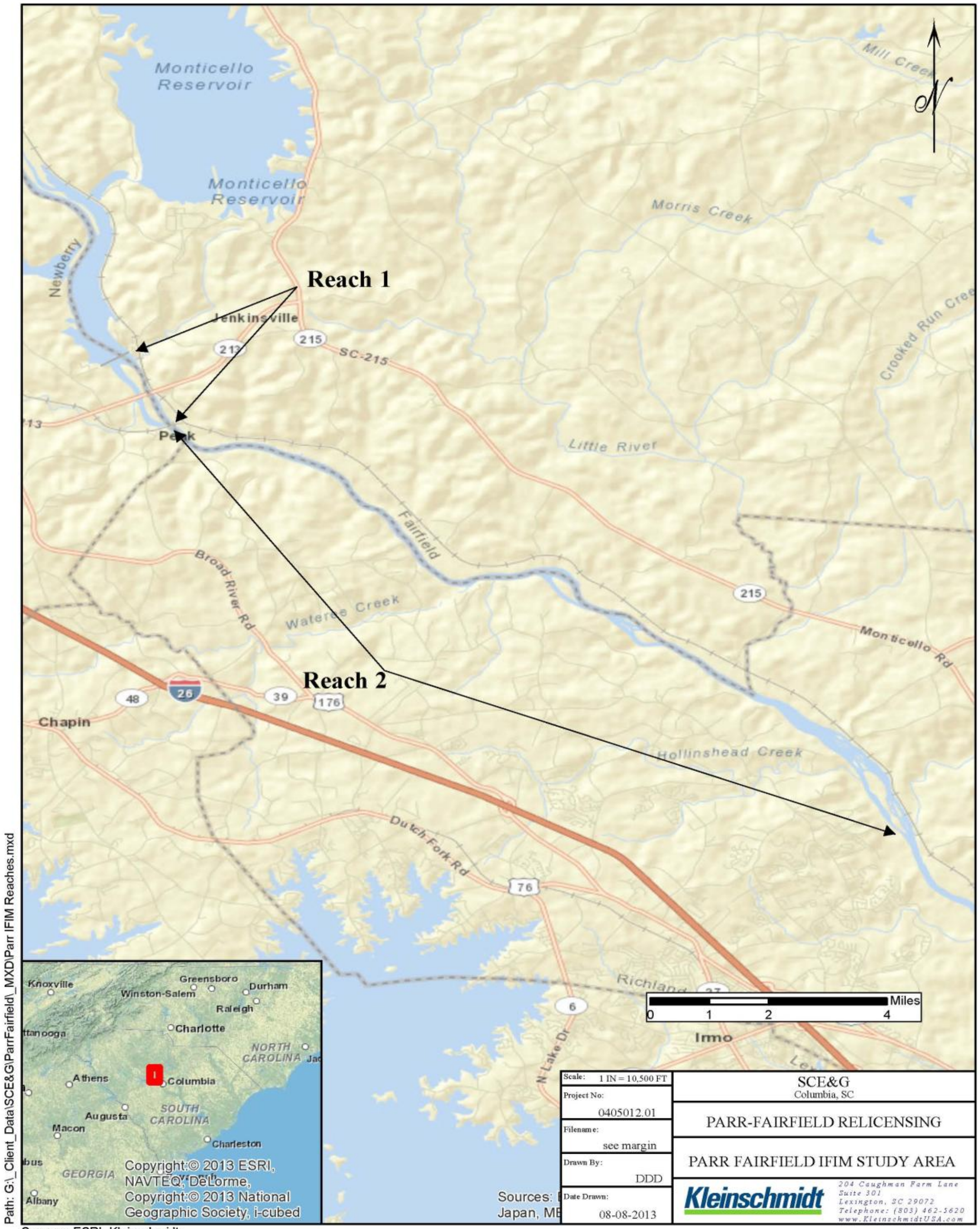
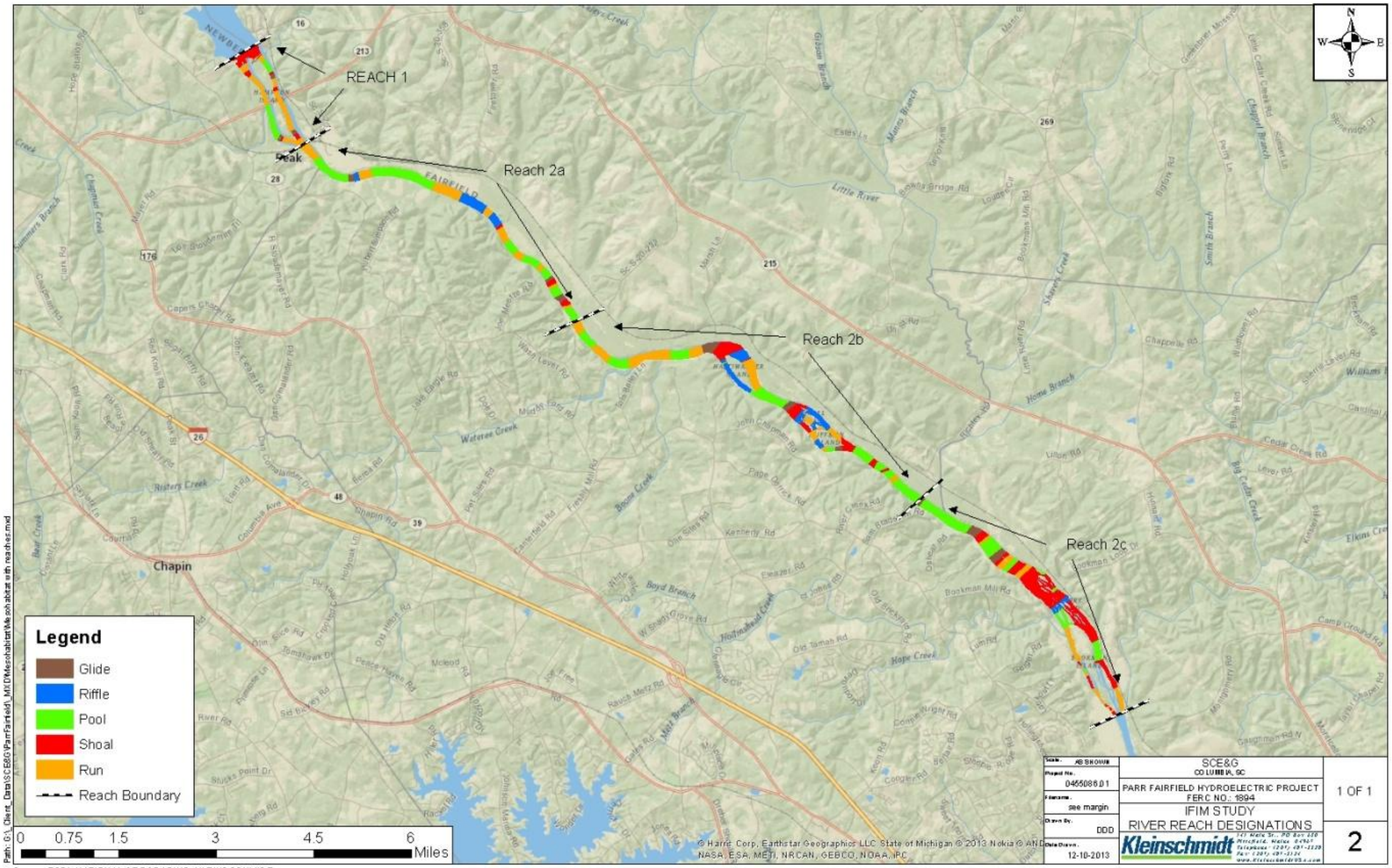


FIGURE 1 PARR-FAIRFIELD PROJECT, BROAD RIVER INSTREAM FLOW STUDY. IFIM STUDY REACHES



Source: ESRI, NATIONAL GEOGRAPHIC, KLEINDSCHMIDT

FIGURE 2 IFIM STUDY RIVER REACH DESIGNATIONS

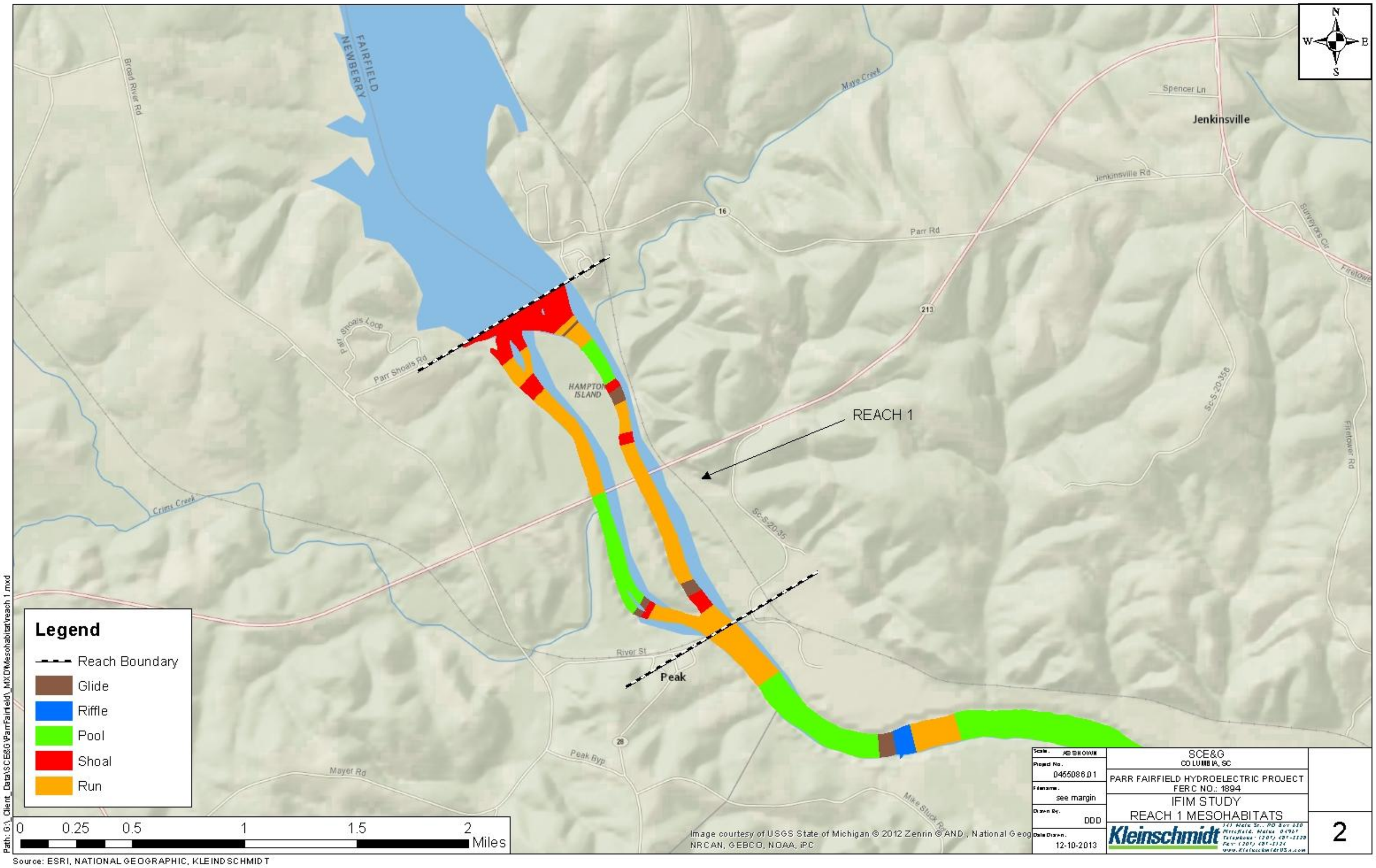


FIGURE 3 IFIM STUDY REACH 1 MESOHABITATS

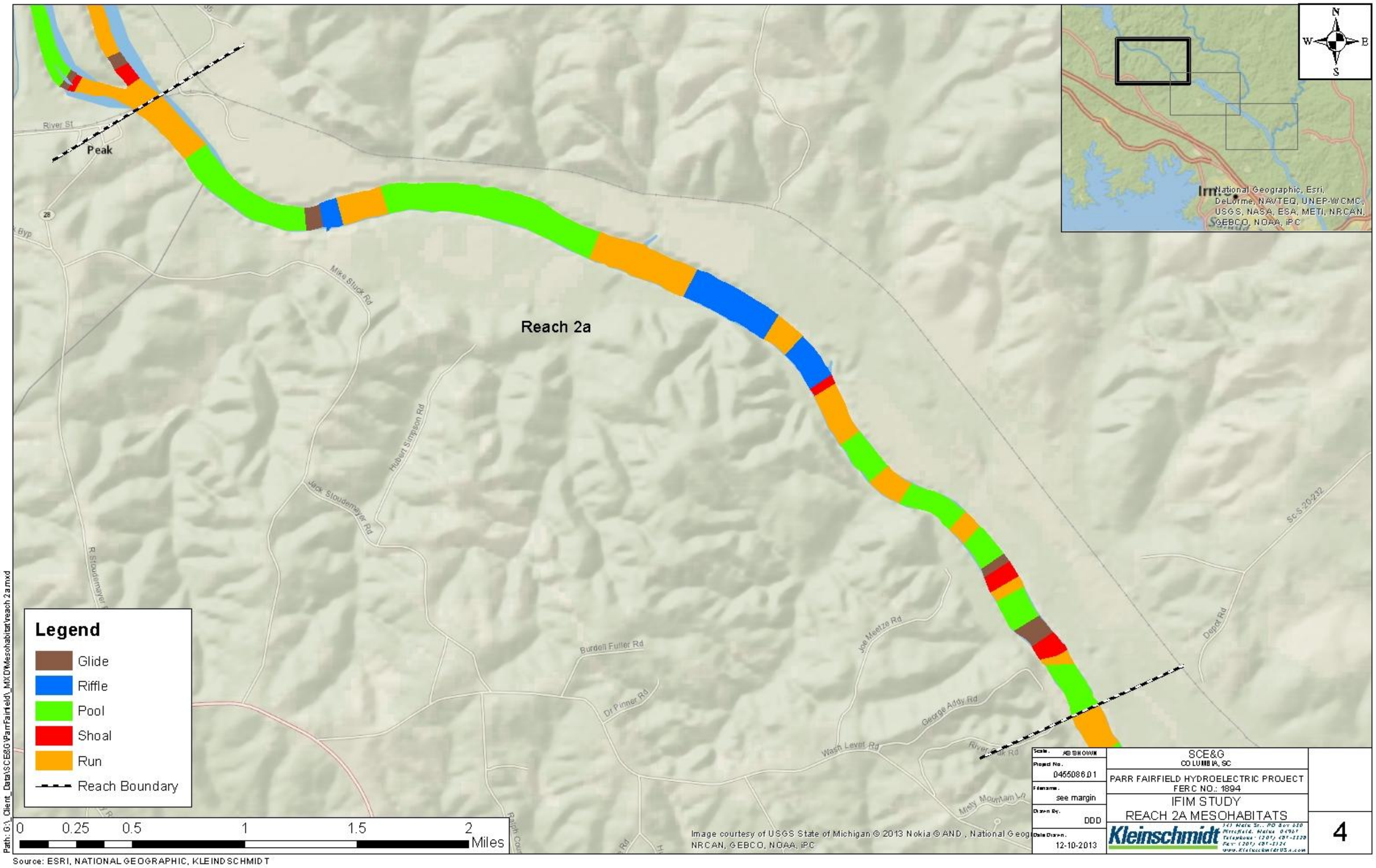
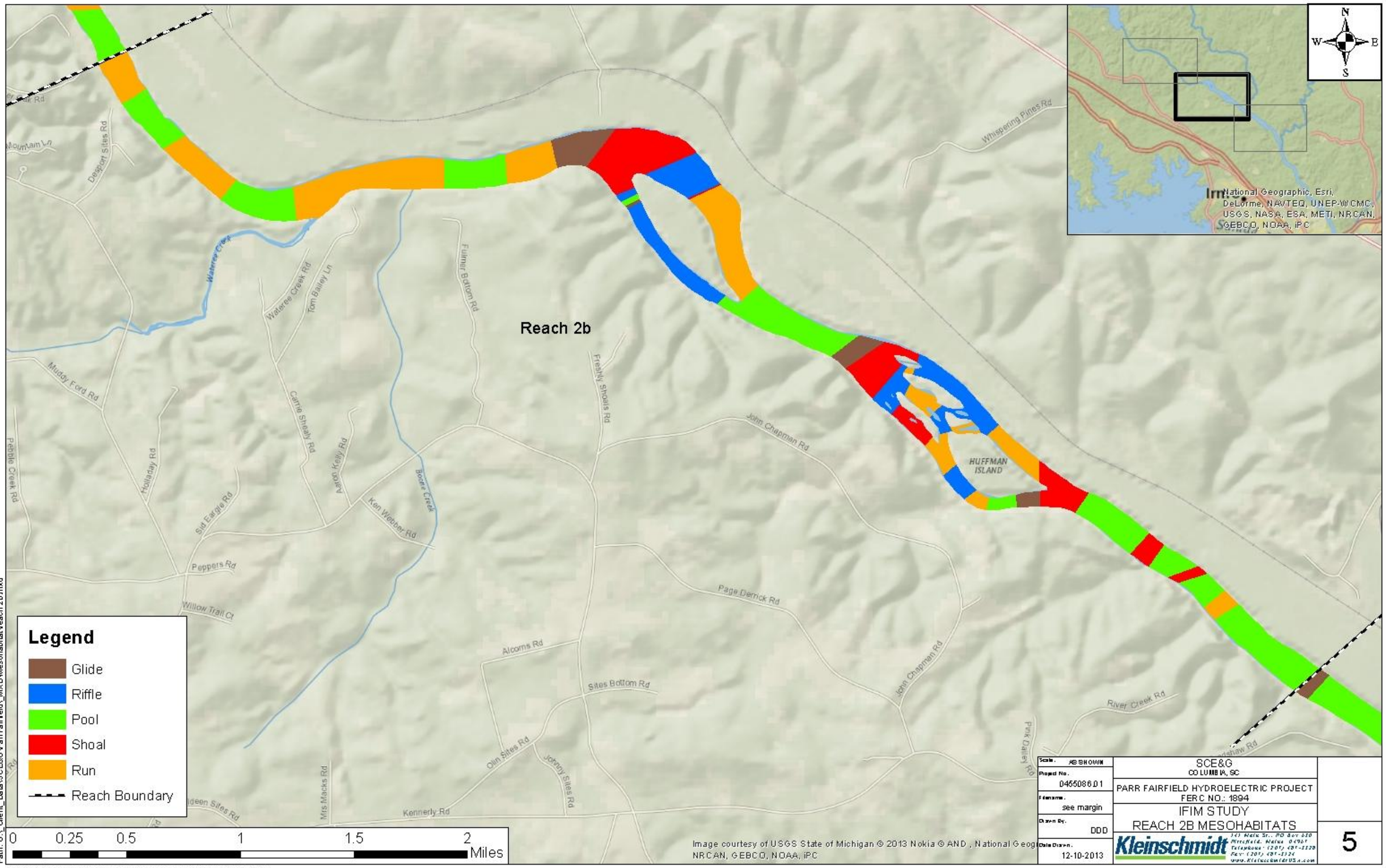


FIGURE 4 IFIM REACH 2A MESOHABITATS



Source: ESRI, NATIONAL GEOGRAPHIC, KLEINDSCHMIDT

FIGURE 5 IFIM STUDY REACH 2B MESOHABITATS

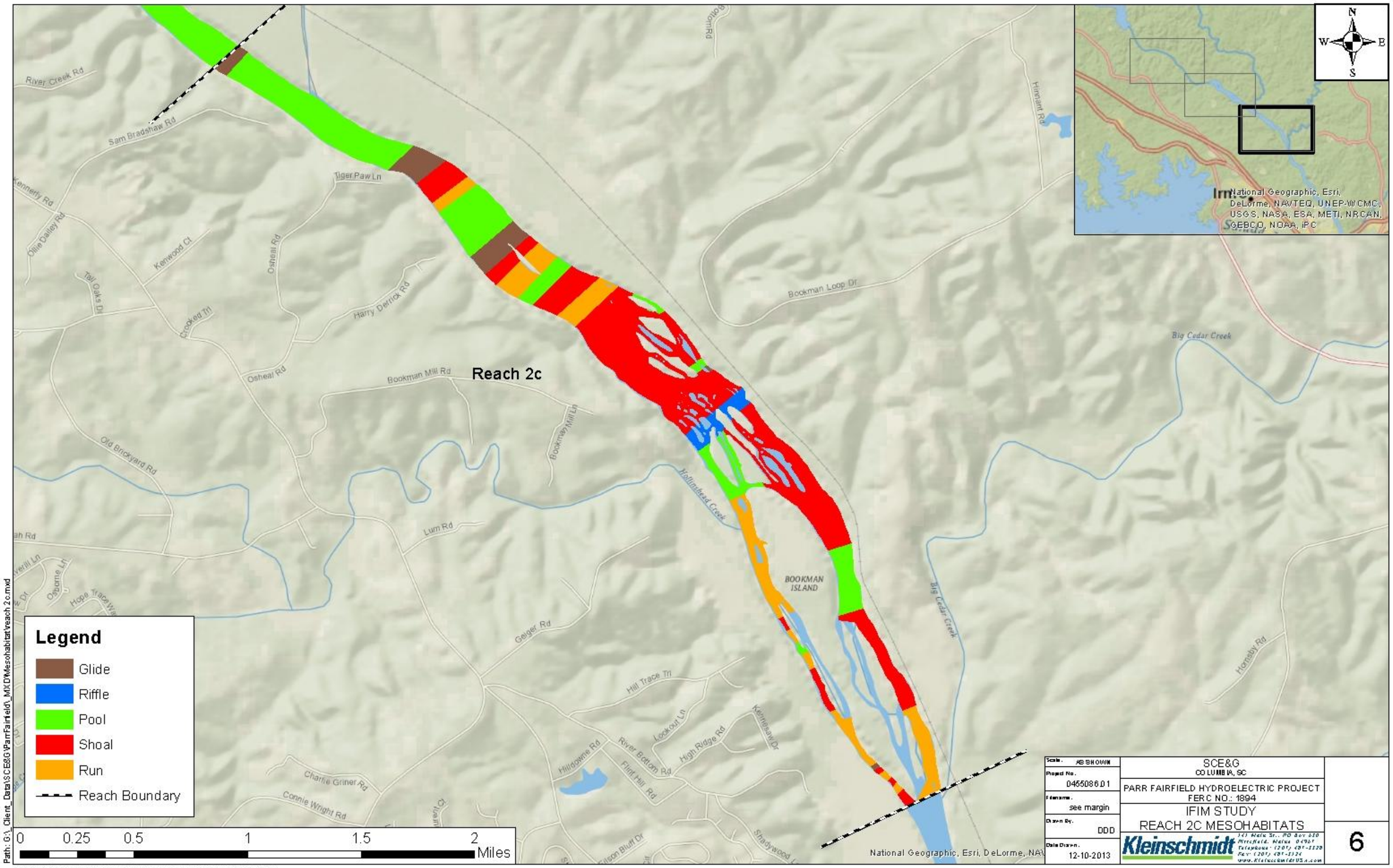


FIGURE 6 IFIM STUDY REACH 2C MESOHABITATS

INSTREAM FLOW STUDY REPORT

PARR HYDROELECTRIC PROJECT

(FERC NO. 1894)

Prepared for:

South Carolina Electric & Gas Co.
Cayce, South Carolina

Prepared by:

Kleinschmidt

Lexington, South Carolina
www.KleinschmidtGroup.com

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INSTREAM FLOW STUDY REPORT

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SOUTH CAROLINA ELECTRIC & GAS CO.

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1.0 INTRODUCTION

The Parr Hydroelectric Project (FERC No. 1894) (Project) is a 526.08 megawatt (MW) licensed hydroelectric facility and is owned and operated by South Carolina Electric & Gas (SCE&G). The Project consists of the Parr Shoals Development and the Fairfield Pumped Storage Development. Both developments are located along the Broad River in Fairfield and Newberry Counties, South Carolina (Figure 1-1).

The Parr Shoals Development forms Parr Reservoir along the Broad River. The Development consists of a 37-foot-high, 200-foot-long concrete gravity spillway dam with a powerhouse housing generating units with a combined licensed capacity of 14.88 MW. Parr Shoals operates in a modified run-of-river mode and normally operates to continuously pass Broad River flow. The 13-mile-long Parr Reservoir has a surface area of 4,400 acres at full pool and serves as the lower reservoir for pumped-storage operations. The Fairfield Pumped Storage Development is located directly off of the Broad River and forms the 6,800-acre upper reservoir, Monticello Reservoir, with four earthen dams. As noted, Parr Reservoir serves as the lower reservoir for pumped storage operations. The Fairfield Development has a licensed capacity of 511.2 MW and is primarily used for peaking operations, reserve generation, and non-peak energy storage.

In anticipation of the Project relicensing process, SCE&G met with a number of state and federal resource agencies and interested stakeholders to begin scoping environmental issues as they pertain to project operations. As a result, the United States Fish and Wildlife Service (USFWS), South Carolina Department of Natural Resources (SCDNR), and several Non-governmental Organizations (NGO’s) requested studies to determine the potential impact of Project operation on fishery resources and aquatic habitat, including an Instream Flow Incremental Methodology Study (IFIM) for the Broad River downstream of the Project. SCE&G formed a Technical

Working Committee (TWC) composed of representatives from each interested party that consult to provide input and guidance for the study design and execution.

The IFIM is a nationally recognized method used to solve competing instream water uses involving aquatic habitat. It was developed by the Instream Flow and Aquatic Systems Group of the U.S. Fish and Wildlife Service (now a branch of the USGS). The IFIM is a tool that provides decision-makers with information showing the degree of habitat available in a defined river reach, across a range of flows (Bovee 1982). It does this by developing a quantitative estimate of habitat area at selected discharges, from site-specific measurements of stream morphology, cover, substrate, depth, velocity and discharge gathered in reaches along the river. These physical measurements are then rated for habitat suitability, based on objective habitat use data developed for the aquatic species and life stages of concern.

The IFIM does not compute a single "answer", but instead estimates degrees of suitability under existing and alternative flow scenarios. In this application, it may be used to estimate the extent that various project water management proposals may affect aquatic habitat in particular stream reaches. IFIM results must be evaluated in the context of watershed hydrology and the strategic needs of other competing uses, which in this case include, but are not necessarily limited to Parr Reservoir lake levels, water quality, fisheries, boating, and hydroelectric power generation.

The scope of this study is to provide data quantifying the effects of flows on aquatic habitat suitability in the Broad River for the aquatic community and its managed fish resources, including diadromous and resident fish species, and to assist the TWC in identifying flow targets that support habitat requirements for a balanced aquatic community. These data are used in conjunction with hydrologic, operational and other models to evaluate the costs and benefits of providing alternate flows to the Broad River. This IFIM study was scoped and directed by a study team that included representatives from the TWC. The study was conducted by SCE&G under the supervision of the TWC.

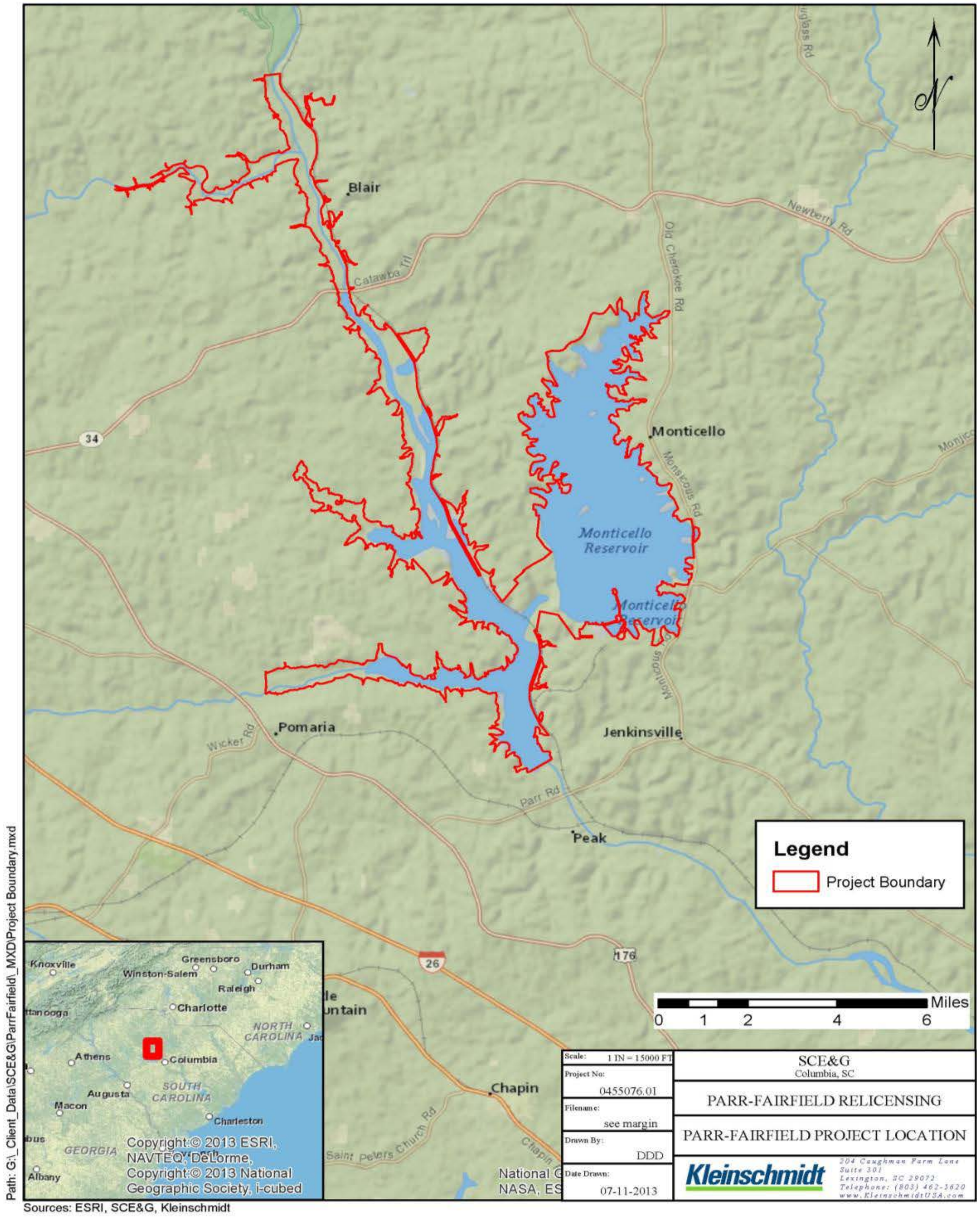


FIGURE 1-1 PROJECT LOCATION MAP

2.0 DESCRIPTION OF THE STUDY AREA

The Broad River rises on the east slope of the Appalachian Mountains, and flows southeasterly across the Piedmont geomorphic province to its confluence at the fall line with the lower Saluda River in Columbia, South Carolina, where the combined flows form the Congaree River. Below the Parr Shoals Dam, the river is free flowing for approximately 26 miles through generally low gradient riverine geomorphology until just below Boatright Island. Below Boatright Island, the Broad River is influenced by backwatering from the Columbia Hydroelectric Project, which is located approximately two miles above the confluence with the lower Saluda River. The drainage area at the Parr Project is 4,750 square miles. A real time stream flow gage exists at USGS 02161000 (*Broad River at Alston, SC*), which is located approximately 1.5 miles below the Parr Shoals Dam.

2.1 UPSTREAM AND DOWNSTREAM BOUNDARIES

The TWC identified the segment of the Broad River between the Parr Shoals Dam and the downstream end of the Bookman Island complex as the study area (Figure 2-1). Flow in this reach is primarily influenced by releases from the Parr Shoals dam and powerhouse. There are no significant flow contributions from tributaries within the study reach.

