SOUTH CAROLINA ELECTRIC & GAS COMPANY

SALUDA RIVER, LEXINGTON, NEWBERRY,
RICHLAND AND SALUDA COUNTIES
SOUTH CAROLINA

SALUDA HYDRO PROJECT

DRAFT REPORT ON INSTREAM FLOW STUDIES

FERC NO. 516

MARCH 2008

Prepared by:

Kleinschmidt
Energy & Water Resource Consultants

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1.0 INTRODUCTION

The Saluda Hydro Project (Project) is a Federal Energy Regulatory Commission licensed (FERC No. 516), 202.6 megawatt (MW)[1] hydroelectric facility owned and operated by South Carolina Electric & Gas (SCE&G) and located on the Saluda River in Lexington, Newberry, Richland, and Saluda counties of South Carolina (Figure 1). The project consists of Lake Murray, the Saluda Dam, the new back-up Saluda Berm, spillway, powerhouse, intakes, and penstocks.

The Project license is due to expire in the year 2010. During the relicensing process, SCE&G formed a Technical Working Committee (TWC) that included the United States Fish and Wildlife Service (USFWS), South Carolina Department of Natural Resources (SCDNR), National Marine Fisheries Service (NMFS), National Park Service, and several Non-governmental Organizations (NGO's) (American Rivers and Trout Unlimited) to assess study needs and issues. The TWC subsequently requested studies to determine the potential impact of Project operation on fishery resources and aquatic habitat, including an Instream Flow Incremental Methodology (IFIM) Study for the lower Saluda River (LSR) downstream of the Project.

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

[1] Three of the four original generators are rated at 32.5 MW and the fourth (Unit 3) has been rewound to a rating of 42.3 MW. The original four turbines are each rated at 55,000 HP at 180 feet of head. The generator for Unit 5 is rated at 67.5 MW, and the turbine is rated at 98,300 HP at 156' head. The total rated generator capacity for the station is 207.3 MW. (Note: the current license gives the station capacity as 202.6 MW. This value assumed a power factor of 0.8 for all four original generators. When Unit 3 was rewound, its power factor changed to 0.9, and this change was not taken into account in the application for the current license.)

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 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.

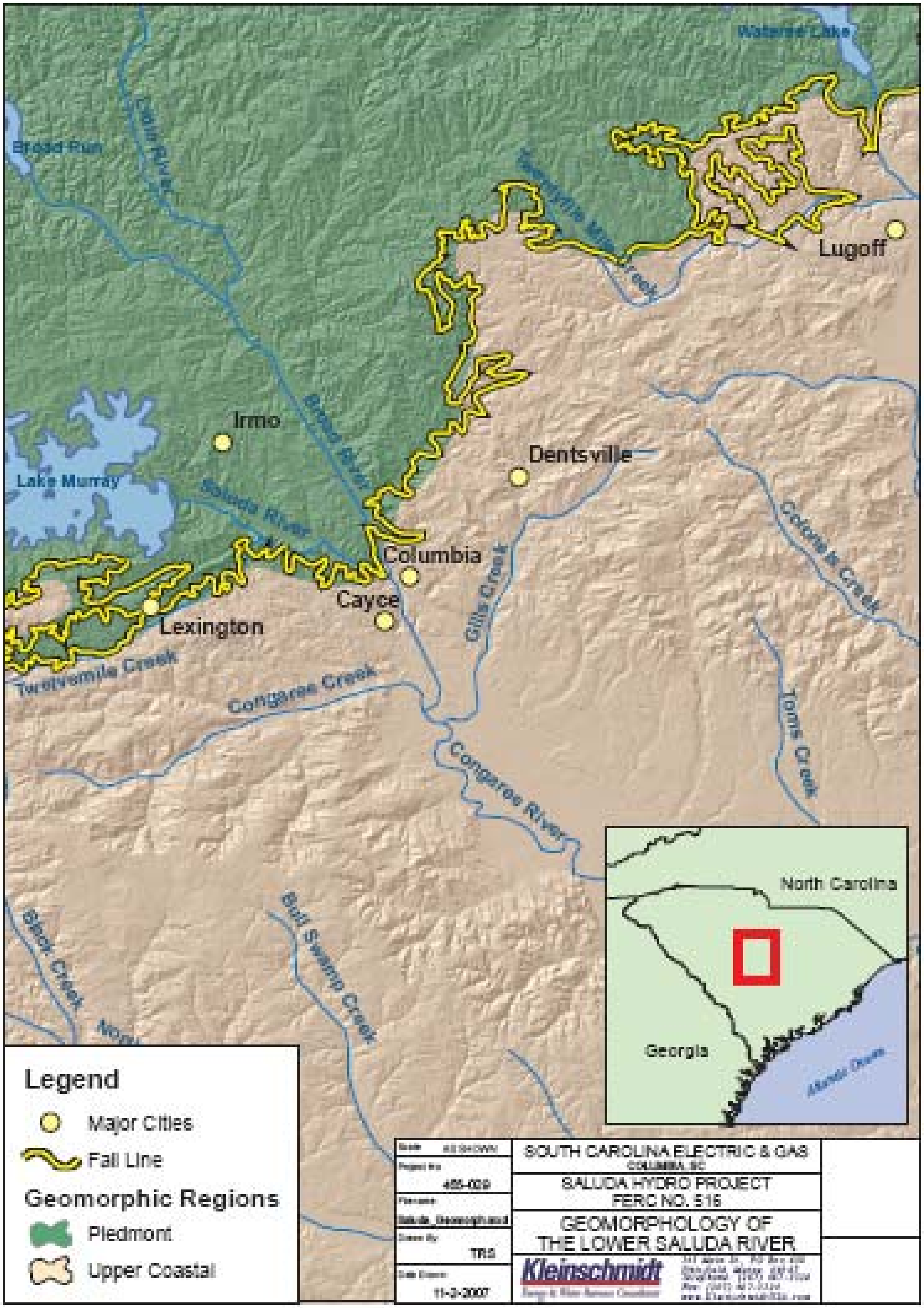

Figure 1: General Location of the Saluda Hydroelectric Project and the Lower Saluda River

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 the case include, but are not necessarily limited to Lake Murray lake levels, water quality, fisheries, boating, and other stream bank related recreation, and hydroelectric power generation.

The scope of this study is to provide data quantifying the effects of flows on aquatic habitat suitability in the LSR for the aquatic community and its managed fish resources and to assist the TWC in identifying flow targets that balance aquatic community and other water management issues. Decision data include modeling assessments of habitat suitability, zone of passage, and the effect of high flows on over-bank areas. These data will be used in conjunction with hydrologic, operational and other models to evaluate the costs and benefits of providing alternate flows to the lower Saluda River.

This IFIM study was scoped and directed by a study team comprising representatives from the TWC. The study was conducted by SCE&G under the supervision of the TWC, and with the assistance of the SCDNR.

2.0 DESCRIPTION OF THE STUDY AREA

The Saluda River flows southwesterly across the Piedmont geomorphic province from the east slope of the Appalachian Mountains to its confluence with the Broad River at the Fall Line (Hunt 1974) in Columbia, South Carolina. Between Lake Murray and the confluence, LSR flows for approximately ten miles through generally low gradient[2] riverine geomorphology (Figure 1). The drainage area at Lake Murray dam is 2,420 square miles. Real time stream flow gages exist at USGS 02168504 (*Saluda River below Lake Murray Dam*), and USGS 02169000 (*Saluda River near Columbia, SC*).

2.1 Upstream and Downstream Boundaries

The TWC identified the study area as the LSR between Lake Murray and the Broad River confluence (Figure 2). Flow is primarily influenced by releases from the Saluda Project, with minor contributions from small tributaries (Rawls, Twelve Mile, Kinley, and Stoop creeks and Senn Branch). These enter the river in middle section of the study area, and collectively contribute approximately 100 square miles of additional drainage area.

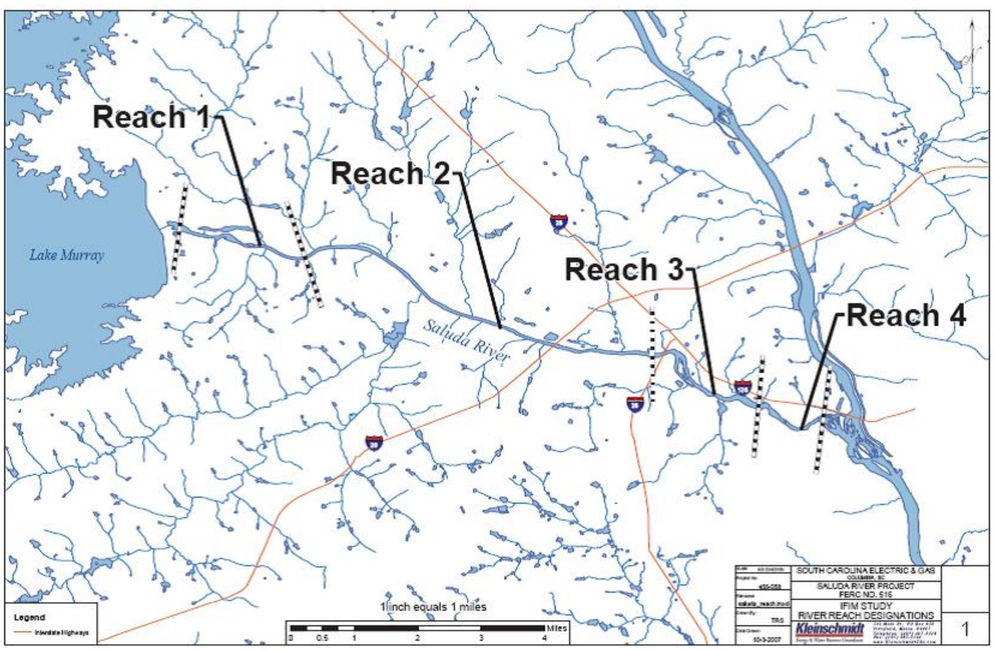

Figure 2: Lower Saluda Instream Flow Study – Study Area and Reach Boundaries

[2] LSR is punctuated by short, higher gradient reaches (3-4%), such as Millrace Rapids, but generally gradient is 1% or less.

2.2 Habitat and Geomorphology

The LSR flows southeasterly through a river corridor that gradually shifts from rural to suburban to urban land uses, and in general the river banks and riparian zones are forested. The river is relatively straight, with gentle bends and little sinuosity. The upper segment of the LSR is dominated by well-defined banks, relatively low-gradient pools and glides periodically segmented by short shoals and alluvial riffles. The lowermost segment reflects down cutting through the piedmont terrace at the Fall Line. It also contains pools, glides and runs, but exhibits higher gradient, more pronounced riffles, and features ledge and boulder substrates. Beginning downstream of Riverbanks Zoo, the LSR is highly braided, with the lowermost portion backwatered by the Broad River (Isely, et. al, 1995). There are a few scattered islands with pronounced side channels and/or braids in both the upper and lower reaches of the LSR.

Ambient water temperature and dissolved oxygen (DO) is influenced by cold water releases from below the Lake Murray thermocline via the project powerhouse. Average LSR water temperatures range from approximately 9.5^{o}C in February to 17.5^{o}C in early October, and approximately 10 to 18.5^{o}C in the vicinity of Riverbanks Zoo[3]. Average LSR DO levels range from 6.2 mg/L during September to 11.0 mg/L during February, with periodic excursions below 1.0 mg/L for short periods of time[4].

2.2.1 Fishery Management

The LSR supports a diverse community of coldwater and warmwater fish species and provides a variety of fishing opportunities (Beard, 1997).

Resident Fishery Resources

The LSR resident fishery includes resident game and non-game species. Studies conducted in 1991 found approximately 50 species of fish, 48 of which are considered endemic to the region (Jöbsis, 1991). SCDNR creel census data

[3] Based on monthly averaged 2000 to 2006 data as measured at USGS Gage # 02168504 (below Murray Dam) and at USGS Gage # 2169000 (Columbia).

suggests that the fishery generates approximately 1.8 million dollars annually, with the trout fishery being responsible for the majority of the revenues (Beard, 2000).

Cold water releases from the Saluda Hydro Project support a regionally unique put, grow, and take rainbow and brown trout fishery. SCDNR annually stocks the LSR with up to approximately 30,000 trout from November – March, at a 3:1 ratio of brown trout to rainbow trout. Fish length at stocking is typically 7-8" for brown trout and 9-10" for rainbow trout. These trout are not a native population, and are restocked to offset angling exploitation and predation. Angler reports of fish of 4 to 8 pounds indicate that some rainbow trout may survive up to several years (Kleinschmidt, 2003).

Redbreast sunfish and bluegill are found in relatively high abundance (Jöbsis, 1991). SCE&G data show that gizzard shad comprised approximately 25% of the catch prior to 1997. After 1997, a decline was observed in gizzard shad abundance, while sport fish species abundance increased. Recent SCDNR sampling indicates similar trends. SCDNR theorized a significant increase in chain pickerel populations is due to recent increases in the aquatic macrophyte community (personal communication, H. Beard, SCDNR, 2003).

Diadromous Fishery Resources

American shad, blueback herring, striped bass, and Atlantic and shortnose sturgeon are anadromous species that have historically (pre-Saluda Hydro) inhabited the LSR. Striped bass are the only anadromous fish known to consistently use the LSR (post-Saluda Hydro), and migrate upstream from the Santee Cooper lakes in early spring to use the LSR in late summer as thermal refuge. SCDNR has reported no presence of blueback herring or American shad in the LSR (Beard, 2002). However, sampling conducted by SCE&G in the

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[4] Based on monthly averaged 2000 to 2006 data as measured at USGS Gage # 02168504 (below Murray Dam).

spring of 2003 detected the presence of three American shad. The American eel is the only catadromous fish to inhabit the LSR (Beard, 2002).

The Santee Cooper Basin Diadromous Fish Passage Restoration Plan (USFWS, 2001) states that the cold hypolimnetic water significantly reduces the ambient LSR water temperature, and thus migrating fish may choose to use the warmer waters of the Broad River rather than the Saluda River (USFWS, 2001).

2.2.2 Hydrology

The total contributing drainage area at the Saluda dam is 2,420 square miles. Two USGS gages are located along the lower Saluda River downstream of the dam. Gage number 02169000, with a period of record dating back to 1925, is located near Columbia, about eight miles downstream from the dam. The contributing drainage area for this gage is 2,520 square miles and it has an average annual flow of 2,792 cfs[5]. A second gage (USGS station number 02168504), was installed approximately one-half mile downstream from the dam in 1988. The mean annual daily flow from this gage is 2,495 cfs; the drainage area for this gage is 2,420 square miles. Table 1 illustrates monthly mean flows for both gages.

Table 1: Average Monthly Flows on the Lower Saluda River Based on Two USGS Gages

GAGE	JAN	FEB	MAR	APR	MAY	JUN
02168504	2,794	3,395	3,756	2,469	1,771	1,864
02169000	2,989	3,241	3,325	3,025	2,230	2,478

GAGE	JUL	AUG	SEP	OCT	NOV	DEC
02168504	2,197	2,430	2,623	2,273	2,077	2,340
02169000	2,620	2,930	2,852	2,810	2,487	2,517

[5] All flow data in this section taken from Water Resource Data, South Carolina, Water Year 2005 by USGS

Annual flow-duration curves for the Project are contained in Appendix Figures B-1 through B-13 of SCE&G Initial Consultation Document (April 2005). The period of record used dates from 1979 through 2003. Data from gage 02169000 was used and pro-rated to the Project drainage area. SCE&G utilizes a flow forecasting model to plan operations, allowing them to create appropriate storage for potentially heavy inflows several days prior to the occurrence. As the reservoir covers approximately 48,000 acres at normal full pond, significant storage allows SCE&G to greatly reduce heavy outflows from the Project. Since the hydraulic capacity was increased in 1971, the Project's spillway gates have not been operated to pass flood waters.

3.0 METHODS

3.1 General Approach

Aquatic habitat suitability 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; Milhous *et al.* (1989). The IFIM quantifies habitat values of alternative stream flows using pre-determined habitat suitability index (HSI) criteria for selected evaluation 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" 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 as defined by the habitat suitability criteria.

3.2 Scoping

The study was collaboratively designed by TWC members, including biologists from USFWS, SCDNR and American Rivers, as well as input from National Park Service, NOAA Fisheries and Trout Unlimited. The TWC provided technical input to the consultant, and determined study area boundaries, evaluation lifestages, HSI criteria, modeling approach, and study site and transect locations within each reach, based on site reconnaissance and first-hand knowledge of habitat in the LSR (Appendix A).

The study area was segmented into four independent reaches (Figure 3). Boundaries were located based on pronounced changes in topography and hydrology (*i.e.* tributary influences). Reach 1 extends downstream approximately two miles from Saluda Dam to the confluence of Rawls Creek, near Saluda Shoals State Park, and is comprised primarily of runs, but also riffles, glides and one small shoal. Reach 2 comprises the five mile segment between Rawls Creek and the head of the Oh Brother/Ocean Boulevard complex, which marks the beginning of the Fall Line geomorphic region. This reach is dominated by extensive, but uniform run habitat with gravels and fines and also includes a riffle/glide island complex at Corley Island. Several small tributaries also enter this segment. Reach 3 down cuts through the Fall Line and extends downstream two miles to the crest of Millrace Rapids. Oh Brother Rapids and Ocean Boulevard represent the highest gradient portion of this reach and feature large boulder, cobble substrates in run, riffle and shoal habitat. Reach 4 extends from Millrace Rapids to the Shandon area above the Broad River confluence and is characterized by pool, shoal, and run/glide mesohabitat, with large substrates and bedrock outcrops.

Study sites were located within each reach. Each study site represents a specific type of representative and/or biologically strategic habitat within the subject reach. Transects were placed within each study site (Figure 3) as necessary to portray channel configuration, slope, hydraulics and/or substrate and cover of specific mesohabitat types of interest (Table 2). 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 500cfs).

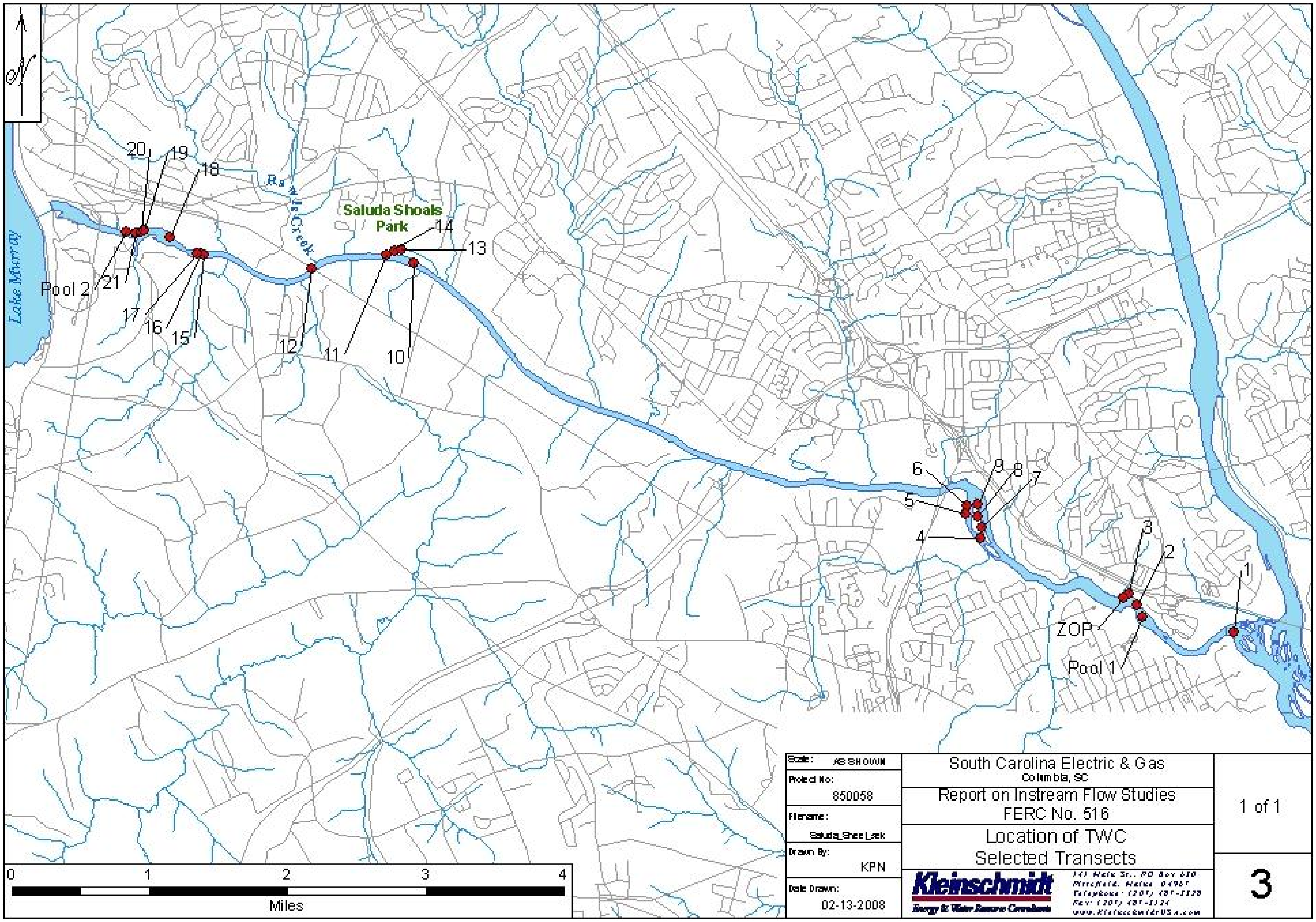


Figure 3: **Lower Saluda River Instream Flow Study**

Location of transects selected by TWC Study Team. Alpha transect ID's represent candidate transect sites selected in the field by the TWC during May 2006. Final sites were subsequently numbered in accordance with PHABSIM modeling requirements.