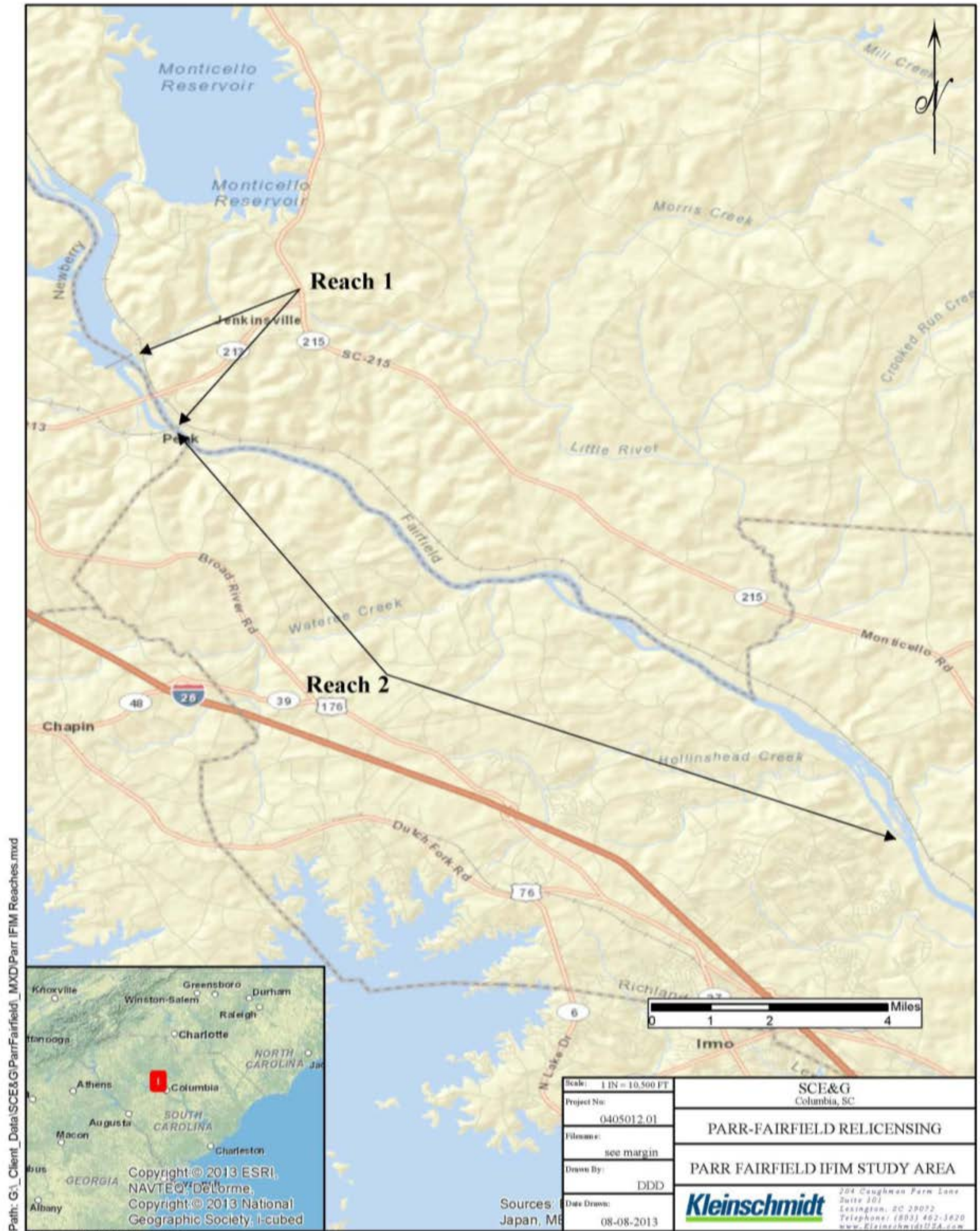


FIGURE 2-1 PARR FAIRFIELD INSTREAM FLOW STUDY AREA

2.2 HABITAT AND GEOMORPHOLOGY

The Broad River flows southeasterly through a river corridor that is predominantly rural, and in general the river banks and riparian zones are forested. Overall the river is relatively straight for much of the reach, with moderate levels of sinuosity. The upper segment of the study area (Reach One) is dominated by well-defined banks (i.e. with discernible and consistent crests and toes) and relatively low-gradient pools, runs and glides, periodically segmented by short riffles. The lower segment (Reach Two) also contains pools, glides and runs, but exhibits higher gradient bedrock drops and more pronounced riffles, and features ledge and boulder substrates which reflect down cutting through the piedmont terrace. There are several islands with pronounced side channels and/or braids such as Haltiwanger, Bookman and Huffman islands.

2.3 FISHERY MANAGEMENT

The varied instream features within the study area support a diverse community of warm water fish species and provide seasonal spawning and nursery habitat for anadromous American shad and striped bass. In addition, smallmouth bass, other centrarchids and catfish provide a sport fishery. Robust redhorse is a rare migratory sucker species present in the study area. Collaborative restoration efforts are underway to protect this fish, and the USFWS describes it as an At-Risk-Species (ARS). Features within the study reach may also provide suitable conditions for robust redhorse spawning and rearing (See Robust Redhorse Spawning Memo in Appendix A).

2.4 HYDROLOGY

The total contributing drainage area for the Parr Shoals development is 4,750 square miles, and the drainage area for the Fairfield Development is 15 square miles. Flows are recorded downstream of Parr Shoals dam at the USGS gage at Alston (USGS gage 02161000). This gage has a continuous period of record dating back to 1981. The monthly mean, minimum and maximum flows for the Project are presented below in Table 2-1. Annual flow-duration curves for the Project are contained in Appendix A of the Pre-Application Document (PAD).

TABLE 2-1 MONTHLY MEAN, MAXIMUM AND MINIMUM DATA FOR THE USGS GAGE AT ALSTON (02161000), FOR WATER YEARS 1981-2013, BY WATER YEAR (WY) (IN CUBIC FEET PER SECOND)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
MEAN	3,565	4,016	5,650	7,252	7,877	9,023	6,606	5,033	3,791	3,198	3,475	2,760
MAX	17,360	14,500	14,190	17,790	16,960	21,560	18,040	14,830	8,909	12,440	10,210	14,740
(WY)	(1991)	(1993)	(2010)	(1993)	(1990)	(1993)	(2003)	(2003)	(2003)	(2013)	(1995)	(2004)
MIN	638	725	1,251	2,106	1,985	3,170	2,821	1,783	763	600	546	624
(WY)	(2008)	(2008)	(2008)	(2011)	(2009)	(2006)	(2012)	(2001)	(2008)	(2008)	(2002)	(2007)

3.0 METHODS

Aquatic habitat suitability at most sites was evaluated using standard field procedures and Physical Habitat Simulation (PHABSIM) modeling techniques of the Instream Flow Incremental Methodology (IFIM), developed by the National Ecology Research Center of the National Biological Survey (Bovee, 1982; Bovee, et al. 1998; Milhouse et al. 1989). The IFIM quantifies habitat values of alternative stream flows using pre-determined habitat suitability index (HSI) criteria for selected species based on stream hydraulics models of study reaches. HSI criteria are based on flow-related depth, velocity, substrate, and cover preferences of targeted lifestages of the evaluation species.

General procedures involve collecting hydraulic data (e.g. bed profile, depth, velocity, and water surface elevation at a series of known calibration flows) and habitat data (i.e. substrate and relevant cover characteristics) at a series of loci (“verticals”) along representative cross-sectional transects. Paired verticals along a transect define the lateral boundaries of a series of "cells". Each cell area is assumed to be homogeneous with respect to depth, velocity, substrate, and cover. The length of stream represented by each transect is determined by field mapping. Hydraulic modeling predicts changes in depth and velocity in each cell as discharge varies. The area of each cell is then weighted relative to HSI criteria for each evaluation species life stage to compute habitat suitability. Total habitat suitability at each flow is calculated by summing weighted habitat area at all transect cells. Weighted Usable Area (WUA) is the standard unit of habitat calculated in standard IFIM computations: one unit of WUA is equal to one square foot of “optimum” habitat suitability as defined by the habitat suitability criteria.

Locations where PHABSIM methodologies were not used include a braided reach where two-dimensional (2-D) modeling was employed (Sites 9 and 10), a backwater area affected by Project operations (Site 4) where wetted perimeter modeling was employed, and a site consisting of perched bedrock pools (Site 1) where calculation of pool volume turnover was conducted for purposes of addressing water quality concerns. These methodologies are discussed in greater detail below.

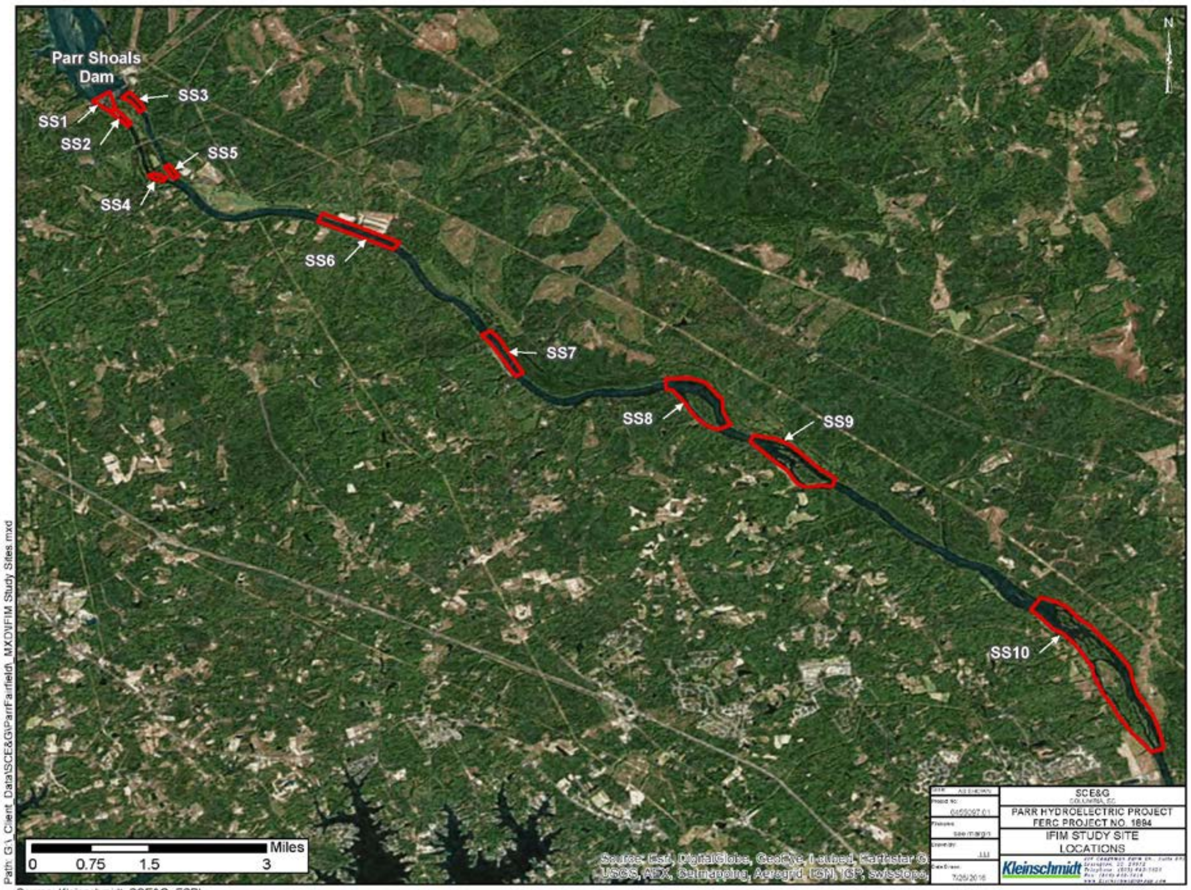
3.1 SCOPING

The study was collaboratively designed by members of the TWC, including biologists from USFWS, SCDNR and American Rivers. The TWC provided technical input to the consultant, and determined study area boundaries, evaluation lifestages, HSI criteria, modeling approach, and study site locations within each reach. These parameters were based on site reconnaissance and first-hand knowledge of habitat in the Broad River (Appendix B – TWC Scoping).

The TWC conducted a float trip in June 2013 to select study reaches study sites and in some cases transects, and data collection and modeling approaches. Based on this site visit, the study area was segmented into two independent reaches (Figure 2-1). Reach One extends from Parr Shoals Dam to the downstream end of Hampton Island, near the Palmetto Trail crossing, and includes five study sites selected by the TWC (Figure 3-1). The TWC determined that PHABSIM would be the primary tool to assess aquatic habitat suitability in Reach One, with the exception of Study Sites 1 and 4. Study Site 1 consisted primarily of perched bedrock pools located at the base of the dam. The TWC requested bathymetric mapping for purposes of determining pool volumes to support determination of flows necessary to maintain acceptable water quality. Study Site 4 was located in the west channel near the downstream terminus of Hampton Island and was deemed not suitable for PHABSIM modeling due to backwatering from the project tailrace. Study Site 4 was subsequently assessed through a wetted perimeter analysis.

Reach Two extended from the Palmetto Trail trestle crossing at the base of Hampton Island to Boatright Island and included five additional study sites (Figure 3-1). PHABSIM was again the primary mean of assessing habitat suitability, with two exceptions. A 2-D modeling approach was deemed appropriate at Study Site 10 due to the braided and complex nature of the Bookman Island complex. Finally, the TWC determined that habitat at Study Site 9 (Huffman Island) was similar to habitat occurring at Study Site 10; therefore the former could be addressed through a simple flow demonstration to confirm transferability of 2-D modeling results from Study Site 10.

Each study site was chosen by the TWC to represent a specific type of representative and/or biologically strategic habitat within the subject reach. PHABSIM transects were placed within each study site (Figures 3-2 and 3-3) as necessary to portray channel configuration, slope, hydraulics and/or substrate and cover of specific mesohabitat types of interest (Table 3-1). The total length of stream represented by each study site within each reach was determined by mesohabitat mapping. Mesohabitat boundaries were delineated in the field by demarking the upstream boundary of each contiguous mesohabitat type with a handheld GPS unit. Boundaries were identified by visual inspection and soundings obtained from a small boat traversing the study area at a low flow (approximately 800 cfs). Additional detail regarding the mesohabitat assessment result are included in Appendix C.



Source: Kleinschmidt, SCE&G, ESRI

FIGURE 3-1 PARR HYDRO PROJECT – IFIM STUDY SITES

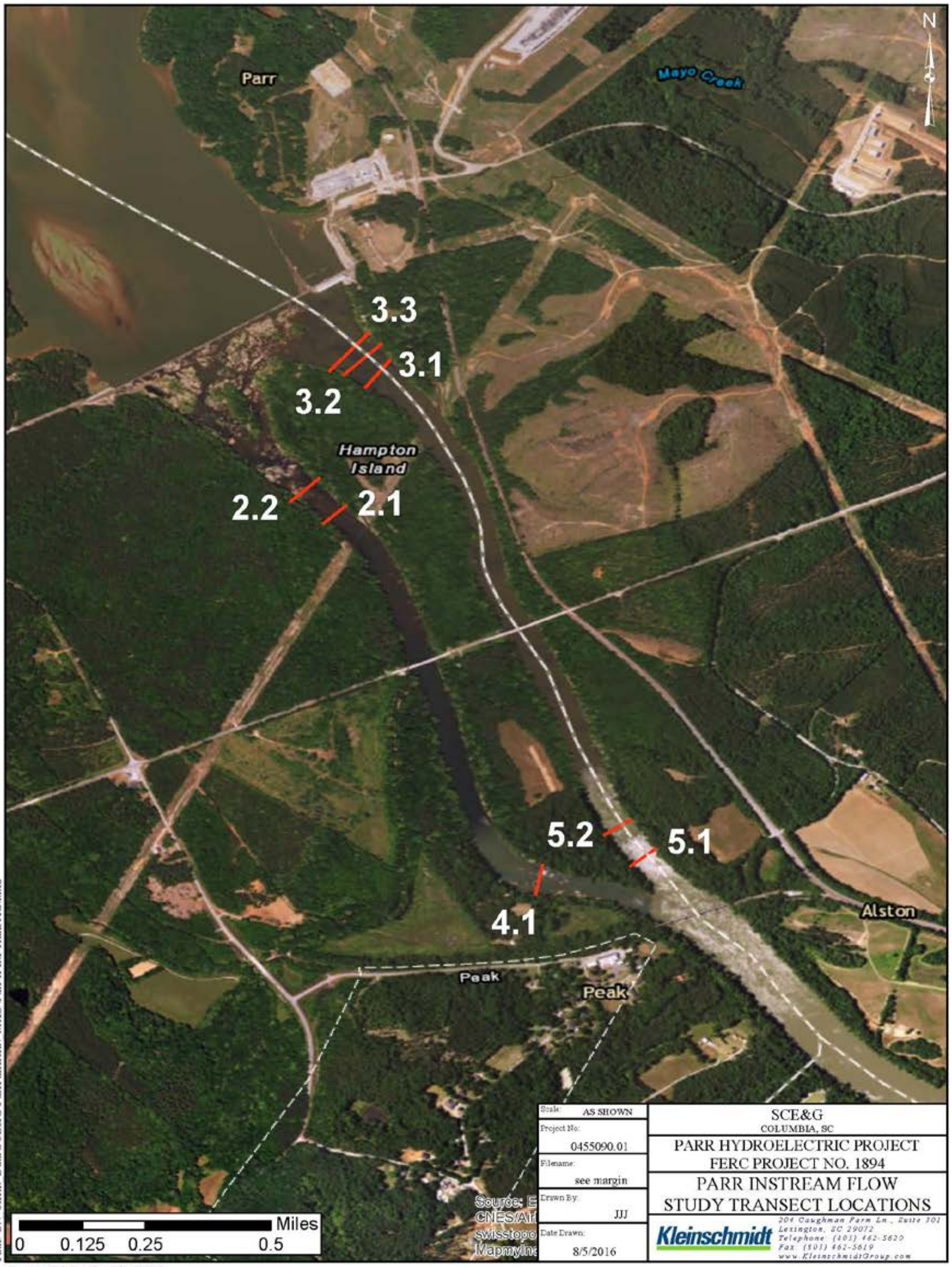


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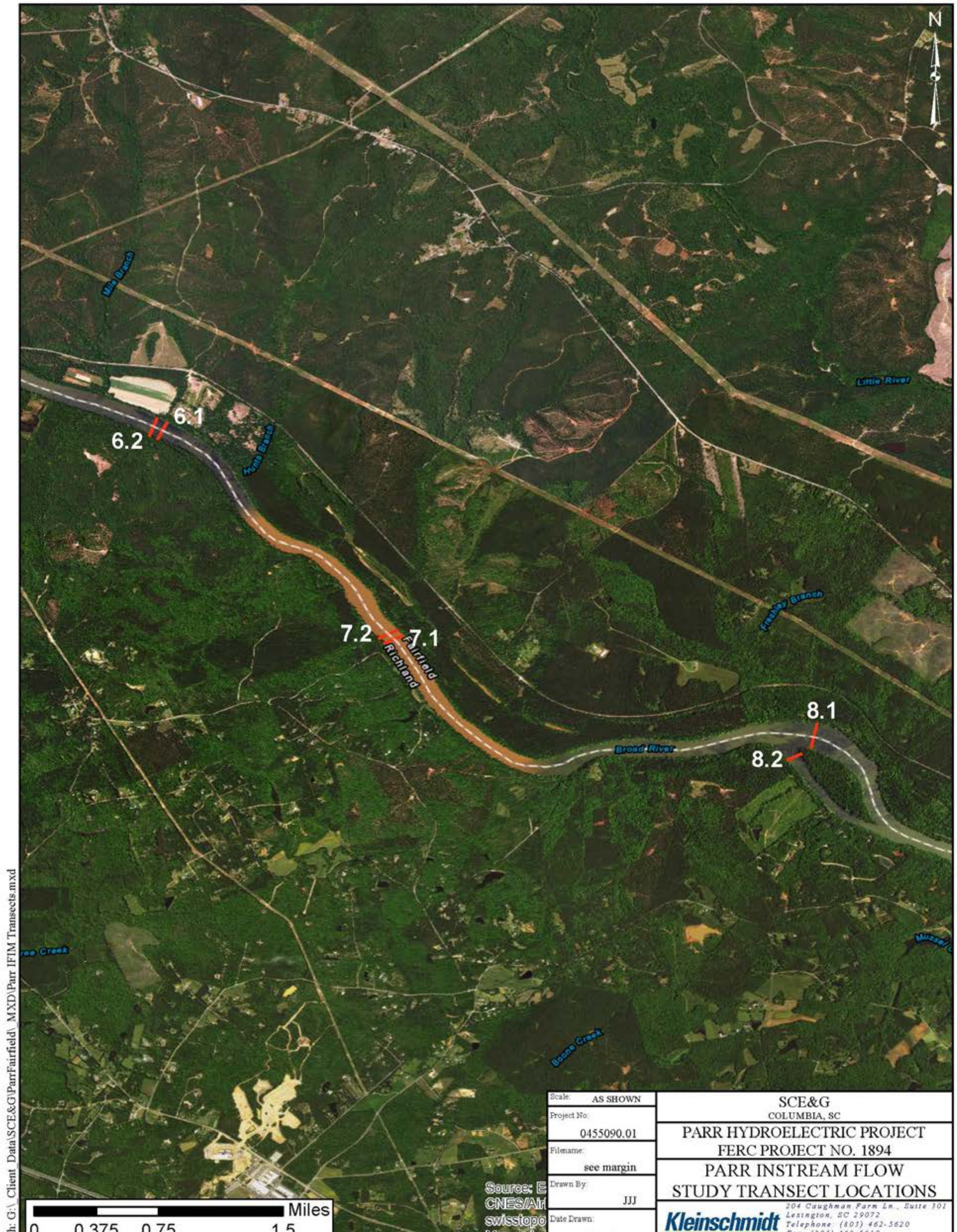
FIGURE 3-2 PARR HYDRO PROJECT - REACH ONE HABITAT TRANSECTS



Source: Kleinschmidt, ESRI

FIGURE 3-3 PARR HYDRO PROJECT - REACH TWO HABITAT TRANSECTS

TABLE 3-1 PARR HYDRO IFIM STUDY - SUMMARY OF STUDY SITES AND TRANSECTS

STUDY SITE	TRANSECT ID	MESOHABITAT
2	2.2	Glide
	2.1	Run
3	3.3	Run
	3.2	Glide
	3.1	Riffle
4	4.1	backwater
5	5.2	Run
	5.1	Riffle
6	6.2	Glide
	6.1	Riffle
7	7.2	Glide
	7.1	Riffle
8	8.2	Riffle
	8.1	Riffle

In addition to habitat study sites, the TWC also identified two areas during scoping that were potentially restrictive to the upstream passage of fish. These areas were identified in the Study Plan as "Ledge 1" and "Ledge 2" (Figure 3-4). Ledge 1 consists of a bedrock ledge located at a lat/long of 34°12’49.999”N, 81°15’46.507”W, approximately 2.4 miles upstream of Haltiwanger Island. Ledge 1 is located directly downstream and serves as the hydraulic control for IFIM Study Site 7. The study plan originally identified a primary passage point for Ledge 1 on river left (looking upstream); however, a secondary passage point, located near mid-channel, was also noted during execution of the field effort. Ledge 2 consists of a bedrock ledge located at a lat/long of 34°10’18.154”N, 81°10’15.941”W, 1.3 miles upstream of Hickory Island and approximately 0.5 miles downstream of the mouth of Little River. Field investigations identified the primary navigational passage point on river left (looking upstream).

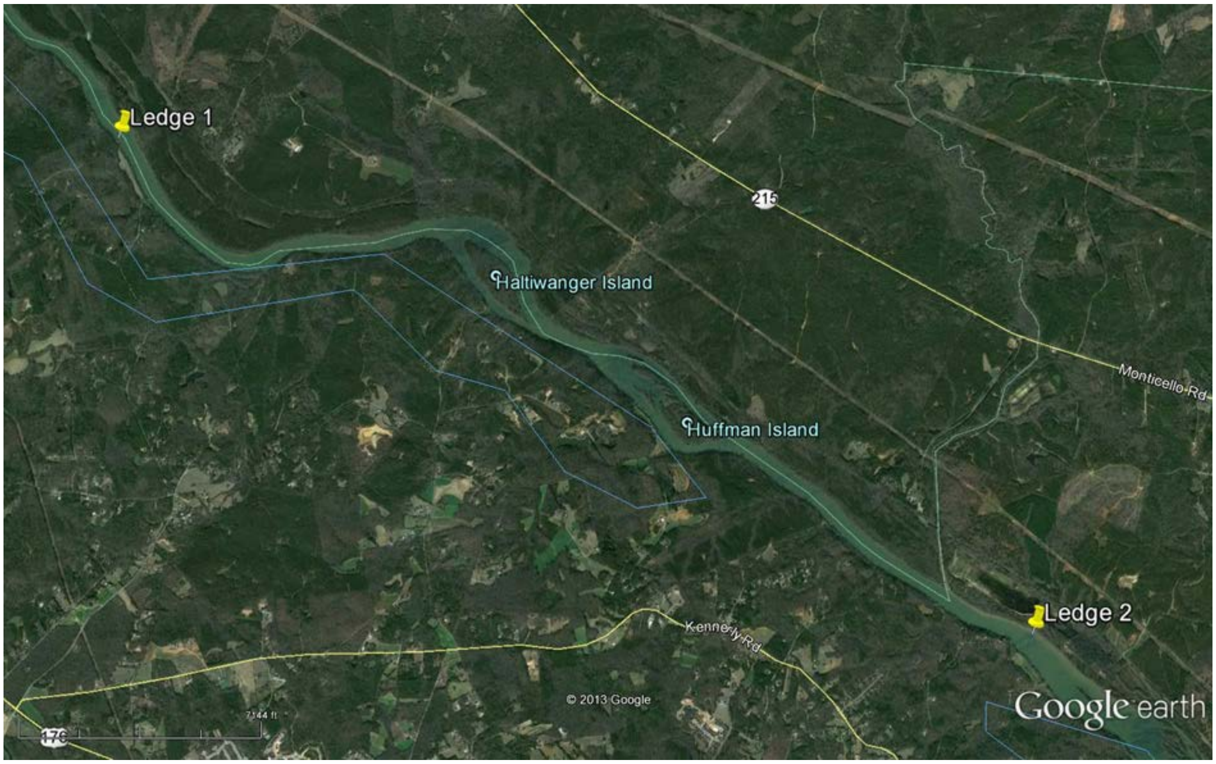


FIGURE 3-4 ZONE-OF-PASSAGE SITES IDENTIFIED BY THE TWC

3.1.1 EVALUATION LIFESTAGES

Each species and lifestage was quantitatively rated using HSI criteria, in which parameters of depth, velocity, and substrate were independently assigned rating values based on research, literature, observations, and/or professional judgment (Bovee, 1982; Bovee et al., 1998). The TWC originally identified 11 target species for evaluation during the IFIM study (Table 3-2). Consultation with the TWC resulted in many of these species being combined into guilds based on similar habitat requirements, with smallmouth bass (spawning, fry, juveniles and adults), redbreast sunfish (spawning and adults), and American shad (spawning) remaining as stand-alone species (Table 3-2).

HSI curves used in this study are included in Appendix D and were adopted primarily from the Lower Saluda River IFIM Study (Kleinschmidt 2008). One exception was smallmouth bass spawning depth, for which the TWC identified a HSI curve developed for the Deerfield River, MA as being more appropriate. Similarly, the TWC elected to utilize curves recently developed by Hightower et al. (2012) to quantify spawning habitat for American shad.

TABLE 3-2 TARGET SPECIES HABITAT USE GUILDS AND HSI CRITERIA SOURCE

	LIFESTAGE	SOURCE	GUILD
smallmouth bass	spawning (depth)	Deerfield River, MA	N/A
smallmouth bass	spawning (velocity and substrate)	Saluda	N/A
smallmouth bass	fry	Saluda	N/A
smallmouth bass	juvenile	Saluda	N/A
smallmouth bass	adult	Saluda	N/A
American shad	spawning	Hightower et al. 2012	N/A
brassy jumprock	adult	Saluda	deep fast/shallow fast~~slow~~
brassy jumprock	juvenile	Saluda	shallow fast~~slow~~
brassy jumprock	spawning	Saluda	shallow fast
whitefin shiner	adult	Saluda	shallow slow; deep slow
whitefin shiner	juvenile	Saluda	shallow slow
whitefin shiner	spawning	Saluda	shallow fast
robust redhorse	adult	Saluda	deep fast/shallow fast~~slow~~
robust redhorse	juvenile	Saluda	shallow fast~~deep slow~~
robust redhorse	spawning	Saluda	shallow fast
Santee chub	adult	Saluda	shallow fast
striped bass	adult	Saluda	deep fast
piedmont darter	adult	Saluda	shallow fast
piedmont darter	spawning	Saluda	shallow fast
snail bullhead	adult	Saluda	deep slow
redbreast sunfish	adult	Saluda	N/A
redbreast sunfish	spawning	Saluda	N/A
channel catfish	adult	Saluda	deep slow
channel catfish	juvenile	Saluda	deep slow; deep fast

3.2 PHABSIM 1-D MODELING SITES

Field Methods

The location of each transect was field blazed with flagging and paint and documented using Global Position System (GPS) technology. The transect headpin and tailpin ends were located at or above the top-of-bank elevation, and were secured by steel rebar. Each headpin was positioned on river right (looking downstream) and tailpins were located on river left. A measuring tape or kevlar line was secured at each transect to enable repeat field measurements to occur at specific stream loci. Stream bed and water elevations tied to a local datum were surveyed to the nearest 0.1 ft using standard optical surveying instrumentation and methods.

Depth, velocity, cover and substrate data were gathered at intervals (verticals) along each transect. Each vertical was located to the nearest 0.1 ft wherever an observed shift in depth or substrate/cover occurred. Verticals were arranged so that no more than 10% of the river discharge passed between any pair, enhancing hydraulic model calibration. A staff gage was set and monitored at the beginning and end of each set of hydraulic measurements to confirm stable flow during measurements.

Mean column velocity was measured to the nearest 0.1 ft/second with either a calibrated electronic velocity meter mounted on a top-setting wading rod or an Acoustic-Doppler Current Profiler (ADCP) transducer. In water less than 2.5 ft depth, measurements were made at 0.6 of total depth (measured from the water surface); at greater depths, paired measurements were made at 0.2 and 0.8 of total depth, and averaged.

Discharge through the study area is regulated by Parr Shoals Dam and therefore field work was coordinated with pre-arranged releases from the Project. Hydraulic data were collected at three calibration discharges according to study objectives (approximately 400; 2,000 and 6,000 cfs), to facilitate modeling in a range from approximately 200 cfs up to 15,000 cfs. One exception to this was Study Site Two, which is located in the West Channel below the dam and is not subject to powerhouse flows. At this site, calibration flows of approximately 46, 395 and 1,880 cfs were released into the West Channel via the spillway crest gates to allow modeling from 20 cfs up to 2,000 cfs.

Because the stage-discharge relationship is rarely linear, a minimum of three calibration flows is required to define the shape of stage-discharge curve for the flow range of interest. PHABSIM hydraulic models, as a rule of thumb, may extrapolate to as low as 40% of the lowest flow and up to 250% of the highest flow under ideal conditions. Therefore a low calibration flow of 400 cfs was selected to adequately provide data to model down to approximately 200 cfs and a high calibration flow of 6,000 cfs was selected to enable model extrapolation up to 15,000 cfs. The choice of middle calibration flow was made to be at least twice as high as the low flow in order to capture a set of hydraulic conditions significantly different than the low flow, and also approximately an order of magnitude lower than the high calibration flow.

Hydraulic Modeling

Hydraulic modeling and quality assurance/quality control techniques were conducted in accordance with standard practices for PHABSIM. Hydraulic modeling was accomplished by correlating each surveyed WSEL with discharge to develop a stage-discharge relationship for each transect. The model then adjusted velocities obtained at calibration flows to each flow increment of interest for which a defined water stage had been calculated. The model was then calibrated by comparing simulated hydraulics to empirical measurements taken at the calibration flows. Detailed steps are summarized below.

Field data collected at transects (e.g. cross section surveys, WSELs, velocities, discharge and slope measurements) were entered into a computer database compatible with PHABSIM software. All field calculations of discharge and data entry were proofed and cross-checked for accuracy. The field data included measurements at all three calibration flows, and were used to simulate depth, velocity, substrate, and cover conditions at discharges other than the calibration flows. Discharges and WSELs were determined for all calibration flows. Bed profiles, substrate, and cover used in the model were derived from surveys made during low flows. Velocity calibration in the PHABSIM model typically relies on velocities measured during mid-range flows, although velocity measurements are sometimes made in the field for low flows at features such as riffles where velocities are irregular across the cross section.

Transects within a common study site and mesohabitat type were linked hydraulically (*i.e.* within the same datum) with adjacent contiguous transects and/or with downstream hydraulic controls that create backwater conditions. Stand-alone transects were independently modeled. Simulation of water surface elevations at each transect was accomplished using one of three models within the PHABSIM analysis: IFG4, MANSQ or WSP. Often, all three models are run with the best stage-discharge relationship determined for each cross-section. The specific model used at a given transect depends on site characteristics, including gradient and backwatering from downstream hydraulic controls. IFG4 uses a log-log fit to determine a stage-discharge curve for the three calibration flows. MANSQ determines the stage-discharge relationship using the Manning's equation for stream flow, while WSP uses hydraulically-linked cross-sections in a backwater model to determine the relationship. WSP is similar to backwater models such as the U.S. Army Corps of Engineers' HEC-RAS program.

Velocity calibrations for each transect were performed using routines within the IFG4 model. The range of simulated flows represented by each calibration set is determined by the hydraulic engineer based on the model's performance at the calibration flows and trends in hydraulic parameters such as water surface elevation and velocity. PHABSIM output for each simulated flow, such as Velocity Adjustment Factors (VAFs), were plotted as smooth curves, with aberrations in these curves indicative of range boundaries for a given calibration flow. Typically, these fall toward extreme low or high flows in high gradient channels, at which point one of the other three calibration sets is used to continue the model out to the extremes. The hydraulic engineer reviewed all hydraulic output and determined and documented the acceptable range of simulated flows. This range usually extended from slightly below the low calibration flow to slightly higher than the high calibration flow.

3.3 DATA COLLECTION (2-D MODEL)

The TWC recommended that a 2-D hydraulic model as most appropriate for capturing the hydraulics and habitat suitability of the Bookman Island complex (Study Site 10) due to the complex channel characteristics. This process included the following steps:

- Raw data (terrain, velocity, depth and substrate) gathering and processing
- 2-D model development and calibration

- WUA computations

The preliminary data processing included the acquisition of remote-sensed terrain data, and merging this data with other bathymetric and topographic data. Aerial surveying was conducted at a flow of approximately 500 cfs, which provided comprehensive coverage of the study site. The end-product was a georeferenced bedfile, which is, in general terms, an xyz datafile with points that comprise the topology of the model domain (Figure 3-5).

FIGURE 3-5 SUBSECTION OF MODEL DOMAIN BEDFILE - (EACH PIXEL IS A DATAPOINT WITHIN THE 2D MODEL)

Depth, velocity, WSEL, and substrate information were collected throughout the reach during two different periods of controlled flows of 1,000 and 2,000 cfs. There were three water level loggers deployed within the study reach to provide additional model calibration data. These level loggers were deployed in the upper, middle, and lower sections of the study reach.

A two dimensional substrate map (Figure 3-6) was developed based on data collected during the field effort. Substrate and cover were categorized based on codes specified within the HSI curves.

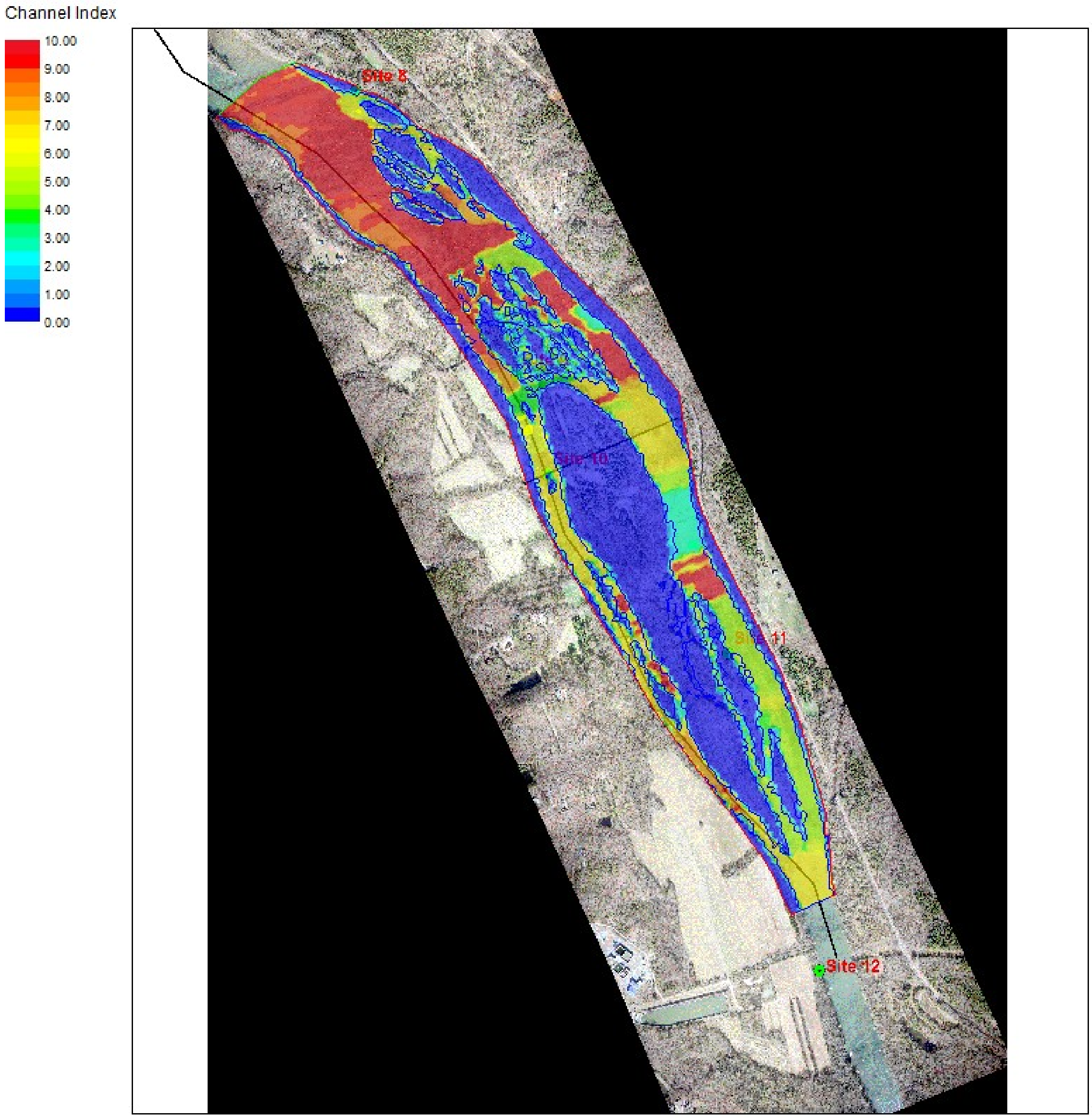


FIGURE 3-6 CHANNEL INDEX (SUBSTRATE) MAP - STUDY SITE 10

The 2-D modeling was performed with River2D (Steffler and Blackburn 2002), which is a public domain software package developed as a cooperative effort between the University of Alberta, Fisheries and Oceans – Canada, and the USGS. The River2D suite includes subroutines for bed editing, mesh development and editing, depth-averaged hydrodynamic modeling, and computation of WUA. Subsequent to the bedfile development, the model mesh was developed and edited in conjunction with the model calibration. The mesh editing and calibration, in brief, involved inspecting the flow pathways within the model domain. The majority of this effort was directed at refining the mesh in locations where the base data did not accurately shape the flow pathways (Figure 3-7).

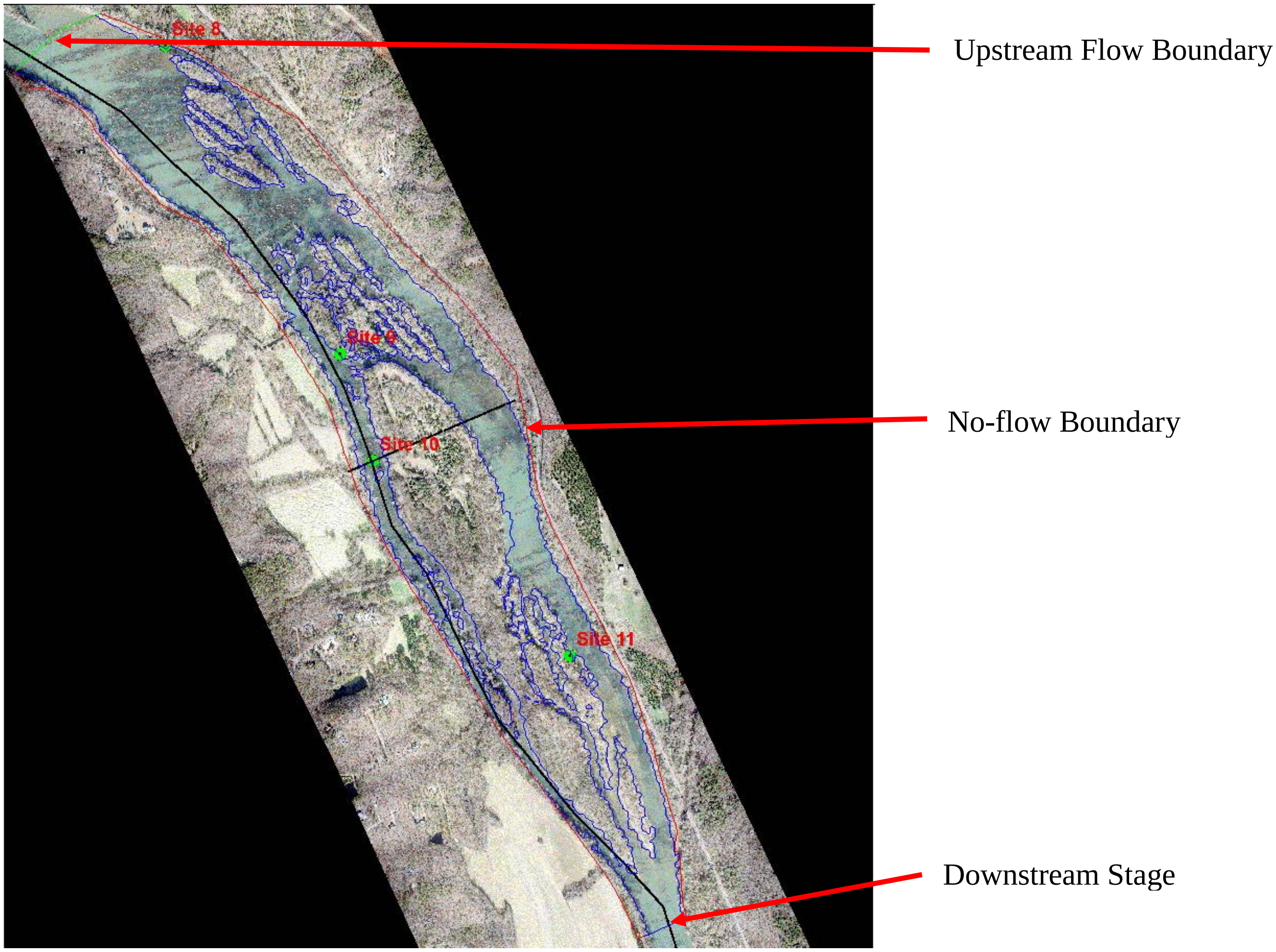


FIGURE 3-7 FLOW PATHWAY MAP - STUDY SITE 10

The WUA calculations were performed within the River2D model suite, using the same data that were used to simulate the flow. The HSI curves for depth, velocity and substrate were incorporated into the modeling data. The WUA calculations were performed using the simulated velocity and depth, and a lookup of the substrate. The WUA value was computed as the summation of the product of the HSI values times the area for all mesh cells.

3.4 DATA COLLECTION (LEDGE POOLS BELOW DAM IN STUDY SITE 1)

Bedrock pools occurring in the upper West Channel directly downstream of Parr Shoals Dam were surveyed using a Sontek M-9 ADCP unit to provide bathymetric data for the area.

Supplemental depth data was collected manually in each of the primary pools at full pool leakage flow (approximately 50 cfs) during a site visit conducted in May 2016. These representative depths were then used in combination with Geographic Information System (GIS)-based surface area calculation to determine pool volumes at low flow conditions when water quality issues are likely to occur.

3.5 DATA COLLECTION (WETTED PERIMETER AT STUDY SITE 4; BACKWATER AT LOWER WEST CHANNEL)

The transect end points at Study Site 4 were field blazed with flagging and paint and documented with sub-meter GPS. The transect headpin and tailpin ends were located above the top-of-bank elevation, and secured by steel rebar. A Kevlar line was secured at the transect to enable repeat field measurements at specific stream locations. Streambed and water elevations tied to a local datum were surveyed to the nearest 0.1 ft using standard optical surveying instrumentation and methods. Approximately 30 verticals were established along the transect to accurately depict cross-sectional channel geometry. Water elevation at three flows spanning the range of releases associated with the PHABSIM data collection was recorded through both survey and staff gaging, so that a stage-discharge relationship could be established. These data were then used to establish a wetted perimeter rating curve.

4.0 RESULTS

Calibration flow data were primarily collected in April, June and July of 2015, with additional low flow data in support of the 2-D modeling at Study Site 10 collected in April of 2016. Results are presented below for each study site, beginning upstream.

4.1 STUDY SITE 1 (BEDROCK POOLS IN UPPER WEST CHANNEL)

Bathymetric mapping in Study Site 1 indicated five primary pools in the upstream portion of the West Channel (Figure 4-1). The estimates of pool volume range in size from 0.2 to 4.9 acre-ft (Table 4-1). Additional testing is scheduled at this site for August 2016, during which pulses of varying magnitudes will be released to the West Channel via the spillway crest gates. The releases will be monitored to determine the extent which adequate turnover is achieved to reach the desired water quality conditions.

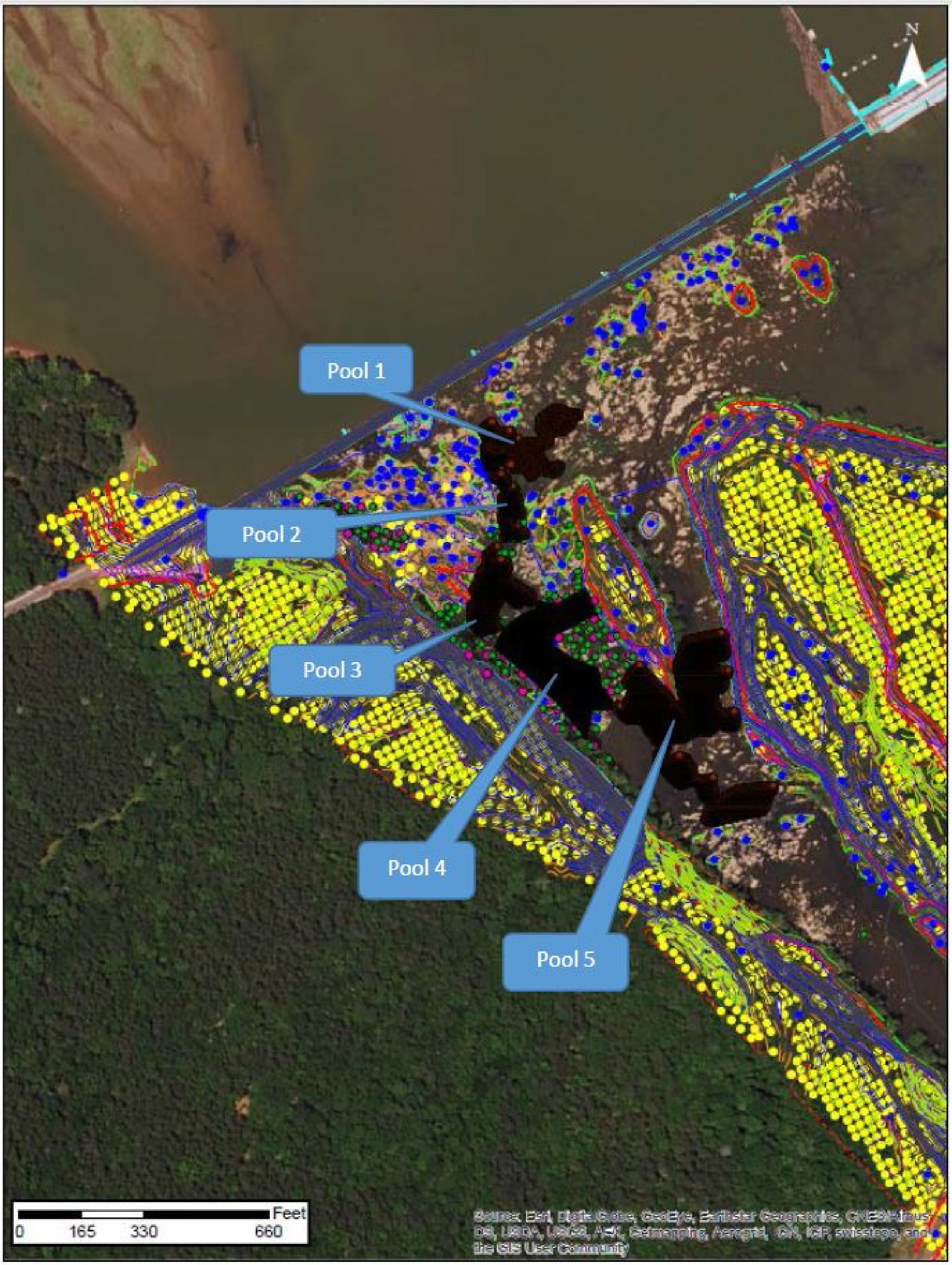


FIGURE 4-1 PRIMARY POOLS IN UPPER WEST CHANNEL BELOW PARR SHOALS DAM (IFIM STUDY SITE 1)

TABLE 4-1 ESTIMATED VOLUME OF FIVE MAJOR POOLS IN THE UPSTREAM PORTION OF THE WEST CHANNEL

POOL #	AREA (SQ FT)	DEPTH AT 50 CFS (FT)	POOL VOLUME (CUBIC FT)	POOL VOLUME (ACRE FT)
1	29,394	3.1	91,121	2.1
2	3,760	2.3	8,648	0.2
3	39,255	1.5	58,882	1.4
4	35,952	3.1	75,499	1.7
5	119,771	1.8	215,588	4.9
TOTAL				**10.3**

4.2 STUDY SITE 2 (RIFFLE AND RUN COMPLEX LOCATED IN WEST CHANNEL)

This site is comprised of two linked transects spanning a boulder-dominated riffle and run complex located in the West Channel below the project dam. Data from this site suggest that WUA for several key lifestages, namely adult redbreast sunfish, smallmouth bass juveniles and the deep-slow and shallow-fast guilds, peaks in the range of 250 to approximately 500 cfs (Figure 4-2) (Table 4-2). American shad spawning and smallmouth bass adults experience maximum WUA at approximately 1,000 cfs, but this is at the detriment of many other lifestages. Finally, several lifestages, including smallmouth bass fry, redbreast sunfish spawning and the shallow-slow guild, appear velocity limited at this site, with WUA values falling as flow increases from the base flow.

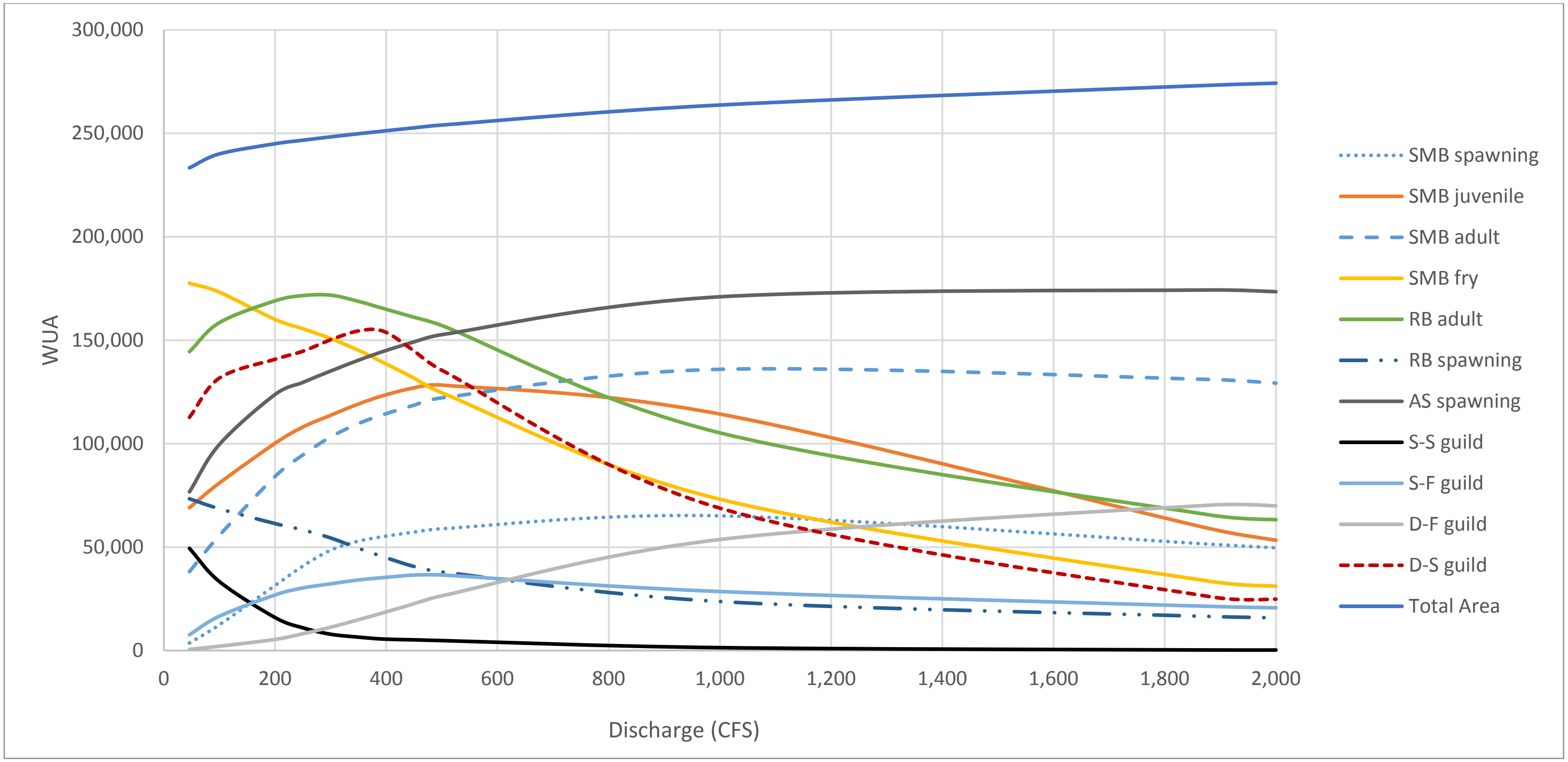


FIGURE 4-2 STUDY SITE 2 HABITAT SUITABILITY

TABLE 4-2 STUDY SITE 2 HABITAT SUITABILITY[1]

Discharge	SMB spawning		SMB juvenile		SMB adult		SMB fry		RB adult		RB spawning		AS spawning		S-S guild		S-F guild		D-F guild		D-S guild	
46	3,593	6%	69,023	54%	38,107	28%	177,587	100%	144,465	84%	73,381	100%	76,695	44%	49,409	100%	7,628	21%	552	1%	112,750	73%
100	12,447	19%	81,000	63%	55,695	41%	173,223	98%	158,542	92%	68,520	93%	99,675	57%	33,296	67%	16,616	46%	2,083	3%	131,748	85%
200	31,419	48%	100,168	78%	84,144	62%	160,052	90%	169,059	98%	61,376	84%	123,780	71%	15,941	32%	26,854	74%	5,358	8%	140,813	91%
250	40,828	63%	108,057	84%	94,555	70%	155,581	88%	171,592	100%	58,300	79%	129,619	75%	10,971	22%	30,255	83%	8,136	12%	144,693	94%
300	48,503	74%	113,747	89%	103,268	76%	150,849	85%	171,812	100%	54,404	74%	135,135	78%	7,869	16%	32,231	88%	11,255	16%	150,234	97%
350	52,879	81%	119,193	93%	109,727	81%	145,157	82%	168,805	98%	49,425	67%	140,343	81%	6,473	13%	34,118	93%	14,886	21%	154,505	100%
395	55,112	85%	123,293	96%	114,102	84%	139,183	78%	165,331	96%	45,290	62%	144,651	83%	5,539	11%	35,270	97%	18,281	26%	154,341	100%
450	57,259	88%	127,005	99%	118,596	87%	131,707	74%	161,105	94%	40,626	55%	149,215	86%	5,166	10%	36,469	100%	22,624	32%	144,867	94%
500	58,896	90%	128,312	100%	122,177	90%	124,582	70%	157,107	91%	37,982	52%	152,723	88%	4,803	10%	36,497	100%	26,461	38%	135,481	88%
600	60,139	92%	125,515	98%	124,932	92%	114,295	64%	146,731	85%	35,123	48%	156,382	90%	4,120	8%	34,903	96%	31,904	45%	122,150	79%
700	61,382	94%	122,718	96%	127,688	94%	104,008	59%	136,356	79%	32,265	44%	160,040	92%	3,437	7%	33,308	91%	37,347	53%	108,818	70%
800	62,626	96%	119,921	93%	130,443	96%	93,721	53%	125,980	73%	29,406	40%	163,699	94%	2,754	6%	31,713	87%	42,790	61%	95,487	62%
900	63,869	98%	117,124	91%	133,199	98%	83,434	47%	115,604	67%	26,547	36%	167,357	96%	2,071	4%	30,119	83%	48,233	69%	82,155	53%
1,000	65,112	100%	114,327	89%	135,955	100%	73,148	41%	105,229	61%	23,689	32%	171,016	99%	1,388	3%	28,524	78%	53,676	76%	68,823	45%
1,100	63,563	98%	108,227	84%	135,285	100%	68,944	39%	101,032	59%	22,900	31%	171,261	99%	1,274	3%	27,736	76%	55,303	79%	64,424	42%
1,200	62,014	95%	102,126	80%	134,615	99%	64,741	36%	96,834	56%	22,111	30%	171,507	99%	1,160	2%	26,948	74%	56,930	81%	60,025	39%
1,300	60,465	93%	96,025	75%	133,944	99%	60,537	34%	92,637	54%	21,322	29%	171,752	99%	1,045	2%	26,160	72%	58,556	83%	55,626	36%
1,400	58,916	90%	89,925	70%	133,274	98%	56,333	32%	88,440	51%	20,533	28%	171,998	99%	931	2%	25,371	70%	60,183	86%	51,227	33%
1,600	57,367	88%	83,824	65%	132,604	98%	52,130	29%	84,243	49%	19,745	27%	172,243	99%	817	2%	24,583	67%	61,810	88%	46,828	30%
1,880	51,434	79%	58,992	46%	131,051	96%	33,514	19%	65,590	38%	16,478	22%	174,298	100%	252	1%	21,364	59%	70,253	100%	26,080	17%
2,000	49,621	76%	53,321	42%	129,254	95%	31,112	18%	63,256	37%	15,800	22%	173,471	100%	245	0%	20,643	57%	69,943	100%	24,833	16%
100%	65,112		128,312		135,955		177,587		171,812		73,381		174,298		49,409		36,497		70,253		154,505	
75%	48,834		96,234		101,966		133,190		128,859		55,036		130,724		37,057		27,373		52,690		115,879	

[1] Shading indicates WUA value that are equal or exceed 75% of maximum WUA for that species/lifestage at that study site.

4.3 Study Site 3 (Run-Glide-Riffle Complex Directly Downstream of Parr Powerhouse)

This site consists of three linked transects spanning a cobble and gravel dominated run-glide-riffle complex located directly downstream of the Parr Shoals powerhouse. This site has been noted as an important site for freshwater mussels and as a potential robust redhorse spawning site. WUA results show that several lifestages, including redbreast sunfish adult and smallmouth bass juveniles, have peak habitat suitability at flows ranging from 400 to approximately 900 cfs (Figure 4-3) (Table 4-3). The shallow-fast guild, which includes robust redhorse spawning, also peaks in this range. Finally, habitat suitability for smallmouth bass adults, smallmouth bass spawning and American shad spawning follow similar patterns to one another, peaking at approximately 1,500 to 2,000 cfs. Smallmouth bass fry and the shallow-slow guild appear to be velocity limited at this site, with WUA values falling as flow increases from the base flow. Both deep-slow and shallow-slow guilds have limited habitat suitability at this under all flow increments.

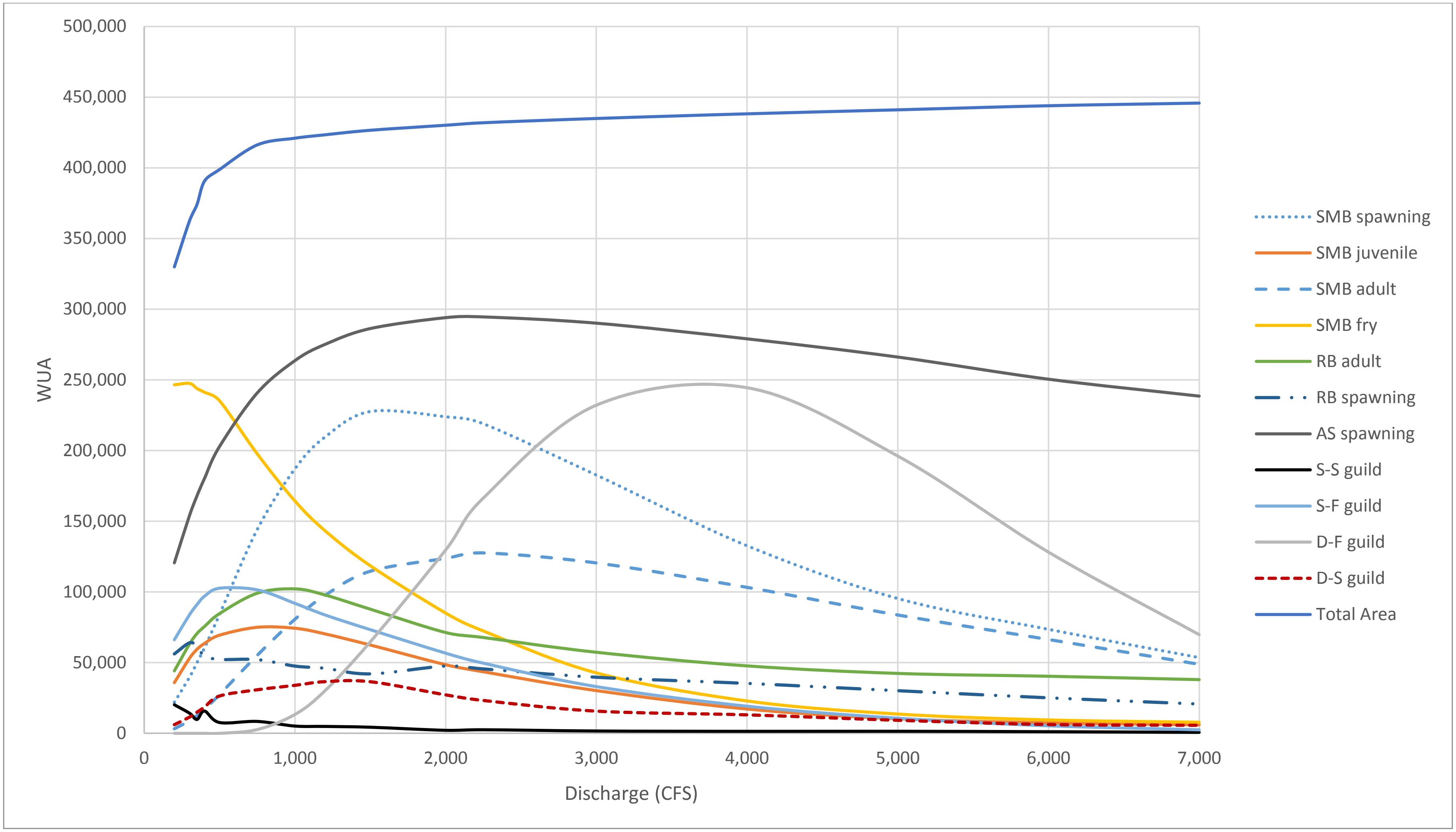


FIGURE 4-3 STUDY SITE 3 HABITAT SUITABILITY

TABLE 4-3 STUDY SITE 3 HABITAT SUITABILITY

Discharge	SMB spawning		SMB juvenile		SMB adult		SMB fry		RB adult		RB spawning		AS spawning		S-S guild		S-F guild		D-F guild		D-S guild	
200	22,010	10%	35,895	48%	3,245	3%	246,534	100%	44,190	43%	56,194	88%	120,632	41%	20,227	100%	66,201	64%	0	0%	6,155	17%
300	39,568	17%	53,023	71%	8,842	7%	247,519	100%	63,111	62%	64,009	100%	153,920	52%	14,301	71%	83,824	82%	0	0%	11,464	31%
350	49,956	22%	59,398	79%	12,657	10%	243,919	99%	70,590	69%	61,535	96%	167,976	57%	9,857	49%	91,012	89%	0	0%	14,970	41%
400	60,444	27%	63,598	85%	17,079	13%	241,241	97%	75,583	74%	54,781	86%	180,321	61%	15,779	78%	97,020	94%	0	0%	18,557	51%
500	84,153	37%	69,445	93%	27,450	22%	235,249	95%	84,730	83%	52,279	82%	202,960	69%	7,678	38%	102,671	100%	18	0%	26,424	72%
600	108,176	48%	71,675	96%	38,563	30%	220,223	89%	90,492	89%	52,231	82%	218,096	74%	7,989	39%	102,207	100%	1,084	0%	28,182	77%
750	144,211	63%	75,020	100%	55,233	43%	197,685	80%	99,135	97%	52,159	81%	240,800	82%	8,456	42%	101,510	99%	2,683	1%	30,820	84%
900	169,961	75%	74,625	99%	70,526	55%	177,690	72%	100,972	99%	49,417	77%	254,511	86%	6,481	32%	95,779	93%	9,107	4%	32,714	89%
1,000	187,128	82%	74,361	99%	80,722	63%	164,360	66%	102,196	100%	47,588	74%	263,652	90%	5,165	26%	91,959	90%	13,389	5%	33,976	93%
1,100	198,374	87%	72,351	96%	89,180	70%	153,828	62%	100,034	98%	46,805	73%	269,389	91%	5,037	25%	87,850	86%	21,793	9%	35,273	96%
1,200	209,621	92%	70,340	94%	97,638	77%	143,295	58%	97,872	96%	46,021	72%	275,126	93%	4,908	24%	83,741	82%	30,196	12%	36,570	100%
1,300	215,631	95%	67,729	90%	103,323	81%	135,051	55%	94,529	92%	44,706	70%	278,857	95%	4,721	23%	80,277	78%	41,700	17%	36,553	100%
1,400	221,641	97%	65,117	87%	109,007	85%	126,806	51%	91,187	89%	43,392	68%	282,587	96%	4,534	22%	76,813	75%	53,205	22%	36,537	100%
1,500	227,651	100%	62,505	83%	114,691	90%	118,562	48%	87,845	86%	42,077	66%	286,317	97%	4,346	21%	73,349	71%	64,709	26%	36,520	100%
1,600	226,903	100%	59,717	80%	116,507	91%	111,868	45%	84,541	83%	43,188	67%	287,860	98%	3,909	19%	70,025	68%	77,711	32%	34,663	95%
2,000	223,911	98%	48,562	65%	123,771	97%	85,089	34%	71,328	70%	47,632	74%	294,034	100%	2,162	11%	56,730	55%	129,719	53%	27,237	74%
2,250	218,971	96%	43,563	58%	127,623	100%	72,426	29%	67,802	66%	45,587	71%	294,550	100%	2,559	13%	49,660	48%	166,430	68%	23,277	64%
2,400	211,716	93%	40,901	55%	126,207	99%	66,497	27%	65,714	64%	44,409	69%	293,666	100%	2,384	12%	46,342	45%	179,569	73%	21,766	60%
2,600	206,879	91%	39,126	52%	125,263	98%	62,544	25%	64,322	63%	43,624	68%	293,076	99%	2,268	11%	44,130	43%	188,329	77%	20,759	57%
3,000	182,696	80%	30,254	40%	120,543	94%	42,781	17%	57,363	56%	39,697	62%	290,129	98%	1,686	8%	33,070	32%	232,128	95%	15,725	43%
3,500	157,697	69%	23,741	32%	111,904	88%	32,844	13%	52,545	51%	37,521	59%	284,590	97%	1,563	8%	26,136	25%	238,302	97%	14,404	39%
4,000	132,698	58%	17,228	23%	103,264	81%	22,907	9%	47,726	47%	35,346	55%	279,051	95%	1,440	7%	19,202	19%	244,475	100%	13,084	36%
4,500	114,045	50%	13,765	18%	93,499	73%	18,286	7%	45,068	44%	32,764	51%	272,609	93%	1,462	7%	14,954	15%	220,313	90%	11,167	31%
5,000	95,391	42%	10,302	14%	83,733	66%	13,665	6%	42,410	41%	30,183	47%	266,167	90%	1,483	7%	10,706	10%	196,150	80%	9,249	25%
6,000	73,583	32%	7,408	10%	66,396	52%	9,506	4%	40,400	40%	25,129	39%	250,501	85%	1,184	6%	5,364	5%	128,195	52%	6,275	17%
7,000	53,598	24%	6,030	8%	48,860	38%	7,856	3%	38,010	37%	20,758	32%	238,542	81%	721	4%	2,515	2%	69,829	29%	5,693	16%
100%	227,651		75,020		127,623		247,519		102,196		64,009		294,550		20,227		102,671		244,475		36,570	
75%	170,738		56,265		95,717		185,639		76,647		48,007		220,913		15,171		77,004		183,356		27,428	

4.4 STUDY SITE 4 (WEST CHANNEL WETTED PERIMETER TRANSECT)

A bed profile depicting the wetted perimeter transect at Study Site 4 is provided in Figure 4-4. A rating curve depicting the wetted width – flow relationship for Study Site 4 is provided is Figure 4-5.