Table 2: Lower Saluda River Instream Flow Study – Summary of Transects, Listed in Order from Upstream to Downstream

PRELIMINARY TWC ID	FINAL ID	MESOHABITAT	STUDY SITE
A_1	**Pool 2**	pool	below USGS gage
B	**21**	glide-run	Toenail
C	**20**	riffle/run	Toenail
D	**19**	riffle/run	Toenail
E	**18**	run	point bar
F	**17**	glide	Sandy Beach
G	**16**	shoal	Sandy Beach
H	**15**	riffle	Sandy Beach
K	**14**	glide	Corley
L	**13**	glide	Corley
I	**12**	run	Corley
J	**11**	glide	Corley
L	**10**	riffle	Corley
O	**9**	glide/shoal	Ocean Boulevard
N	**8**	run	Ocean Boulevard
M	**7**	shoal	Ocean Boulevard
P	**6**	riffle	Oh Brother
Q	**5**	riffle	Oh Brother
Q_1	**4**	riffle	Oh Brother
R	**3**	shoal	Millrace
S	**2**	run	Riverbanks Zoo
T	**Pool 1**	pool	Riverbanks Zoo
U	**1**	glide	Shandon
	ZOP	shoal	Millrace

3.3 Evaluation Lifestages

Each species and lifestage was quantitatively rated using HSI criteria, in which parameters of depth, velocity, and substrate are independently assigned rating values, based on research, literature, observations, and/or professional judgment (Bovee, 1982; Bovee et al., 1998). The TWC recommended HSI criteria for a cross-section of game and non-game species of ecological and management interest. A number of species and lifestages were combined by guilded habitat use groups (Table 3) to ease interpretation (Appendix A). Criteria for each representative species and lifestage within each guild were then selected as a surrogate to represent collective similar habitat requirements for the larger group of species and lifestages. Specific guilds were assigned to study sites following Leonard and Orth (1988), based on overall depth and velocity characteristics existing at low to medium discharges that corresponded to each guild depth and velocity definition. In this study guilds were initially assigned as follows:

REACH	STUDY SITE	GUILD	MESOHABITAT
1	Toenail Riffle (T 19-21)	Shallow-fast	Riffle, with a run thalweg
1	Point Bar Run (T 18)	Deep-slow	Run
1	Sandy Beach (T 15-17)	Shallow-fast	Glide/riffle/shoal complex
2	Corley Island side channel (T 13-14)	Shallow-slow	glide
2	Corley Island main channel (T 10-11)	Shallow-fast	Riffle/glide complex
2	Reach 2 Run (T 12)	Deep-fast	Run
3	Ocean Boulevard (T 7-9)	Shallow-fast	Riffle /shoal complex
3	Oh Brother Rapids (T 4 -6)	Shallow-fast	Riffle/shoal complex
4	Reach 4 Run (T 2)	Deep-fast	Run
4	Shandon Glide (T 1)	Shallow-slow	glide

During subsequent TWC review, it was recommended that a shallow-slow guild should be modeled at all study sites to better account for fish habitat use in stream margins and transition zones after Leonard and Orth (1988), and also that deep fast guild attributes should be modeled in riffle/shoal habitat,, and that habitat suitability for striped bass in run habitat be modeled using criteria from Crance (1985). Results of these runs are contained in Appendix H.

HSI criteria adopted for this study are presented in Appendix B. Stand-alone species of specific management interest (smallmouth bass, rainbow trout, brown trout and shortnose sturgeon) were also modeled, including juvenile and adult lifestages of trout. Juvenile trout habitat suitability was modeled to account for habitat use among recently stocked fish that exhibit habitat preferences that differ from adult-sized fish. Results of modeling for spawning and fry life stages of trout are presented in Appendix F. Zone-of-Passage criteria were also applied to estimate discharges needed to facilitate volitional fish migration past a ledge outcrop at Millrace Rapids.

Table 3: Lower Saluda River Instream Flow Study – Summary of Habitat Use Guilds and SI Criteria Sources

Deep Slow Guild		
Targeted Species	**Life stage**	**Catawba-Wateree Curve or Surrogate**
American shad	YOY	American shad
blueback herring	spawning	RB sunfish spawning
blueback herring	YOY	RB Sunfish adult
N. hogsucker	adult	RB Sunfish adult
redbreast sunfish	adult	RB Sunfish adult
robust redhorse	juvenile	golden redhorse juv.
robust redhorse	adult	golden redhorse adult
spotted sucker	juvenile	RB sunfish spawning
spotted sucker	adult	RB Sunfish adult

Shallow Fast Guild		
Targeted Species	**Life Stage**	**Catawba-Wateree Curve or Surrogate**
benthic macroinvert.	juvenile	“diversity” curve
robust redhorse	spawning	robust redhorse
Saluda darter	adult	Fantail Darter
spottail shiner	spawning	Fantail Darter
spotted sucker	spawning	Generic guild curve

Deep Fast Guild		
Species	**Life stage**	**Catawba-Wateree Curve or Surrogate**
American shad	YOY	American shad
American shad	spawning	American shad
N. hogsucker	spawning	White bass spawning
N. hogsucker	fry/YOY	silver redhorse YOY
N. hogsucker	juvenile	golden redhorse
shorthead redhorse	adult	golden redhorse

Shallow Slow Guild		
Species	**Life stage**	**Catawba-Wateree Curve or Surrogate**
redbreast sunfish	spawning	RB sunfish spawning
robust redhorse	fry/YOY	Generic guild curve
spotted sucker	juvenile	RB sunfish spawning
spotted sucker	fry/YOY	RB sunfish spawning

3.4 Field Methods

Field methods used in this study were based on standardized procedures (Bovee *et al.*, 1998). Transect data were collected in accordance with data requirements for completing hydraulic modeling with the IFG4 model using a single velocity calibration data set. This entailed the collection of transect bed profile elevations, cover and substrate data, water surface elevations (WSEL's) at a series of three calibration flows, mean-column-velocity calibration data on at least one calibration flow, and stream discharge at each WSEL calibration flow. Substrate types (sand, gravel, cobble, *etc.*)[6] were classified using a viewing scope according to particle diameter that corresponded to pre-defined substrate suitability criteria, using the scale cited in Bovee (1982). The viewing scope lens was equipped with a measuring scale, and pressed as close to the substrate as possible so that the size of the dominant substrate types could be readily assessed at each point of interest.

Lateral survey boundaries of each study transect were defined by head- and tailpins established above the crest of each bank. Headpins were located along the right bank (looking downstream). Pins were field-blazed and semi-permanently fixed with either rebar or by using a large tree or other fixed object and then benchmarked by survey. At sites with multiple transects, longitudinal cell distance was also measured by established upstream and downstream cell boundaries located at observed shifts in cover, depth, hydraulics, or stream channel shape. All transect location and mapping work was done at a time of low stream discharge to ease examination of stream channel characteristics, and the location of each transect was geo-referenced using a handheld WAAS-enabled Garmin Model 76 GPS Unit.

In wadable areas, fiberglass survey tape or high-strength Kevlar® lines were secured between headpin and tailpin at each transect. Streambed elevation, mean-column-velocity, dominant substrate and edge of water were recorded at intervals (verticals) along the tape. Verticals were established at intervals on each transect wherever an observable change in any of the above four parameters occurred along each

[6] Also sometime referred to as "Channel Index".

transect. This typically resulted in about 40 or more verticals per transect. Verticals were also arranged so that not more than 10% of the total estimated transect discharge passed between any pair, in order to optimize the accuracy of the hydraulic model. At each vertical, substrate type was recorded, and bed and water surface elevations were surveyed to the nearest 0.01-ft elevation using a surveying level and standard surveying techniques. Discharge through the LSR study area is regulated by the Saluda Project 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 (low, middle, and high), to facilitate modeling in a range from approximately 500 cfs up to 20,000 cfs as follows:

TARGET	TARGET DISCHARGE (CFS)	NOTES
Low	500	
Medium	1,200; 1,600	data collected during two discrete field events
High	10,000	

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 500 cfs was selected to adequately provide data to model down to approximately 300 cfs and a high calibration flow of 10,000 cfs was selected to enable model extrapolation up to 20,000 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.

Bed profile, substrate and cover data were collected at the low calibration flow. Water surface elevation (stage) was surveyed at each transect at all three flows. Velocity data were generally collected at all transects at a single flow; however, at transects containing complex hydraulics, such a shoals, additional velocity data sets were collected at both the low flow and mid flow (within the limits of safety) to enhance hydraulic calibration. Table 4 summarizes hydraulic data gathered at each transect. Appendix C contains surveyed bed profiles and calibration flow water elevations.

A temporary staff gage was installed in the vicinity of each transect or study site to verify that discharge remained adequately stable during hydraulic measurements. Stage (water height) was checked at the beginning and end of velocity measurements, and before and after water surface elevation measurements at each transect. If a stage change occurred during measurements, the associated hydraulic data were discarded, and re-gathered again later once suitable conditions stabilized.

Velocity was measured at wadable transects to the nearest 0.1-ft/s using a calibrated Marsh-McBirney Model 2000 Flowmate electronic current meter attached to a top-setting wading rod. In water less than 2.5-ft deep, mean-column-velocity was measured at 0.6 of the depth. In very turbulent areas less than 2.5 ft deep and in water greater than 2.5-ft deep, mean-column-velocity was taken as the average of the velocities measured at 0.2 and 0.8 of the depth. Each point velocity measurement used on a given vertical was the mean of 20-second time-averaged readings. Velocity and bed profile data were collected on unwadable transects by using a Teledyne/RDI StreamPro Acoustic Doppler Current Profiler (ADCP). The Steam-Pro is a 2.0 MHz unit that has 4 beams that shoot out at a 20 degree angle. The ADCP unit was mounted to a standard Ocean Surveys trimaran float, and had Bluetooth wireless data transmission to a handheld PDA that allowed for real-time data collection review and recording. The ADCP unit was aimed vertically from the tethered trimaran platform and was drawn across the river on the alignment of the transect to continuously record data during its transit.

Stream discharge at each study reach was determined by a review of real time data from both the Saluda Project powerhouse as well as the USGS gages below Lake Murray Dam (#02168504)and near Columbia, SC (#02169000). Where possible, this was also opportunistically checked against concurrent results obtained through the ADCP unit. Discharge through side channels at islands were determined through computations obtained from collected depth, width and velocity data gathered at intervals along a transect in each channel location. At the Oh Brother/Ocean Boulevard island, channel flow was field measured on at least one channel at wadable flows; flow through the opposite channel was estimated by subtracting the field measured flow against the recorded full-river flow obtained for the corresponding time period from the USGS Columbia gage (#02169000), located a short distance downstream. At Corley Island, flows were manually gaged on each channel at each wadable flow, summed and compared against the flow recorded for net river flow at the gage below Lake Murray Dam (#02168504), located approximately two miles upstream.

Table 4: Lower Saluda River Instream Flow Study – Summary of Hydraulic Data Collected at Each Habitat Transect

Transect Number	Mesohabitat	Study Site	Comments	Guild Category	PHABSIM Calibration data 500 cfs	1,200/1,600 cfs	10,000 cfs
Pool 2	Pool		below USGS gage		WSEL and bed survey	WSEL	WSEL
21	glide/run	Toenail Rapids		Shallow - Fast	WSEL, velocity and bed survey	WSEL and velocity	WSEL
20	riffle/run	Toenail Rapids		Shallow - Fast	WSEL, velocity and bed survey	WSEL and velocity	WSEL
19	riffle/run	Toenail Rapids		Shallow - Fast	WSEL, velocity and bed survey	WSEL and velocity	WSEL
18	Run	eagles nest	point bar	Deep-Slow	WSEL and bed survey	WSEL and velocity	WSEL
17	Glide	Sandy Beach	Sandy Beach	Shallow -Slow	WSEL and bed survey	WSEL and velocity	WSEL
16	Shoal	Sandy Beach	Sandy Beach	Shallow - Fast	WSEL, velocity and bed survey	WSEL and velocity	WSEL
15	Riffle	Sandy Beach	Sandy Beach	Shallow - Fast	WSEL, velocity and bed survey	WSEL and velocity	WSEL
14	Glide	Corley	Corley side channel	Shallow -Slow	WSEL, velocity and bed survey	WSEL and velocity	WSEL
13	glide	Corley	Corley side channel	Shallow-Slow	WSEL, velocity and bed survey	WSEL and velocity	WSEL
12	run	Corley	above Corley island	Deep - Fast	WSEL, velocity and bed survey	WSEL and velocity	WSEL
11	glide	Corley	Corley main channel	Shallow - Fast	WSEL and bed survey	WSEL and velocity	WSEL
10	riffle	Corley	Corley main channel	Shallow - Fast	WSEL, velocity and bed survey	WSEL and velocity	WSEL
9	shoal	Ocean Blvd		Shallow - Fast	WSEL, velocity and bed survey	WSEL and velocity	WSEL
8	run	Ocean Blvd		Shallow - Fast	WSEL, velocity and bed survey	WSEL and velocity	WSEL
7	shoal	Ocean Blvd		Shallow - Fast	WSEL, velocity and bed survey	WSEL and velocity	WSEL
6	riffle	Oh Brother		Shallow - Fast	WSEL, velocity and bed survey	WSEL and velocity	WSEL
5	riffle	Oh Brother		Shallow - Fast	WSEL, velocity and bed survey	WSEL and velocity	WSEL
4	riffle	Oh Brother		Shallow - Fast	WSEL, velocity and bed survey	WSEL and velocity	WSEL
ZOP	shoal	Millrace	irregular ledge outcrop		WESL, velocity and bed profile	WSEL	
3	*shoal*	*Riverbanks Zoo*	*below Millrace*		**transect abandoned**		
2	run-riffle	Riverbanks Zoo		Deep - Fast	WSEL, velocity and bed survey	WSEL and velocity	WSEL
Pool 1	pool	Riverbanks Zoo	near picnic site		WESL and bed profile	WSEL	WSEL
1	glide	Riverbanks Zoo	above Shandon	Shallow-Slow	WSEL, velocity and bed survey	WSEL and velocity	WSEL

The zone of passage study site at Millrace Rapids is located on a v-shaped ledge outcrop spanning a portion of the channel (Appendix D) that formed an irregularly-shaped polygon rather than a linear cross-section. This required a modified data gathering approach. The profile and related water elevations at 500 cfs were surveyed using a rod and level as at other transects, but spatial data were recorded using a Trimble Model Pro XRS GPS unit with sub-meter accuracy combined with a TDS Model 200C Ranger data logger to record each survey point node. The study site topography was surveyed to create a mesh model from these nodes that was subsequently entered into a CAD program to generate a detailed 3-D model. At 1,600 cfs (an unwadable flow), WSELs were obtained at reference points by level loggers (Solinest Model 3001 and Barologger) and temporary benchmarks that had been deployed prior to the flow increase. The level loggers were subsequently retrieved, and the recorded WSELs converted to survey datum and entered into the CAD model to provide a stage-discharge relationship.

3.5 Hydraulic Modeling

The IFG4 hydraulic model was used in calibrating the hydraulic model component of PHABSIM (Milhous, *et. al*, 1989). Although the MANSQ and WSP models are also available through PHABSIM for developing stage-discharge relationships, IFG4 provided the best calibration over the relatively wide range of surveyed flows. IFG4 uses the STGQ routine to develop a log-log fit for three stage-discharge pairs. IFG4 was then run to simulate velocity in each cell along each transect at the flow increments of interest.

The first step of modeling involved establishing the stage-discharge relationship for each transect for the entire range of simulated flows (300 cfs through 20,000 cfs). It was observed that discharges through study sites in reaches 3 and 4 were consistently 100 cfs higher than those for the corresponding conditions at sties in reaches 1 and 2, due to tributary inflow entering the river in reach 3 between Corley Island and Ocean Boulevard. For split channels at islands, it was necessary to assign net station discharge to each channel. This was done by using a best estimate based on the proportional stream channel flow differences recorded during calibration flows in the field. The best estimate at the Oh Brother/Ocean Boulevard island was developed from the mid-calibration flow, indicating a 53:4 flow split, respectively. Although this ratio may shift in favor of the Oh Brother channel at lower flow, the exact point at which the shift occurs is unknown. At Corley Island, the ratio derived from the mid-flow was 86:14.

Next, calibration of the model for velocities consisted of simulating velocities at calibration flows and comparing simulated vs. empirical results. Velocities were iteratively refined by adjusting the model-given stream channel roughness coefficient (Mannings "n") within selected cells on each transect to allow the predicted velocity values to correlate in the model as closely as possible to each corresponding velocity recorded during the applicable calibration flow. Decisions about roughness adjustments are base on given field measured velocities; information about object cover and eddies, *etc*.; and stream slope values. Velocity Adjustment Factors (VAF's) reported for each flow increment by the model are used as guideline indicators of model reasonableness.[7]

For flows greater than 10,000 cfs, a different modeling approach was used to verify hydraulic conditions at flows where the river begins to exceed the bankfull condition and inundate the floodplain. One objective of this modeling was to estimate the extent to which high flows may provide flood plain inundation and other hydrologic channel maintenance and ecological functions. To account for floodplain topography, each transect was located on a DEM topographic map to extend the field-surveyed channel profile out of the river bed and across the floodplain terrace terrain to points where the topographic elevation exceeds the projected 20,000 cfs water surface elevation. This also allowed transects to be tied into a common USGS datum.

A HEC-RAS model extending from Lake Murray to the Broad River incorporating all 21 surveyed transects was developed. Transects were converted to a common datum (NAVD 88). Points collected using ADCP instrumentation were also converted to this datum and incorporated into each applicable cross section. To ensure accuracy, Manning's "n" roughness coefficients were adjusted to calibrate the model to the 10-year flood levels found in the Flood Insurance Study for Lexington County, South

[7] The VAF is the ratio by which the model adjusts the velocities to enable discharge to adhere to the given stage-discharge value assigned to each flow increment. A VAF of 1.0 indicates perfect accordance of velocities.