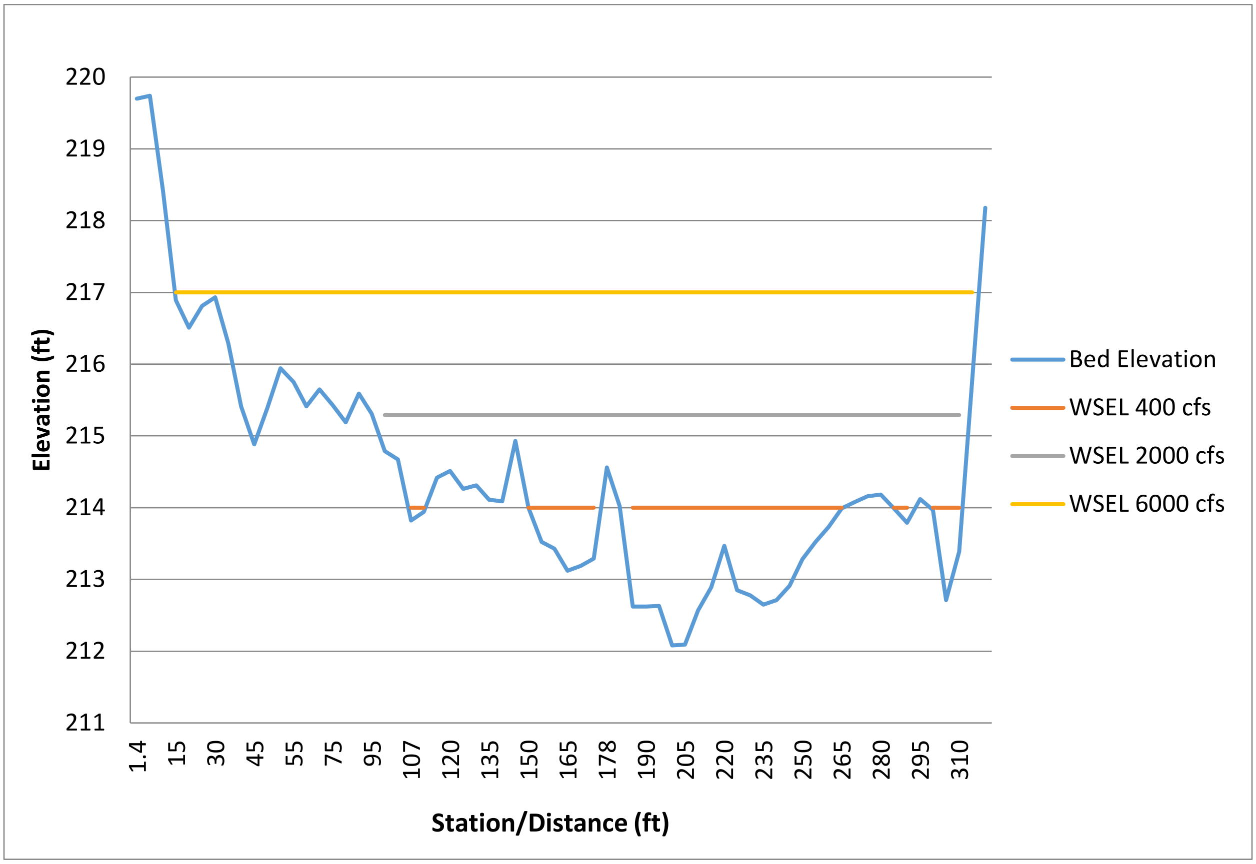


FIGURE 4-4 BED PROFILE AT STUDY SITE 4 SHOWING WATER SURFACE ELEVATION AT IFIM CALIBRATION FLOWS

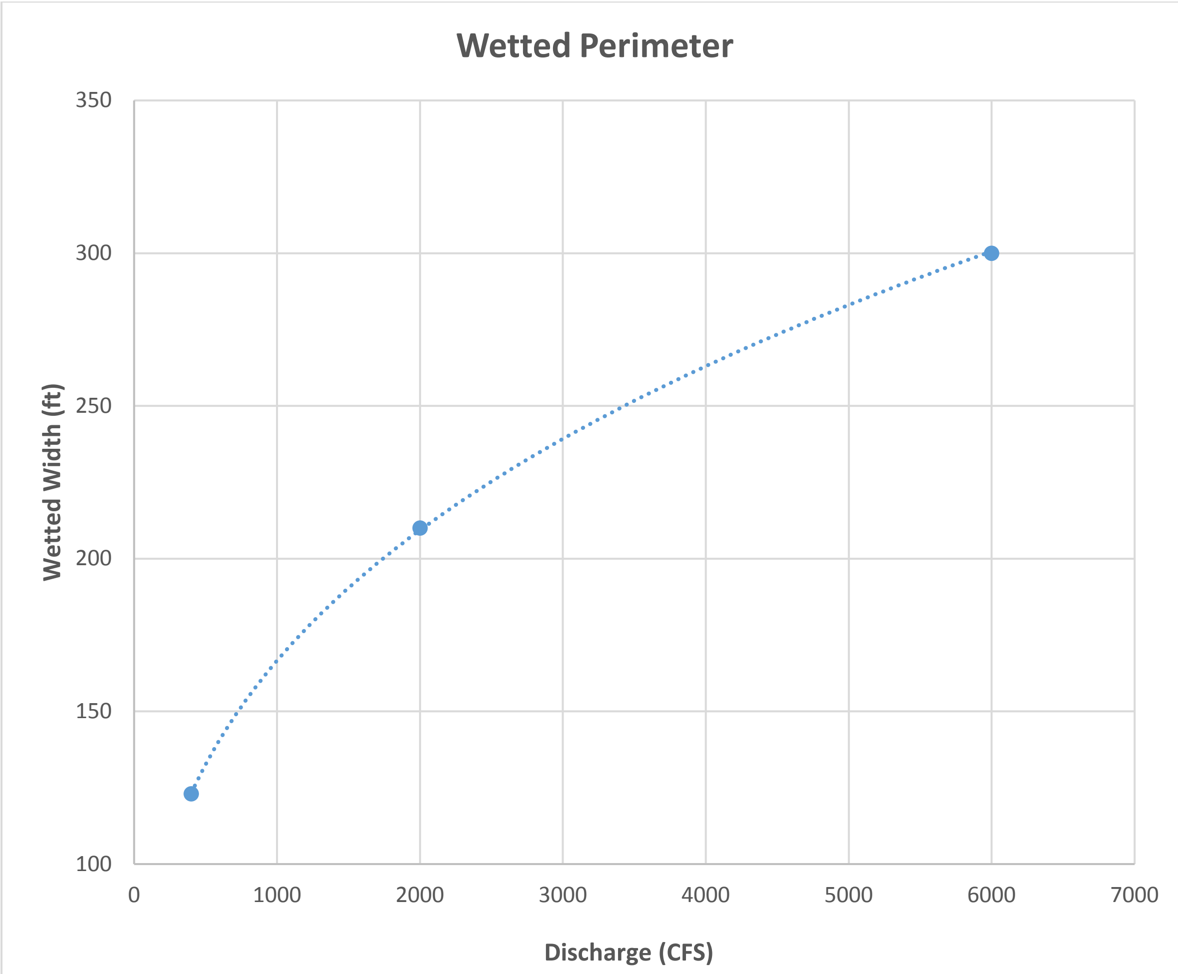


FIGURE 4-5 WETTED WIDTH RATING CURVE FOR STUDY SITE 4

4.5 STUDY SITE 5 (LEDGE-CONTROLLED RIFFLE IN LOWER EAST CHANNEL)

This site consists of two linked transects located at a ledge-controlled glide-riffle located downstream of the Parr Shoals powerhouse just upstream of the downstream terminus of Hampton Island. All of the lifestages and guilds modeled at this site experienced peak WUA in the range of 500 to approximately 1000 cfs (Figure 4-6) (Table 4-4). This site provides relatively limited suitability for a number of lifestages, including shallow-fast guild, deep-fast guild, smallmouth bass fry, and redbreast sunfish spawning.

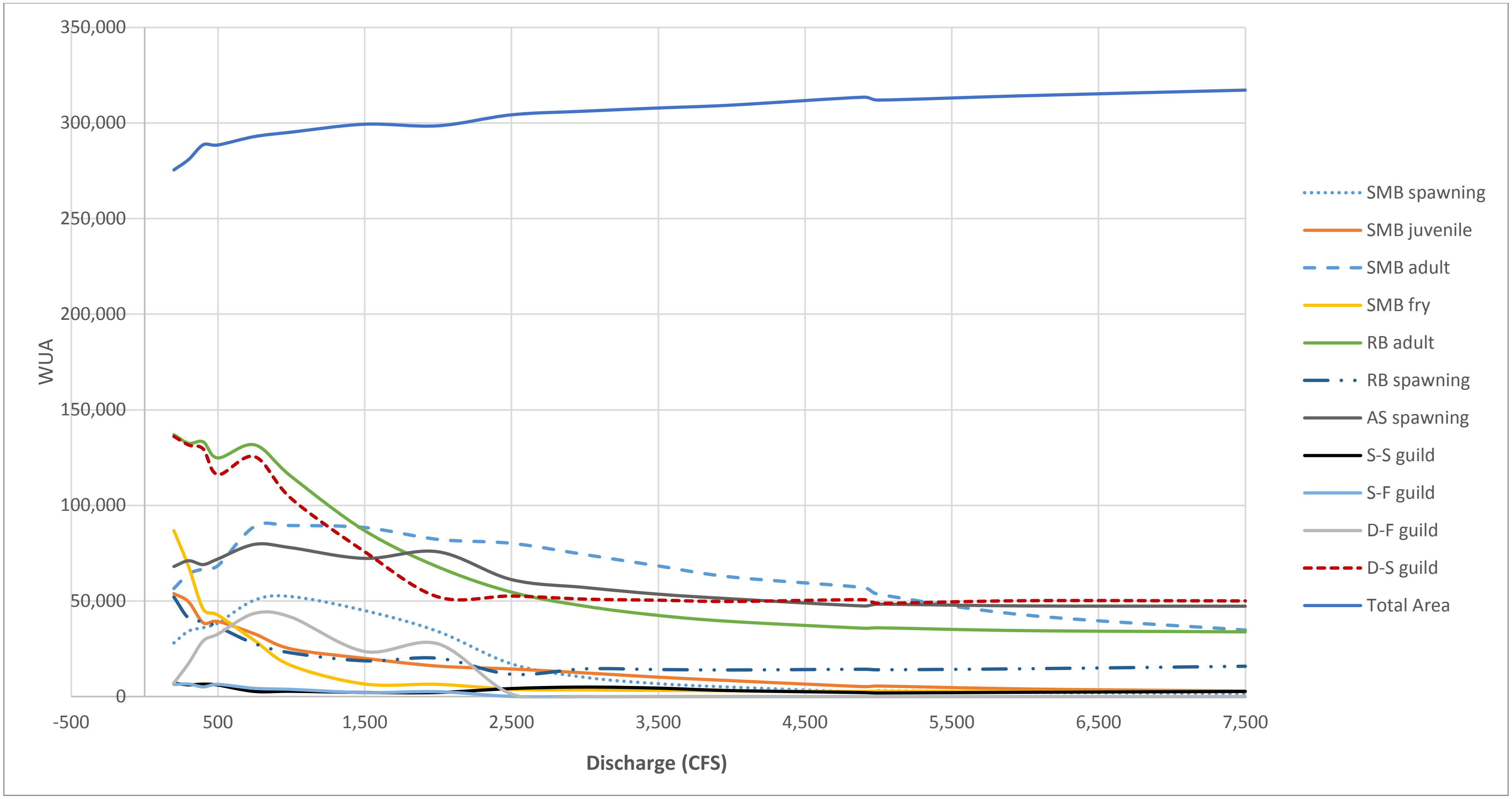


FIGURE 4-6 STUDY SITE 5 HABITAT SUITABILITY

TABLE 4-4 STUDY SITE 5 HABITAT SUITABILITY

Discharge	SMB spawn		SMB juvenile		SMB adult		SMB fry		RB adult		RB spawning		AS spawning		S-S guild		S-F guild		D-F guild		D-S guild	
200	28,083	54%	53,848	100%	56,543	63%	86,800	100%	136,977	100%	52,055	100%	68,051	85%	7,018	100%	6,342	96%	7,119	16%	136,092	100%
300	34,276	66%	49,561	92%	64,142	72%	67,987	78%	132,491	97%	40,997	79%	71,047	89%	6,160	88%	6,572	100%	17,363	40%	131,583	97%
400	36,049	69%	38,556	72%	66,756	75%	45,721	53%	133,190	97%	39,197	75%	69,047	87%	6,514	93%	5,081	77%	29,183	67%	129,485	95%
500	38,478	74%	39,271	73%	68,494	77%	42,613	49%	124,819	91%	36,520	70%	72,001	90%	6,032	86%	6,393	97%	32,730	75%	116,099	85%
600	43,284	83%	36,677	68%	76,693	86%	37,280	43%	127,556	93%	32,985	63%	75,054	94%	4,695	67%	5,556	85%	37,055	85%	119,861	88%
750	50,493	97%	32,787	61%	88,993	99%	29,282	34%	131,661	96%	27,682	53%	79,632	100%	2,689	38%	4,302	65%	43,541	100%	125,505	92%
900	51,580	99%	28,062	52%	89,268	100%	21,450	25%	121,716	89%	24,781	48%	78,559	99%	2,743	39%	3,989	61%	42,314	97%	112,328	83%
1,000	52,305	100%	24,913	46%	89,452	100%	16,229	19%	115,085	84%	22,847	44%	77,843	98%	2,779	40%	3,780	58%	41,495	95%	103,544	76%
1,150	50,107	96%	23,438	44%	89,140	100%	13,336	15%	106,593	78%	21,608	42%	76,174	96%	2,590	37%	3,268	50%	36,121	83%	95,210	70%
1,350	47,177	90%	21,472	40%	88,725	99%	9,478	11%	95,271	70%	19,956	38%	73,949	93%	2,338	33%	2,586	39%	28,956	67%	84,098	62%
1,500	44,979	86%	19,998	37%	88,413	99%	6,584	8%	86,780	63%	18,717	36%	72,279	91%	2,149	31%	2,075	32%	23,583	54%	75,763	56%
1,650	41,695	80%	18,779	35%	86,552	97%	6,532	8%	81,081	59%	19,116	37%	73,316	92%	2,150	31%	2,219	34%	24,783	57%	68,674	50%
1,850	37,318	71%	17,155	32%	84,070	94%	6,462	7%	73,483	54%	19,647	38%	74,697	94%	2,152	31%	2,411	37%	26,384	61%	59,221	44%
2,000	34,035	65%	15,936	30%	82,209	92%	6,410	7%	67,785	49%	20,045	39%	75,734	95%	2,153	31%	2,555	39%	27,585	63%	52,131	38%
2,500	17,113	33%	14,441	27%	80,148	90%	3,840	4%	54,643	40%	11,662	22%	61,197	77%	4,216	60%	91	1%	1,333	3%	52,594	39%
3,000	10,080	19%	12,385	23%	74,277	83%	3,483	4%	47,300	35%	14,517	28%	57,062	72%	4,976	71%	0	0%	0	0%	50,984	37%
3,500	6,759	13%	10,156	19%	68,334	76%	3,235	4%	42,455	31%	14,154	27%	53,573	67%	4,421	63%	0	0%	0	0%	50,415	37%
4,000	4,938	9%	8,315	15%	62,530	70%	3,046	4%	39,279	29%	13,929	27%	51,134	64%	3,144	45%	0	0%	0	0%	49,753	37%
4,900	2,439	5%	5,211	10%	56,984	64%	2,667	3%	35,760	26%	14,309	27%	47,393	60%	2,098	30%	0	0%	0	0%	50,663	37%
5,000	3,049	6%	5,526	10%	53,526	60%	2,802	3%	35,985	26%	14,020	27%	48,334	61%	1,890	27%	0	0%	0	0%	48,825	36%
6,000	2,213	4%	4,004	7%	42,668	48%	2,604	3%	34,497	25%	14,561	28%	47,419	60%	2,263	32%	0	0%	0	0%	50,155	37%
7,500	1,615	3%	2,883	5%	34,807	39%	2,755	3%	33,855	25%	15,873	30%	47,275	59%	2,690	38%	0	0%	0	0%	50,047	37%
100%	52,305		53,848		89,452		86,800		136,977		52,055		79,632		7,018		6,572		43,541		136,092	
75%	39,229		40,386		67,089		65,100		102,733		39,041		59,724		5,264		4,929		32,656		102,069	

4.6 STUDY SITE 6 (LARGE MAIN CHANNEL RIFFLE)

This site is comprised of two linked transects located in gravel and cobble-dominated riffle complex located approximately 3.5 miles downstream of Parr Shoals Dam. Habitat suitability for the majority of target lifestages and guilds peaks at approximately 1,500 to 1,900 cfs at this site. Smallmouth bass spawning and adult lifestages, as well as the deep fast guild, peaked at approximately 3500 cfs (Figure 4-7) (Table 4-5).

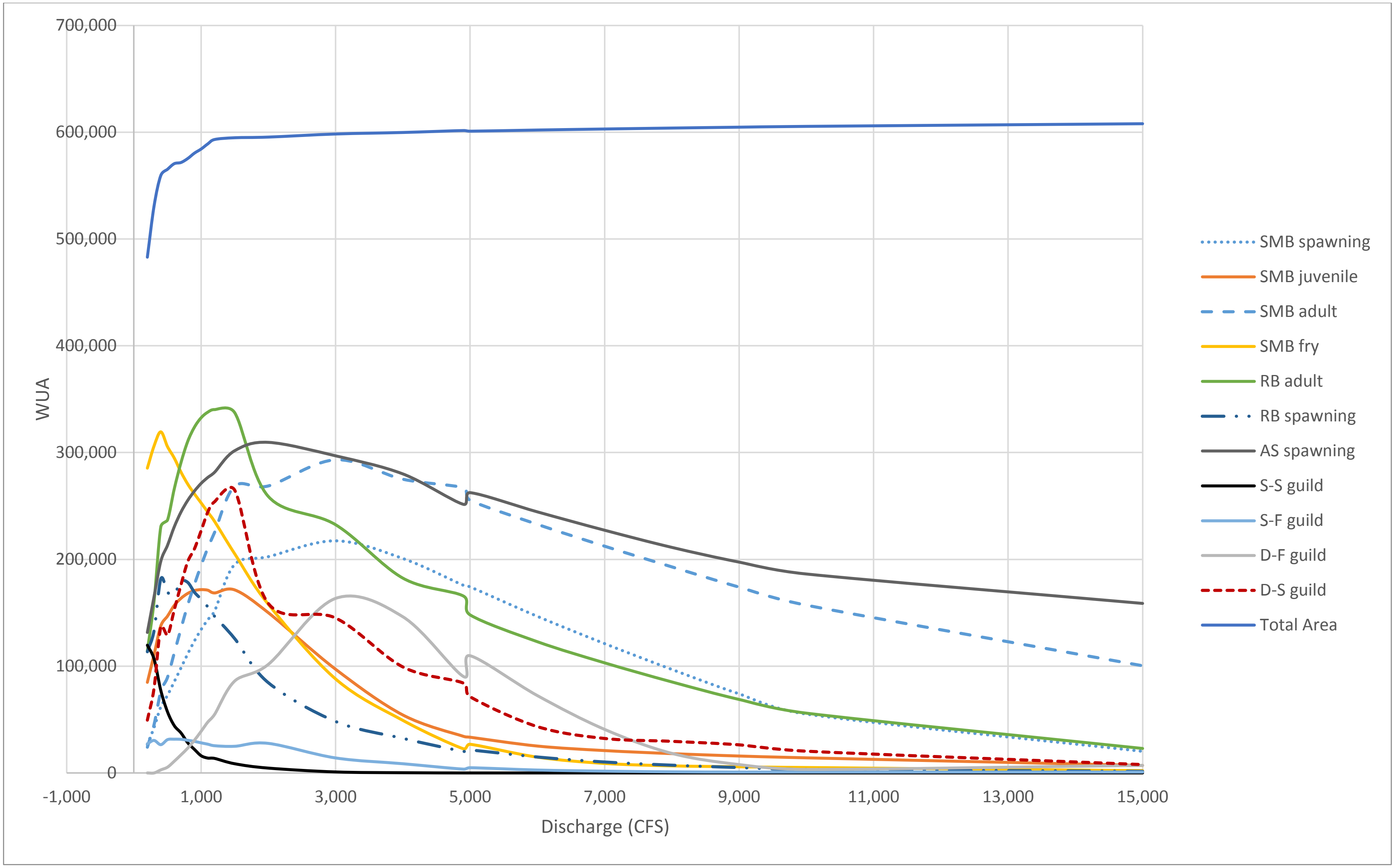


FIGURE 4-7 STUDY SITE 6 HABITAT SUITABILITY

TABLE 4-5 STUDY SITE 6 HABITAT SUITABILITY

Discharge	SMB spawning		SMB juvenile		SMB adult		SMB fry		RB adult		RB spawning		AS spawning		S-S guild		S-F guild		D-F guild		D-S guild	
200	26,585	12%	84,857	49%	24,118	8%	285,437	89%	114,115	34%	113,475	62%	131,577	43%	119,617	100%	27,340	86%	0	0%	49,474	19%
300	42,637	20%	110,798	65%	45,260	15%	306,222	96%	160,968	47%	133,234	73%	165,137	53%	106,635	89%	30,427	96%	0	0%	79,497	30%
400	61,906	28%	137,727	80%	76,247	26%	319,394	100%	230,410	68%	181,637	100%	198,199	64%	77,266	65%	26,471	84%	2,864	2%	136,779	52%
500	72,730	33%	146,876	86%	89,526	31%	305,488	96%	236,882	70%	169,259	93%	213,162	69%	57,169	48%	31,181	99%	5,417	3%	128,920	49%
600	85,471	39%	156,886	91%	112,313	38%	294,903	92%	265,947	78%	167,381	92%	230,434	74%	44,331	37%	31,617	100%	10,954	7%	152,720	58%
700	98,310	45%	163,508	95%	135,068	46%	281,734	88%	290,581	85%	179,292	99%	244,294	79%	37,514	31%	31,491	100%	16,941	10%	176,107	67%
800	111,494	51%	168,086	98%	157,142	54%	270,554	85%	310,409	91%	178,462	98%	255,182	82%	28,297	24%	30,600	97%	23,183	14%	197,806	75%
900	123,595	57%	170,807	100%	176,480	60%	261,320	82%	323,790	95%	169,242	93%	263,953	85%	22,044	18%	29,573	94%	30,634	19%	209,830	79%
1,000	134,345	62%	171,663	100%	194,370	66%	252,831	79%	332,639	98%	162,699	90%	271,192	88%	16,105	13%	28,176	89%	39,037	24%	226,852	86%
1,100	143,613	66%	171,112	100%	210,820	72%	244,155	76%	337,882	99%	155,421	86%	276,775	89%	13,912	12%	26,919	85%	47,747	29%	244,469	92%
1,200	151,615	70%	168,556	98%	225,268	77%	235,503	74%	340,255	100%	146,664	81%	281,595	91%	13,618	11%	25,488	81%	54,830	34%	253,984	96%
1,500	195,308	90%	171,373	100%	268,572	92%	205,111	64%	337,243	99%	125,677	69%	301,792	97%	8,596	7%	24,979	79%	86,147	53%	264,661	100%
2,000	202,531	93%	150,005	87%	268,770	92%	157,825	49%	258,831	76%	84,461	47%	309,582	100%	4,538	4%	27,685	88%	101,722	62%	158,617	60%
3,000	217,358	100%	97,067	57%	293,225	100%	87,967	28%	232,410	68%	48,187	27%	296,949	96%	942	1%	14,045	44%	163,477	100%	145,056	55%
4,000	200,810	92%	54,266	32%	275,050	94%	49,201	15%	182,416	54%	32,379	18%	280,009	90%	204	0%	8,629	27%	146,235	89%	99,247	37%
4,900	175,703	81%	34,291	20%	266,943	91%	22,600	7%	165,653	49%	20,187	11%	251,537	81%	0	0%	3,575	11%	90,326	55%	84,097	32%
5,000	174,226	80%	33,445	19%	255,326	87%	26,829	8%	147,997	43%	21,491	12%	262,462	85%	0	0%	4,891	15%	109,750	67%	71,327	27%
6,000	146,633	67%	25,185	15%	232,790	79%	14,774	5%	122,888	36%	14,915	8%	244,481	79%	0	0%	2,732	9%	72,430	44%	43,378	16%
7,000	121,113	56%	20,946	12%	212,332	72%	8,898	3%	103,098	30%	10,256	6%	227,281	73%	0	0%	1,687	5%	40,786	25%	32,282	12%
8,000	96,921	45%	18,087	11%	192,959	66%	6,637	2%	85,223	25%	7,271	4%	211,218	68%	0	0%	1,055	3%	18,319	11%	29,607	11%
9,000	74,082	34%	15,851	9%	174,016	59%	5,770	2%	68,824	20%	5,035	3%	197,430	64%	0	0%	836	3%	7,838	5%	26,329	10%
10,000	55,106	25%	14,153	8%	157,095	54%	5,083	2%	55,986	16%	3,257	2%	186,297	60%	0	0%	883	3%	3,321	2%	20,375	8%
15,000	20,244	9%	7,050	4%	100,384	34%	2,152	1%	22,933	7%	1,460	1%	158,756	51%	0	0%	863	3%	7,059	4%	7,834	3%
100%	217,358		171,663		293,225		319,394		340,255		181,637		309,582		119,617		31,617		163,477		264,661	
75%	163,019		128,747		219,919		239,546		255,191		136,228		232,186		89,713		23,713		130,782		198,495	

4.7 STUDY SITE 7 (PIZZA OVEN SITE)

This site is comprised of two linked transects located in a ledge-controlled riffle-glide complex located approximately 5.4 miles downstream of Parr Shoals Dam. Habitat suitability for the majority of target lifestages and guilds peaked at approximately 700 to 1,000 cfs at this site (Figure 4-8) (Table 4-6). American shad spawning reached an inflexion point at around 1,500 cfs and remained steady through the remainder of the flow range modeled. A much broader range of suitability was indicated for smallmouth bass adult, with a relatively broad peak occurring between approximately 500 and 4000 cfs. Habitat for the shallow-fast guild rose moderately as the flow departed from base flow, peaking at around 2000 cfs.

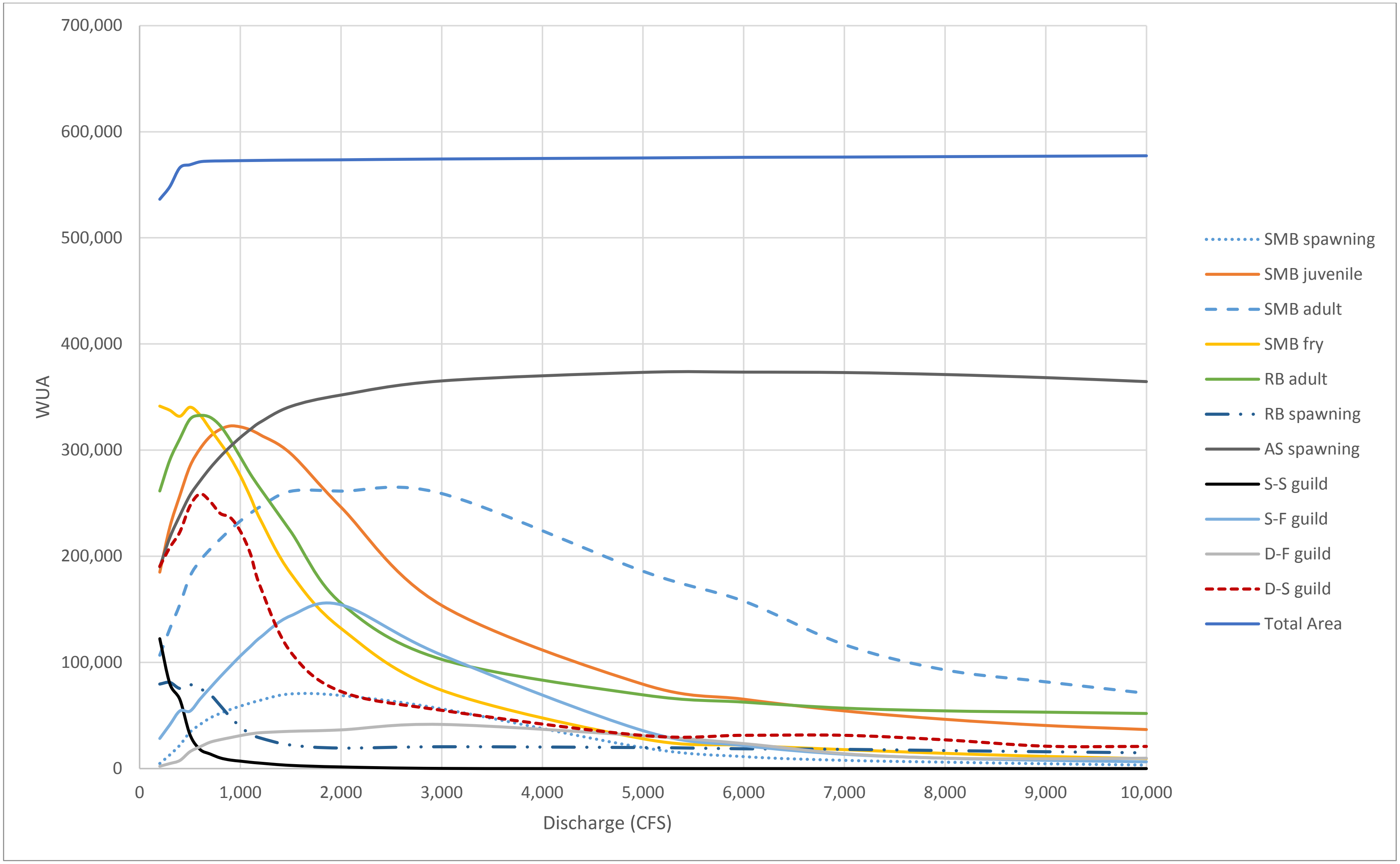


FIGURE 4-8 STUDY SITE 7 HABITAT SUITABILITY

TABLE 4-6 STUDY SITE 7 HABITAT SUITABILITY

Discharge	SMB spawning		SMB juvenile		SMB adult		SMB fry		RB adult		RB spawning		AS spawning		S-S guild		S-F guild		D-F guild		D-S guild	
200	4,778	7%	185,059	57%	106,819	41%	341,484	100%	261,525	79%	79,634	98%	190,039	51%	122,349	100%	28,370	18%	2,170	5%	190,546	74%
300	12,942	18%	227,495	70%	131,731	50%	337,537	99%	290,739	87%	81,168	100%	217,716	58%	79,969	65%	41,312	27%	4,747	11%	208,321	81%
400	22,121	31%	257,381	80%	154,708	59%	331,938	97%	310,815	93%	75,471	93%	238,470	64%	64,989	53%	54,353	35%	7,648	18%	222,996	86%
500	34,302	49%	284,854	88%	181,096	69%	340,459	100%	329,123	99%	79,053	97%	257,465	69%	31,947	26%	54,073	35%	15,931	38%	247,404	96%
600	41,500	59%	301,292	93%	195,795	75%	333,109	98%	332,707	100%	75,154	93%	270,953	73%	18,056	15%	65,422	42%	20,536	49%	258,756	100%
700	47,678	68%	312,857	97%	206,639	79%	319,872	94%	330,990	99%	69,883	86%	283,123	76%	13,759	11%	76,079	49%	24,832	60%	251,728	97%
800	51,975	74%	319,568	99%	216,098	83%	306,876	90%	323,038	97%	59,448	73%	293,809	79%	10,047	8%	86,486	56%	27,215	65%	240,446	93%
900	55,638	79%	322,798	100%	225,065	86%	293,088	86%	309,500	93%	48,517	60%	303,336	81%	8,054	7%	96,392	62%	29,135	70%	236,609	91%
1,000	58,836	84%	321,939	100%	233,257	89%	275,941	81%	293,562	88%	39,499	49%	311,927	84%	7,023	6%	106,071	69%	31,049	75%	223,683	86%
1,100	61,701	88%	319,118	99%	240,484	92%	255,893	75%	277,494	83%	32,494	40%	319,565	86%	5,963	5%	115,004	75%	32,678	79%	202,451	78%
1,200	64,396	92%	314,315	97%	246,780	94%	234,437	69%	263,507	79%	28,756	35%	326,457	87%	5,119	4%	123,672	80%	33,791	81%	171,054	66%
1,500	70,354	100%	296,828	92%	261,265	100%	183,945	54%	223,513	67%	22,186	27%	341,146	91%	3,001	2%	143,933	93%	35,123	84%	109,837	42%
2,000	68,846	98%	246,315	76%	261,421	100%	132,089	39%	155,888	47%	19,335	24%	351,931	94%	1,539	1%	154,310	100%	36,462	88%	72,651	28%
3,000	56,303	80%	153,774	48%	259,133	99%	73,814	22%	102,887	31%	20,563	25%	365,229	98%	154	0%	106,998	69%	41,599	100%	54,884	21%
5,000	19,731	28%	79,456	25%	185,911	71%	28,076	8%	69,454	21%	19,786	24%	373,297	100%	0	0%	35,689	23%	30,924	74%	31,185	12%
6,000	11,261	16%	65,346	20%	157,747	60%	21,965	6%	62,599	19%	18,668	23%	373,525	100%	0	0%	21,625	14%	23,526	57%	31,344	12%
7,000	7,733	11%	54,310	17%	116,788	45%	17,849	5%	56,946	17%	18,123	22%	373,111	100%	0	0%	13,469	9%	13,985	34%	31,344	12%
8,000	6,028	9%	46,404	14%	92,940	36%	14,344	4%	54,355	16%	16,964	21%	371,234	99%	0	0%	9,784	6%	9,834	24%	27,074	10%
9,000	4,534	6%	40,600	13%	81,702	31%	11,438	3%	53,145	16%	15,861	20%	368,321	99%	0	0%	7,763	5%	9,207	22%	21,086	8%
10,000	3,312	5%	36,778	11%	70,898	27%	9,418	3%	51,921	16%	14,828	18%	364,584	98%	0	0%	6,388	4%	9,782	24%	20,862	8%
100%	70,354		322,798		261,421		341,484		332,707		81,168		373,525		122,349		154,310		41,599		258,756	
75%	52,765		242,098		196,066		256,113		249,530		60,876		280,144		91,762		115,733		31,199		194,067	

4.8 STUDY SITE 8 (HALTIWANGER ISLAND)

Study Site 8 consists of a pair of adjacent transects located near the upstream end of Haltiwanger Island, with one transect (8.1) located on the east side of the island and the second (8.2) on the west. Transect 8.1 is predominantly a riffle with a deeper run/thalweg along the east shore. Transect 8.2 is located in a steep riffle habitat and represents the smaller of the two channels. Hydraulic analyses indicate a 68:32 flow split between the east channel (Transect 8.2) and west channel (Transect 8.1), respectively, at the 400 cfs calibration flow; a 73:27 split at 2000 cfs; and 78:22 split at 6000 cfs. Habitat suitability at Transects 8.1 and 8.2 are combined below on Figures 4-9. Habitat suitability for the majority of target lifestages and guilds peaks at approximately 1,000 to 1,500 cfs at this site (Figure 4-9) (Table 4-7). American shad spawning reached an inflexion point at around 4,000 cfs and remained optimal throughout the remainder of the flow range. Adult smallmouth bass display a broad suitability, peaking at approximately 3,000 cfs and gradually decreasing with increased flow.