Carolina. The roughness coefficients ranged from 0.045 to 0.07 for the over bank areas and 0.015 to 0.045 in the channel.

After the model was calibrated, a steady flow simulation was run in the four flows ranging from 10,000 to 20,000 cfs in 2,000 cfs increments. Within the modeled reach, there are two locations where island split the river into two separate reaches. At these points, junctions were used within HEC-RAS and optimized to calculate the distribution of flow around each side of the island based on the geometry of the first cross section of each reach. Areas where the cross sections appear to end before all of the flow rates are contained are around the island of the split reaches where the highest elevation of the island was lower than the water levels for the higher flow rates. For these cases, it can be assumed that the island dividing the river would be completely inundated.

The HEC-RAS modeling showed that channel hydraulics predicted by the PHABSIM model for flows greater than 10,000 cfs were reasonable. Even at high flows, the channel modeled by PHABSIM carries over 95% of the flow for nearly all transects. Although the HEC-RAS model may provide a slightly better estimate of wetted width at 20,000 cfs, the HEC-RAS model can only predict average velocity for three areas: left over bank, channel, and right over bank. PHABSIM better conveys the variability in depth and velocity within the channel (which influences microhabitat) and was therefore used for the hydraulic results for flows greater than 10,000 cfs. It is also important to note that hydraulics predicted for flows greater than 10,000 cfs are extrapolations, given that the highest surveyed flow was 10,000 cfs. This may affect the accuracy of the modeling at high flows. That is, hydraulic predictions are likely more accurate near 10,000 cfs than they are towards 20,000 cfs. This uncertainty is inherent with any type of modeling.

Zone Of Passage

WSELs were used to develop a stage-discharge curve and superimposed onto the 3D CAD model. A stage corresponding to suitable depth and width characteristics based on the SCDHEC fish passage criterion (1.5’ deep by 10’ wide) (DeKozlowski, 1988) was then iteratively interpolated from the curve. Triangulated Irregular Networks (TINs) were created using ESRI ArcGIS 9.2 for both the channel bed and the water surface. The WSEL profile empirically observed in the field at 500 cfs, and 1,600 cfs flows was entered as X Y coordinates into ArcGIS 9.2 to capture localized irregularities. WSEL at interpolated flows were estimated from these using a uniform increase in water surface based on the stage-discharge relationship, rather than trying to interpret more localized WSEL points from limited data. Three parallel transects were then drawn across the study site surfaces to capture zone of passage at representative loci from downstream to upstream throughout the site. This was done using a 3-dimensional line interpolation tool, which allowed X and Y data along the transect to be exported into MS Excel. Areas meeting SCDHEC fish passage criteria were highlighted on figures.

Velocity at each resulting discharge was then estimated by running a steady state HEC-RAS model through the area of concern at flows ranging from 300 to 1,600 cfs in increments of 100 cfs. Based on observed water levels at 583 cfs, the discharge through the Zone of Passage site was calculated to be approximately 48% of the total river flow. Manning's "n" roughness coefficients were adjusted to calibrate the model to observed velocities at 583 cfs. The roughness coefficient was set to 0.030 in the channel.

Deep Riverine Pools

Two deep riverine pools were surveyed by Kleinschmidt and SCDNR staff using a 1200 kilohertz Workhorse Monitor ADCP unit equipped with an Ocean Sciences Riverboat trimaran in order to obtain a bed profile. Water surface elevations surveyed at the low, medium and high calibration flow were then used to construct a stage-discharge curve that could be used to predict changes in depth and wetted area at increments of interest.

3.6 Habitat Modeling

Habitat suitability was computed independently for each study site using the HABTAE option in PHABSIM. HABTAE is the standard program applied to combine hydraulic output with HSI criteria. Habitat suitability for each site is expressed in Weighted Usable Area (WUA) units of square feet available per 1,000 ft. of similar stream reach for each flow increment. HABTAE calculates WUA for each projected flow at each transect, based on the parameters (depth, velocity and wetted substrate) forecasted for each wetted cell by the hydraulic model as they relate to the HSI criteria established for the species and lifestage of interest, and the dimensions of the cell. For each wetted cell, the program rates each criterion on a scale of 0.0 to 1.0, multiplies these values together with the established area of the cell, and sums all the resulting areas. The WUA output for each habitat was then expanded to the reach, based on the proportion of corresponding habitat within the reach provided by each mesohabitat type.

4.0 RESULTS

Calibration flow data were collected on June 3-8 and 26-28, 2007. Additional WSEL data were gathered at Millrace Rapids during July 2007, and deep pool ADCP data were collected by SCDNR in August 2007. Data were gathered on all transects with the exception of one shoal transect at Millrace Rapids. This transect was provisionally selected by the study team, however during scoping, concerns were raised about the feasibility of collecting data safely and potential for modeling error due to channel complexity. These concerns were born out during field work, and this transect was abandoned.

4.1 Mesohabitat Measurements

Runs were the dominant mesohabitat type in Reaches 1 through 3 and accounted for 35-72% of these reaches (Table 5). Pools were second most dominant in these reaches, accounting for 19-37%. Riffle, shoals, and glides individually comprised 1-13% of various reaches. Reach 3 contained a segment of habitat in the upper portion of Ocean Boulevard that exhibited glide characteristics at low flows but became shoal-like at higher flows. Reach 4 was dominated by a long riverine pool that accounted for 70% of reach length. The remainder of this reach was comprised of shoal, glide and run.

Table 5: Lower Saluda River Instream Flow Study – Summary of Mesohabitat Types

REACH	RUN	POOL	RIFFLE	RAPID/ SHOAL	GLIDE	GLIDE/ SHOAL	TOTALS
Reach 1 (ft)	5,129.8	3,700	825	170	254	0	10,079
Percent	51%	37%	8%	2%	3%	0%	100%
Reach 2 (ft)	19,480	5,187	1,409	248	555	0	26,879
Percent	72%	19%	5%	1%	2%	0%	100%
Reach 3 (ft)	4,024	3,832	1,525	1,052	126	843	11,402
Percent	35%	34%	13%	9%	1%	7%	100%
Reach 4 (ft)	452	3,978	0	695	589	0	5,714
Percent	8%	70%	0%	12%	10%	0%	100%

4.2 Weighted Usable Area

Results are presented separately for each reach, beginning upstream. Bed and water surface profiles for each transect are presented in Appendix C, and study site photos are in Appendix D. PHABSIM hydraulic models require that transects be numbered consecutively from downstream to upstream. Habitat suitability is reported in units of Weighted Usable Area (square feet per 1,000 linear feet of river). Note that the X axis (discharge) is scaled in following figures to provide better resolution of trends, however, un-graphed data are included in tabular format.

4.2.1 Reach No. 1 – Saluda Dam to Rawls Creek

4.2.1.1 Riffle and Run Complex Near Overflow Channel Confluence

This site was comprised of three linked transects (T-19, T-20, and T-21) spanning a cobble bar and riffle complex. At low flows, all three transects share the characteristics of riffle mesohabitat, although there is a distinct, deeply-incised run along a narrow portion of the tailpin side of the study site. As flow increases, backwatering that changes the characteristics of this site, occurs. The gravel bar at the upstream end of the run serves as a hydraulic control, and causes transect 21 to become a glide, while transect 20 remains a riffle throughout most of the flow range. However, transect 19 becomes backwatered by a downstream hydraulic control and changes from supercritical to sub-critical flow. As a result, velocity calibration at transect 19 was very poor. Model calibration at T-20 and T-21 was good and these two were used for habitat modeling. Table 6and Figures 4-6 summarize results.

Habitat Data

Rainbow trout and brown trout. Habitat suitability rises sharply from 300 to 800 cfs for both lifestages of each species, with sharp inflection points occurring at 800-1,000 cfs for most lifestages other than adult brown trout, which did not demonstrate an inflection point but continued to rise as an arc to a plateau between 2,000 and 4,000 cfs, reflecting a tolerance for depth and velocity. Most lifestages achieved 75% of their optimal suitability at flows in the 600-700 cfs range.

Smallmouth bass. Juvenile and adult suitability reach optima at 1,000 and 1,800 cfs respectively. These lifestages achieved 75% of their respective optima between approximately 600 and 1,200 cfs. Early lifestages (spawning and fry) are velocity-limited, and thus suitability peaks and then declines at flows greater than 600 cfs as velocity increases.

Shallow-fast guild. Habitat suitability was based on a suite of four guild surrogates taken from the Catawba-Wateree study to represent habitat use for a range of species and lifestages of interest to the TWC. Habitat suitability peaked across a range of flows from 300 cfs (Robust redhorse) to 900 cfs (macroinvertebrates), with rapidly increasing suitability occurring for shallow-spawning generic spawning and macroinvertebrates between 300 and approximately 600 cfs. Adult Saluda darter habitat suitability had a limited response to flow between 300 and 600 cfs, with a slight peak at 400 cfs, then declined gradually at higher flows.

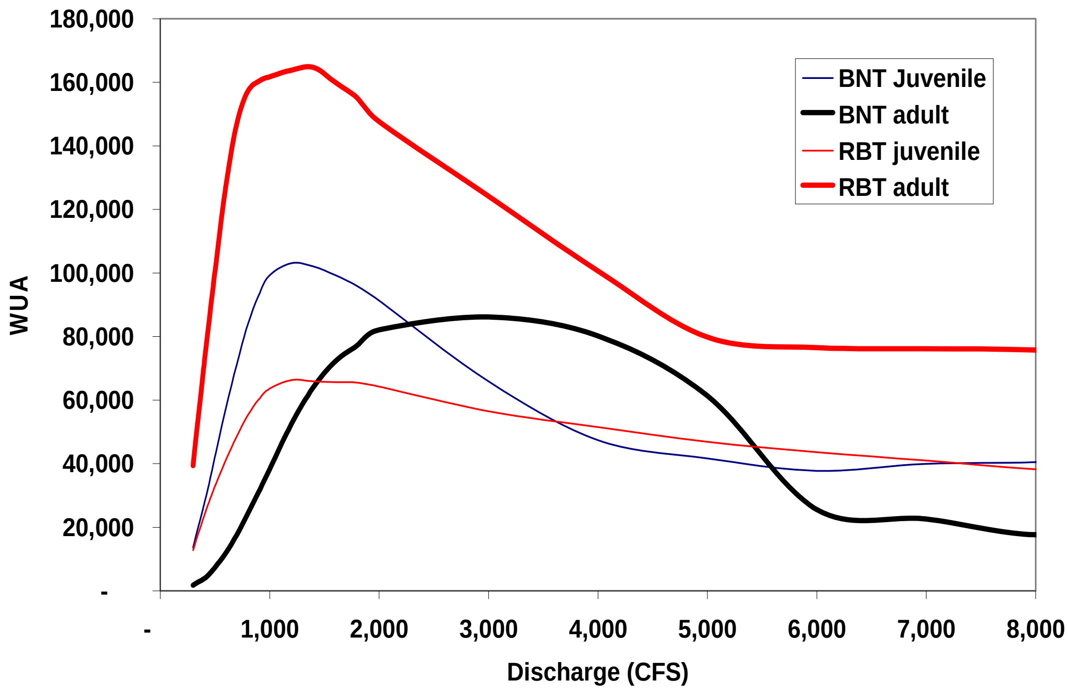


Figure 4: **Saluda Instream Flow Study – Reach 1, Riffle-Run-Glide Habitat – Trout Habitat Suitability**

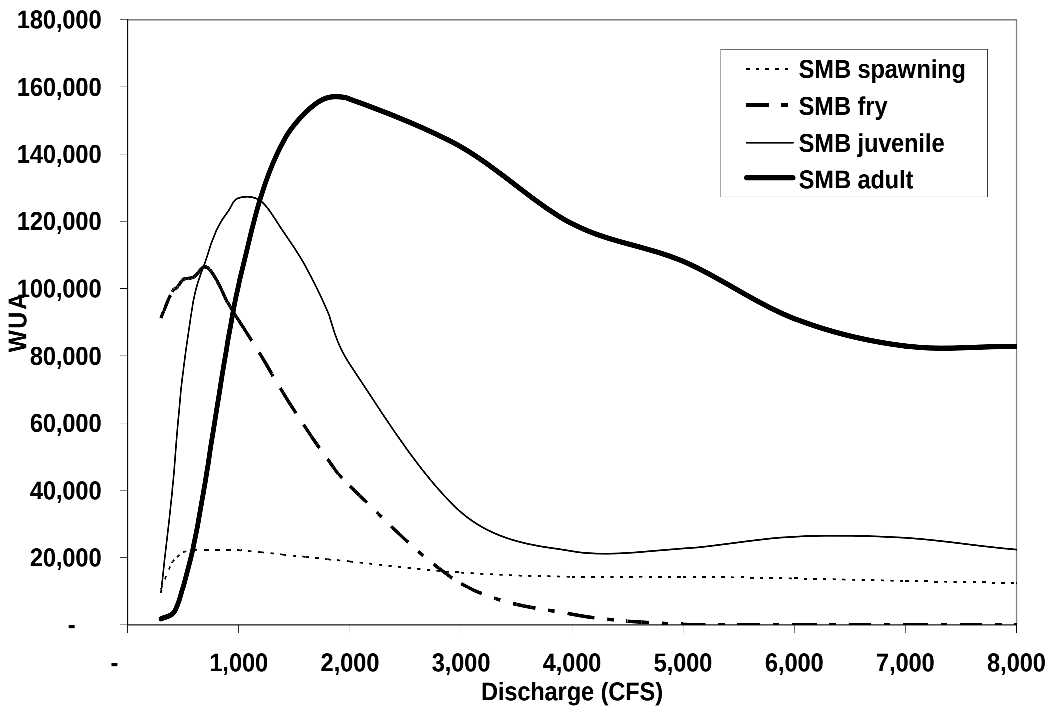


Figure 5: **Saluda Instream Flow Study – Reach 1, Riffle-Run-Glide Habitat – Smallmouth Bass Habitat Suitability**

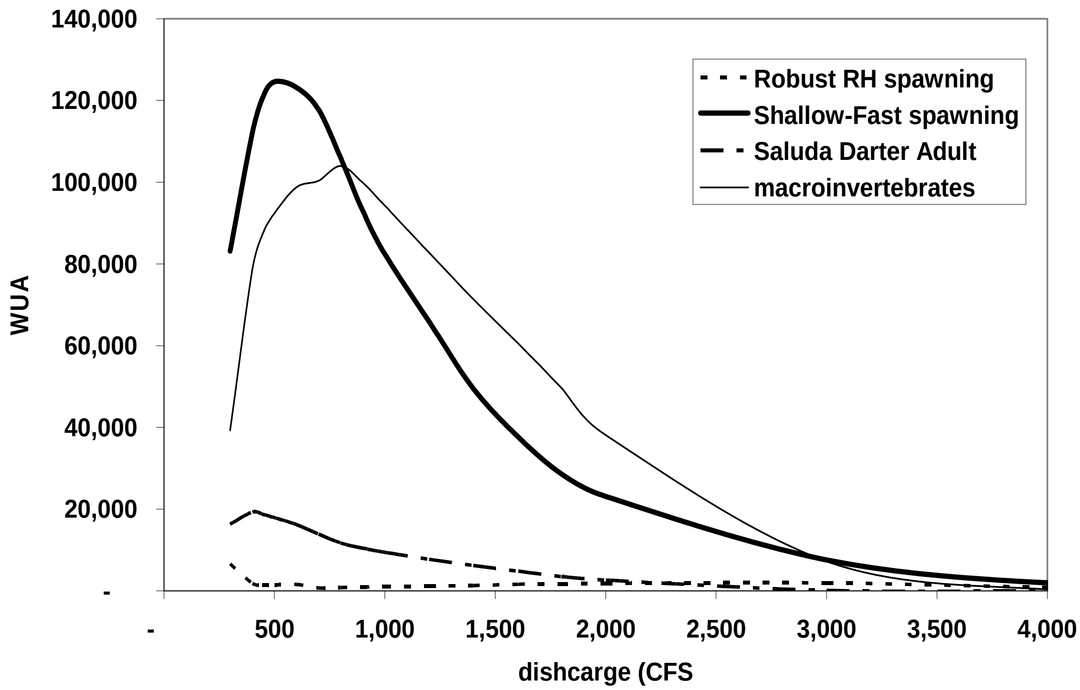


Figure 6: Saluda Instream Flow Study – Reach 1, Riffle-Run-Glide Habitat – Shallow-Fast Guild Habitat Suitability

Table 6: Saluda Instream Flow Study – Habitat Suitability-Discharge Relationship, Reach 1, Riffle-Run-Glide Complex

DISCHARGE (cfs)	BNT Juvenile	BNT Adult	RBT Juvenile	RBT Adult	SMB Spawning	SMB Fry	SMB Juvenile	SMB Adult	Robust RH Spawning	Shallow-Fast Spawning	Saluda Darter Adult	Macroinvertebrates
300	13,621	1,706	12,743	39,356	10,556	91,214	9,573	1,764	6,598	83,143	16,341	39,252
400	27,161	3,800	23,554	71,117	18,388	99,052	38,967	3,103	1,811	112,118	19,306	78,713
446	33,576	5,184	27,917	84,710	20,098	100,336	57,325	5,651	1,384	120,532	18,728	87,198
500	42,097	7,272	32,836	100,109	21,535	102,689	75,402	11,262	1,467	124,587	17,887	92,388
600	57,402	11,922	41,176	127,468	22,254	103,496	97,336	24,386	1,538	123,172	16,192	98,753
700	71,340	17,604	48,686	147,071	22,269	106,552	108,110	42,865	721	117,792	13,858	100,372
800	83,642	24,188	55,124	157,068	22,247	102,601	117,318	63,504	810	105,969	11,660	103,973
900	92,955	31,147	60,187	160,274	22,226	95,851	122,727	83,965	893	93,022	10,457	99,898
1,000	99,309	38,296	63,658	161,731	22,134	90,534	126,917	101,020	1,013	82,408	9,438	94,266
1,200	103,115	52,521	66,314	163,789	21,581	80,097	125,997	127,263	1,139	65,888	7,692	82,760
1,400	102,064	64,072	65,887	164,735	20,824	68,952	117,068	143,598	1,285	49,562	6,235	71,410
1,605	99,250	72,279	65,630	159,869	20,163	58,408	106,498	152,447	1,620	37,573	4,810	60,470
1,800	95,840	77,183	65,506	155,050	19,504	49,295	93,339	156,763	1,728	28,617	3,489	49,667
2,000	91,297	82,055	64,214	147,636	18,790	41,201	77,421	156,344	1,799	23,066	2,640	38,060
3,000	65,909	86,119	56,464	124,137	15,492	12,237	33,475	142,138	1,915	7,551	124	7,171
4,000	47,405	80,148	51,510	100,638	14,267	3,107	21,895	119,297	883	1,925	6	335
5,000	41,690	61,367	46,876	79,785	14,322	138	22,677	108,108	131	2,000	8	170
6,000	37,708	25,575	43,596	76,477	13,768	51	26,147	91,050	-	2,999	9	110
7,000	39,945	22,620	40,948	76,191	13,030	22	25,849	82,897	-	3,253	0	37
8,000	40,474	17,633	38,190	75,723	12,360	9	22,343	82,770	-	3,187	-	-
10,000	43,180	27,290	34,362	70,549	11,635	-	18,167	82,046	-	2,484	-	-
14,000	33,526	37,557	27,774	59,562	10,546	-	11,957	75,065	-	2,855	-	-
16,000	25,275	37,523	25,388	59,179	10,294	-	9,631	69,784	-	1,324	-	-
20,000	12,379	26,716	20,988	59,016	9,848	-	8,105	65,537	-	299	-	-

4.2.1.2 Point-Bar-Run

This study site was comprised of a uniform run with woody debris and an alluvial isthmus that created a small backwater side arm along the headpin side of the channel. Dominant substrate was gravel. The thalweg in this site was poorly defined. One transect (T-18) was used to describe this site. Table 7 and Figures 7-10 summarize results.