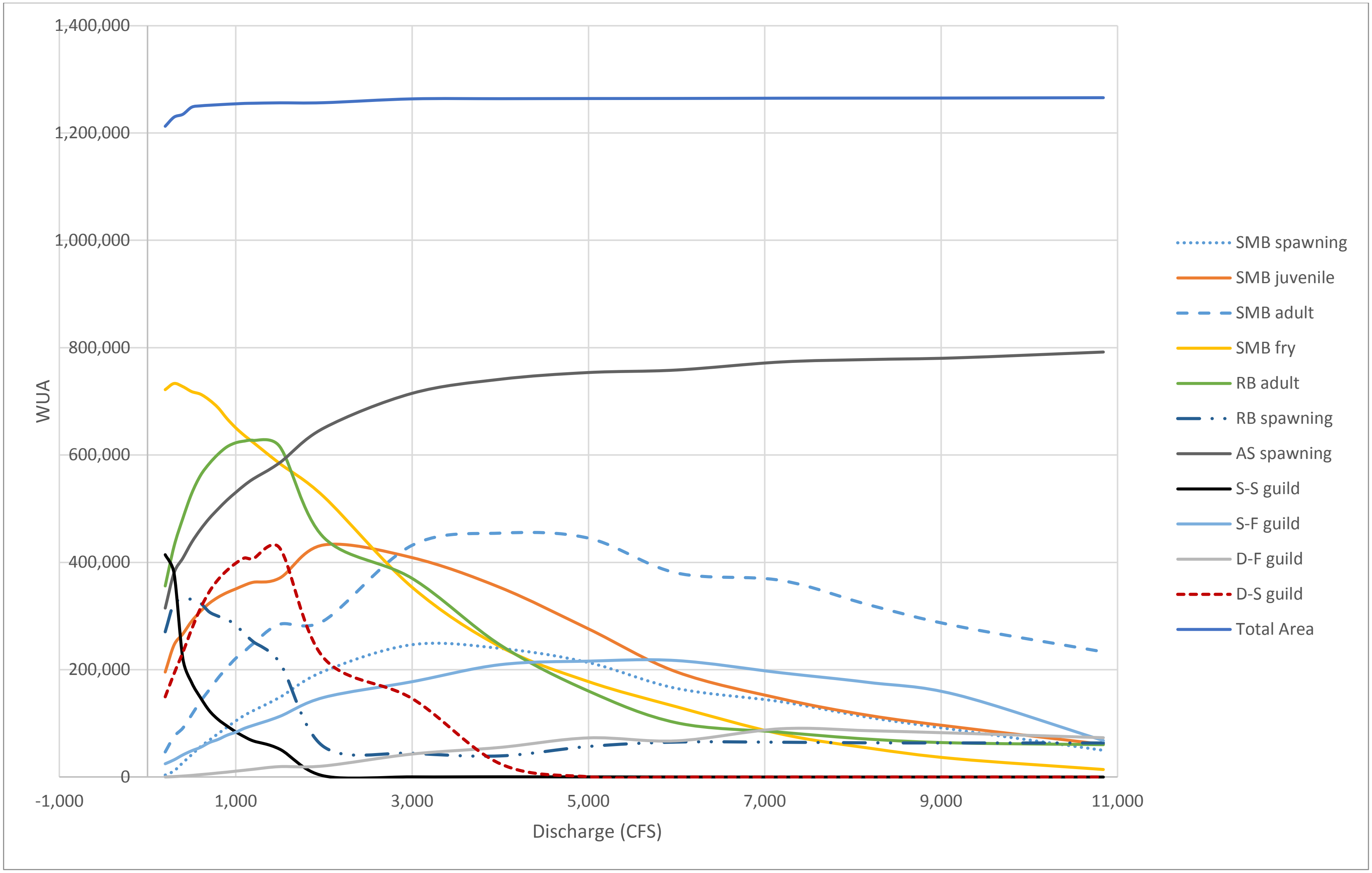


FIGURE 4-9 STUDY SITE 8 HABITAT SUITABILITY

TABLE 4-7 STUDY SITE 8 HABITAT SUITABILITY

Discharge	SMB spawning		SMB juvenile		SMB adult		SMB fry		RB adult		RB spawning		AS spawning		S-S guild		S-F guild		D-F guild		D-S guild	
200	3,720	2%	195,659	45%	46,839	10%	721,773	98%	356,086	57%	270,665	82%	314,815	40%	414,242	100%	24,760	11%	166	0%	149,560	35%
300	11,454	5%	245,974	57%	75,439	17%	733,279	100%	429,842	69%	324,069	98%	380,288	48%	379,840	92%	32,086	15%	840	1%	192,595	45%
400	26,831	11%	266,697	62%	91,273	20%	727,425	99%	482,042	77%	329,175	99%	407,905	52%	220,601	53%	41,293	19%	1,875	2%	232,315	54%
500	41,634	17%	290,381	67%	115,972	26%	718,183	98%	528,262	84%	331,371	100%	437,285	55%	175,901	42%	48,963	23%	3,065	3%	275,507	65%
600	56,489	23%	308,680	71%	141,045	31%	713,354	97%	561,905	90%	324,021	98%	461,329	58%	147,922	36%	55,300	25%	4,562	5%	314,469	74%
700	68,856	28%	323,788	75%	162,671	36%	702,619	96%	584,088	93%	307,575	93%	481,975	61%	123,687	30%	64,177	30%	5,953	7%	345,334	81%
800	80,862	33%	335,029	77%	184,653	41%	688,045	94%	601,579	96%	299,726	90%	499,479	63%	107,299	26%	70,081	32%	7,639	8%	367,988	86%
900	92,719	38%	343,683	79%	203,627	45%	667,906	91%	615,229	98%	293,642	89%	515,893	65%	95,238	23%	77,859	36%	9,176	10%	384,954	90%
1,000	104,570	42%	350,523	81%	221,233	49%	650,628	89%	622,795	99%	283,118	85%	530,301	67%	84,249	20%	83,585	39%	11,013	12%	398,347	93%
1,100	115,183	47%	357,569	83%	234,509	52%	636,083	87%	626,048	100%	266,684	80%	543,988	69%	74,911	18%	90,937	42%	12,743	14%	408,175	96%
1,200	123,807	50%	362,965	84%	248,852	55%	623,217	85%	627,310	100%	251,980	76%	555,727	70%	67,242	16%	96,478	44%	14,539	16%	407,006	95%
1,500	148,669	60%	370,903	86%	284,722	63%	584,023	80%	615,528	98%	212,865	64%	585,840	74%	51,834	13%	113,087	52%	19,458	22%	426,396	100%
1,750	172,905	70%	401,724	93%	288,049	63%	553,105	75%	530,790	85%	134,574	41%	618,084	78%	26,971	7%	130,762	60%	20,089	22%	323,960	76%
2,000	197,141	80%	432,546	100%	291,377	64%	522,187	71%	446,052	71%	56,283	17%	650,328	82%	2,109	1%	148,437	68%	20,719	23%	221,524	52%
2,500	221,910	90%	420,686	97%	361,574	80%	437,908	60%	408,119	65%	50,305	15%	682,629	86%	1,205	0%	163,054	75%	31,787	35%	183,913	43%
3,000	246,679	100%	408,827	95%	431,772	95%	353,629	48%	370,186	59%	44,326	13%	714,931	90%	301	0%	177,672	82%	42,856	48%	146,301	34%
3,500	243,189	99%	380,938	88%	443,135	97%	298,212	41%	308,111	49%	41,869	13%	728,038	92%	371	0%	193,536	89%	49,060	55%	85,503	20%
4,000	239,700	97%	353,049	82%	454,498	100%	242,795	33%	246,036	39%	39,412	12%	741,146	94%	441	0%	209,400	96%	55,265	61%	24,704	6%
4,500	226,543	92%	314,586	73%	449,830	99%	210,318	29%	203,154	32%	48,211	15%	747,432	94%	354	0%	212,696	98%	64,126	71%	12,632	3%
5,000	213,386	87%	276,123	64%	445,163	98%	177,842	24%	160,272	26%	57,011	17%	753,718	95%	267	0%	215,992	100%	72,986	81%	561	0%
6,000	165,147	67%	195,876	45%	380,246	84%	130,922	18%	101,113	16%	65,215	20%	758,374	96%	105	0%	217,047	100%	67,462	75%	0	0%
7,180	140,433	57%	146,134	34%	366,469	81%	80,343	11%	83,555	13%	64,896	20%	773,326	98%	0	0%	194,347	90%	89,994	100%	0	0%
8,180	111,113	45%	114,875	27%	320,858	71%	53,984	7%	70,642	11%	63,805	19%	777,900	98%	0	0%	176,258	81%	86,345	96%	0	0%
9,170	87,961	36%	93,164	22%	281,520	62%	34,044	5%	63,590	10%	63,553	19%	781,042	99%	0	0%	153,515	71%	81,857	91%	0	0%
10,840	49,805	20%	60,943	14%	233,230	51%	14,076	2%	60,365	10%	63,484	19%	791,919	100%	0	0%	68,001	31%	73,303	81%	0	0%
100%	246,679		432,546		454,498		733,279		627,310		331,371		791,919		414,242		217,047		89,994		426,396	
75%	185,009		324,409		340,873		549,960		470,482		248,528		593,939		310,681		162,785		67,496		319,797	

4.9 STUDY SITE 9 (HUFFMAN ISLAND)

This site is to be evaluated through the proposed flow demonstration only and will be described after the TWC field observations.

4.10 STUDY SITE 10 (BOOKMAN ISLAND COMPLEX)

Habitat suitability for velocity-intolerant lifestages such as shallow slow, and smallmouth bass fry peaked at 200 cfs and declined rapidly at higher flows due to increases in velocity (Figure 4-10). Redbreast sunfish spawning also declined at rising flows but at a gradual rate, inflecting downward at approximately 2,000 cfs. Smallmouth bass spawning and juvenile lifestages, adult redbreast sunfish, shallow-fast, and the deep fast guild, generally achieve the greatest suitability in a range between approximately 700 – 3,000 cfs before slowly declining in suitability at higher flows. Smallmouth bass adult exhibit a sharp peak of suitability at 3,000 cfs, but are generally in a plateau of relatively high suitability between 2,000-10,000 cfs. American shad spawning habitat suitability reaches an inflection point at approximately 1,200 cfs, gradually rises to an absolute peak at 4,000 cfs then gently declines at higher flows (Figure 4-10) (Table 4-8).

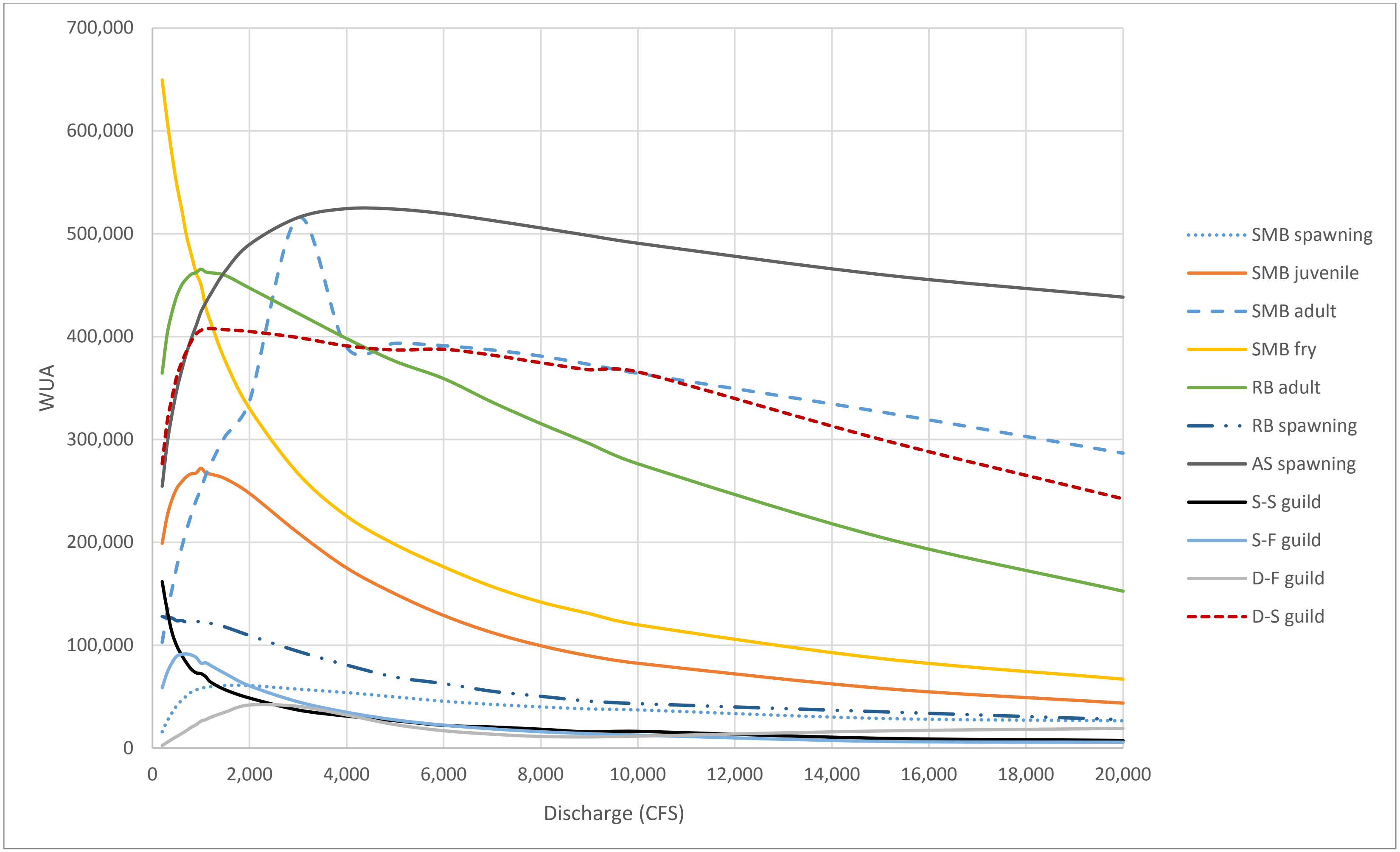


FIGURE 4-10 STUDY SITE 10 HABITAT SUITABILITY

TABLE 4-8 STUDY SITE 10 HABITAT SUITABILITY

Discharge	SMB spawning		SMB juvenile		SMB adult		SMB fry		RB adult		RB spawning		AS spawning		S-S guild		S-F guild		D-F guild		D-S guild	
200	15,928	26%	199,145	73%	102,985	20%	649,442	100%	364,539	78%	128,007	100%	254,591	49%	161,819	100%	58,679	64%	2,612	6%	276,504	68%
300	26,186	43%	225,022	83%	131,339	25%	611,007	94%	401,820	86%	126,720	99%	295,234	56%	134,449	83%	73,244	80%	5,633	13%	316,376	78%
400	34,282	56%	241,384	89%	153,838	30%	577,108	89%	423,349	91%	126,515	99%	323,861	62%	112,886	70%	82,985	91%	8,648	21%	340,069	83%
500	41,427	68%	252,537	93%	176,506	34%	547,736	84%	439,415	94%	123,901	97%	348,047	66%	99,508	61%	89,424	98%	11,441	27%	361,310	89%
600	46,541	76%	258,908	95%	194,749	38%	523,940	81%	450,035	97%	124,147	97%	366,965	70%	90,537	56%	91,205	100%	14,193	34%	374,690	92%
700	50,821	83%	263,908	97%	211,866	41%	498,166	77%	456,214	98%	122,416	96%	383,823	73%	82,987	51%	91,627	100%	17,128	41%	385,859	95%
800	54,551	89%	266,671	98%	226,999	44%	479,577	74%	460,611	99%	122,401	96%	398,192	76%	76,764	47%	90,558	99%	20,359	48%	395,625	97%
900	56,569	93%	267,506	98%	240,853	47%	461,675	71%	462,315	99%	122,196	95%	410,855	78%	73,243	45%	88,219	96%	22,786	54%	402,553	99%
1,000	58,310	96%	272,046	100%	252,029	49%	450,274	69%	465,506	100%	124,383	97%	424,207	81%	72,492	45%	82,685	90%	26,305	63%	406,112	100%
1,100	59,200	97%	267,211	98%	265,624	52%	427,936	66%	462,794	99%	122,957	96%	433,210	83%	69,395	43%	83,046	91%	27,813	66%	407,510	100%
1,200	59,811	98%	266,324	98%	275,994	54%	413,859	64%	462,037	99%	121,360	95%	441,486	84%	64,222	40%	80,362	88%	29,999	71%	407,904	100%
1,500	61,016	100%	261,923	96%	303,244	59%	376,252	58%	459,447	99%	117,753	92%	463,727	88%	56,794	35%	72,480	79%	35,081	84%	406,762	100%
1,750	60,939	100%	254,760	94%	320,287	62%	353,185	54%	453,329	97%	113,632	89%	476,669	91%	52,762	33%	66,538	73%	38,541	92%	405,882	100%
2,000	60,862	100%	247,598	91%	337,330	65%	330,119	51%	447,210	96%	109,511	86%	489,611	93%	48,730	30%	60,597	66%	42,000	100%	405,001	99%
2,500	59,135	97%	228,452	84%	426,528	83%	298,556	46%	434,926	93%	101,818	80%	502,668	96%	42,923	27%	52,835	58%	41,335	98%	402,054	99%
3,000	57,409	94%	209,306	77%	515,726	100%	266,992	41%	422,641	91%	94,124	74%	515,726	98%	37,115	23%	45,073	49%	40,670	97%	399,108	98%
3,500	55,722	91%	192,263	71%	452,623	88%	246,280	38%	410,404	88%	87,456	68%	520,046	99%	34,156	21%	40,010	44%	36,471	87%	395,051	97%
4,000	54,035	89%	175,220	64%	389,520	76%	225,568	35%	398,166	86%	80,787	63%	524,367	100%	31,196	19%	34,947	38%	32,272	77%	390,995	96%
4,500	51,951	85%	162,609	60%	391,503	76%	211,806	33%	387,110	83%	74,935	59%	524,136	100%	28,958	18%	31,245	34%	27,596	66%	389,029	95%
5,000	49,866	82%	149,997	55%	393,487	76%	198,045	30%	376,055	81%	69,083	54%	523,905	100%	26,720	17%	27,544	30%	22,921	55%	387,064	95%
6,000	45,643	75%	129,004	47%	391,164	76%	176,282	27%	359,215	77%	62,778	49%	519,506	99%	22,182	14%	22,432	24%	16,984	40%	387,711	95%
7,000	42,583	70%	112,357	41%	387,016	75%	157,062	24%	336,321	72%	55,331	43%	512,876	98%	20,562	13%	18,775	20%	13,608	32%	382,017	94%
8,000	40,152	66%	99,624	37%	381,099	74%	142,052	22%	315,493	68%	50,430	39%	505,625	96%	18,433	11%	16,008	17%	11,391	27%	374,653	92%
9,000	38,147	63%	89,761	33%	372,981	72%	130,865	20%	296,073	64%	45,753	36%	498,147	95%	15,818	10%	14,138	15%	10,965	26%	367,839	90%
10,000	37,224	61%	82,577	30%	364,316	71%	119,961	18%	276,451	59%	43,285	34%	490,768	94%	16,374	10%	12,723	14%	11,698	28%	365,756	90%
15,000	28,938	47%	58,283	21%	326,924	63%	87,254	13%	205,152	44%	35,439	28%	460,335	88%	9,615	6%	6,631	7%	16,741	40%	300,232	74%
20,000	26,610	44%	43,863	16%	286,761	56%	67,153	10%	152,602	33%	27,737	22%	438,390	84%	7,585	5%	5,804	6%	19,210	46%	242,391	59%
100%	61,016	100%	272,046	100%	515,726	100%	649,442	100%	465,506	100%	128,007	100%	524,367	100%	161,819	100%	91,627	100%	42,000	100%	407,904	100%
75%	45,762		204,035		386,795		487,082		349,129		96,006		393,275		121,364		68,720		31,500		305,928	

4.11 FISH PASSAGE LEDGES

SCDNR zone-of-passage criteria state that instream flow should be sufficient to provide a minimum 10 ft-wide passage point with a minimum depth of 1.5 ft. At Ledge 1 (IFIM Study Site 7). This criterion is met by a flow of 500 cfs, with the minimum 1.5 ft depth provided over a cross-sectional distance of approximately 85 ft at the primary passage point identified in the study plan (Figure 4-11). The secondary passage point at Ledge 1, which was identified during the field efforts, provides an additional passage point approximately 44 ft in width that also meets the minimum 1.5 ft depth criteria at 500 cfs (Figure 4-12). These results suggest that fish passage is not a limiting factor at this location for flows as low as 500 cfs.

At Ledge 2, field data demonstrate that the fish passage criterion is met at flows as lows as 700 cfs, with the minimum 1.5 ft depth provided over a cross-sectional distance of approximately 27 ft (Figure 4-13). These results indicate that Ledge 2, located just upstream of the Bookman Shoals complex, is the more limiting of the two study sites from both the navigational and fish passage perspectives.

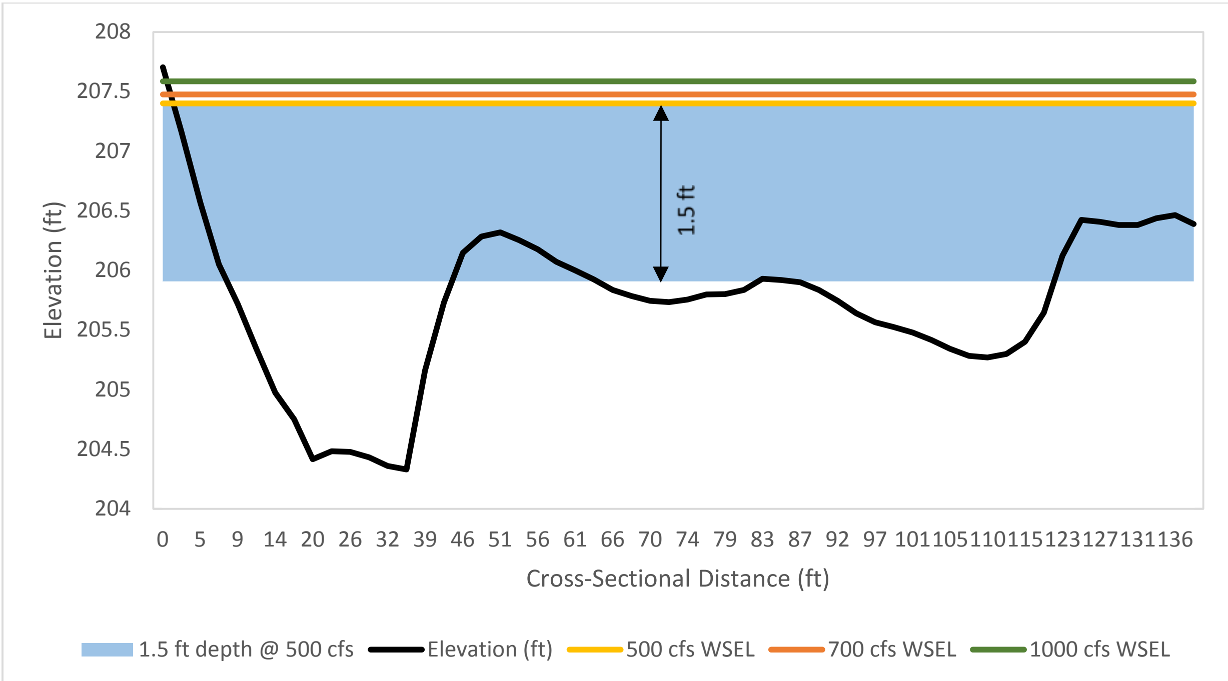


FIGURE 4-11 BED PROFILE AND WATER SURFACE ELEVATIONS AT THE RIVER LEFT PASSAGE POINT AT LEDGE 1 (UPSTREAM VIEW)

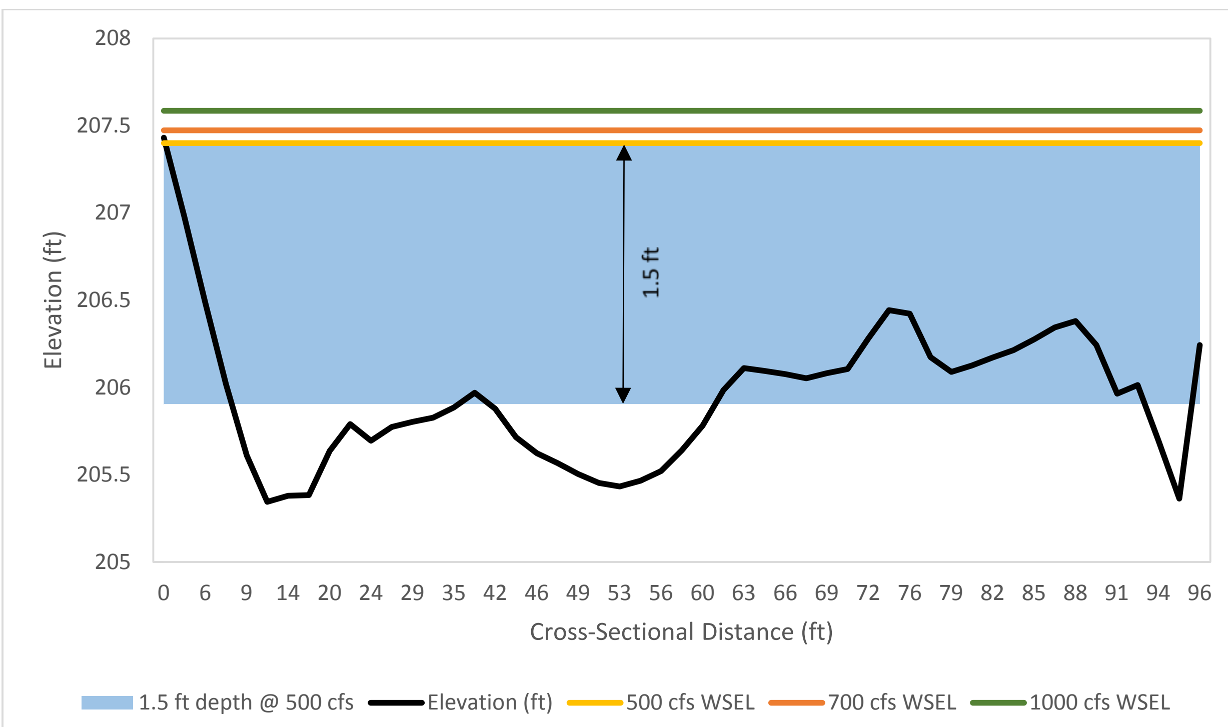


FIGURE 4-12 BED PROFILE AND WATER SURFACE ELEVATIONS AT THE MID-CHANNEL PASSAGE POINT AT LEDGE 1 (UPSTREAM VIEW)

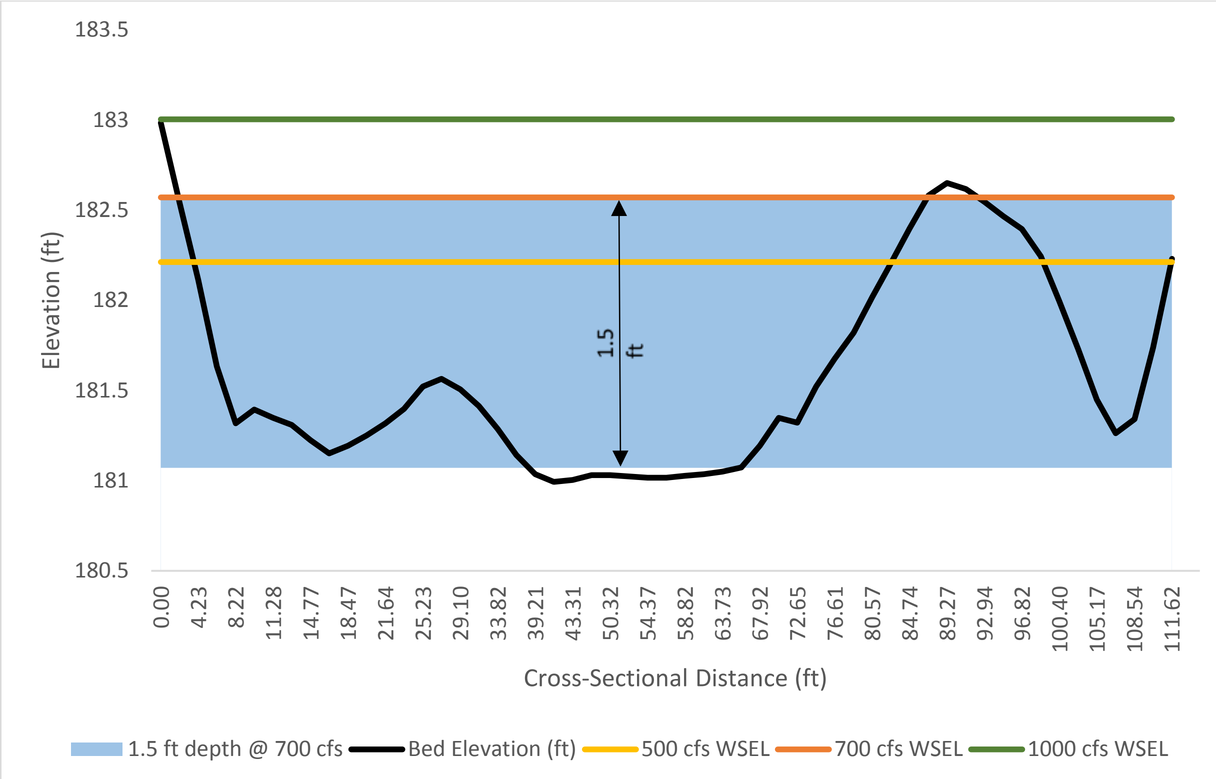


FIGURE 4-13 LEDGE 2 BED PROFILE SHOWING NAVIGATION PASSAGE AREA AT 700 CFS (UPSTREAM VIEW)

5.0 DISCUSSION

According to MESC (2001) “the basic WUA versus discharge relationships obtained in PHABSIM represent only instantaneous variation of physical habitat with flow and should not be interpreted in the absence of one or more alternative flow regimes for a particular study site”. The purpose of this discussion is to recommend how these data may help determine suitable instream flow ranges for accommodating both aquatic habitat objectives and other instream uses. These data can then be integrated into additional analyses such as time series, and/or further dissection of results.

5.1 PRIORITIZATION OF SPECIES AND LIFESTAGES

In multiple species/lifestage assessments, WUA curves among target species and lifestages frequently peak and decline inharmoniously. Examples of such conflicting curves can be observed in this study. This makes it difficult to form recommendations that satisfy all biological goals (MESC 2001). A number of balancing techniques are commonly employed to resolve this type of issue; there is no single “right” or “wrong” approach. Most involve prioritizing particular species and lifestages either through time or space, or under different management priorities. Some possibilities include:

- delete species/lifestages that are not sensitive to habitat/flow changes;
- delete species/lifestages with redundant flow-WUA relationships;
- combine species in a post-modeling guilding such as cumulative multispecies curve;
- parse species and lifestages into monthly or seasonal time units that correspond to applicable seasonal habitat functions (e.g. spawning criteria are applied during March-May, etc., YOY criteria are applied June- October, etc.); and
- limiting lifestage. For species for which multiple lifestages are modeled, such as smallmouth bass, a particular lifestage may be determined to be the population bottleneck for recruitment to catchable sized fish. Giving habitat priority to the limiting or critical lifestage may relieve some conflicts and support the management for the species.

5.2 PRIORITIZATION AND BALANCING OF RIVER REACHES AND MESOHABITATS

The PHABSIM data contained in this report quantify the raw relationship between flow and aquatic habitat suitability in specific reaches of the Broad River, and are indices that can be applied to estimate the extent to which the existing project operation and alternatives may affect aquatic habitat suitability. Analysis of these data should be made in the context of watershed hydrology and the strategic needs of management of upstream reservoir fluctuations, water quality, recreation, and hydroelectric power generation. These data should be used in conjunction with specific hydrologic, operational and other models to evaluate the costs and benefits of providing alternate flows to the lower Broad River.