Habitat Data

Rainbow trout and brown trout. Habitat suitability for juveniles peaks at 400 cfs (rainbow trout) and 500 cfs (brown trout), then declines at higher flows. Adult rainbow trout suitability exhibits a sharp inflection point at 800 cfs and an absolute peak at 1,800 cfs, then rapidly declines to 4,000 cfs. Adult brown trout suitability exhibits an absolute peak at approximately 1,200 cfs; then suitability declines sharply between 2,000 and 4,000 cfs.

Smallmouth bass. Juvenile and adult suitability reach optima at 700 and 1,600 cfs respectively. The juvenile lifestage exceeds 75% of optimal between 300 and 1,400 cfs; adult suitability exceeds 75% between 400 and 4,000 cfs. Fry lifestage suitability declines at flows greater than 300 cfs. Optimal spawning suitability occurs at 1,400 cfs; 75% of optimal suitability is exceeded between 500 and approximately 3,000 cfs, and the inflection point occurs at 600 cfs.

Deep-slow guild. Habitat suitability was based on a suite of five guild surrogates taken from the Catawba-Wateree study to represent habitat use for a range of species and lifestages of interest to the TWC. Habitat suitability peaks across a range of flows from 300 cfs (redbreast sunfish spawning and juvenile redhorse) to 2,000 cfs (American shad YOY). However, most optima and inflection points occur between approximately 600 and 900 cfs. American shad suitability reaches a plateau between approximately 1,200 and 4,000 cfs, and a flow of 700 cfs provides 75% of the optimal suitability.

Shortnose sturgeon. Suitability for this species rises steadily to a peak at 4,000 cfs, and 75% of optimal occurs at approximately 2,500 cfs.

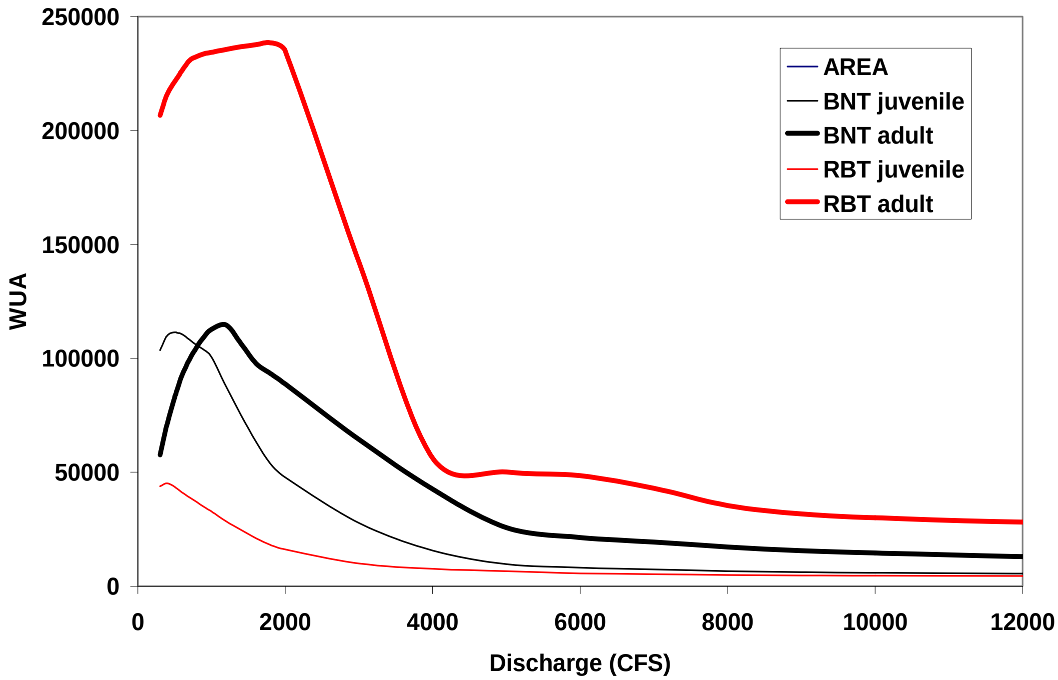


Figure 7: Saluda River Instream Flow Study – Point Bar Run, Trout Habitat Suitability

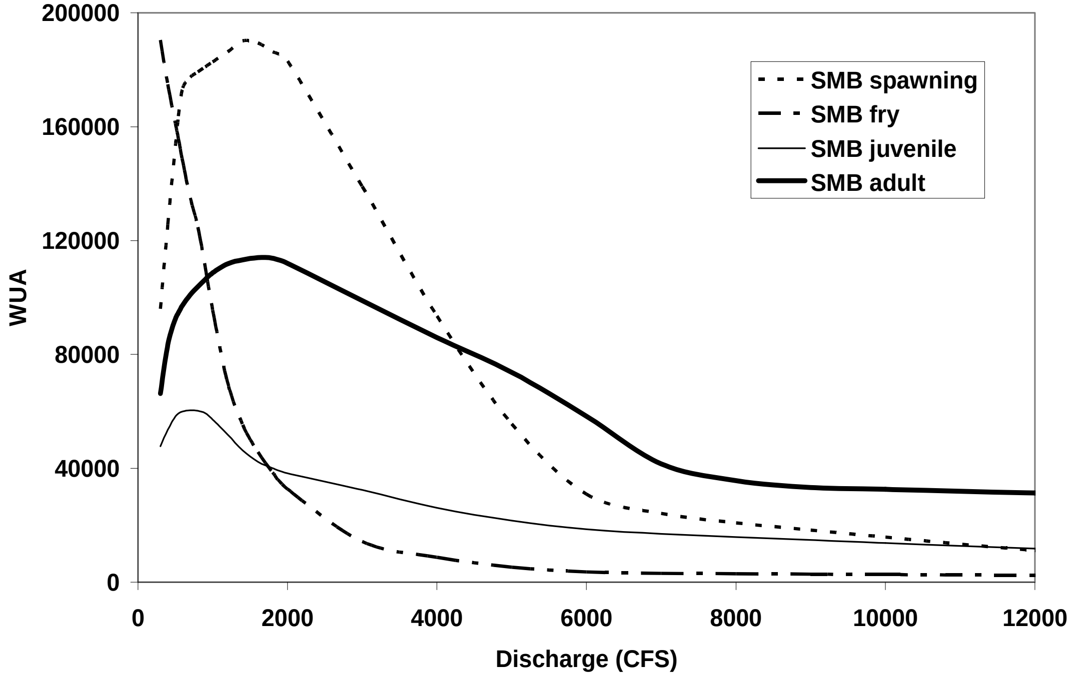


Figure 8: **Saluda River Instream Flow Study – Reach 1 Point Bar Run, Smallmouth Bass Habitat Suitability**

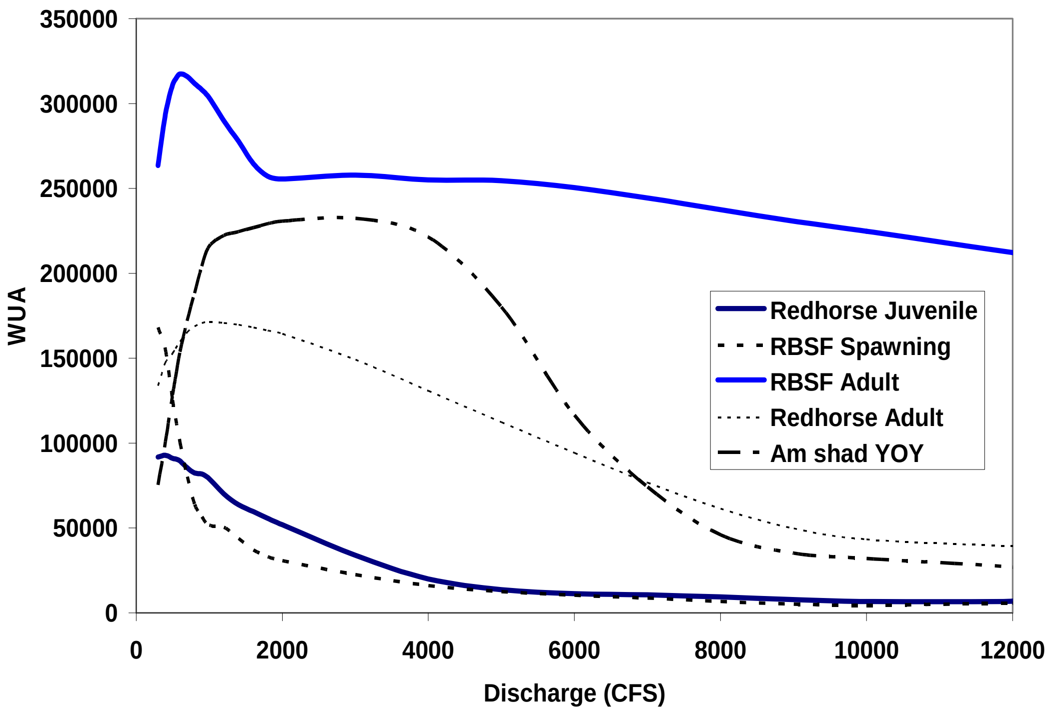


Figure 9: **Saluda River Instream Flow Study – Reach 1 Point Bar Run, Deep-Slow Guild Habitat Suitability**

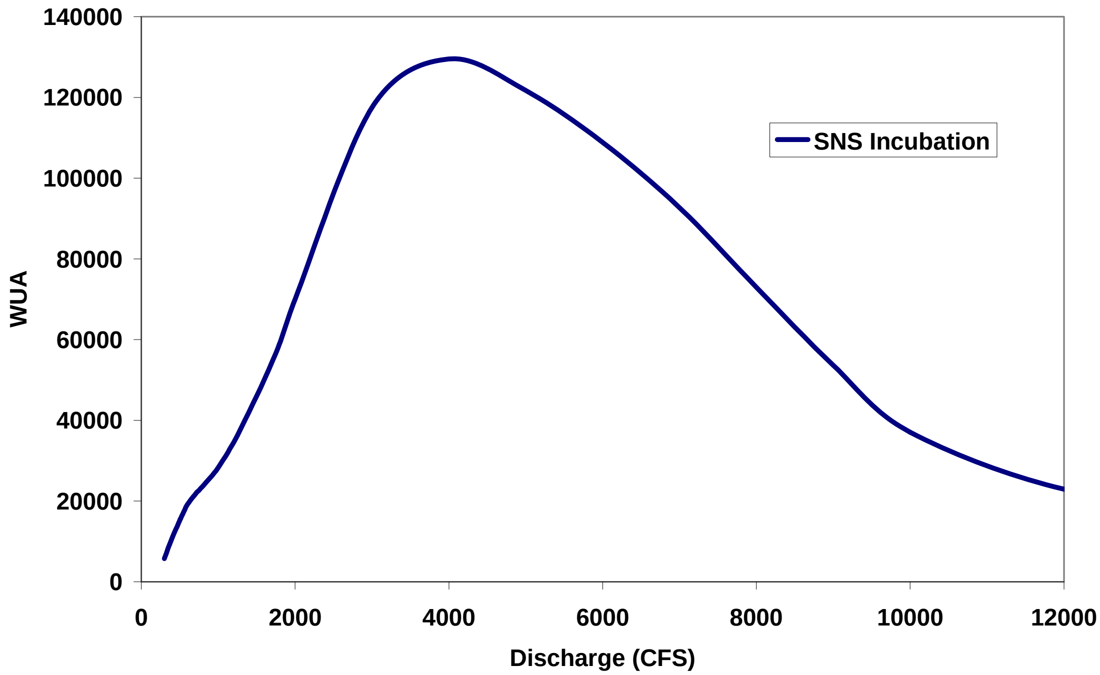


Figure 10: Saluda River Instream Flow Study – Reach 1 Point Bar Run, Shortnose Sturgeon Spawning and Incubation Habitat Suitability

Table 7: Saluda Instream Flow Study – Reach 1 Point Bar Run, Habitat Suitability-Discharge Relationship

DISCHARGE (cfs)	BNT Juvenile	BNT Adult	RBT Juvenile	RBT Adult	SMB Spawning	SMB Fry	SMB Juvenile	SMB Adult	Redhorse Juvenile	RBSF Spawning	RBSF Adult	Redhorse Adult	Am shad YOY	SNS Incubation
300	103,583	57,631	43,894	206,699	96,051	190,450	47,724	66,245	91,754	168,152	263,578	133,802	75,335	5,772
400	110,026	71,331	45,147	216,011	125,628	174,909	53,552	83,404	92,744	155,050	293,770	147,355	100,700	10,894
500	111,414	82,772	43,593	221,400	153,276	161,115	58,273	92,567	90,978	125,254	310,960	152,827	128,493	15,145
540	111,149	86,989	42,617	223,417	163,773	155,801	59,291	94,656	90,593	114,615	314,421	155,739	138,944	16,765
600	110,659	92,557	41,198	226,331	173,596	147,669	59,995	97,383	89,538	100,539	317,441	159,769	153,739	19,171
700	108,206	99,492	39,009	230,743	177,418	135,036	60,430	100,974	85,496	80,297	315,993	165,295	172,053	21,611
800	105,711	105,048	36,885	232,539	179,263	124,773	60,236	103,861	82,430	63,811	311,732	168,752	188,384	23,638
900	103,631	109,515	34,773	233,698	181,058	110,721	59,378	106,332	81,766	56,575	308,125	170,764	204,130	25,866
1,000	100,498	112,810	32,732	234,392	182,808	95,556	57,159	108,661	79,023	51,611	303,444	171,336	215,999	28,272
1,200	87,473	114,581	28,408	235,658	186,271	70,040	51,856	111,877	70,165	50,338	289,903	170,798	222,239	34,486
1,400	75,071	106,443	24,655	236,751	190,129	55,305	46,341	113,218	63,681	43,824	277,894	169,690	224,580	42,028
1,605	63,266	97,645	21,007	237,703	189,400	45,708	42,310	114,064	59,662	37,093	264,520	168,050	226,981	50,290
1,800	53,768	93,319	18,096	238,512	186,311	38,563	40,077	113,797	55,649	33,037	257,202	166,313	229,191	59,120
2,000	47,719	88,699	16,059	234,861	183,047	32,728	38,275	111,983	51,873	30,809	255,620	164,469	230,757	69,943
3,000	27,693	64,365	9,933	142,164	138,996	14,261	32,406	98,946	33,927	22,500	257,884	149,092	232,438	117,454
4,000	15,610	42,614	7,617	56,248	93,503	8,740	26,148	85,958	19,956	16,062	255,121	130,713	221,438	129,505
5,000	9,676	25,680	6,610	50,094	55,579	5,275	21,644	73,735	13,609	12,518	254,571	112,232	180,206	121,690
6,000	8,150	21,314	5,589	48,466	30,981	3,643	18,587	58,288	11,210	10,406	250,464	94,226	116,516	108,858
8,000	6,620	17,227	4,847	35,346	20,846	3,001	15,859	35,678	9,335	6,688	237,500	61,346	45,990	73,008
10,000	5,837	14,526	4,569	30,029	15,860	2,693	13,769	32,598	6,717	4,386	224,760	43,344	32,087	37,062
14,000	5,495	11,441	4,304	28,421	7,648	2,669	10,368	30,458	9,564	5,780	200,883	37,868	19,697	19,525
16,000	5,434	10,488	4,285	28,975	6,568	2,740	9,725	27,175	11,656	5,636	190,938	36,354	14,531	17,886
20,000	5,102	8,082	4,310	26,824	4,893	2,493	9,352	26,464	11,626	5,249	173,437	33,369	7,053	13,611

4.2.1.3 Glide/Shoal/Riffle Complex Sandy Beach

This site was comprised of three linked transects (T-15, T-16 and T-17) in the ledge and boulder complex adjacent to Sandy Beach island. The upstream end of the side channel features a gravel bar in dynamic disequilibrium that controls flow into the side channel. In its current configuration the bar keeps water out of the side channel at 500 cfs, but at the mid calibration flow begins to admit water to the side channel. Table 8 and Figures 11-14 summarize results.

Habitat Data

Rainbow trout and brown trout. Habitat suitability for juveniles peaks at 500 cfs (rainbow trout) and 540 cfs (brown trout), but does not vary significantly between 300 and 900 cfs. Adult rainbow trout suitability exhibits a sharp peak at 600cfs but remains relatively high between 400 and 1,000 cfs, a range that provides approximately 75% of optimal suitability. Adult brown trout suitability increased rapidly between flows of 300 to 800 cfs; flows greater than 600 cfs provide at least 75% of optimal habitat. Optimal habitat is achieved at 1,200 cfs; higher flows result in minor fluctuations in suitability.

Smallmouth bass. Juvenile and adult suitability reach respective optima at 600 and 1,200 cfs. These lifestages achieve 75% of their respective optima between approximately 300 and 1,000 cfs, and 600 to 4,000 cfs. Fry lifestage suitability declines at flows greater than 300 cfs. Optimal spawning suitability occurs at 500-600 cfs; 75% of optimal is exceeded from 300 to1,800 cfs. Suitability declines to 2,000 cfs, but then rises again at 3,000 cfs due to increases in the side channel that compensate for declines in the main channel.

Shallow-fast guild. Habitat suitability was based on a suite of four guild surrogates that represent habitat use for a range of species and lifestages of interest to the TWC. The greatest habitat suitability for all members of this group is at flows of 700 cfs or less. Habitat suitability peaked across a range of flows from 300 cfs (shallow-fast spawning, macroinvertebrates, and Saluda darter) to 540 cfs (robust redhorse spawning).

Shortnose sturgeon. Suitability for this species rises steadily to a peak at 4,000 cfs, and 75% of optimal occurs at approximately 3,000 cfs.

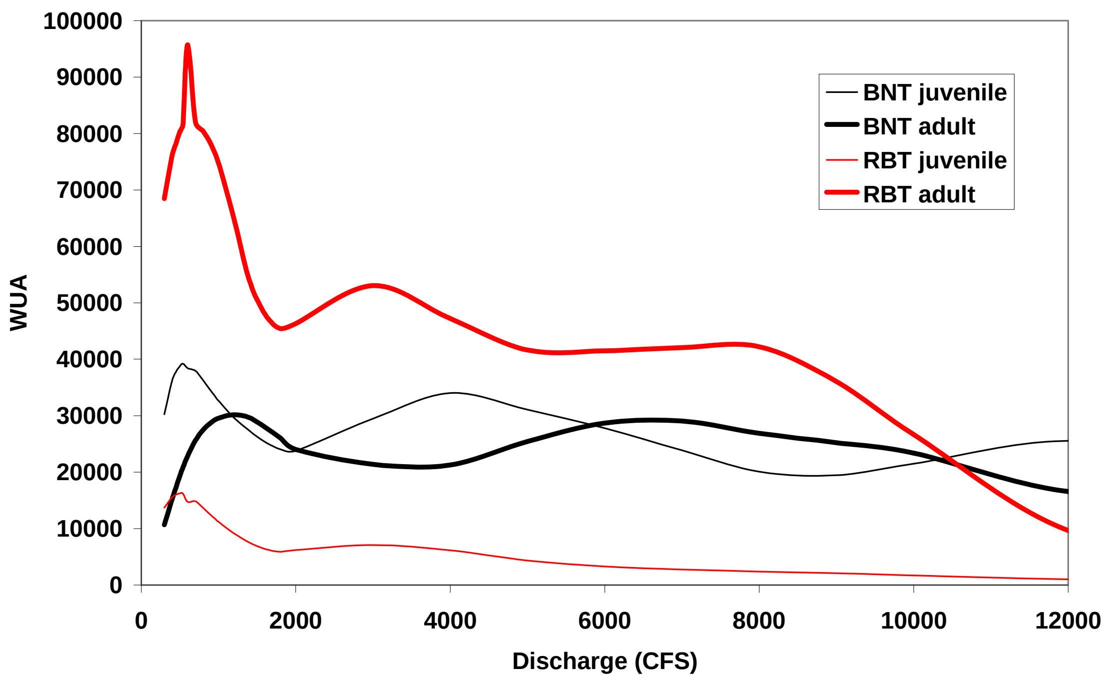


Figure 11: Saluda River Instream Flow Study – Sandy Beach Glide/Shoal/Riffle, Rainbow and Brown Trout Habitat Suitability

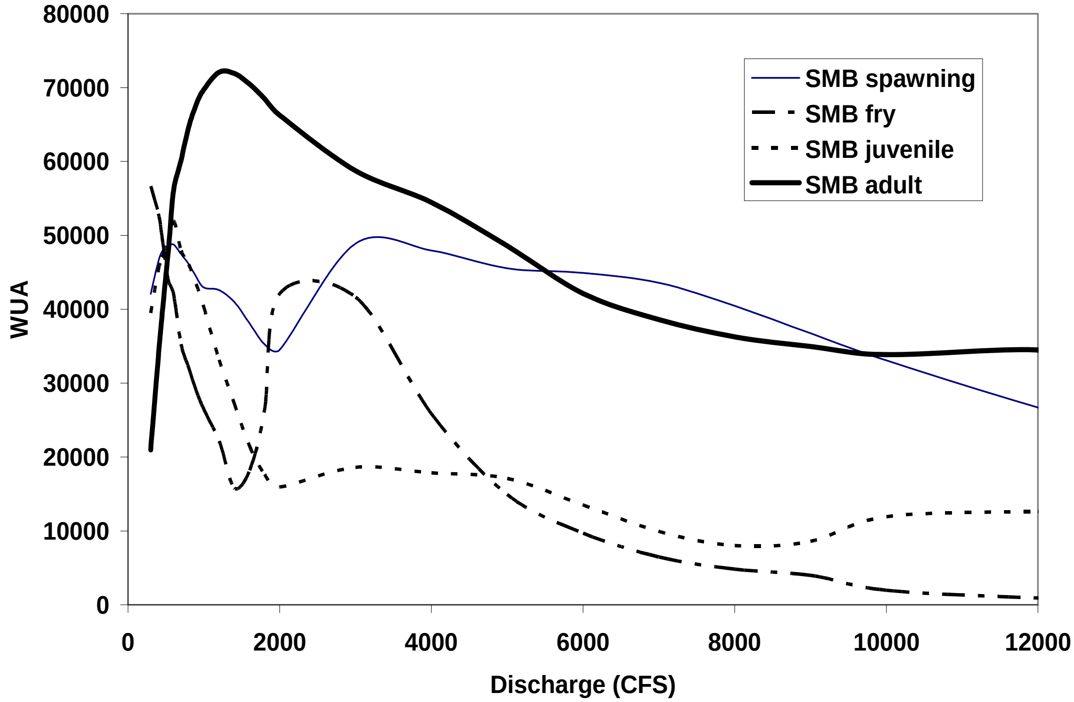


Figure 12: **Saluda River Instream Flow Study – Sandy Beach Glide/Shoal/Riffle, Smallmouth Bass Habitat Suitability**

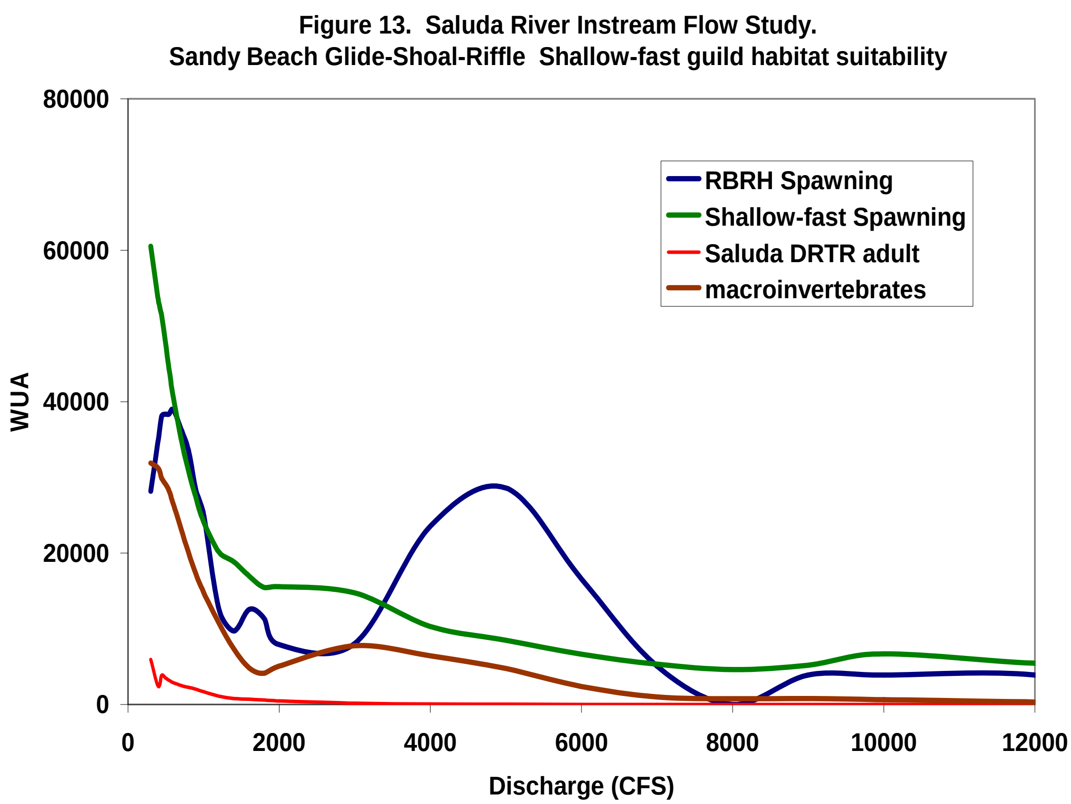


Figure 13: **Saluda River Instream Flow Study – Sandy Beach Glide/Shoal/Riffle, Shallow-Fast Guild Habitat Suitability**

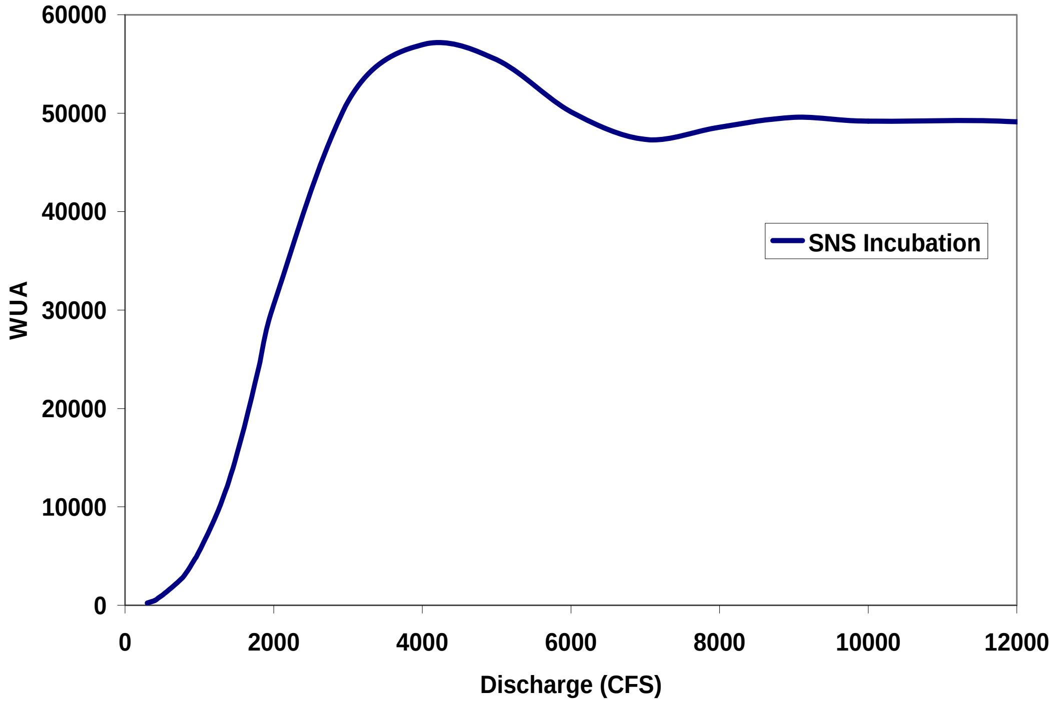


Figure 14: Saluda River Instream Flow Study – Sandy Beach Glide/Shoal/Riffle, Shortnose Sturgeon Spawning/Incubation Habitat Suitability

Table 8: Saluda Instream Flow Study – Reach 1, Sandy Beach Glide/Shoal/Riffle, Habitat Suitability-Discharge Relationship

DISCHARGE (cfs)	BNT Juvenile	BNT Adult	RBT Juvenile	RBT Adult	SMB Spawning	SMB Fry	SMB Juvenile	SMB Adult	RBRH Spawning	Shallow-fast Spawning	Saluda DRTR adult	Macroinvertebrates	SNS Incubation
300	30,257	10,686	13,725	68,475	42,089	56,634	39,483	20,983	28,173	60,523	5,938	31,897	234
400	36,219	15,198	15,558	76,074	46,514	52,898	45,333	33,631	34,919	53,515	2,400	31,193	497
446	37,723	17,176	16,006	78,127	47,781	49,916	46,991	38,898	38,088	51,406	3,847	29,861	732
500	38,773	19,363	16,228	80,367	48,504	45,848	47,972	44,741	38,351	47,562	3,465	29,050	1,030
540	39,209	20,830	16,212	81,579	48,531	43,623	48,558	48,626	38,351	44,447	3,223	28,282	1,260
600	38,434	22,853	14,713	95,729	48,763	42,047	51,997	56,052	38,923	40,615	2,865	26,485	1,619
700	37,943	25,615	14,832	82,074	47,465	35,250	47,933	60,172	36,449	35,267	2,531	23,292	2,288
800	36,267	27,488	13,657	80,441	46,143	32,080	46,068	64,645	33,613	30,884	2,265	20,083	3,034
900	34,460	28,730	12,418	78,194	44,401	28,954	43,359	67,701	28,242	27,293	1,997	17,229	4,199
1,000	32,654	29,542	11,218	74,784	42,952	26,454	40,242	69,738	25,124	24,137	1,670	14,826	5,524
1,200	29,637	30,164	9,137	64,916	42,592	22,165	33,154	72,070	12,689	20,180	1,114	10,804	8,687
1,400	27,363	29,684	7,527	54,017	41,007	15,794	27,238	71,932	9,700	18,853	781	7,340	12,678
1,800	24,053	26,035	5,900	45,455	35,294	26,260	17,664	68,496	11,389	15,466	569	4,807	24,142
2,000	23,775	24,005	6,180	46,314	34,543	42,122	15,936	66,238	7,912	15,585	451	4,108	30,559
4,000	34,025	21,257	6,159	47,231	47,965	25,879	17,848	54,458	23,520	10,301	66	5,055	56,950
6,000	27,798	28,687	3,307	41,512	44,912	9,692	13,500	42,135	16,593	6,635	14	7,754	50,139
8,000	20,087	26,898	2,389	42,205	40,467	4,821	8,028	36,259	-	4,593	-	6,433	48,576
10,000	21,498	23,360	1,704	26,668	33,094	1,976	11,926	33,850	3,870	6,684	-	4,733	49,194
12,000	25,543	16,581	1,029	9,655	26,728	915	12,657	34,494	3,870	5,453	-	2,375	49,114
14,000	20,935	17,295	859	7,194	21,291	335	12,804	32,772	-	5,008	-	996	47,342
16,000	17,977	15,851	769	6,659	16,305	-	10,808	29,430	-	4,164	-	763	44,616
18,000	18,968	16,968	729	4,761	11,848	-	8,335	27,963	-	4,689	-	777	41,489
20,000	17,838	16,808	699	2,987	7,720	-	8,908	27,241	-	4,593	-	639	38,255

4.2.1.4 Deep Pool Below Saluda Dam

A long, deep riverine pool located below the USGS gage site was surveyed by SCNDR and Kleinschmidt staff using an ADCP unit. It extends from below the abandoned bridge piers near the USGS gage to a hydraulic control formed by the gravel bar at the top of the riffle/run complex described above. Bed profile and waters surface elevations for calibration flows are shown in Appendix C. Bed profile data relative to water surface elevation reveal that at the lowest calibration flow (approximately 500 cfs), this reach provides adequate depths for striped bass and other pool dwelling species, with channel depth averaging approximately 6 to 7 ft. An increase in water surface elevation of approximately 1.5 ft was observed when flow increased to 1600 cfs, and an additional 7.5 ft was observed at the high calibration flow (10,000 cfs). The observed increases in water depth resulted in little additional wetted area or foraging habitat for pool species along the river margins, however, due to the deeply incised nature of the reach.

4.2.2 Reach No. 2 – Rawls Creek to I-26

4.2.2.1 Run

A single transect representing the uniform run habitat extending throughout the study reach was located at T-12, near Coley Island. This represents habitat comprising a uniform trapezoidal channel with gravel, sand and cobble substrates. Table 9 and Figures 15-18 summarize results.

Habitat Data

Rainbow trout. Habitat suitability for juveniles is high between 300 and 1,200 cfs, and peaks at 600 cfs. Juvenile brown trout suitability peaks at 400 cfs, but does not vary significantly between 300 and 600 cfs, A flow of approximately 1,000 cfs provides 75% of optimal habitat suitability. Adult rainbow trout suitability exhibits a plateau between 800 and 2,000 cfs; a range between 300 and 3,000 cfs exceeds 75% of optimal suitability. Adult brown trout suitability increased rapidly between flows of 300 to 700 cfs (the optimal suitability flow for this species and lifestage); suitability then declines at flows greater than 700 cfs. Flows between 300 and 900 cfs exceed 75% of optimal habitat.

Smallmouth bass. Juvenile and adult suitability's reach optima at 800 and 1,400 cfs respectively. These lifestages exceed 75% of their respective optima at approximately 400 and 500 cfs. Fry lifestage suitability declines at flows greater than 300 cfs. Optimal spawning suitability occurs at 2,000 cfs but reaches a plateau with 75% of optimal exceeded between 800-3,500 cfs.

Deep-fast guild. Habitat suitability was based on a suite of five guild surrogates that represent habitat use for a range of species and lifestages of interest to the TWC. Habitat uses represented by juvenile and adult redhorse and American shad peak at 1,600 cfs. Early lifestages represented by redhorse fry and deep-fast guild spawning show relatively little overall habitat suitability, peak at 300 cfs and tend decline at higher flows. Adult redhorse suitability peaks at 1,000-1,211 cfs.

Shortnose sturgeon. Suitability for this species rises steadily to a broad peak at 3,000 cfs, and 75% of optimal occurs in a range between approximately 1,200 to 7,000 cfs.

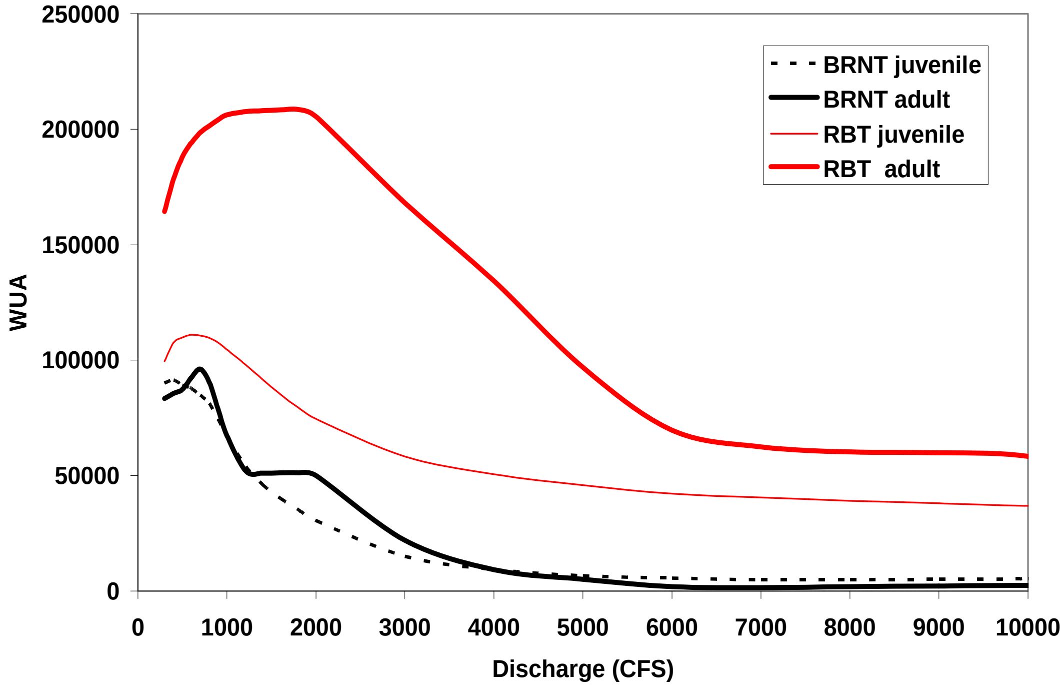


Figure 15: **Saluda River Instream Flow Study – Reach 2 Representative Run, Trout Habitat Suitability**

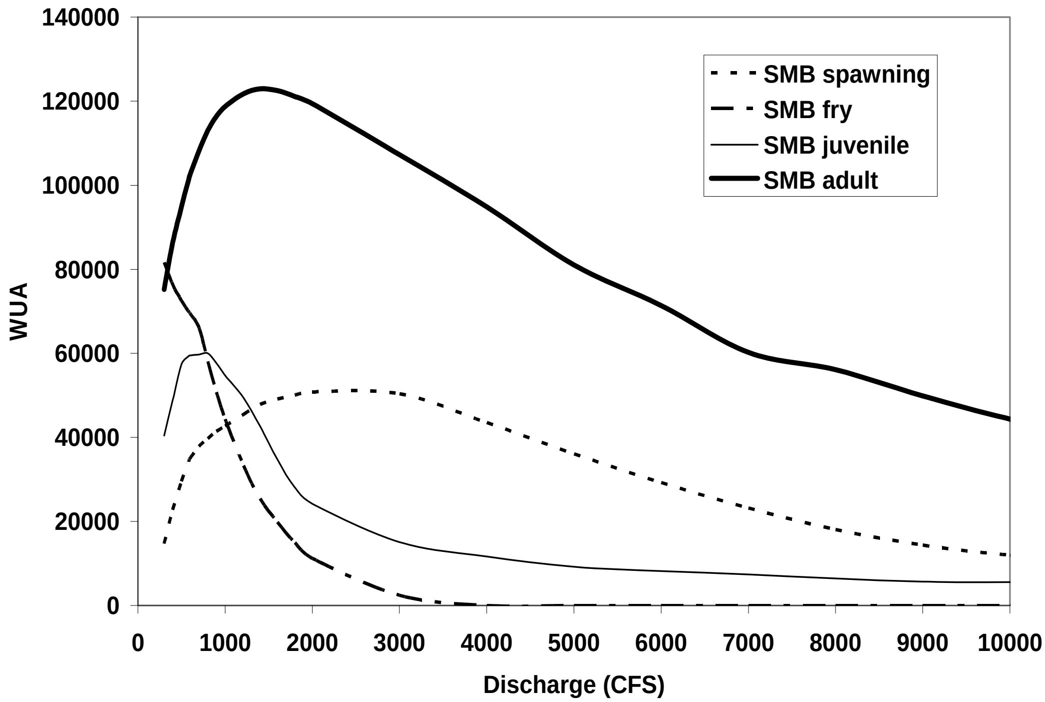


Figure 16: **Saluda River Instream Flow Study – Reach 2 Representative Run, Smallmouth Bass Habitat Suitability**