The study area is comprised of two independent study reaches, each with distinct geomorphic characteristics. Different mesohabitat types were modeled within each reach. WUA – flow relationships vary within each reach due to differences in hydraulics, stream slope and geometry, and in some cases because different guild criteria are applicable. The TWC will need to consider techniques for balancing and/or prioritizing these reaches.

Representative Habitat − WUA is an index calculated in units per 1,000 ft of similar stream reach. For reaches and mesohabitats shared by all species/lifestages, WUA results within each study site are commonly weighted and summed according to relative contributing reach length of each modeled mesohabitat type throughout the study area. The weighting information can be quantified directly from existing mesohabitat mapping measurements.

Critical Habitat − A particular reach, mesohabitat type or study site that may be a minority of the study area, but which is strategic because it is where a critical lifestage function (such as spawning) occurs is prioritized during the time of year it is required. Conversely, a reach, mesohabitat type or study site can be deleted from the analysis if no applicable species/lifestage-specific habitat function occurs there during a given time frame.

6.0 CONCLUSIONS

This IFIM study report will serve as the basis for TWC discussions regarding selection of a minimum flow for the Parr Project. The data contained in this report covers the life stages and transect areas that were identified as important by the TWC. After discussion and selection of a minimum flow(s), the TWC will schedule a field observation to observe the flow(s) at selected transect sites. These observations and recommendations from the TWC will be recorded and included in the creation of a protection, mitigation, or enhancement (PME) that will be evaluated as part of the Parr Project Operations Model. That Model will determine if the recommended flow(s) can be maintained in the new license without significant impact to the future project operations of the Parr and Fairfield Developments.

7.0 REFERENCES

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APPENDIX A

ROBUST REDHORSE SPAWNING MEMORANDUM

APPENDIX B

TWC SCOPING

APPENDIX C

MESOHABITAT ASSESSMENT MEMORANDUM

APPENDIX D

HABITAT SUITABILITY INDEX (HSI) CURVES

APPENDIX E

SITE PHOTOGRAPHS

Parr Hydroelectric Project – FERC No. 1894
Downstream Flow Fluctuations – Memorandum

TO:	Parr/Fairfield Relicensing Water Quality, Fish and Wildlife Resource Conservation Group (RCG)
FROM:	Kelly Miller and Henry Mealing – Kleinschmidt Associates
DATE:	December 16, 2015
RE:	Downstream Flow Fluctuations – Initial Analysis

As part of the comments received on the Preliminary Application Document (PAD), several agencies requested additional information on the periodic flow fluctuations from the Parr Hydroelectric Project (Project). At the August 26, 2015 relicensing meeting, stakeholders presented concerns that flow fluctuations from the Project could impact the spawning of several species of fish in the Broad River downstream of the Project and extending downstream to where Highway 601 crosses the Congaree River. The target species identified in the meeting were shortnose sturgeon, American shad, striped bass, and robust redhorse. Target spawning months include January through May (RCG Meeting Notes 08-26-2015).

As the initial step in addressing these concerns, flow records for 2010-2015 were collected from USGS for the following gage locations: Carlisle (2156500), Tyger (2160105), Enoree (2160700), Alston (2161000), Saluda downstream of Lake Murray (2169000), and the Congaree River (2169500). Flows were compared from January through May on an annual basis, and were prorated based on drainage areas. All flow data will be provided on a CD upon request by RCG members.

Methods

Hourly inflows to the Project were prorated using data from the Carlisle, Tyger, and Enoree gages, which represent the contributing drainage area of the Parr Reservoir. A regional coefficient and exponent, which were determined by regression analysis as part of the Parr operations model inflow dataset development[1], were applied to the ratios for accuracy. These flows were graphically compared with the Project outflow data (from the Alston gage), and an offset applied to account for flow travel time; a shift of 9 hours was visually determined to best fit the datasets, based on inflow events exceeding 40,000 cfs, which are outside of the Project impact. The comparison of these datasets gave a depiction of the frequency and magnitude of how Project operations affect downstream flow. Shifts in streamflow greater than 2,000, 3,000, 5,000 and 10,000 cfs (on an hourly basis) were identified.

Flow records from Carlisle, Tyger and Enoree gages were summed and prorated to the drainage area of the Broad River, approximated by subtracting the drainage area of the Saluda gage from

[1] Kleinschmidt, "Inflow Dataset Development: Statistical Methodology," May 2014.

that of the Congaree gage. This dataset was added to flow records from the Saluda gage, then compared with the Congaree gage data. This provided an hourly estimate of downstream flows without the influence of the Parr Project operations. Flow records from the Alston gage were also prorated and added to flow records from the Saluda gage, and then compared with the Congaree gage data. This allowed for the observation of flow attenuation downstream, or the persistence of a peak wave down to the upper portion of the Congaree River. It also showed how the Saluda Hydro Project influenced flows in the Congaree River. Flows prorated down to the Congaree area were prorated using direct area only, as no regional coefficient or exponent has been determined for this additional drainage area. As with the inflow comparison with the Alston data, the upstream datasets were offset to account for flow travel time (18 hours for the three gages upstream of the Project, and 7 hours to the Alston data).

Discussion

Inflow, which was calculated by adding flows from the Carlisle, Tyger and Enoree gages, was compared to outflow, represented by the Alston gage flows (Appendix A - Figures 1 through 6).

Shifts in streamflow greater than 2,000, 3,000, 5,000, and 10,000 cfs on an hourly basis were identified for the entire period of study (January-May, 2010-2015). Because this evaluation accounts for hourly differences, the percent of time the difference occurs is provided, rather than the number of flow variance events. The average percent of time these variances occur is provided, not the number of flow variance events in any given month or year (which independently could last longer than one hour). The results of these magnitudes and frequency of occurrence are shown in Table 1 below. The frequency and magnitude of flow shifts varied with hydraulic year and operation demands.

Flow Variance	% of Occurrence
2000	20.0%
3000	11.5%
5000	4.7%
10000	0.9%

Table 1 – Project-Induced Flow Variance Magnitude and Frequency

Prorated flow datasets from Carlisle, Tyger and Enoree gages combined with flows records from Saluda, which represents Congaree River inflows without the influence of the Project operation, were graphically compared to flows as recorded by the Congaree River gage (Appendix A - Figures 7 through 12).

Finally, prorated Alston flows added to the flow records from Saluda to compare flows upstream of the Congaree River, which takes into account effects of the Parr Project operations were graphically compared to flows as recorded by the Congaree River gage (Appendix A - Figures 13 through 18).

Figures 19 through 24 in Appendix A depict flow releases from Alston with and without the addition of Saluda flow contributions. This demonstrates that some of the spikes in flow downstream at Congaree are attributed to contributions from the Saluda River, and not the Parr Project.

Next Steps

The RCG should review this information and provide their input to move to the next steps.

1. Does it look like there may be a potential impact on downstream fish spawning? If so, please provide reasons for that assumption.

2. Provide any potential RCG requests that may move towards diminishing the flow impact?

Based on RCG input, SCE&G will go to their Operations Group and determine if the suggested changes are feasible. If the RCG can provide timely input, SCE&G may be able to perform a few one-day tests at the Project to see if the operation changes can be implemented and whether they 1) diminish the peak; 2) cause inconsistencies with safety at the plant, or 3) increase the chances of upstream flooding issues.

APPENDIX A

FLOW DATA

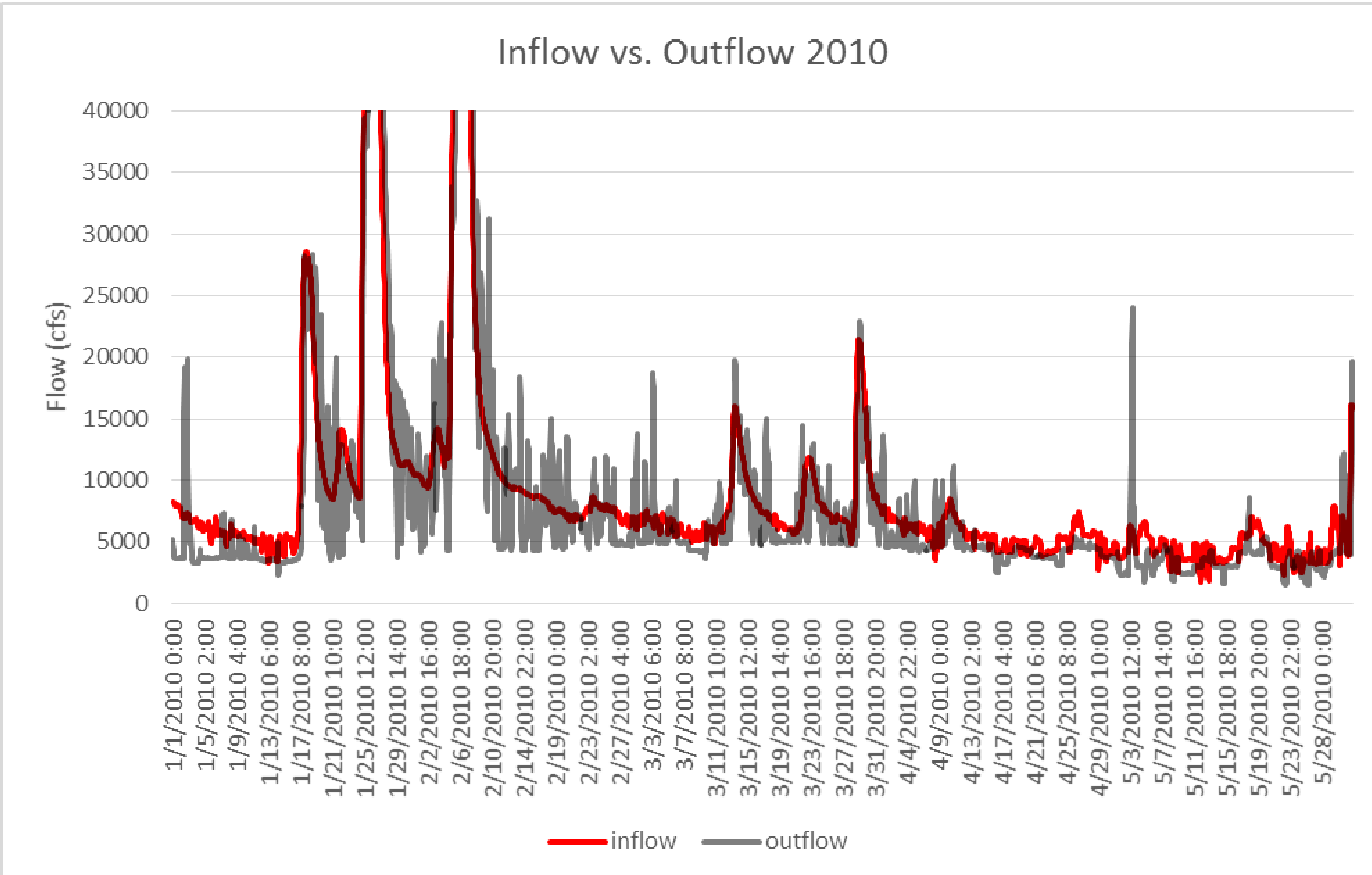

FIGURE 1 2010 PARR PROJECT INFLOW (CARLISLE, ENOREE, TYGER GAGES) VS. OUTFLOW (ALSTON GAGE)

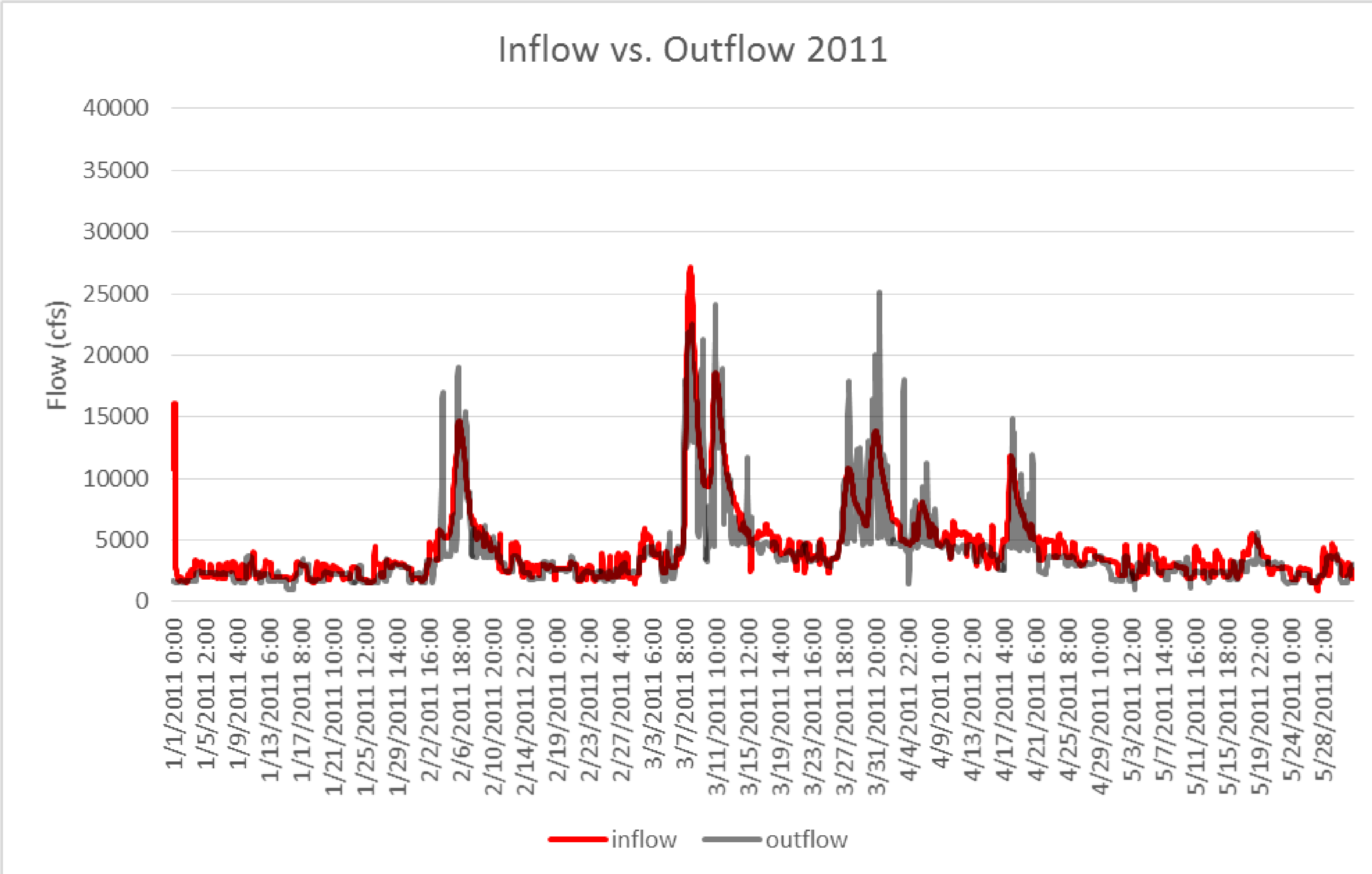

FIGURE 2 2011 PARR PROJECT INFLOW (CARLISLE, ENOREE, TYGER GAGES) VS. OUTFLOW (ALSTON GAGE)

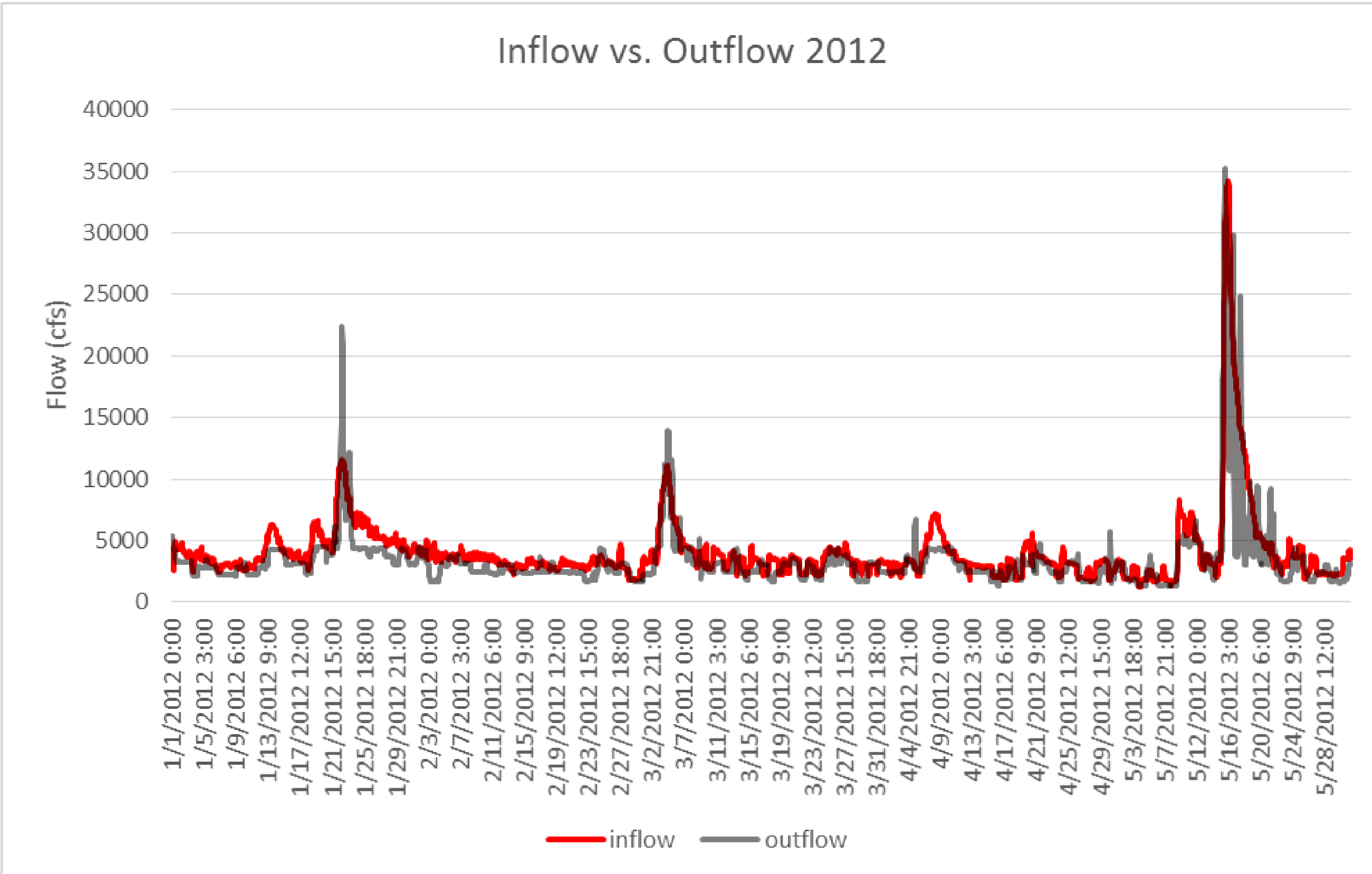

FIGURE 3 2012 PARR PROJECT INFLOW (CARLISLE, ENOREE, TYGER GAGES) VS. OUTFLOW (ALSTON GAGE)

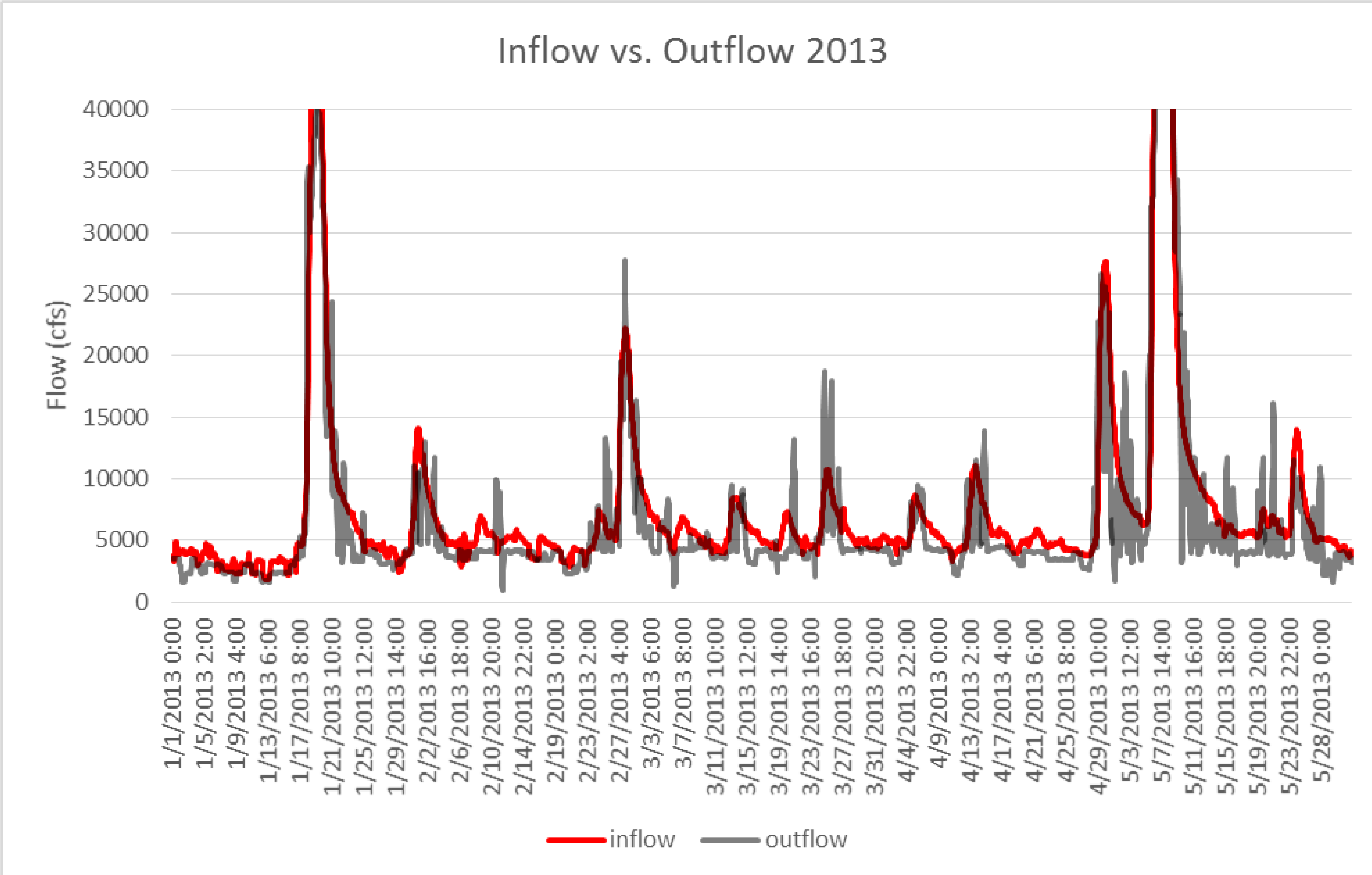

FIGURE 4 2013 PARR PROJECT INFLOW (CARLISLE, ENOREE, TYGER GAGES) VS. OUTFLOW (ALSTON GAGE)

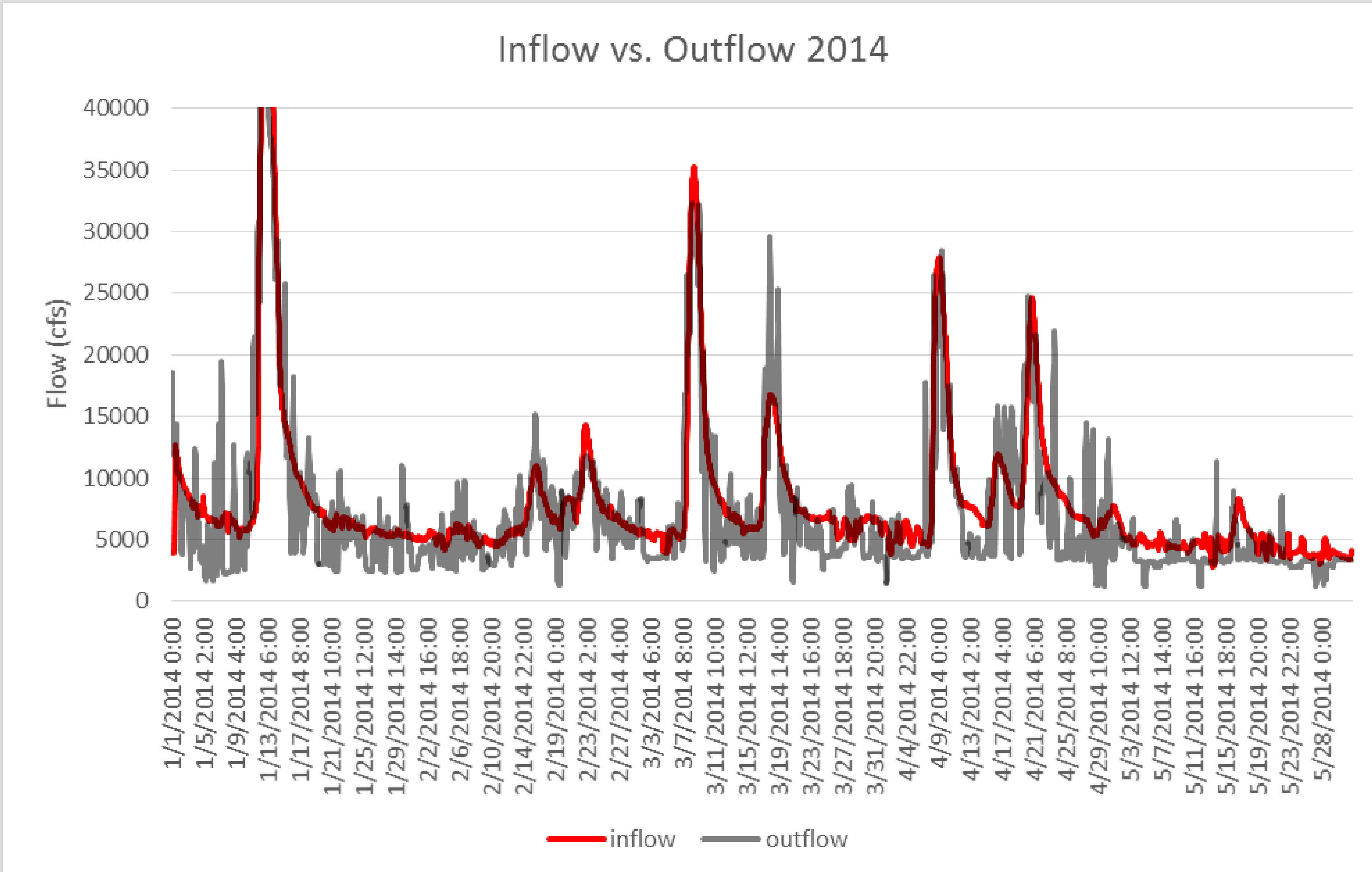

FIGURE 5 **2014 PARR PROJECT INFLOW (CARLISLE, ENOREE, TYGER GAGES) VS. OUTFLOW (ALSTON GAGE)**

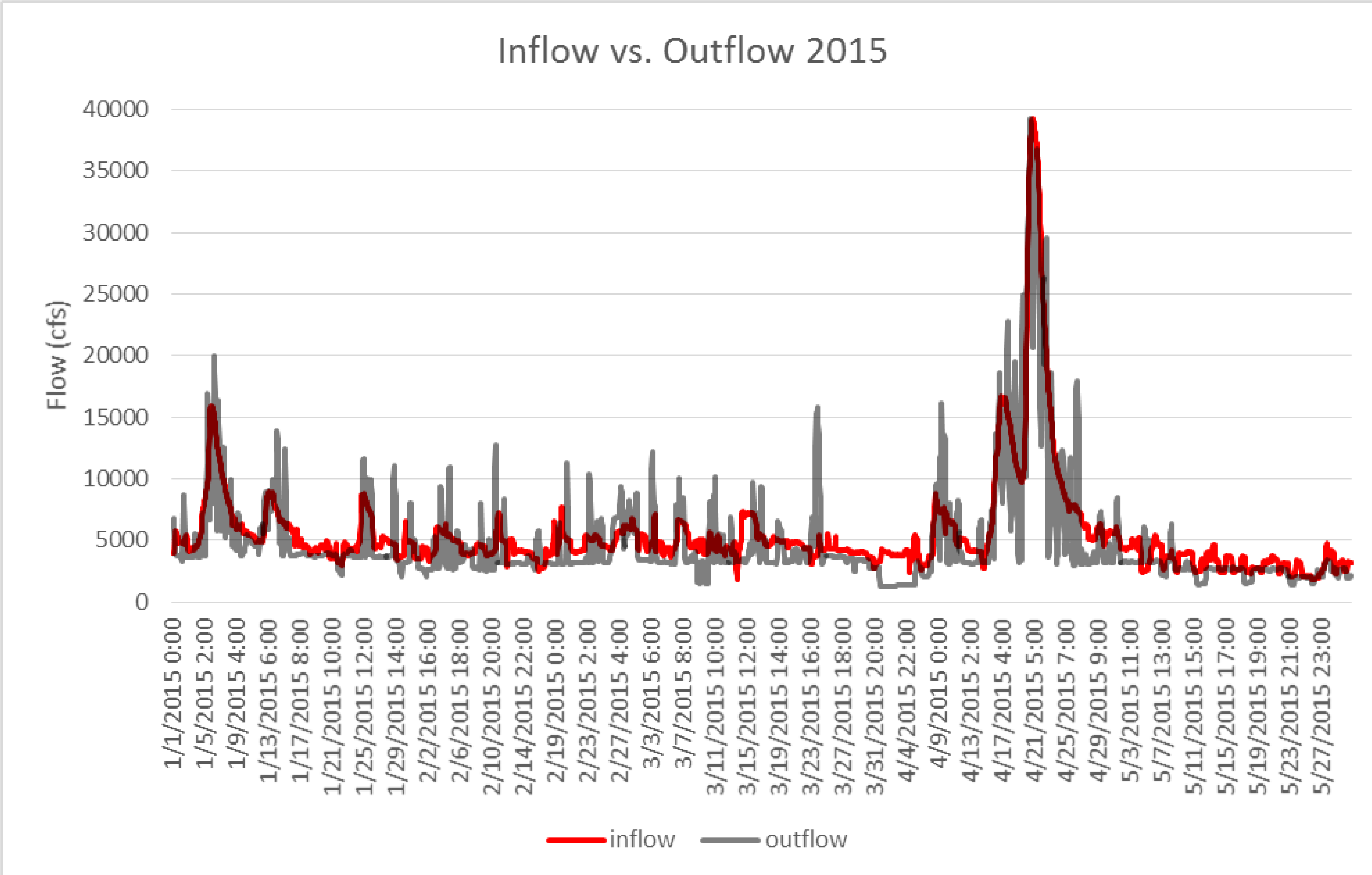

FIGURE 6 2015 PARR PROJECT INFLOW (CARLISLE, ENOREE, TYGER GAGES) VS. OUTFLOW (ALSTON GAGE)