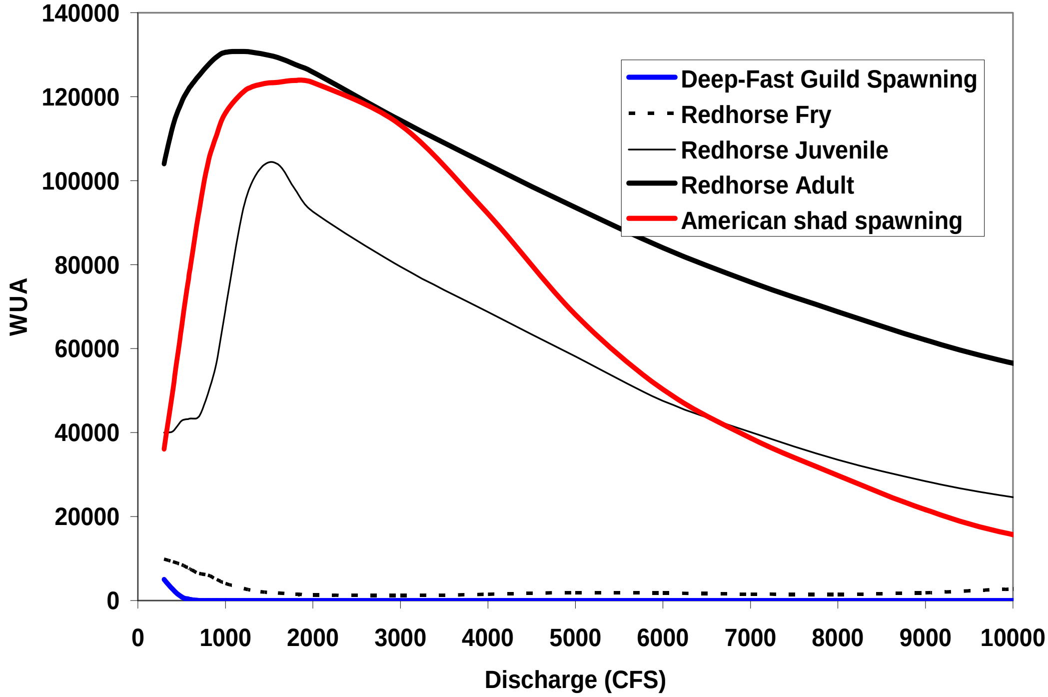


Figure 17: **Saluda River Instream Flow Study – Reach 2 Representative Run, Deep-Fast Guild Habitat Suitability**

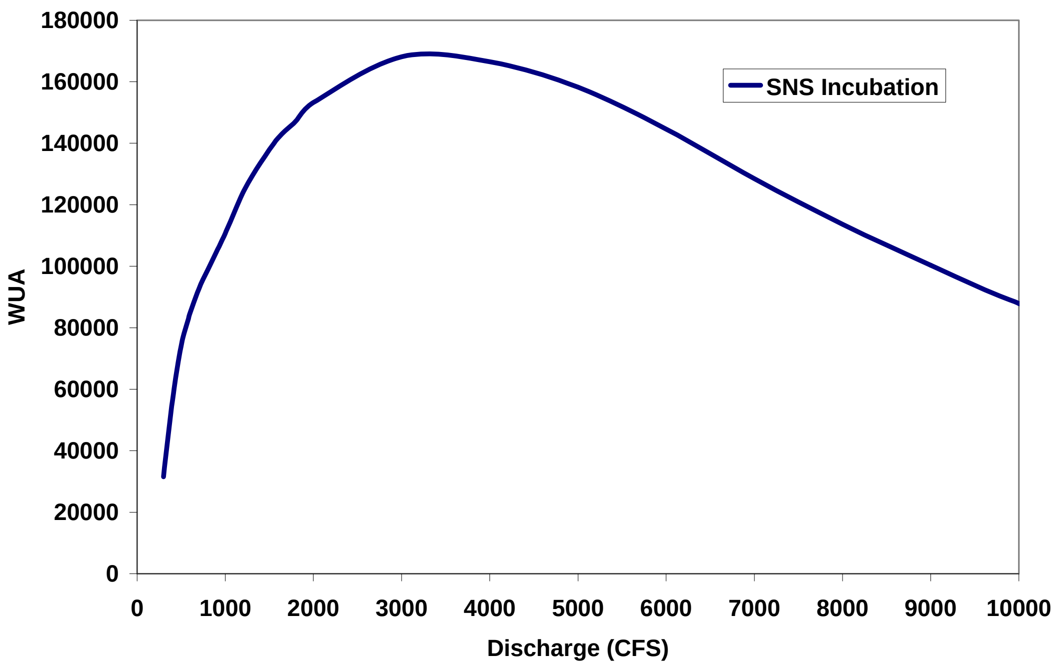


Figure 18: **Saluda River Instream Flow Study – Reach 2 Representative Run, Shortnose Sturgeon Spawning/Incubation Habitat Suitability**

Table 9: Saluda Instream Flow Study – Reach 2 Representative Run, Habitat Suitability-Discharge Relationship

DISCHARGE (cfs)	BRNT Juvenile	BRNT Adult	RBT Juvenile	RBT Adult	SMB Spawning	SMB Fry	SMB Juvenile	SMB Adult	Deep-Fast Spawning	Redhorse Fry	Redhorse Juvenile	Redhorse Adult	Am. Shad Spawning	SNS Incubation
300	89,999	83,430	99,475	164,376	14,761	81,673	40,440	75,233	5,024	9,847	40,021	104,013	36,049	31,532
400	91,374	85,555	107,511	178,365	22,744	76,336	48,841	86,375	2,610	9,196	40,333	112,997	50,084	55,888
500	89,164	87,238	109,804	187,978	29,509	72,505	57,371	94,859	874	8,486	42,810	118,737	65,217	73,956
583	88,145	91,518	110,908	193,323	34,305	69,914	59,381	101,438	284	7,667	43,264	121,941	77,319	82,999
600	87,773	92,431	111,017	194,087	35,031	69,436	59,505	102,579	192	7,376	43,344	122,455	79,672	84,639
700	84,798	96,187	110,597	198,545	37,843	66,085	59,741	108,154	-	6,419	43,856	125,044	92,721	92,489
800	81,270	90,520	109,586	201,468	39,735	58,092	60,004	112,993	-	6,025	49,227	127,510	104,082	98,785
900	74,503	78,926	107,640	204,023	41,436	50,732	57,698	116,336	-	5,019	56,881	129,482	110,943	104,717
1,000	67,424	67,335	104,532	206,251	42,708	44,324	54,778	118,709	-	4,064	69,292	130,568	116,118	110,724
1,211	53,925	51,974	97,961	207,707	45,497	33,294	49,431	121,774	-	2,836	93,913	130,770	121,274	124,530
1,400	46,013	50,985	91,587	208,068	47,833	25,439	42,716	122,956	-	2,052	102,914	130,269	122,934	133,625
1,600	40,027	51,231	85,197	208,429	49,152	19,860	34,724	122,506	-	1,748	103,925	129,330	123,454	141,683
1,800	35,152	51,195	79,493	208,599	50,090	14,938	28,100	121,083	-	1,528	97,822	127,653	123,903	147,160
2,000	30,480	49,980	74,549	205,527	50,873	11,185	24,205	119,407	-	1,310	92,659	125,863	123,370	153,222
3,000	15,058	21,950	58,247	168,164	50,384	2,450	15,099	107,279	-	1,161	79,520	114,370	113,274	168,155
4,000	9,285	9,219	50,518	134,347	43,522	-	11,657	94,865	-	1,444	68,713	103,770	92,117	166,516
6,000	5,614	1,937	42,112	69,665	29,249	-	8,217	71,371	-	1,753	47,567	84,035	50,298	144,651
8,000	4,852	1,885	39,106	60,222	18,102	-	6,448	56,100	-	1,464	33,542	68,780	29,785	113,647
10,000	5,344	2,436	36,939	58,329	11,990	-	5,550	44,360	-	2,697	24,615	56,543	15,709	87,891
12,000	7,197	2,723	35,980	46,643	9,005	-	6,094	34,931	-	3,351	18,897	47,537	8,235	67,877
14,000	9,297	3,726	35,496	38,372	7,393	-	7,162	31,314	-	3,956	15,742	40,377	4,464	51,255
18,000	14,865	6,588	35,308	30,231	4,411	-	8,186	30,516	-	3,674	12,831	33,625	644	29,040
20,000	17,931	6,813	35,302	30,245	3,017	-	7,400	30,803	-	3,035	12,441	32,685	476	22,379

4.2.2.2 Glide/Riffle

A glide and riffle complex associated with a bedrock outcrop adjacent to Corley Island was modeled with two linked transects (T-10 and T-11). These areas were dominated by large cobble, boulder and embedded sands. Table 10 and Figures 19-22 summarize results.

Habitat Data

Rainbow trout and brown trout. Habitat suitability for juveniles peaks at 1,720 cfs (rainbow trout) and 1,204 (brown trout) cfs. Rainbow trout juvenile suitability exceeds 75% of optimal between approximately 900 and 4,300 cfs. Juvenile brown trout suitability exceeds 75% of optimal between 774 and 2,500 cfs. Adult rainbow trout suitability exhibits a sharp peak at 1,032 cfs but exceeds 75% of optimal between approximately 600 and 1,700 cfs. Adult brown trout suitability increases rapidly between flows of 300 to 1,380 cfs; reaches a plateau between 1,720 and 2,580 cfs; at least 75% of optimal suitability exists between approximately 1,200 and 4,000 cfs.

Smallmouth bass. Juvenile and adults reach optima at 774 and 1,720 cfs respectively. These lifestages exceed 75% of respective optima at approximately 600 and 1,032 cfs. Fry lifestage suitability increases to optimal at 774 cfs, then sharply declines at greater flows; 75% of optimal is exceeded between 258-1,200 cfs. Optimal spawning suitability occurs at 688-860 cfs; 75% of optimal is achieved at approximately 400-1,700 cfs. Suitability declines to 2,000 cfs, but then rises again at 3,000 cfs due to increases in suitability in the side channel that compensate for declines in the main channel.

Shallow-fast guild. Habitat suitability was based on four guild surrogates representing habitat use for a range of habitat uses of interest to the TWC. The greatest overall habitat suitability for this group is at flows of 700 cfs or less. Suitability peaks across a range from 384 cfs (robust redhorse spawning) to 602 cfs (macroinvertebrate). Robust redhorse spawning shows the sharpest peak, other guild members exhibit broader plateaus, extending between 384 cfs to as high as 1,380 cfs (robust redhorse spawning).

Shortnose sturgeon. Suitability for this species rises steadily to a peak at 5,160 cfs, and 75% of optimal occurs at approximately 3,000 cfs.

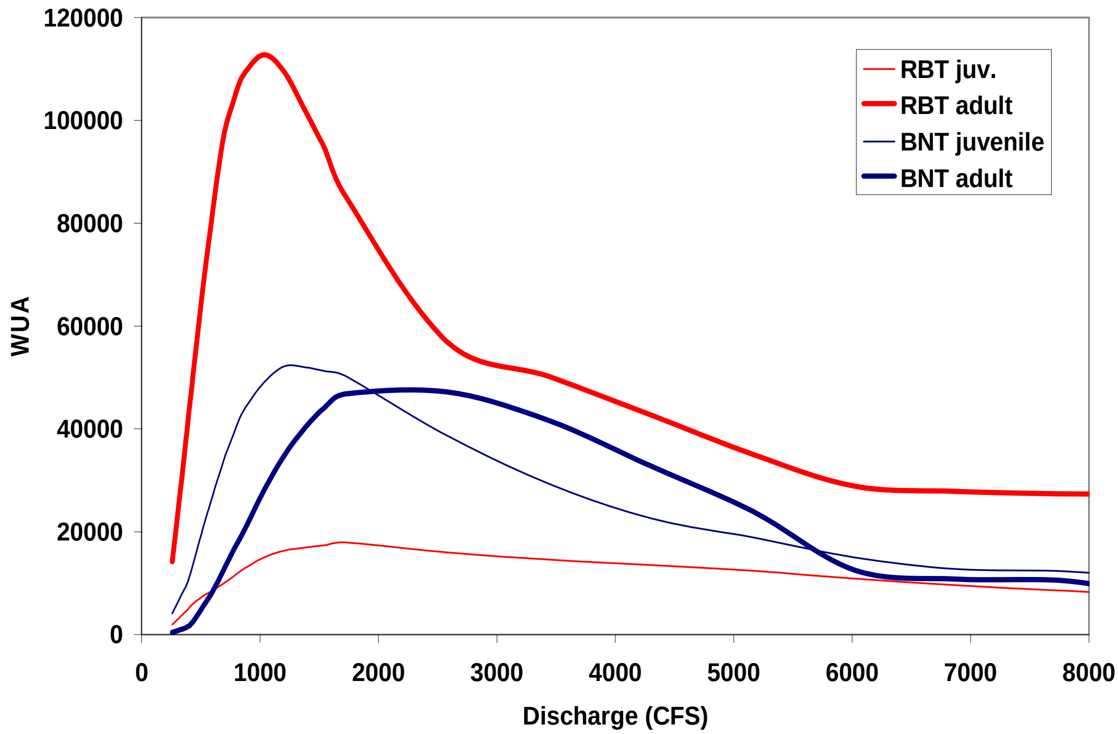


Figure 19: Saluda River Instream Flow Study – Reach 2 Glide/Riffle, Trout Habitat Suitability

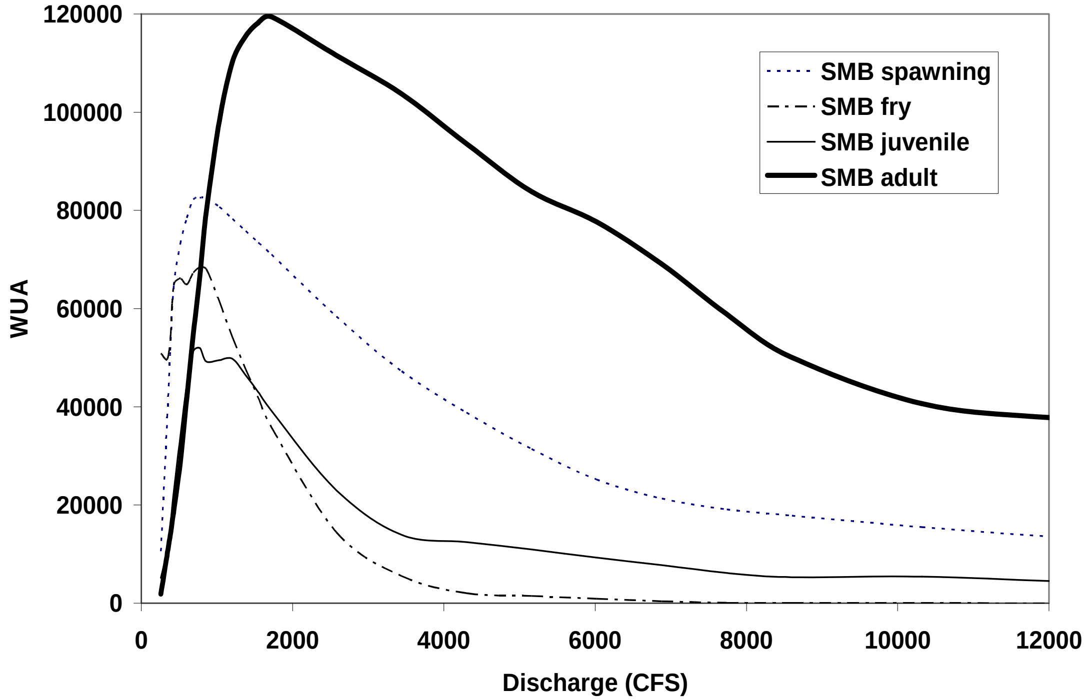


Figure 20: Saluda River Instream Flow Study – Reach 2 Glide/Riffle, Smallmouth Bass Habitat Suitability

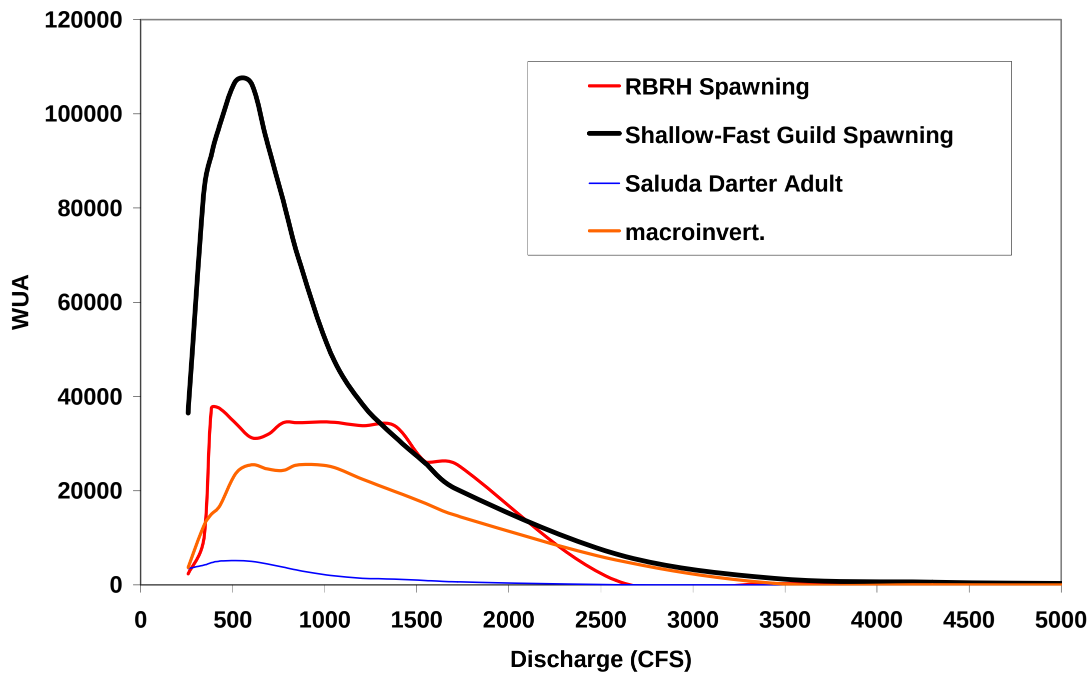


Figure 21: Saluda River Instream Flow Study – Reach 2 Glide/Riffle, Shallow-Fast Guild Habitat Suitability

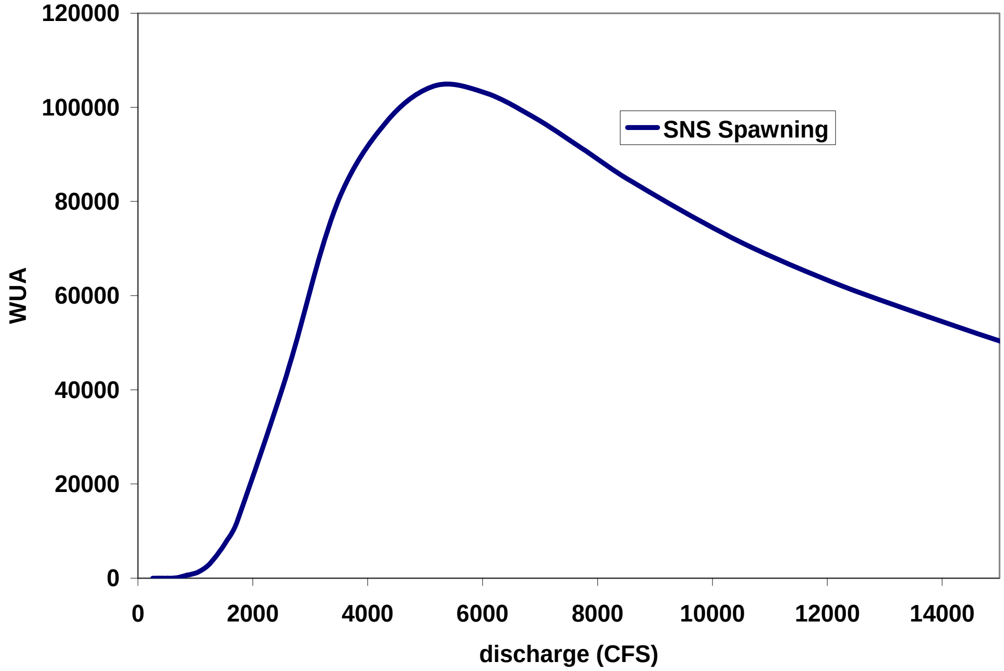


Figure 22: Saluda River Instream Flow Study – Reach 2 Glide/Riffle, Shortnose Sturgeon Spawning/Incubation Habitat Suitability

Table 10: Saluda Instream Flow Study – Reach 2 Glide/Riffle, Habitat Suitability-Discharge Relationship

DISCHARGE (cfs)	RBT Juvenile	RBT Adult	BNT Juvenile	BNT Adult	SMB Spawning	SMB Fry	SMB Juvenile	SMB Adult	RBRH Spawning	Shallow-Fast Spawning	Saluda Darter Adult	Macroinvertebrates	SNS Spawning
258	1,972	14,205	4,143	445	10,605	50,883	5,155	1,865	2,333	36,472	3,488	3,695	-
344	3,867	31,593	8,115	1,090	37,912	49,676	10,896	10,013	9,889	83,696	4,219	12,609	-
384	4,768	40,055	9,971	1,480	51,451	53,670	15,737	13,836	37,444	91,277	4,726	15,003	-
430	5,914	49,464	13,288	2,362	64,671	64,820	22,692	18,832	37,444	97,608	5,042	16,742	-
516	7,429	67,025	20,555	5,349	73,147	66,133	33,931	28,709	34,312	106,971	5,176	23,623	-
602	8,643	82,604	27,154	8,491	78,451	64,891	44,399	41,856	31,222	106,405	5,022	25,524	-
774	11,303	103,668	38,921	16,360	82,570	68,386	51,947	66,618	34,444	81,558	3,778	24,611	361
860	12,745	108,857	43,553	20,019	82,408	68,012	49,255	79,652	34,444	68,914	3,046	24,308	631
1,032	15,022	112,774	49,050	28,029	80,708	61,426	49,505	98,151	34,563	49,207	1,996	25,492	1,188
1,204	16,332	109,457	52,161	34,840	78,270	54,176	49,808	110,175	33,778	38,376	1,418	25,140	2,501
1,380	16,918	101,971	52,012	40,232	75,824	47,612	46,469	115,488	33,778	31,480	1,234	22,438	4,953
1,548	17,392	94,414	51,253	44,219	73,479	41,780	42,975	118,206	26,089	25,743	941	19,849	7,942
1,720	17,958	85,289	50,313	46,803	71,023	35,837	39,192	119,437	25,522	20,224	628	17,286	11,792
2,580	15,968	56,935	38,677	47,214	58,406	14,477	23,002	111,564	978	6,605	42	14,655	42,898
3,440	14,595	50,236	29,322	41,649	47,237	5,521	13,939	103,756	311	1,414	4	5,298	78,750
4,300	13,527	42,746	22,631	32,782	38,801	2,041	12,473	93,604	311	609	-	336	96,506
6,020	10,886	28,853	15,004	12,561	25,197	907	9,294	77,675	-	250	-	31	103,180
6,880	9,593	27,833	12,760	10,795	21,319	411	7,757	69,080	-	306	-	13	98,005
8,600	7,742	27,318	11,361	8,534	17,830	74	5,310	50,058	-	290	-	13	84,223
10,320	6,437	27,171	11,172	9,166	15,487	45	5,441	40,649	-	258	-	13	72,409
12,040	5,549	27,136	10,131	7,623	13,525	12	4,533	37,762	-	186	-	10	63,128
15,480	4,011	22,861	7,493	9,343	11,355	-	3,260	33,601	-	156	-	6	48,541
17,200	3,405	20,484	6,590	6,258	10,725	-	3,199	30,729	-	148	-	-	43,009

4.2.2.3 Corley Side Channel

The bedrock outcrop at the tip of Corley Island acts as a hydraulic control to the side channel, which is composed primarily of gravel and sand and run/glide habitat with steep banks. Several side cuts across the island interconnect it with the main channel. This area was described by transects T-13 and T-14. Table 11 and Figures 23-26 summarize results.

Habitat Data

Rainbow trout and brown trout. Habitat suitability for juveniles peaks at 140 cfs (rainbow trout) and 42 (brown trout) cfs. Rainbow trout juvenile suitability exceeds 75% of optimal at flows as high as approximately 400 cfs. Juvenile brown trout suitability exceeds 75% of optimal at flows as high as 140 cfs. Adult rainbow trout suitability exhibits a broad peak at 280 cfs but exceeds 75% of optimal between approximately 85 and 1,400 cfs. Adult brown trout suitability reaches a plateau between 70 and 140cfs and exceeds 75% of optimal suitability between approximately 56 and 225 cfs.

Smallmouth bass. Juvenile and adult suitability reaches optima at 42 and 560 cfs respectively. Juvenile suitability is essentially a plateau between 42 and 280; adult suitability exhibits a plateau between 280 and approximately 1,500 cfs. Fry lifestage suitability sharply declines at flows greater than 42 cfs; 75% of optimal is exceeded up to approximately 75 cfs. Optimal spawning suitability occurs at 560 cfs in a plateau between 280 and 840 cfs; 75% of optimal is exceeded at approximately 200-1,500 cfs.

Shallow-slow guild. Habitat suitability is based on two guild surrogates representing habitat uses for species and lifestages of interest to the TWC. Redbreast sunfish spawning habitat suitability declines above 42 cfs but retains 75% of optimal up to approximately 70 cfs. Habitat suitability for shallow-slow guild YOY/fry fluctuates across the range with three peaks at 196, 560, and 980 cfs. This reflects the creation and dissolution of various micro-shelters in the channel across the range of flows.

Shortnose sturgeon. Suitability for this species rises steadily to a peak at 1, 400 cfs, and 75% of optimal occurs at approximately 600 cfs.

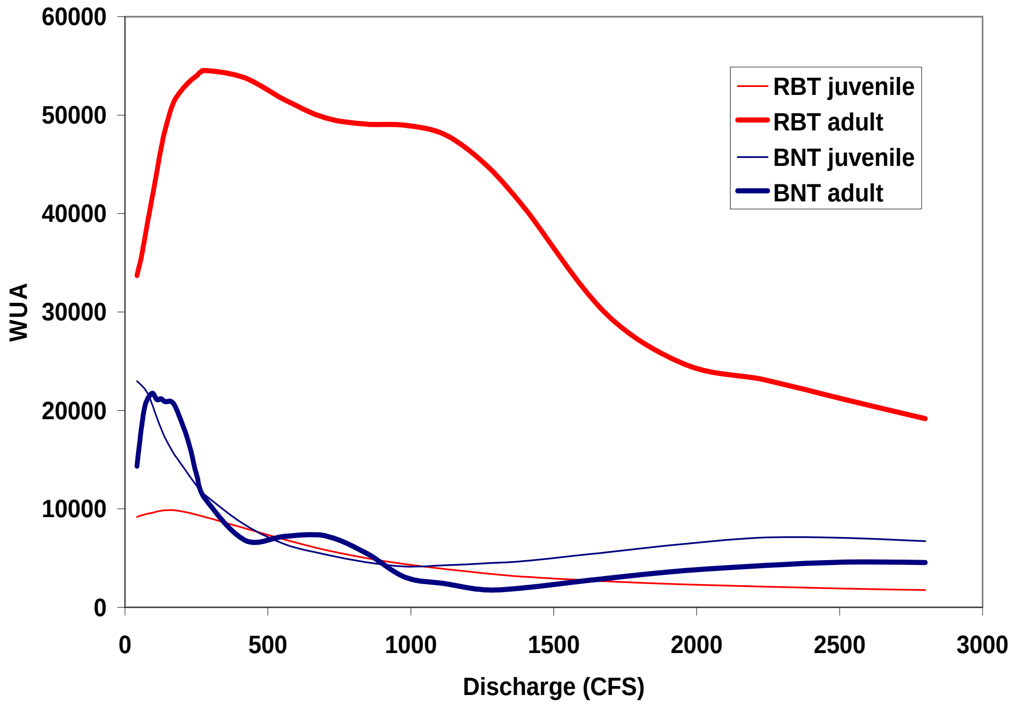


Figure 23: Saluda River Instream Flow Study – Reach 2 Side Channel Glide, Trout Habitat Suitability

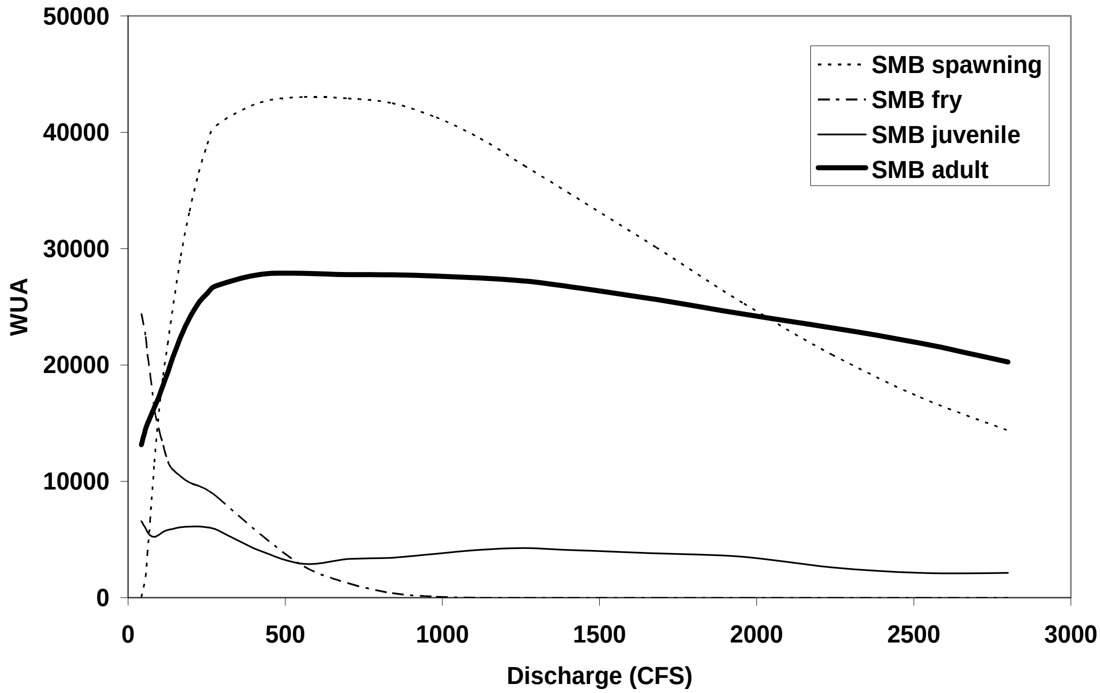


Figure 24: **Saluda River Instream Flow Study – Reach 2 Side Channel Glide, Smallmouth Bass Habitat Suitability**

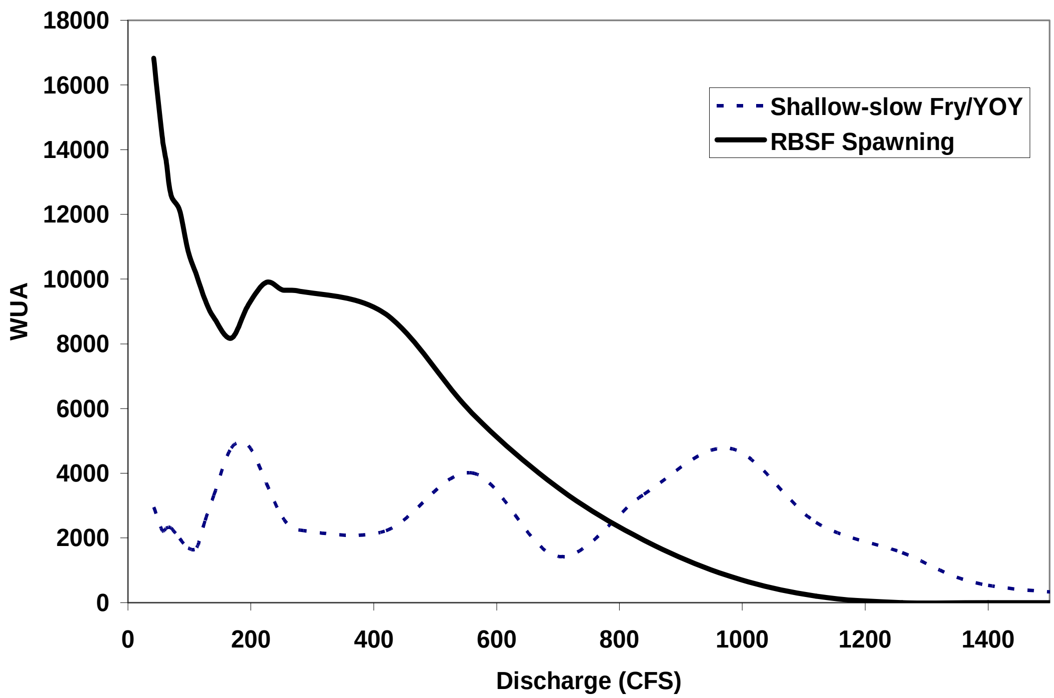


Figure 25: **Saluda River Instream Flow Study – Reach 2 Side Channel Glide, Shallow-Slow Guild Habitat Suitability**

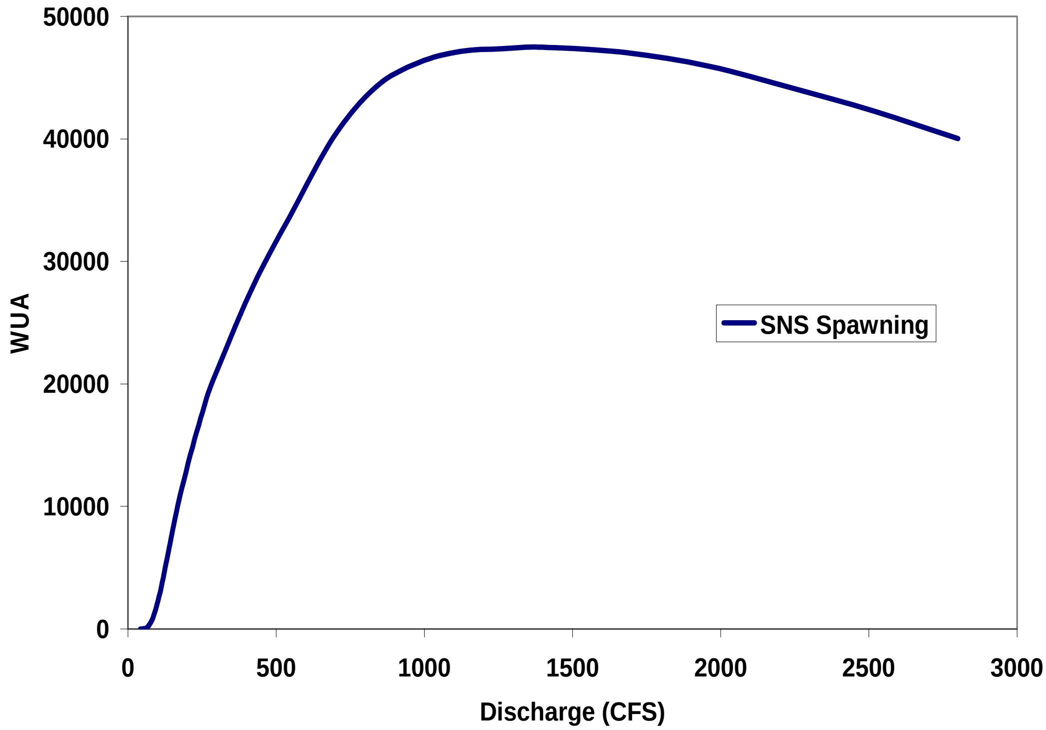


Figure 26: Saluda River Instream Flow Study – Reach 2 Side Channel Glide, Shortnose Sturgeon Spawning/Incubation Habitat Suitability

Table 11: Saluda Instream Flow Study – Reach 2, Side Channel Glide, Habitat Suitability-Discharge Relationship

DISCHARGE (cfs)	Shallow-Slow	RBSF Spawning	RBT Juvenile	RBT Adult	BNT Juvenile	BNT Adult	SMB Spawning	SMB Fry	SMB Juvenile	SMB Adult	SNS Spawning
42	2,951	16,826	9,180	33,713	22,971	14,348	56	24,446	6,584	13,151	-
56	2,212	14,345	9,335	35,384	22,614	17,844	1,853	22,446	5,953	14,528	14
70	2,305	12,599	9,432	37,577	22,154	20,479	6,683	19,265	5,371	15,508	282
84	1,988	12,127	9,524	39,863	21,491	21,408	11,657	16,202	5,235	16,382	897
98	1,688	10,870	9,624	42,069	20,398	21,735	15,971	14,491	5,409	17,275	1,961
112	1,698	10,105	9,730	44,297	19,247	21,100	19,094	13,113	5,670	18,272	3,377
126	2,540	9,338	9,812	46,547	18,181	21,185	21,818	11,719	5,816	19,351	5,026
140	3,311	8,811	9,859	48,458	17,241	20,900	24,398	11,097	5,905	20,419	6,718
196	4,849	9,208	9,759	52,443	14,563	18,985	33,208	9,902	6,122	24,041	12,843
225	3,700	9,897	9,598	53,370	13,389	16,538	36,548	9,597	6,129	25,360	15,529
280	2,243	9,626	9,183	54,523	11,427	11,047	40,580	8,721	5,859	26,804	19,835
420	2,220	8,913	8,026	53,793	8,377	6,821	42,569	5,484	4,031	27,795	27,880
560	4,013	5,861	6,890	51,540	6,407	7,197	43,032	2,684	2,918	27,876	34,293
700	1,425	3,552	5,842	49,732	5,383	7,268	42,906	1,241	3,330	27,775	40,383
840	3,346	1,928	5,023	49,096	4,600	5,571	42,507	398	3,439	27,750	44,311
980	4,765	812	4,393	48,981	4,144	3,051	41,277	82	3,772	27,634	46,241
1,260	1,542	-	3,456	45,029	4,467	1,787	37,139	-	4,261	27,223	47,363
1,400	533	-	3,109	40,475	4,713	1,992	34,818	-	4,101	26,763	47,487
1,960	311	-	2,320	24,686	6,445	3,723	25,270	-	3,515	24,358	45,936
2,520	2,129	-	1,920	21,105	7,051	4,609	17,223	-	2,131	21,893	42,243
2,800	2,633	-	1,755	19,177	6,726	4,550	14,359	-	2,126	20,254	40,035

4.2.3 Reach No. 3 – Oh Brother/Ocean Boulevard to Millrace Rapids

4.2.3.1 Ocean Boulevard

A large island separates the Saluda River at the crest of the Fall Line. The river-left channel (Ocean Boulevard) is comprised of shoal and run mesohabitat with dense boulder cover resting on cobble and ledge substrate; the mid section is a run with ledge substrate, and the lower section is a shoal with ledge substrate and limited object cover. This complex was modeled with three transects (T-7, T-8, and T-9). Table 12 and Figures 27-30 summarize results.

Habitat Data

Rainbow trout and brown trout. Habitat suitability for juveniles peaks at 655 cfs (brown trout) and 562 cfs (rainbow trout). Rainbow trout juvenile suitability exceeds 75% of optimal between 187 and approximately 1,500 cfs; juvenile brown trout suitability exceeds 75% of optimal between approximately 250 and 1,900 cfs. Adult rainbow trout suitability exhibits a peak at 655 cfs and exceeds 75% of optimal between 328 and 4,212 cfs. Adult brown trout suitability is optimal at 1,404 cfs and exceeds 75% of optimal suitability between approximately 600 to 3,600 cfs.