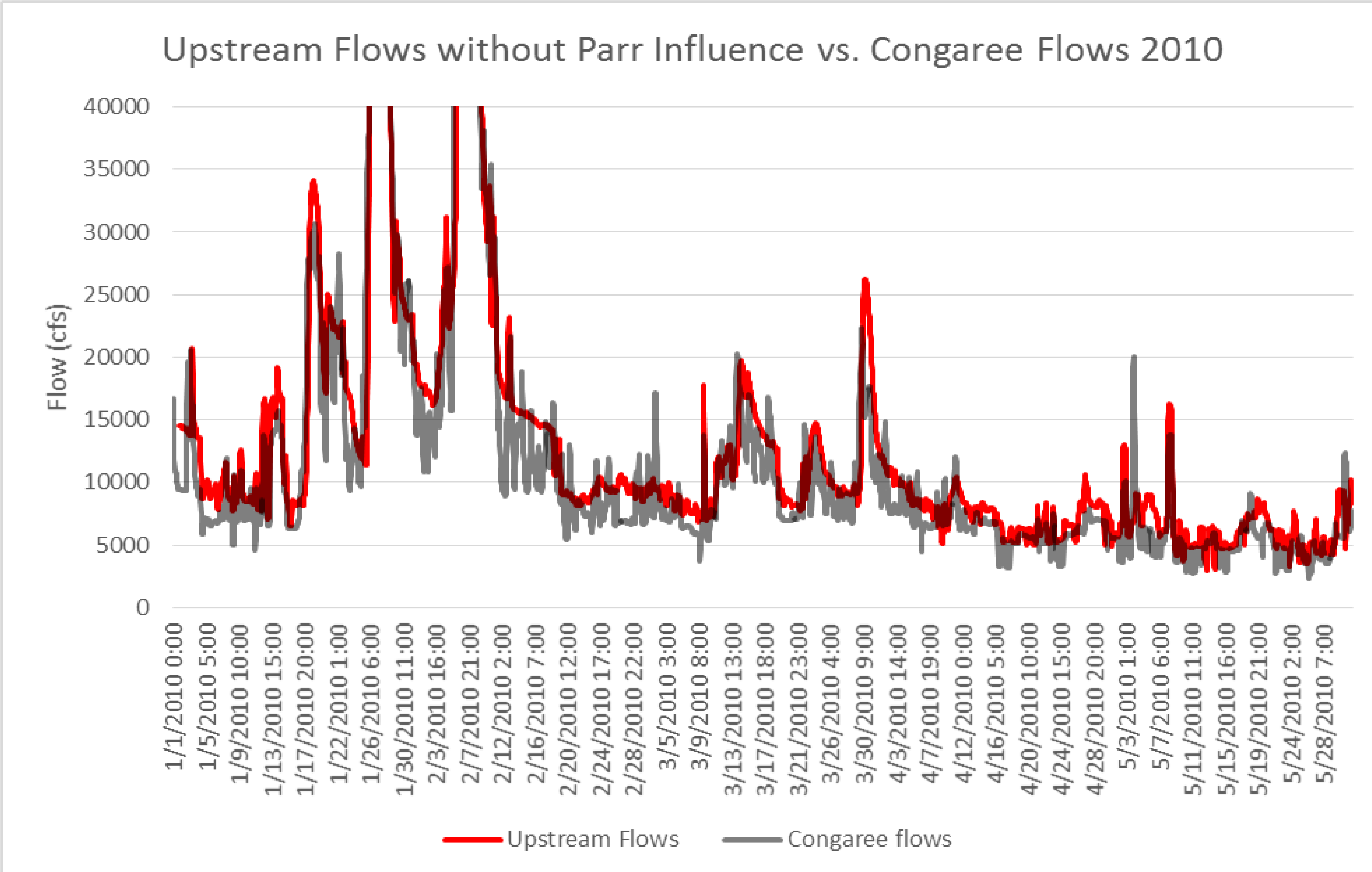

FIGURE 7 **2010 UPSTREAM FLOWS (CARLISLE, ENOREE, TYGER, SALUDA GAGES) VS. CONGAREE FLOWS (CONGAREE RIVER GAGE)**

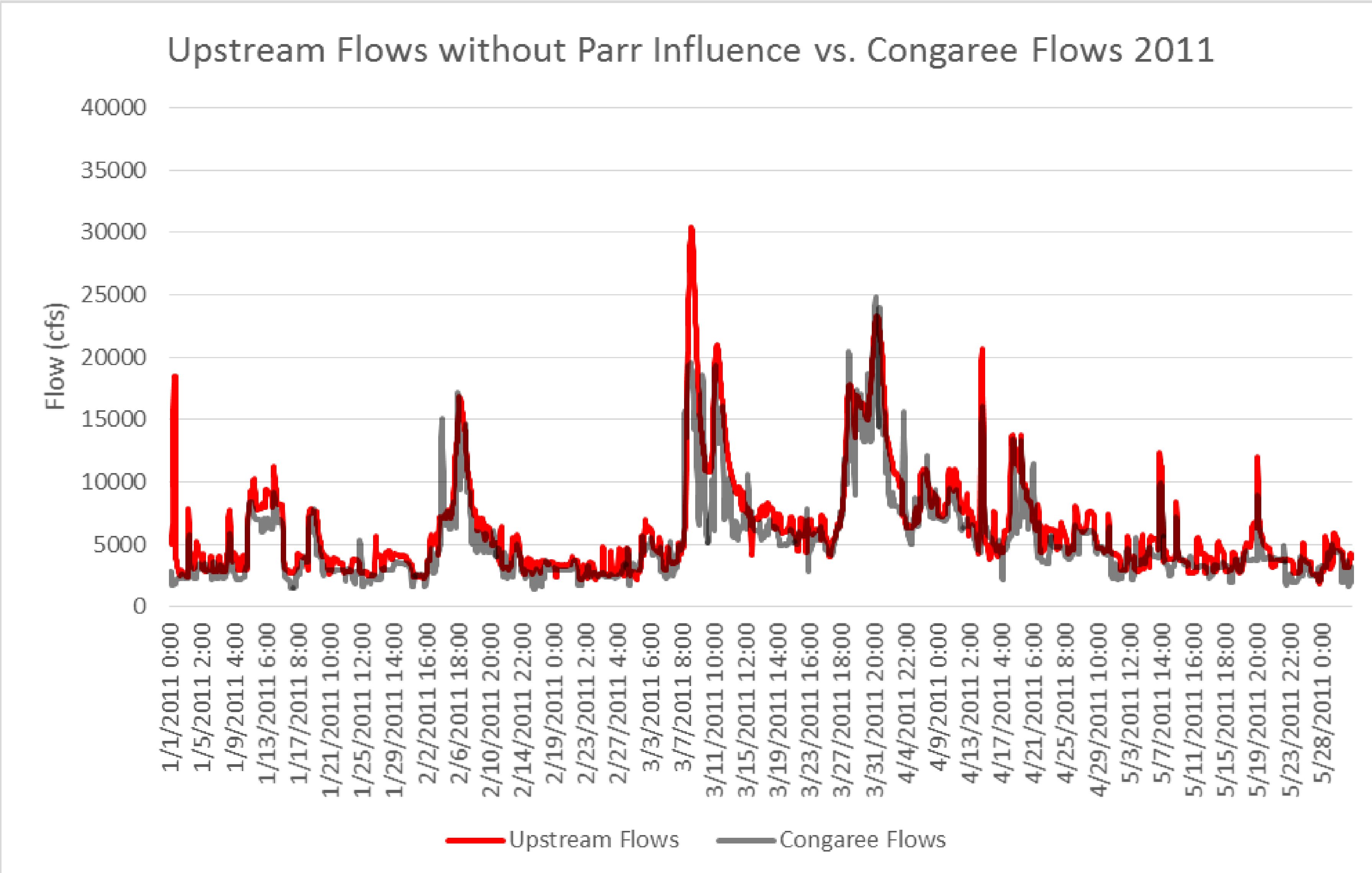

FIGURE 8 **2011 UPSTREAM FLOWS (CARLISLE, ENOREE, TYGER, SALUDA GAGES) VS. CONGAREE FLOWS (CONGAREE RIVER GAGE)**

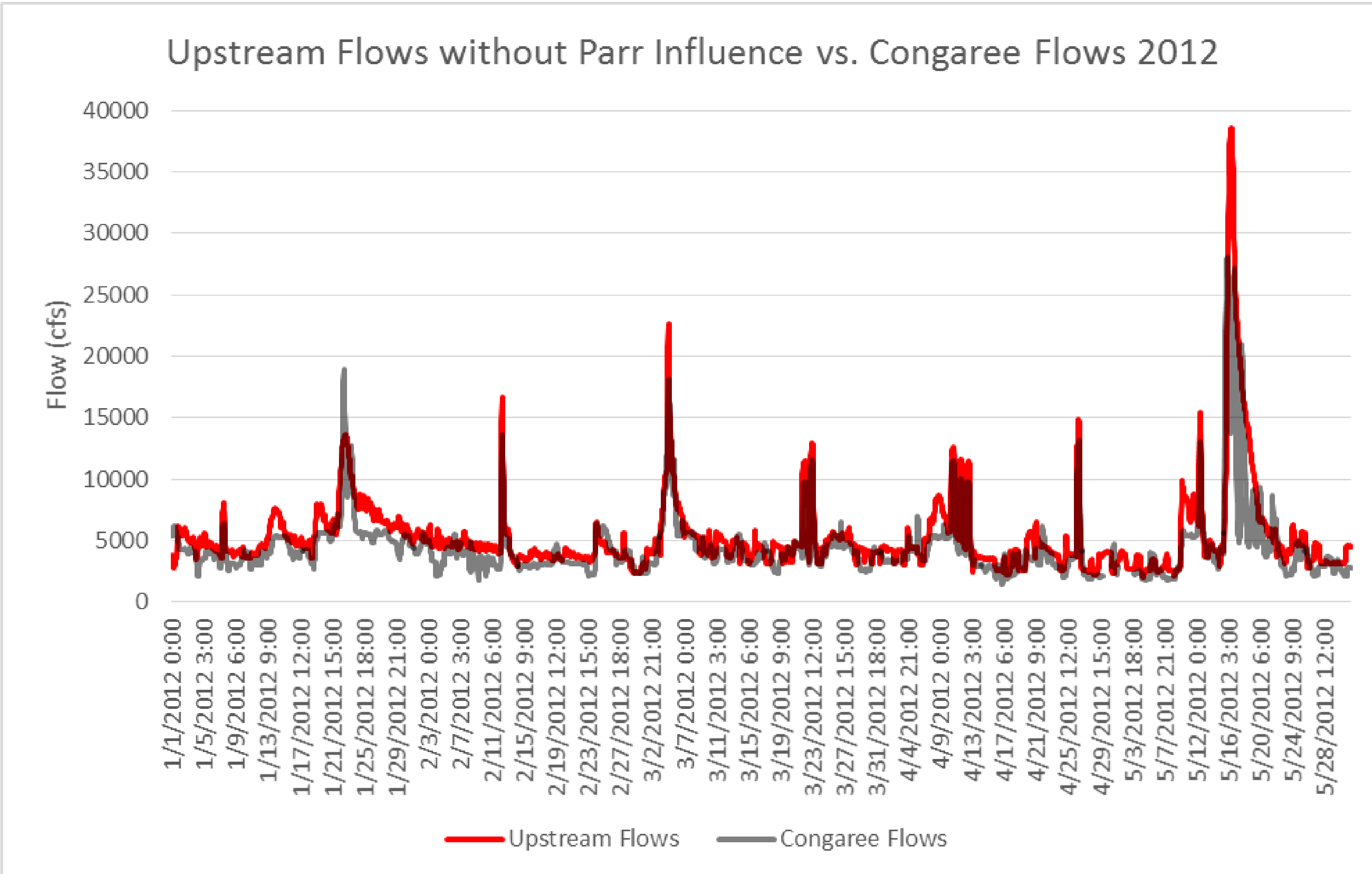

FIGURE 9 2012 UPSTREAM FLOWS (CARLISLE, ENOREE, TYGER, SALUDA GAGES) VS. CONGAREE FLOWS (CONGAREE RIVER GAGE)

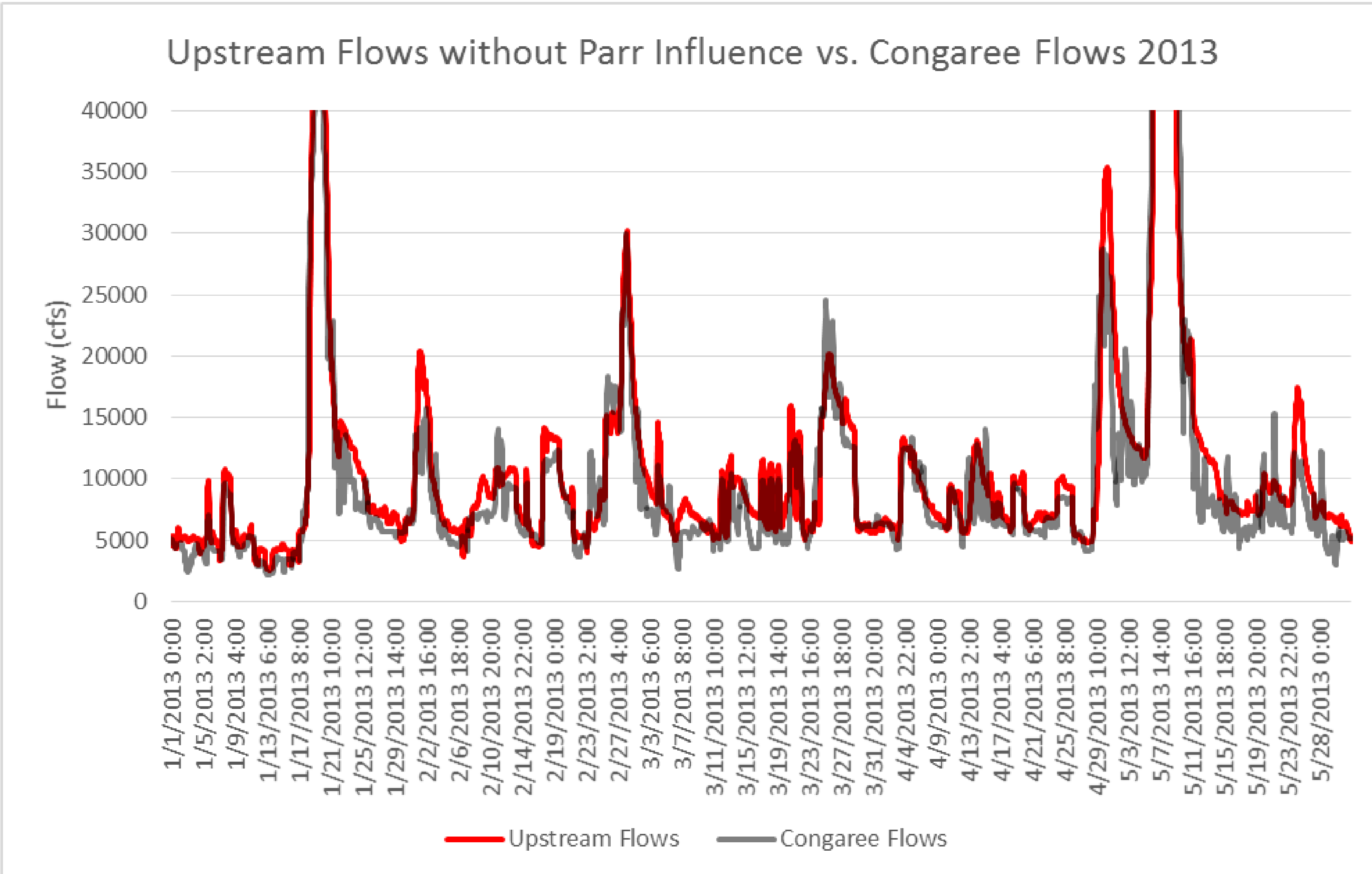

FIGURE 10 2013 UPSTREAM FLOWS (CARLISLE, ENOREE, TYGER, SALUDA GAGES) VS. CONGAREE FLOWS (CONGAREE RIVER GAGE)

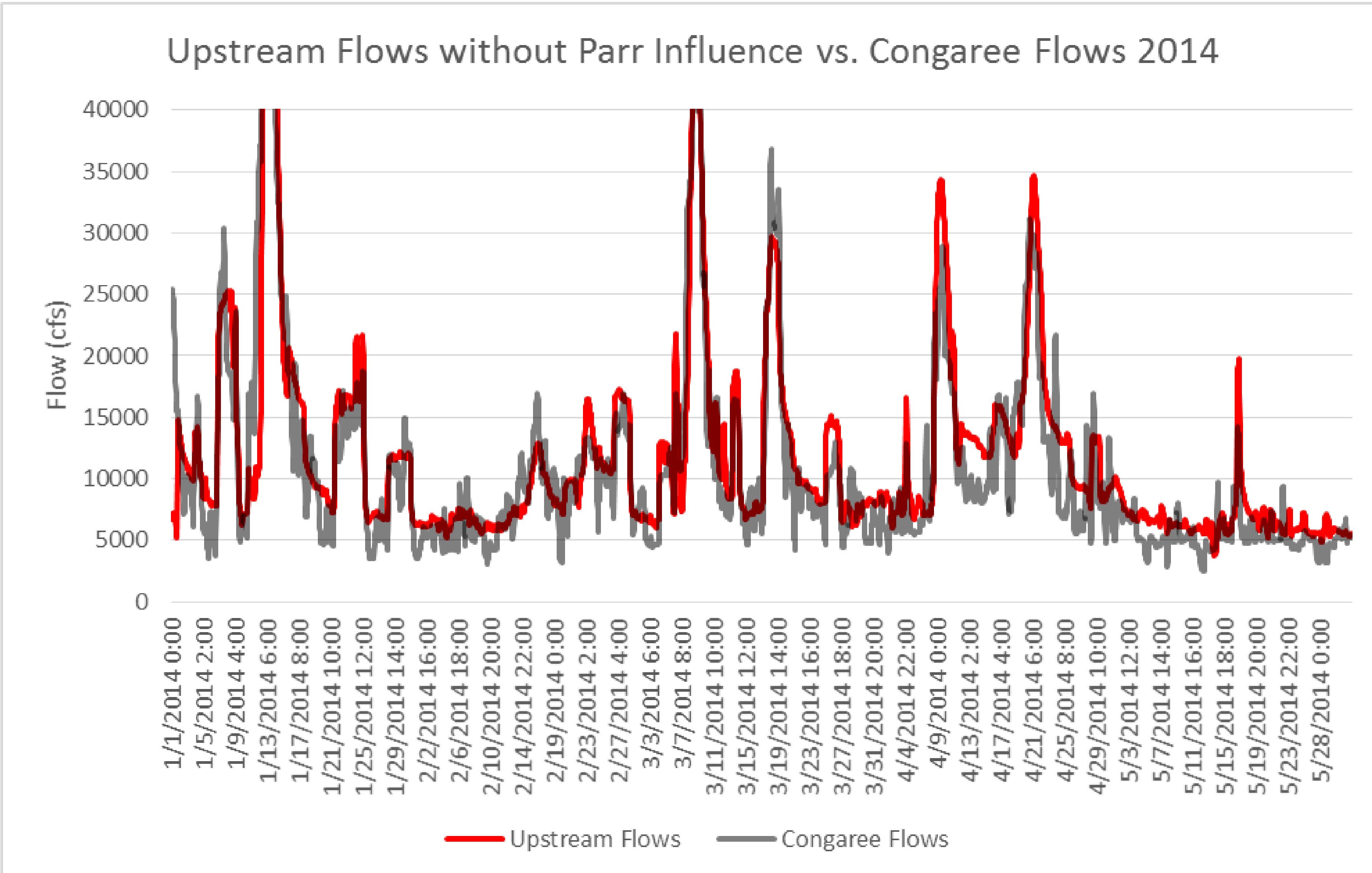

FIGURE 11 **2014 UPSTREAM FLOWS (CARLISLE, ENOREE, TYGER, SALUDA GAGES) VS. CONGAREE FLOWS (CONGAREE RIVER GAGE)**

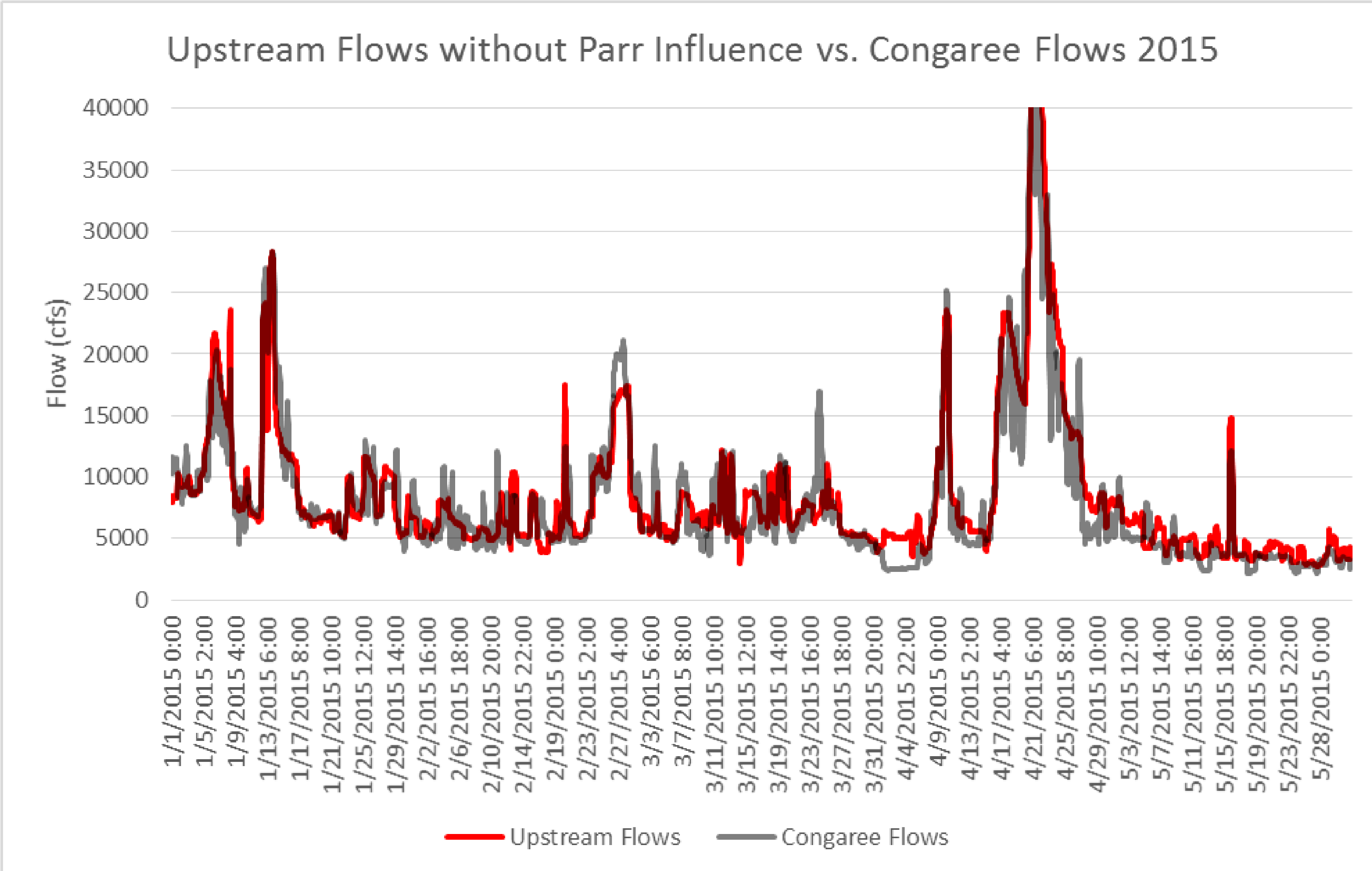

FIGURE 12 **2015 UPSTREAM FLOWS (CARLISLE, ENOREE, TYGER, SALUDA GAGES) VS. CONGAREE FLOWS (CONGAREE RIVER GAGE)**

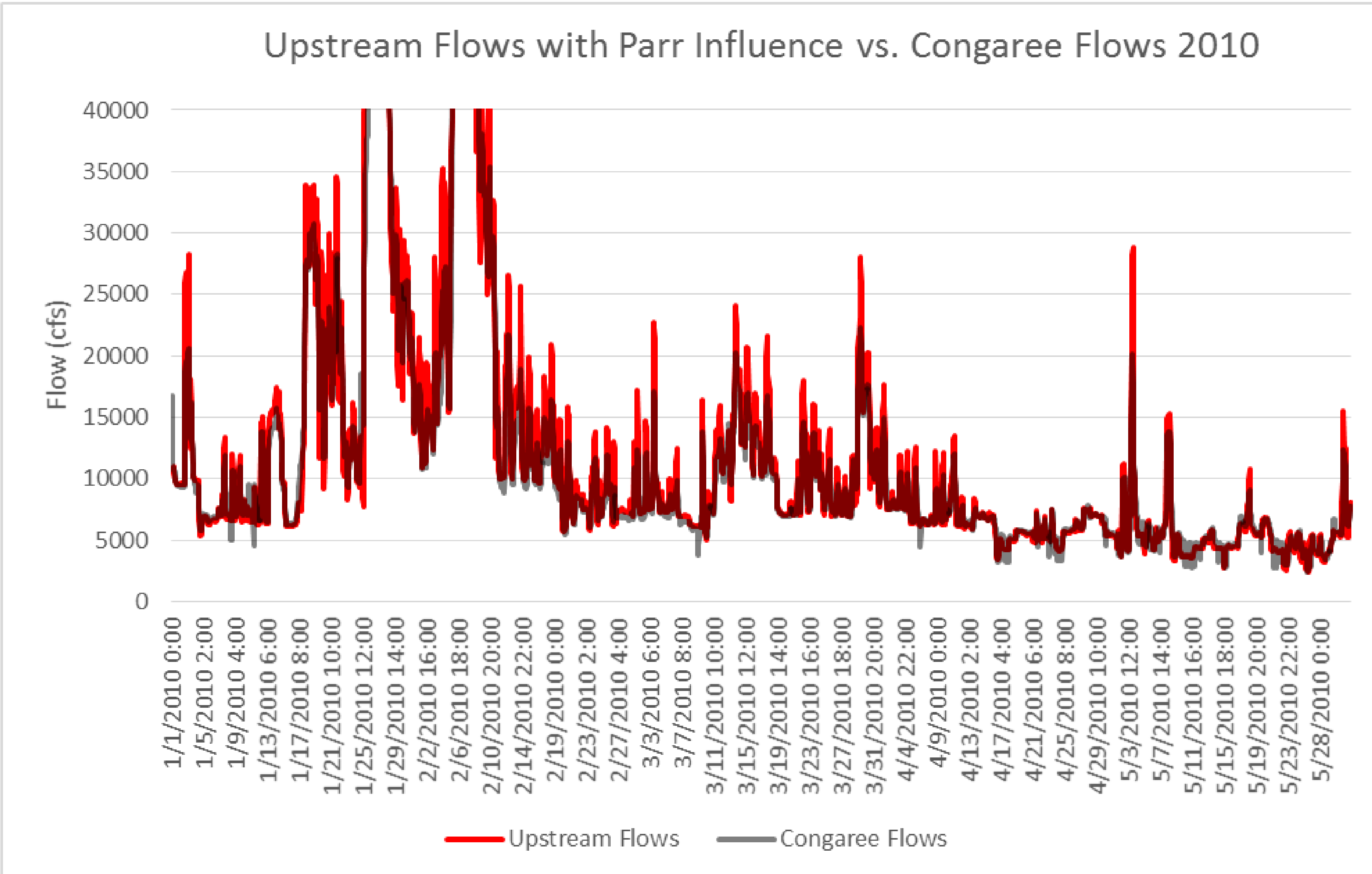

FIGURE 13 2010 UPSTREAM FLOWS (ALSTON AND SALUDA GAGE) VS. CONGAREE FLOWS (CONGAREE RIVER GAGE)

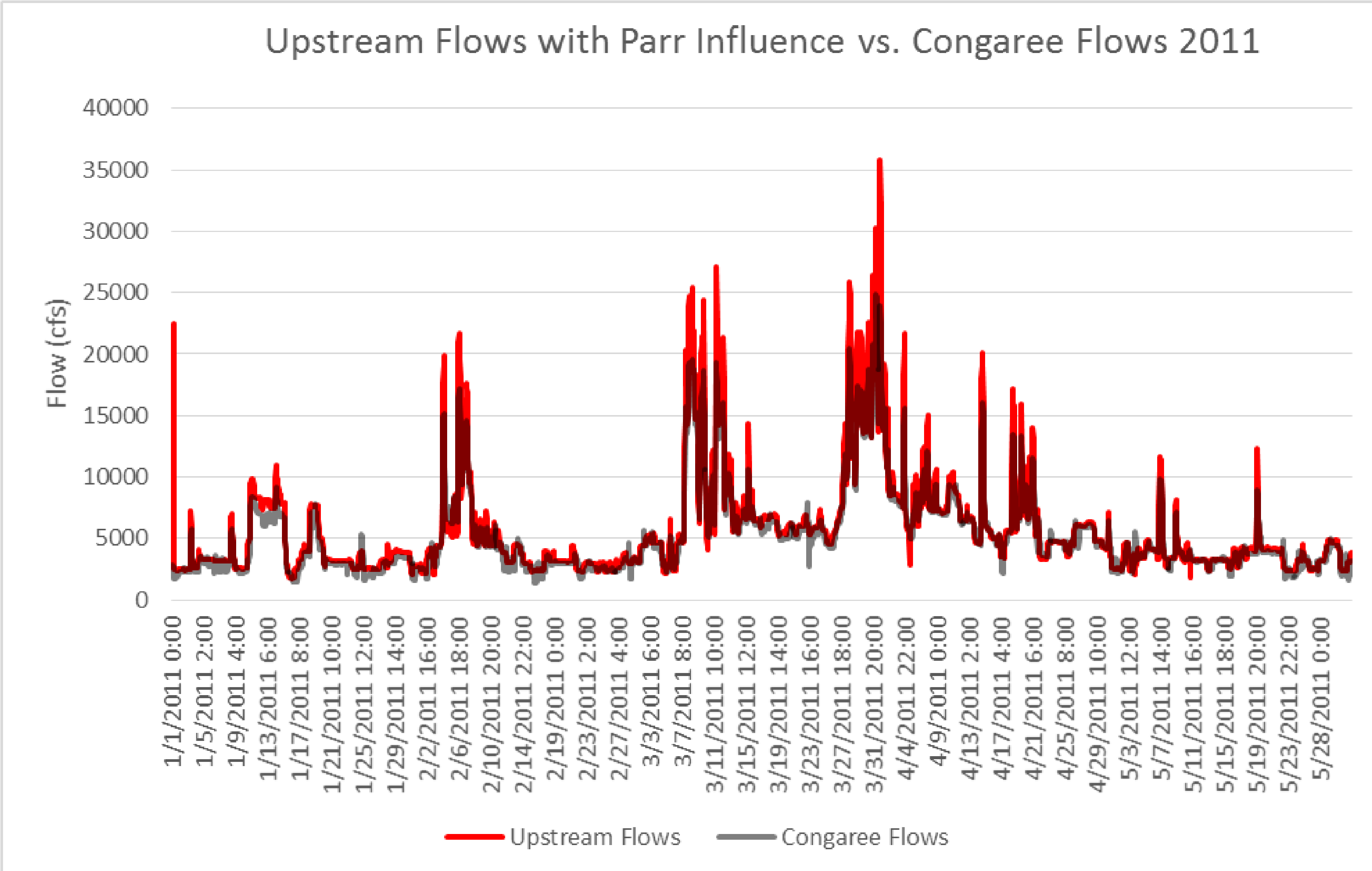

FIGURE 14 2011 UPSTREAM FLOWS (ALSTON AND SALUDA GAGE) VS. CONGAREE FLOWS (CONGAREE RIVER GAGE)

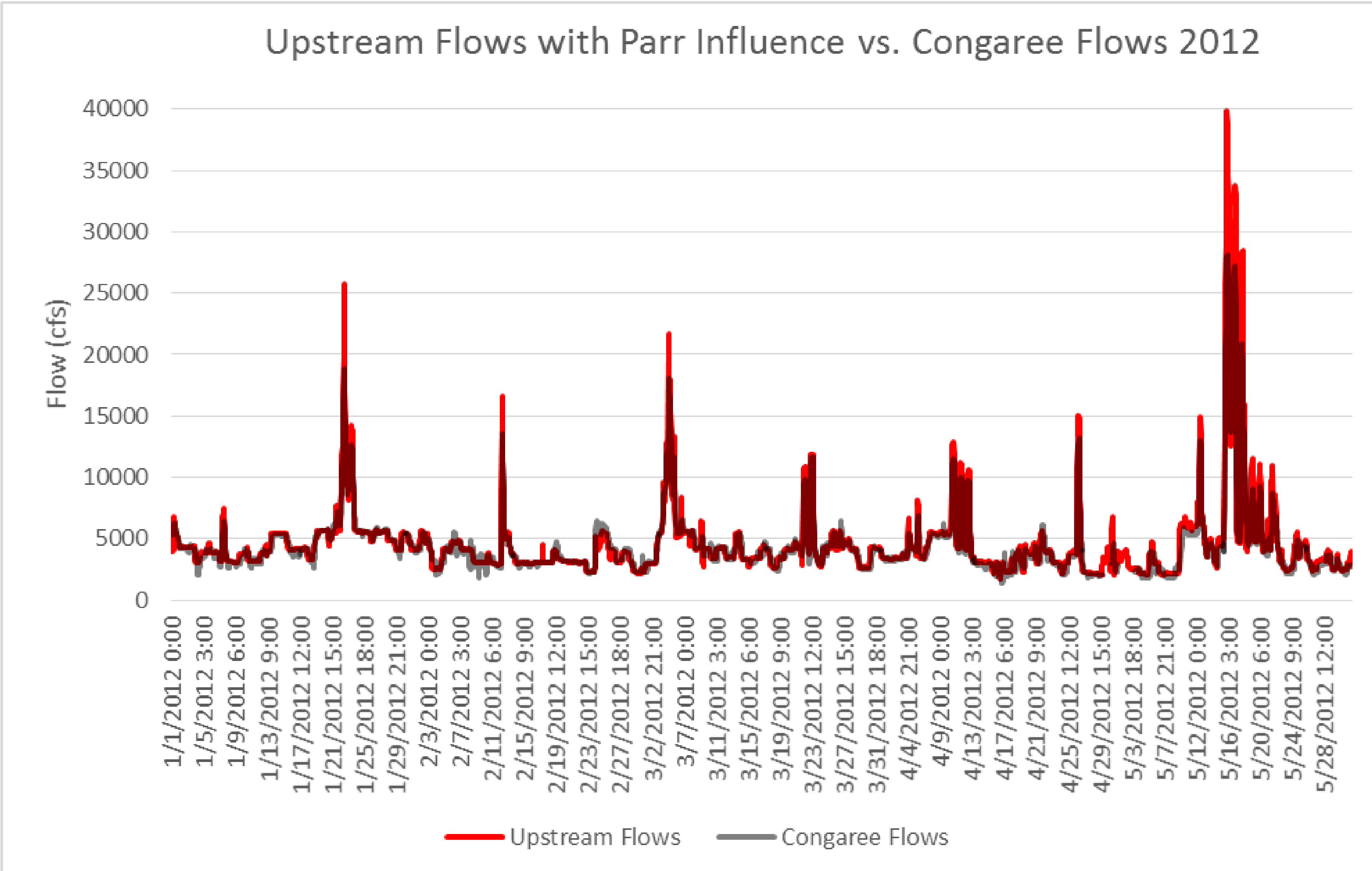

FIGURE 15 **2012 UPSTREAM FLOWS (ALSTON AND SALUDA GAGE) VS. CONGAREE FLOWS (CONGAREE RIVER GAGE)**

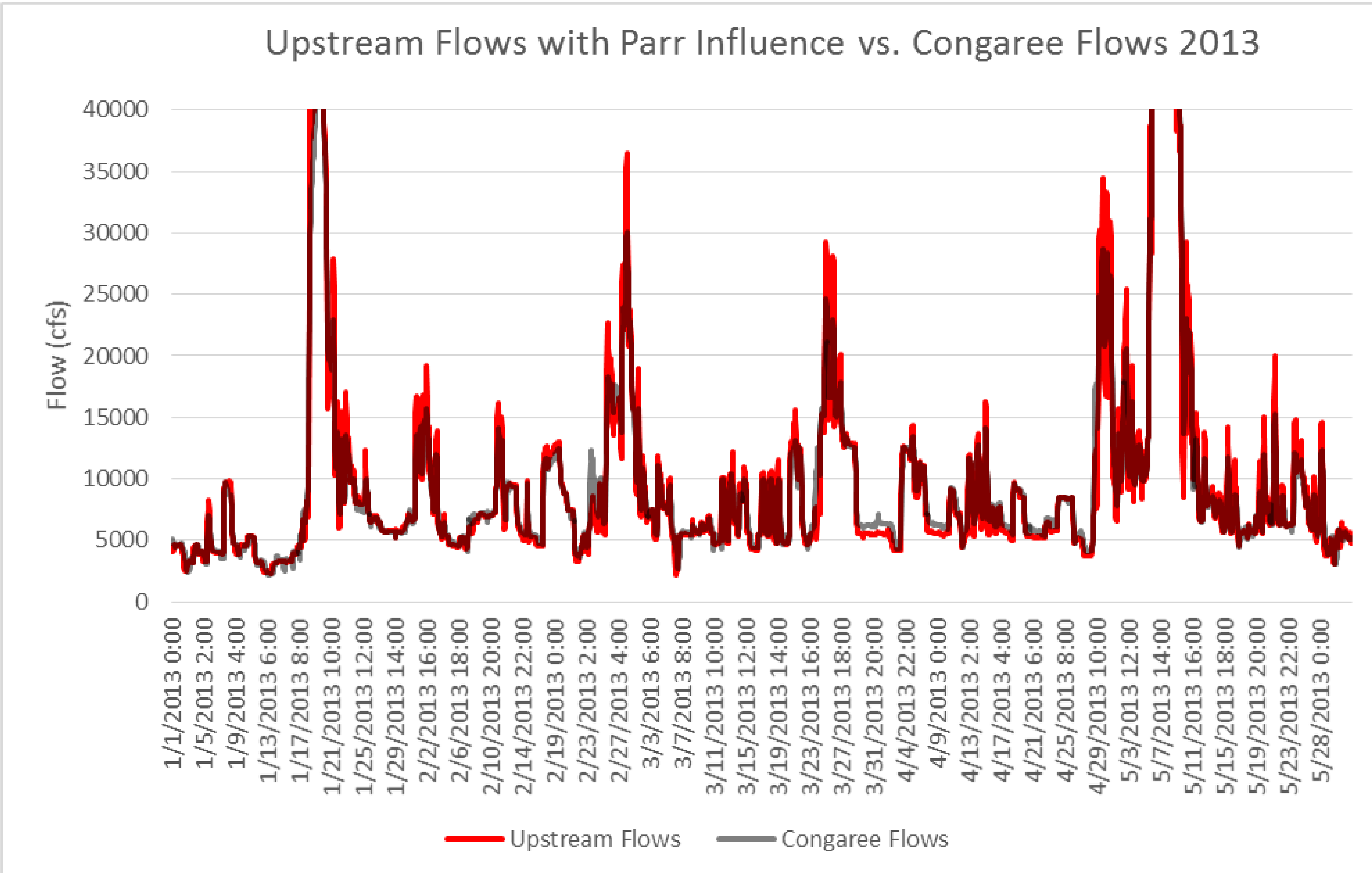

FIGURE 16 **2013 UPSTREAM FLOWS (ALSTON AND SALUDA GAGE) VS. CONGAREE FLOWS (CONGAREE RIVER GAGE)**

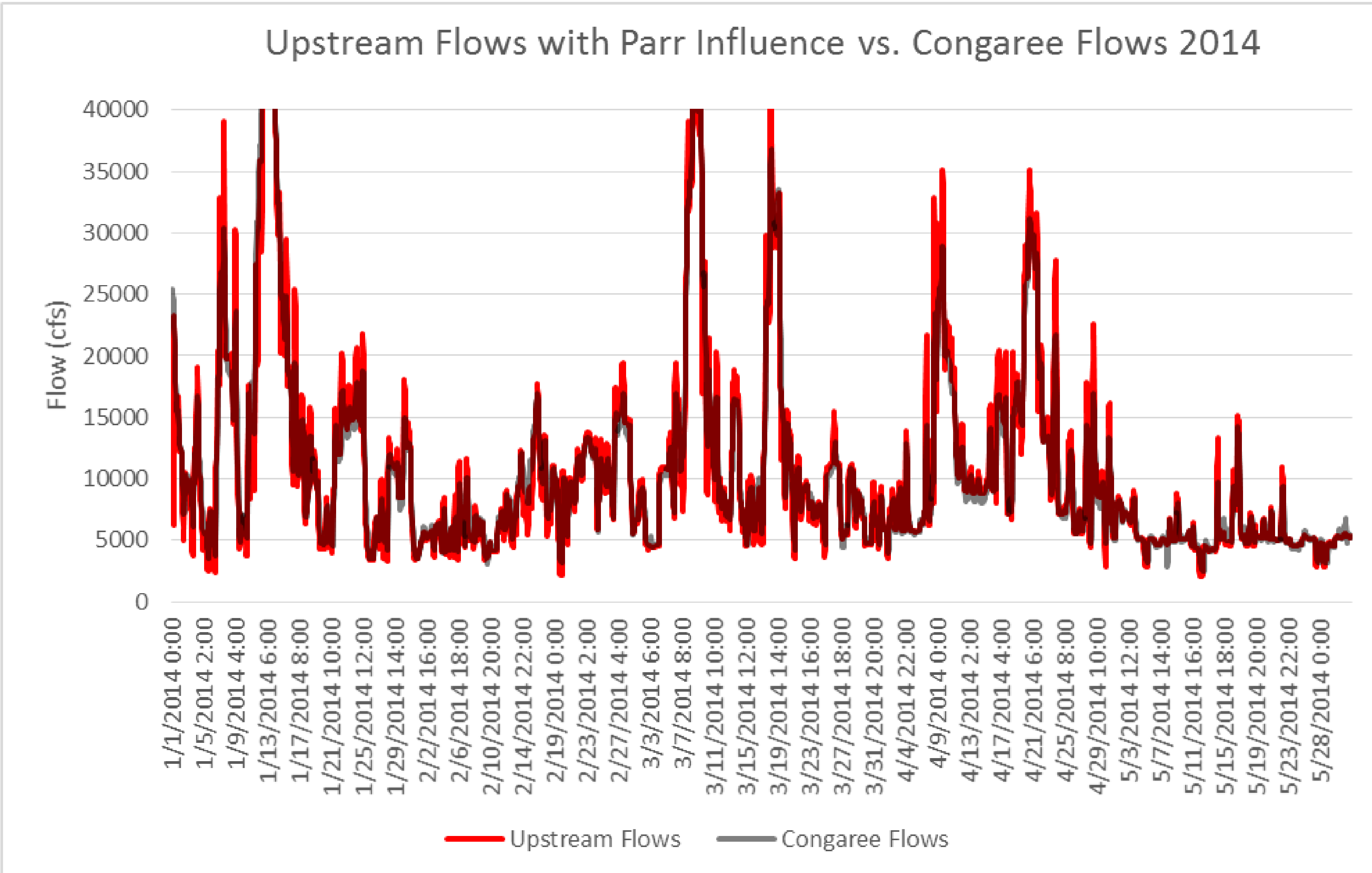

FIGURE 17 **2014 UPSTREAM FLOWS (ALSTON AND SALUDA GAGE) VS. CONGAREE FLOWS (CONGAREE RIVER GAGE)**

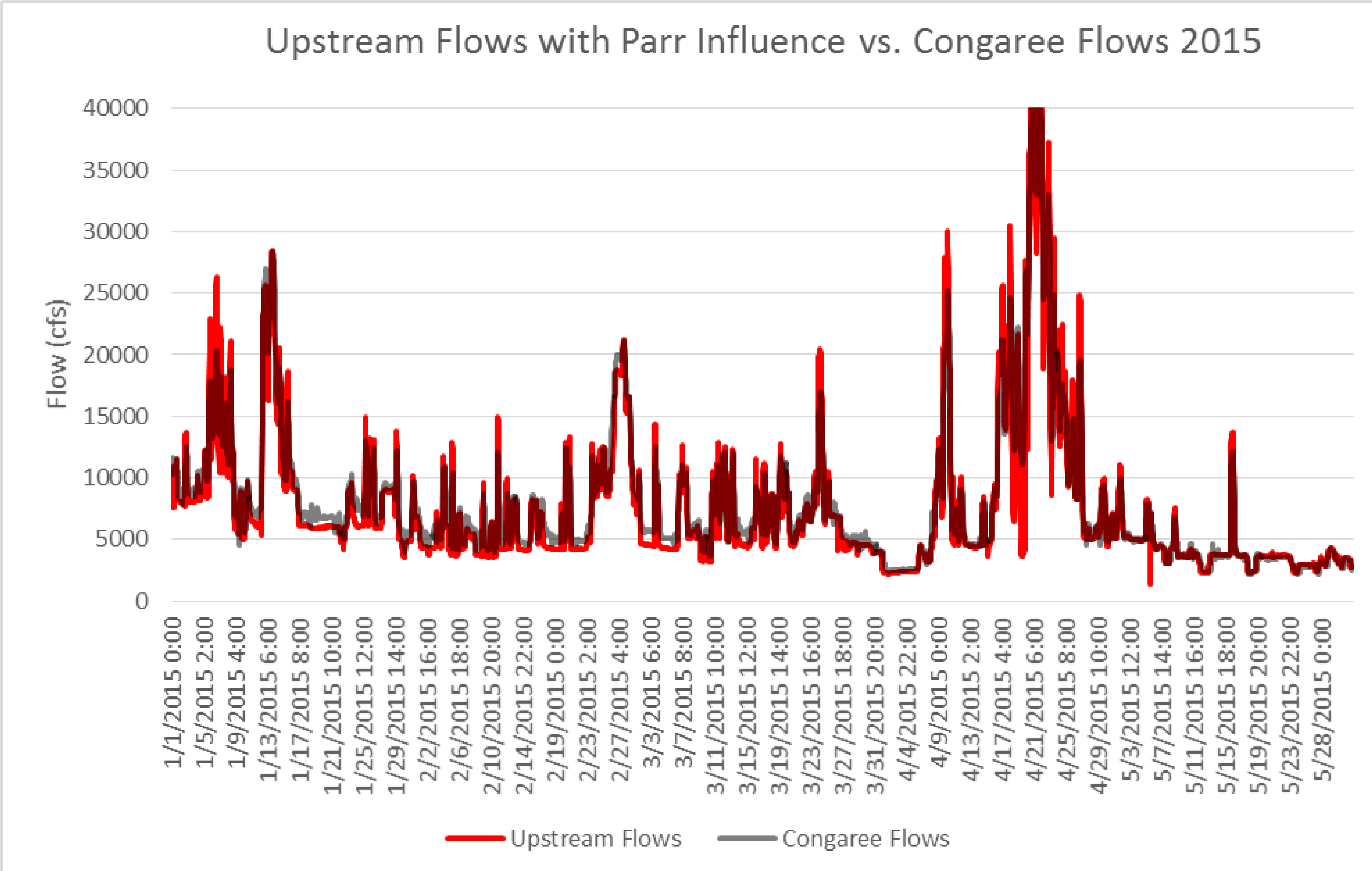

FIGURE 18 **2015 UPSTREAM FLOWS (ALSTON AND SALUDA GAGE) VS. CONGAREE FLOWS (CONGAREE RIVER GAGE)**

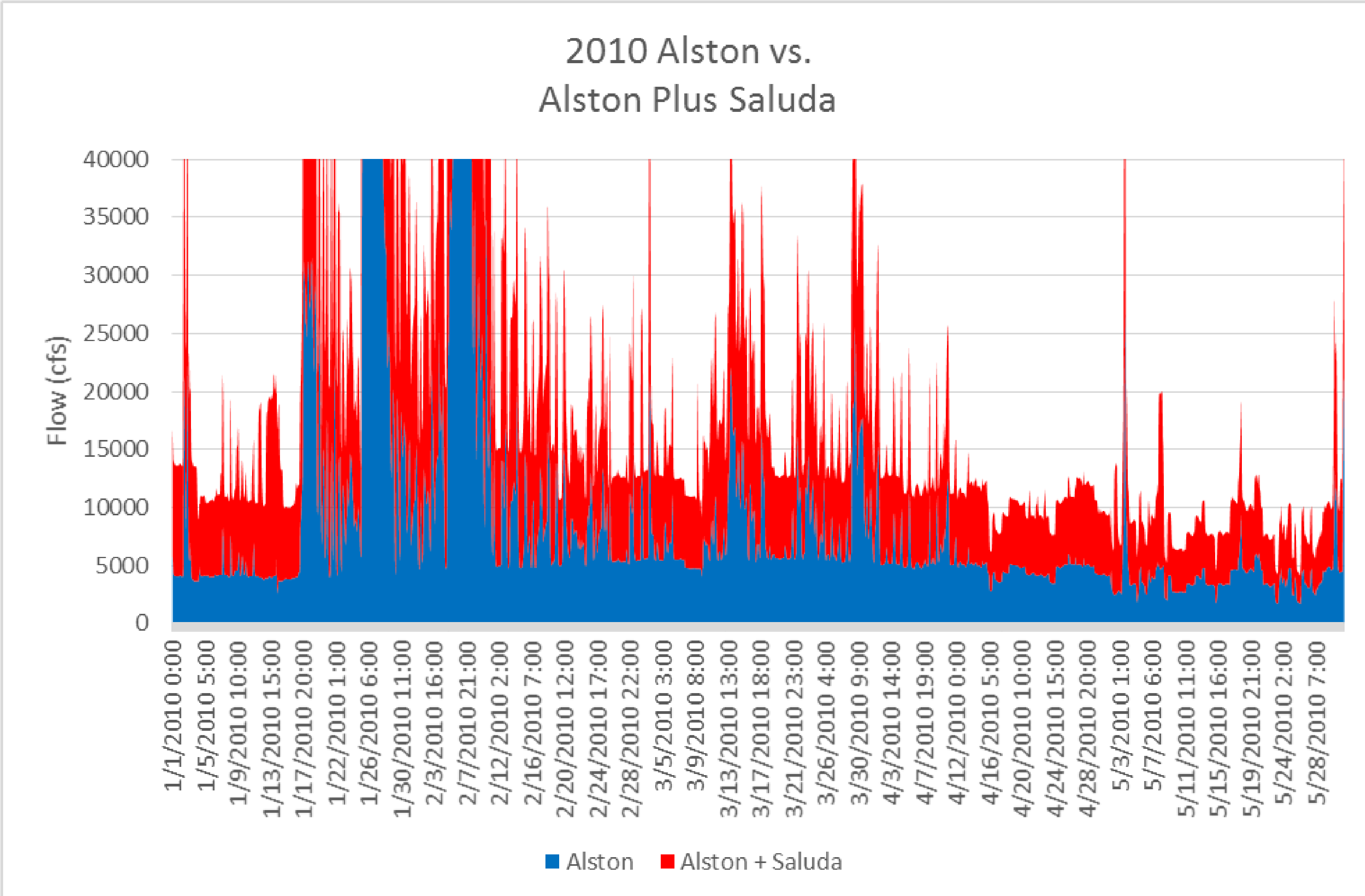

FIGURE 19 2010 ALSTON FLOWS VS. ALSTON AND SALUDA COMBINED FLOWS

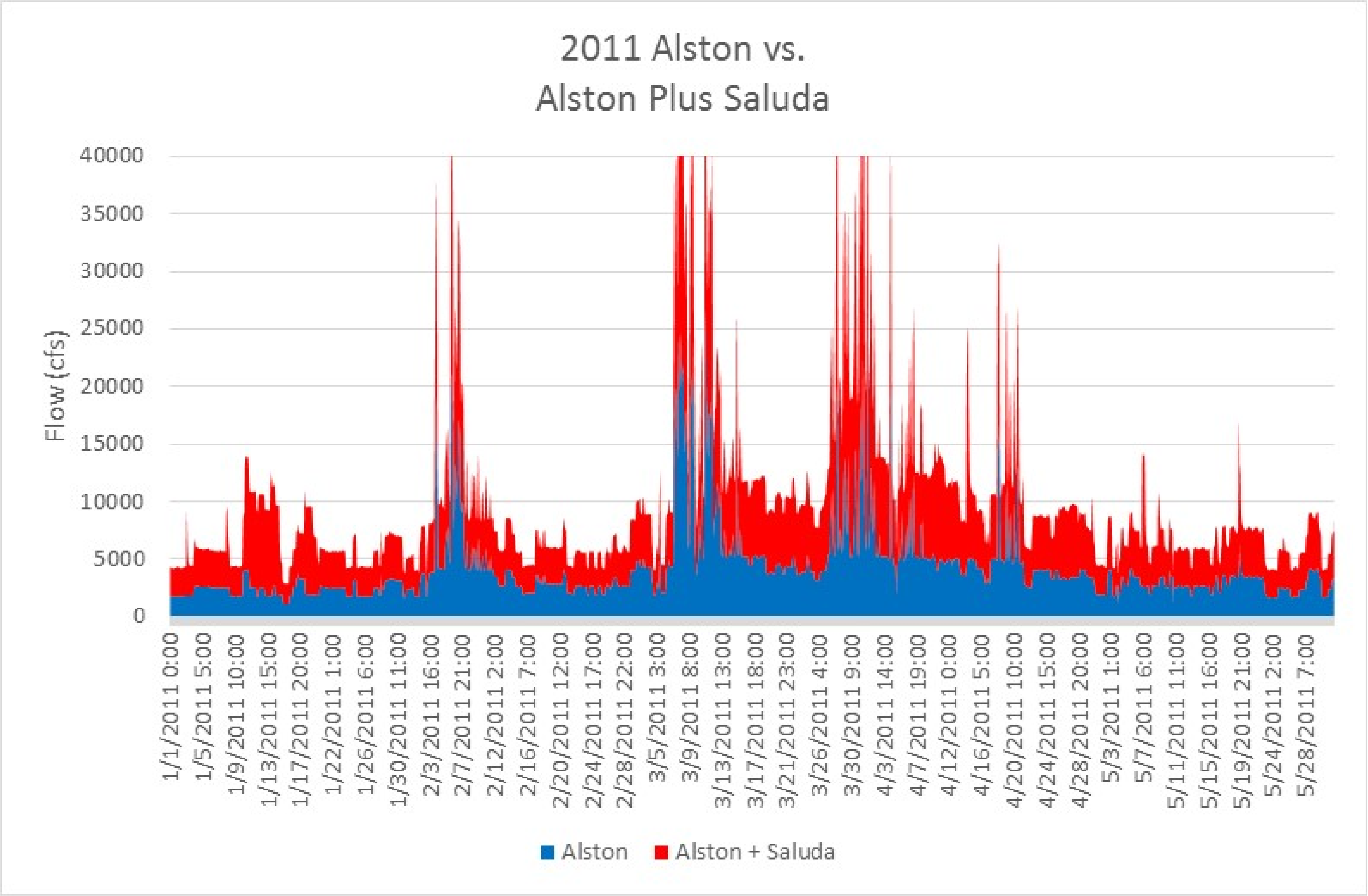

FIGURE 20 2011 ALSTON FLOWS VS. ALSTON AND SALUDA COMBINED FLOWS

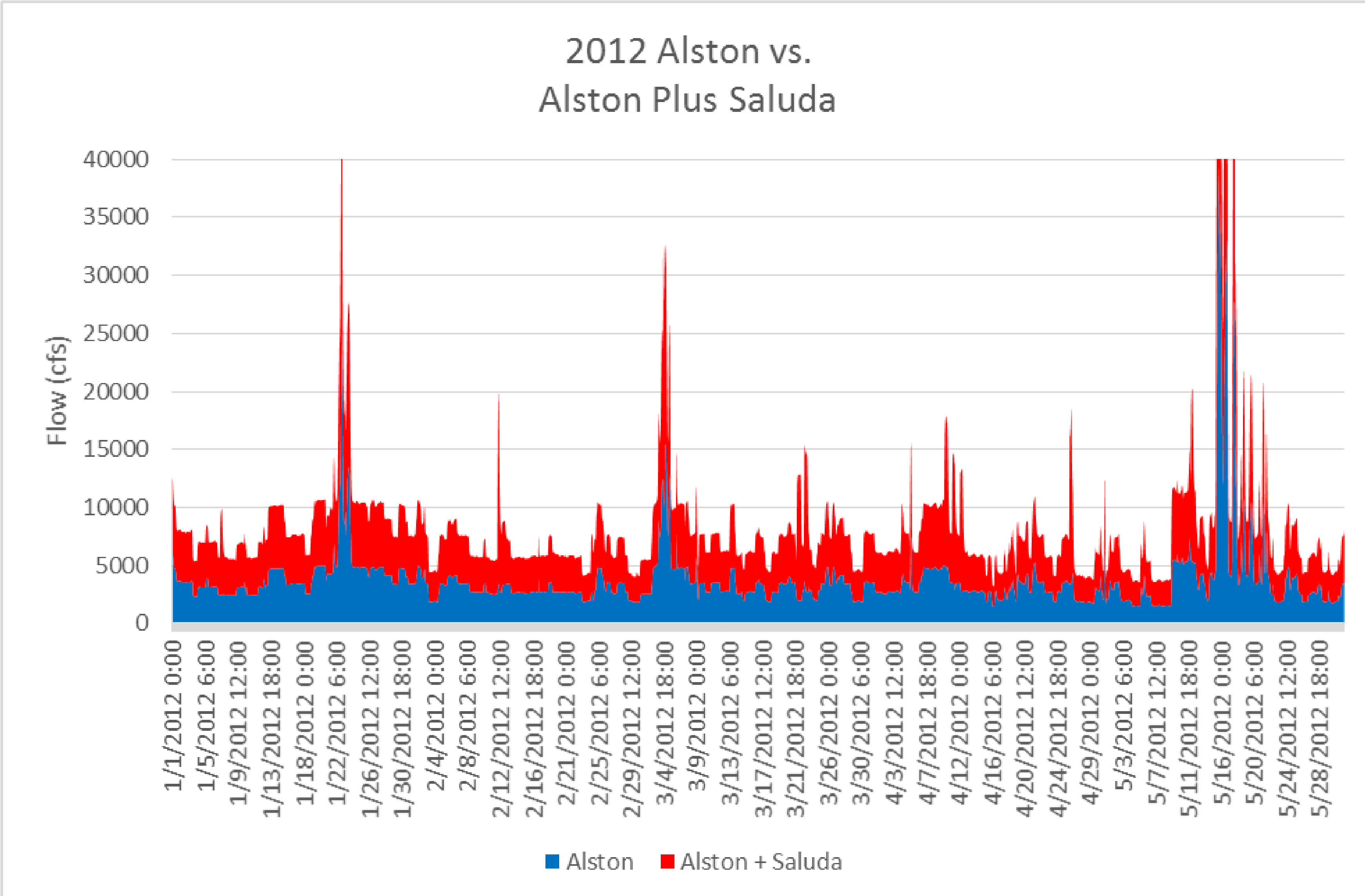

FIGURE 21 **2012 ALSTON FLOWS VS. ALSTON AND SALUDA COMBINED FLOWS**

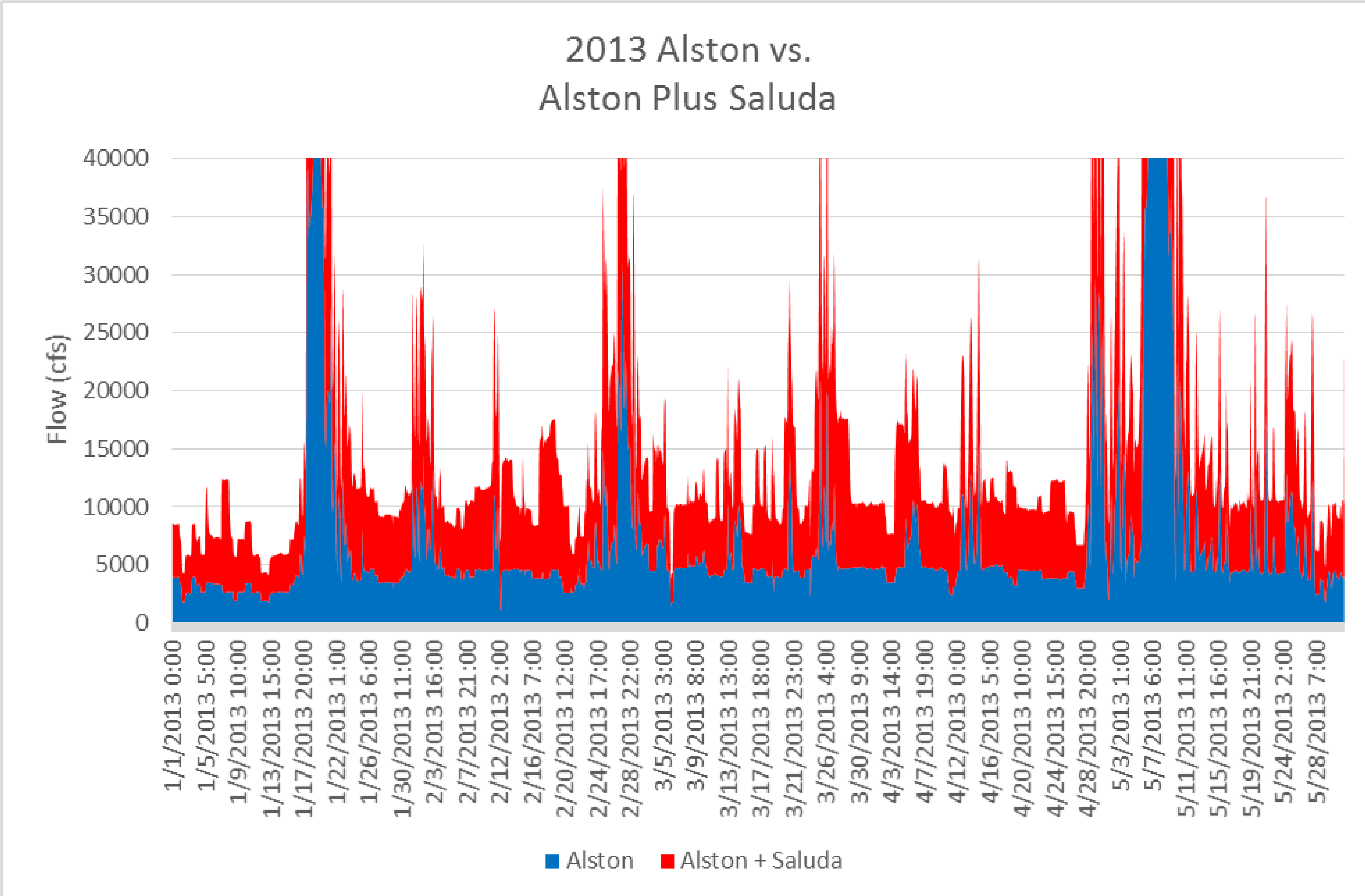

FIGURE 22 2013 ALSTON FLOWS VS. ALSTON AND SALUDA COMBINED FLOWS

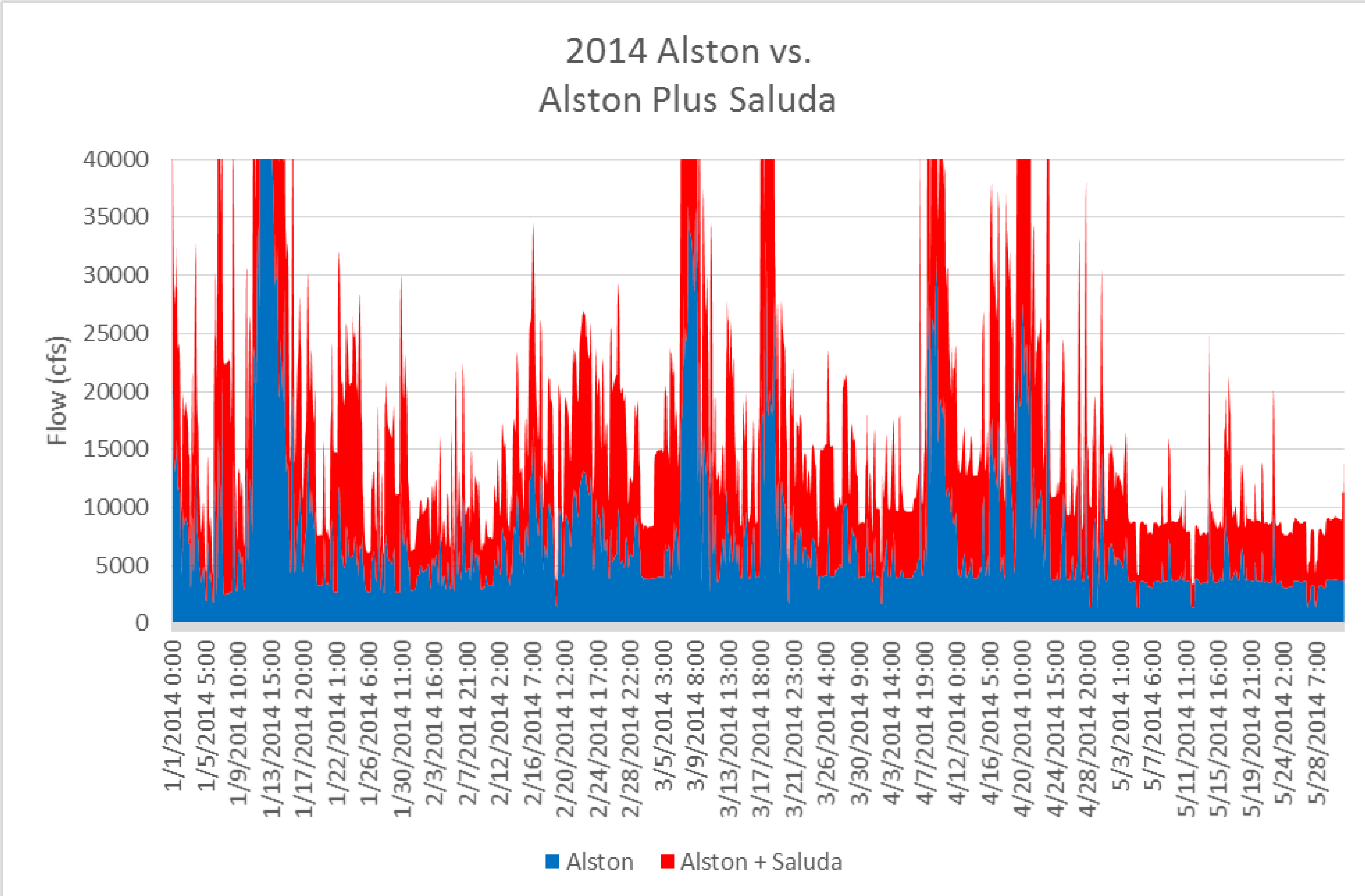

FIGURE 23 **2014 ALSTON FLOWS VS. ALSTON AND SALUDA COMBINED FLOWS**

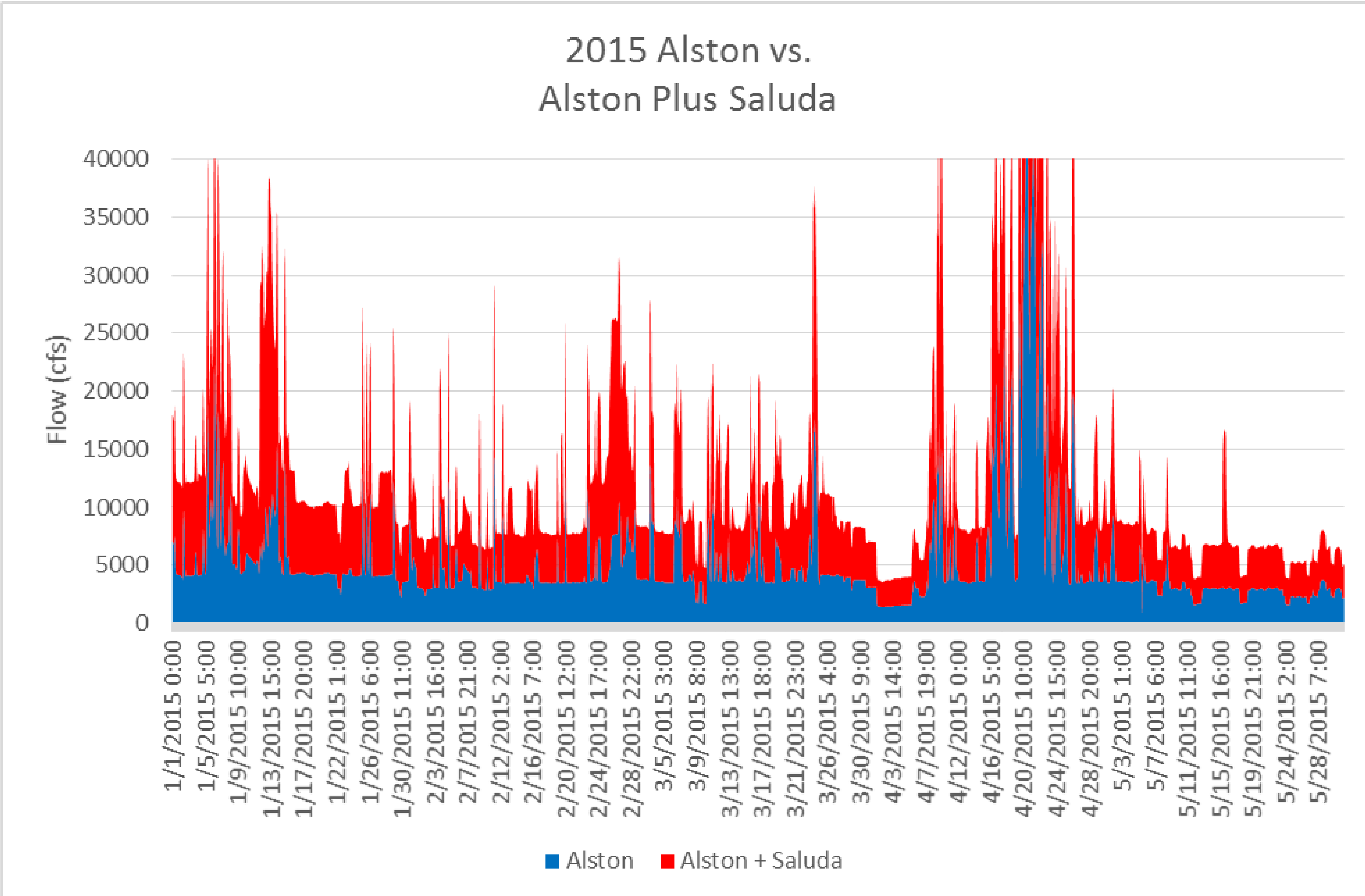

FIGURE 24 2015 ALSTON FLOWS VS. ALSTON AND SALUDA COMBINED FLOWS