Smallmouth bass. Juveniles and adults reach optima at 374 and 3,276 cfs respectively. The adult lifestage has a very broadly arched WUA curve that exceeds 75% of optimal between approximately 750 and 7,500 cfs. Juvenile suitability exceeds 75% of optimal between approximately 230 and 2,000 cfs. Fry lifestage suitability increases to a peak at 234 cfs, then gradually declines at greater flows. 75% of optimal is exceeding at flows of up to 655 cfs. Spawning suitability is very limited, but gradually increases across the entire flow range.

Shallow-fast guild. Habitat suitability was based on four guild surrogates representing habitat uses of interest to the TWC. Habitat suitability peaks from 281cfs (macroinvertebrate) to 1,404 cfs (shallow-fast spawning *and* darter). Robust redhorse spawning suitability is very low and responds poorly to flow changes. Macroinvertebrate suitability peaks at 281 cfs. Shallow-fast spawning habitat suitability exceeds 75% of optimal between approximately 850 and 2,400 cfs. Saluda darter suitability reaches a plateau between 655 and 1,872 cfs with 75% of optimal exceeded between approximately 700 and 1,700 cfs.

Shortnose sturgeon. Suitability for this species rises throughout the modeled range, with the steepest increases occurring between 3,000 and 7,488 cfs.

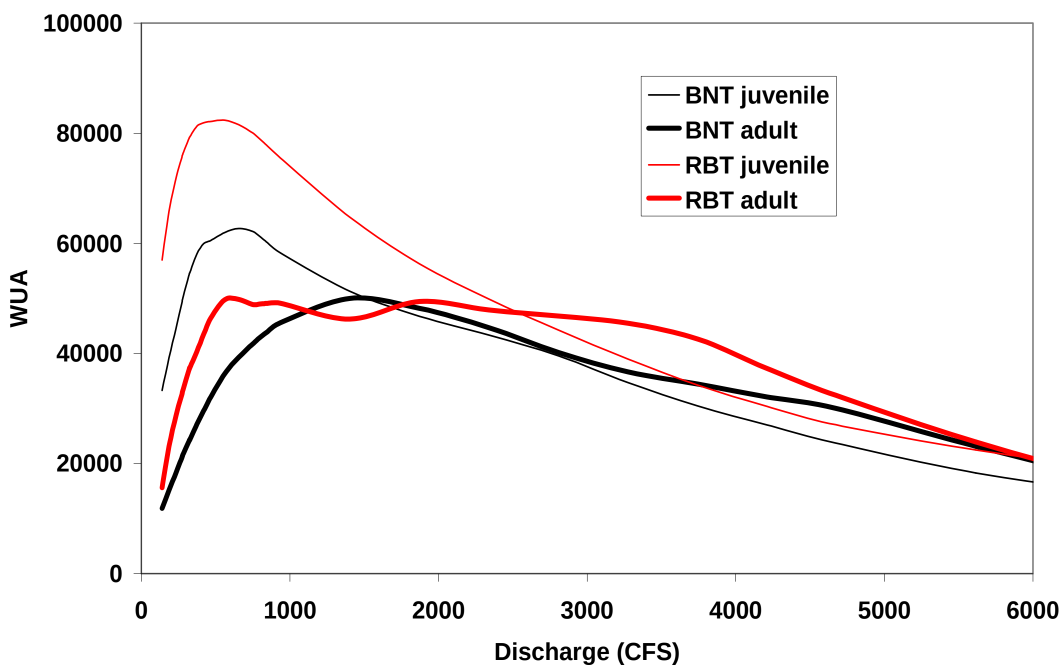


Figure 27: Saluda River Instream Flow Study – Ocean Boulevard Shoal-Run, Trout Habitat Suitability

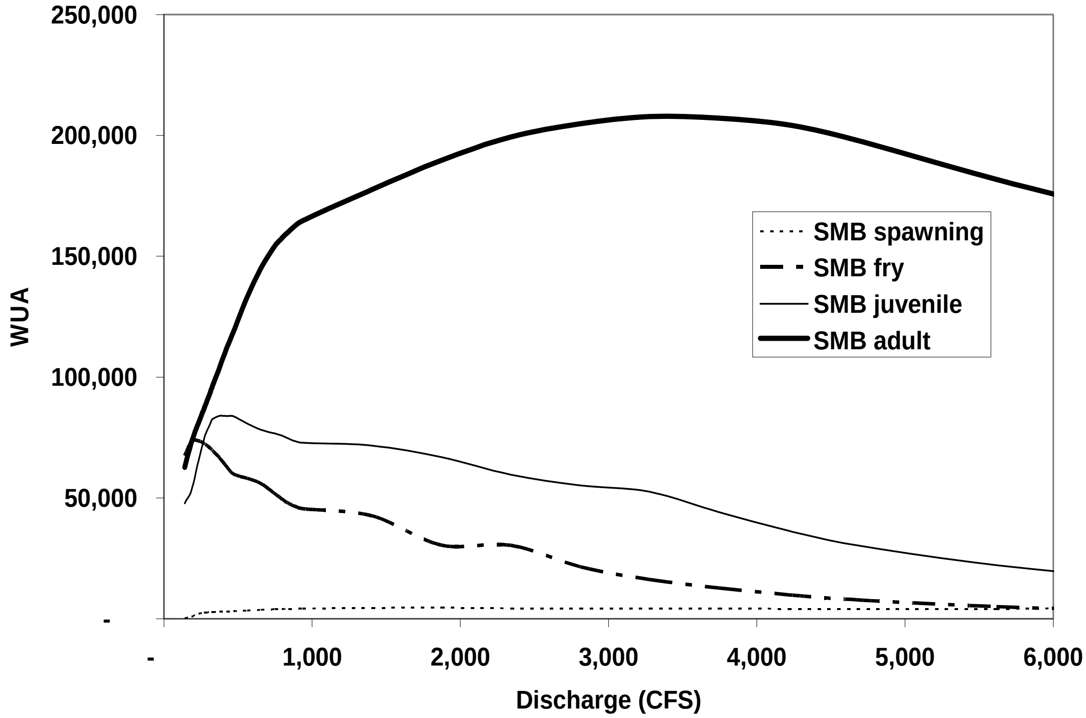


Figure 28: Saluda River Instream Flow Study – Ocean Boulevard Shoal-Run, Smallmouth Bass Habitat Suitability

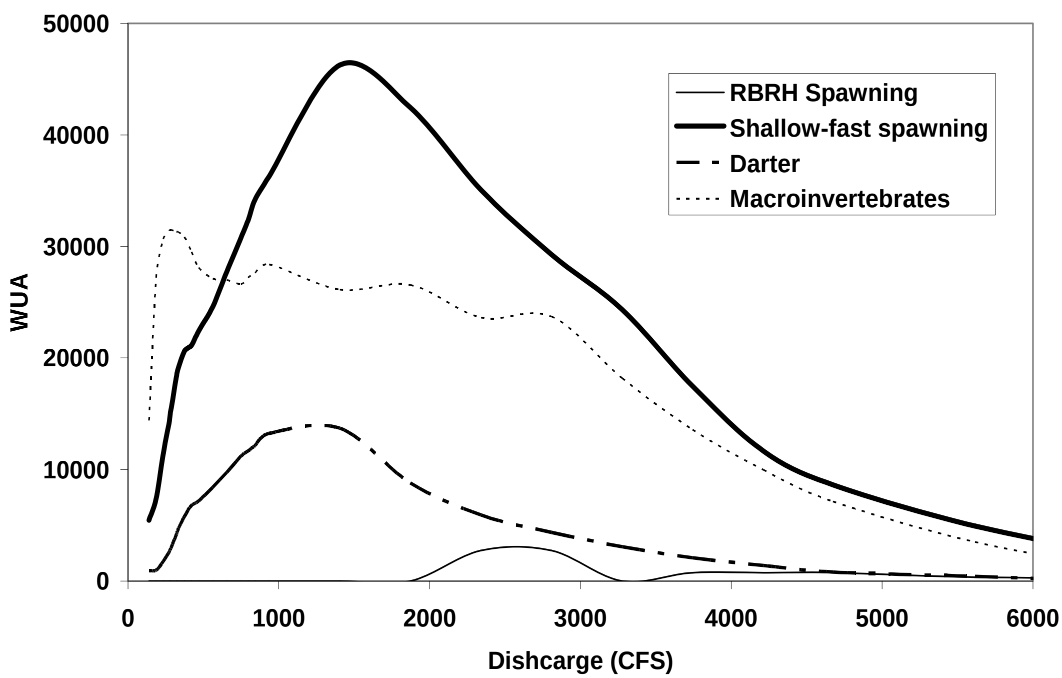


Figure 29: Saluda River Instream Flow Study – Ocean Boulevard Shoal-Run, Shallow-Fast Guild Habitat Suitability

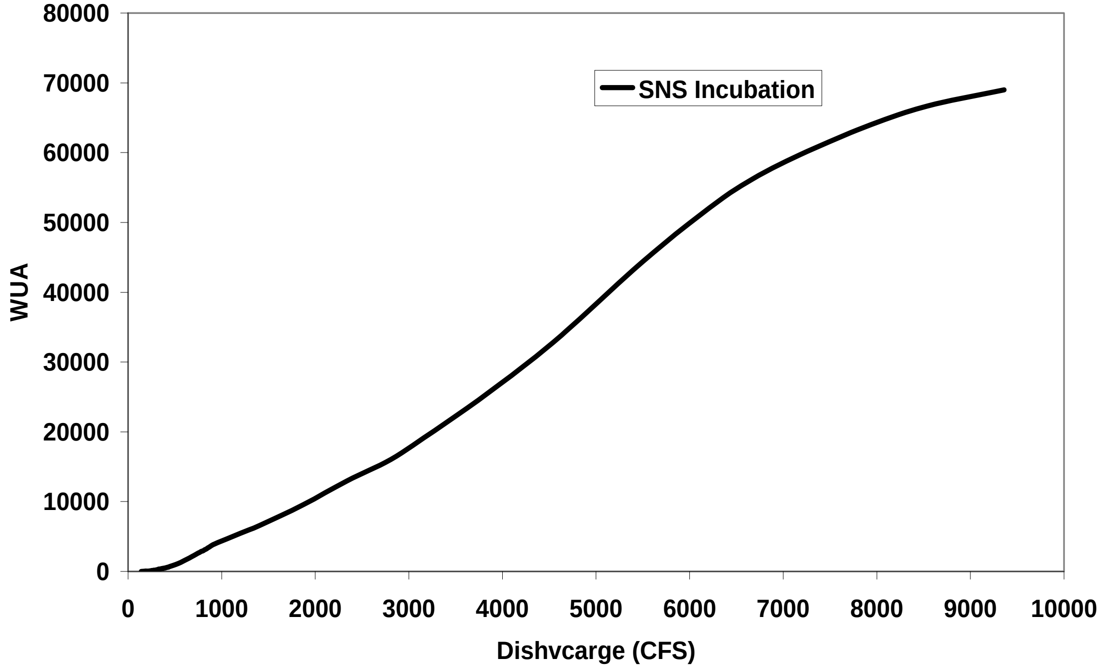


Figure 30: Saluda River Instream Flow Study – Ocean Boulevard Shoal-Run, Shortnose Sturgeon Habitat Suitability

Table 12: Saluda Instream Flow Study – Ocean Boulevard Shoal-Run, Habitat Suitability-Discharge Relationship

DISCHARGE (cfs)	SMB Spawning	SMB Fry	SMB Juvenile	SMB Adult	BNT Juvenile	BNT Adult	RBT Juvenile	RBT Adult	RBRH Spawning	Shallow-Fast Spawning	Darter	Macroinvertebrates	SNS Incubation
140	186	67,471	47,800	62,653	33,285	11,875	56,948	15,600	-	5,451	938	14,400	11
187	879	73,506	53,339	73,324	39,228	15,152	65,780	23,110	-	7,407	969	27,200	28
234	2,040	73,614	65,537	81,185	44,520	18,328	71,805	28,688	-	11,436	1,767	30,666	62
273	2,593	72,442	74,856	87,186	49,213	21,074	75,628	32,542	-	14,266	2,616	31,399	147
281	2,621	72,070	76,399	88,453	50,119	21,609	76,294	33,308	-	14,978	2,802	31,476	161
322	2,801	70,035	82,103	95,280	54,271	24,106	79,078	37,067	-	18,429	4,210	31,353	287
328	2,828	69,618	82,649	96,268	54,813	24,447	79,415	37,531	-	18,816	4,468	31,336	304
374	2,975	66,713	83,991	103,821	58,048	27,112	81,257	40,334	-	20,607	5,782	30,862	443
421	3,066	63,046	83,903	111,589	59,931	29,622	81,903	43,511	-	21,129	6,765	29,508	593
468	3,157	59,938	83,751	118,617	60,526	32,071	82,128	46,410	-	22,411	7,178	28,104	800
562	3,415	58,090	80,819	132,978	61,958	36,357	82,379	49,774	-	24,594	8,404	27,119	1,287
655	3,706	55,930	78,204	145,177	62,709	39,298	81,578	49,824	-	27,759	9,738	26,985	1,932
749	3,976	51,659	76,622	154,261	62,180	41,703	80,050	48,904	-	30,775	11,185	26,619	2,627
796	4,094	49,579	75,787	157,410	61,298	42,828	79,005	48,959	-	32,352	11,666	27,196	2,946
842	4,196	47,745	74,577	160,107	60,267	43,789	77,864	49,073	-	34,202	12,153	27,641	3,291
936	4,223	45,573	72,808	164,643	58,277	45,548	75,527	49,125	-	36,283	13,231	28,391	4,007
1,404	4,554	42,632	71,632	177,553	51,314	49,982	64,748	46,247	-	46,275	13,697	26,120	6,583
1,872	4,572	30,493	66,837	189,642	46,750	48,194	56,261	49,408	-	42,471	8,796	26,551	9,556
2,340	4,313	30,363	59,643	199,369	43,348	44,668	49,903	47,892	2,732	35,084	5,914	23,630	12,969
2,808	4,380	21,569	55,188	204,741	39,559	40,185	44,233	46,784	2,732	29,285	4,354	23,724	16,040
3,276	4,361	16,250	52,613	207,775	34,685	36,633	38,964	45,500	-	24,347	3,078	18,191	20,181
3,744	4,247	12,756	44,162	207,120	30,438	34,448	34,228	42,614	740	17,470	2,082	13,569	24,545
4,212	4,138	9,961	36,454	204,338	27,016	32,105	30,370	37,269	740	11,670	1,391	9,972	29,260
4,674	4,041	7,894	30,359	197,951	23,701	30,029	27,039	32,405	740	8,622	799	7,133	34,348
5,616	4,194	5,102	22,172	181,759	18,297	23,160	22,472	23,891	351	4,927	414	3,500	45,715
6,552	4,527	3,476	16,829	167,240	14,859	17,191	19,159	17,186	351	2,574	15	1,344	55,277
7,488	4,693	2,415	13,356	151,138	13,119	13,695	16,945	12,919	1,130	1,495	0	232	61,525
8,424	4,829	1,603	11,666	137,714	12,406	11,051	15,163	9,835	779	974	-	30	66,251
9,360	5,107	959	10,526	125,846	12,202	9,373	13,761	8,913	779	662	-	18	69,004

4.2.3.2 Oh Brother Rapids

The river-right channel (Oh Brother Rapids) is comprised of moderate-gradient boulder/cobble turbulent flow at most discharges. The upper portion has abundant object cover (large boulders); the middle section is similar but has less object cover, and the lower segment is a complex of cobble and gravel chutes and eddies. This complex was modeled with three transects (T-4, T-5, and T-6). Table 13 and Figures 31-34 summarize results.

Habitat Data

Rainbow trout and brown trout. Habitat suitability for juveniles peaks at 638 cfs (rainbow trout) and 908-1,064 cfs (brown trout). Rainbow trout juvenile suitability exceeds 75% of optimal between 266 and approximately 1,700 cfs; juvenile brown trout suitability was at least 75% of optimal between approximately 400 and 1,600 cfs. Adult rainbow trout suitability ascends sharply to 426 cfs and inflects to a plateau to 851 cfs[8] and exceeds 75% of optimal between 280 and approximately 2,200 cfs. Adult brown trout suitability reaches a broad peak at 2,128 cfs and exceeds 75% of optimal suitability between approximately 1,000 and 4,000 cfs.

Smallmouth bass. Juvenile and adult suitability reaches optima at 532 and 1,596 cfs respectively, and exceed 75% of respective optima at approximately 225 and 700 cfs. Fry suitability increases to a plateau between 266 and 479 cfs, then declines. 75% of optimal is exceeded between approximately 160-908 cfs. Spawning suitability achieves a plateau between 479 and 1,064 cfs, and 75% of optimal is exceeded at approximately 250-1,600 cfs.

[8] The jog in the curve is an artifact of hydraulic calibration at transect 4

Shallow-fast guild. Habitat suitability was based on four guild surrogates that represent a habitat uses of interest to the TWC. Habitat suitability peaks across a range of flows from 160 cfs (Saluda darter) to 372 cfs (robust redhorse). Most of these habitat suitability indices exceed 75% of optimal suitability between 213 and 479 cfs.

Shortnose sturgeon. Suitability for this species is optimal at 6,384 cfs, with the steepest increases occurring between 1,596 and 4,788 cfs.

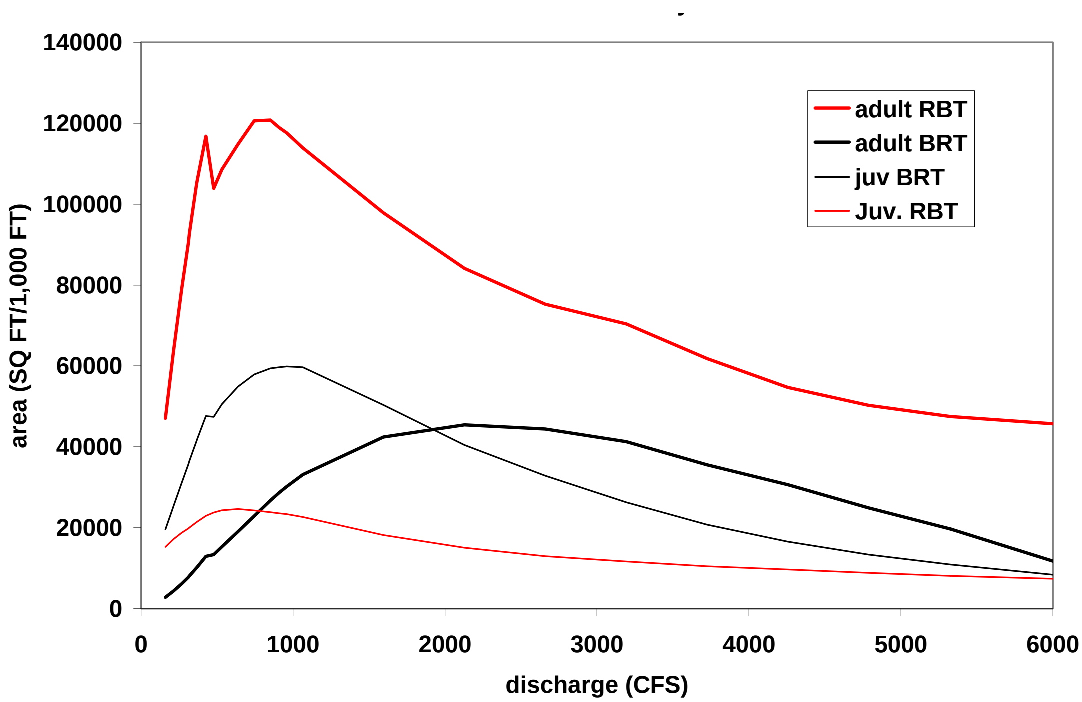


Figure 31: Saluda River Instream Flow Study – Oh Brother Rapids Riffle, Trout Habitat Suitability

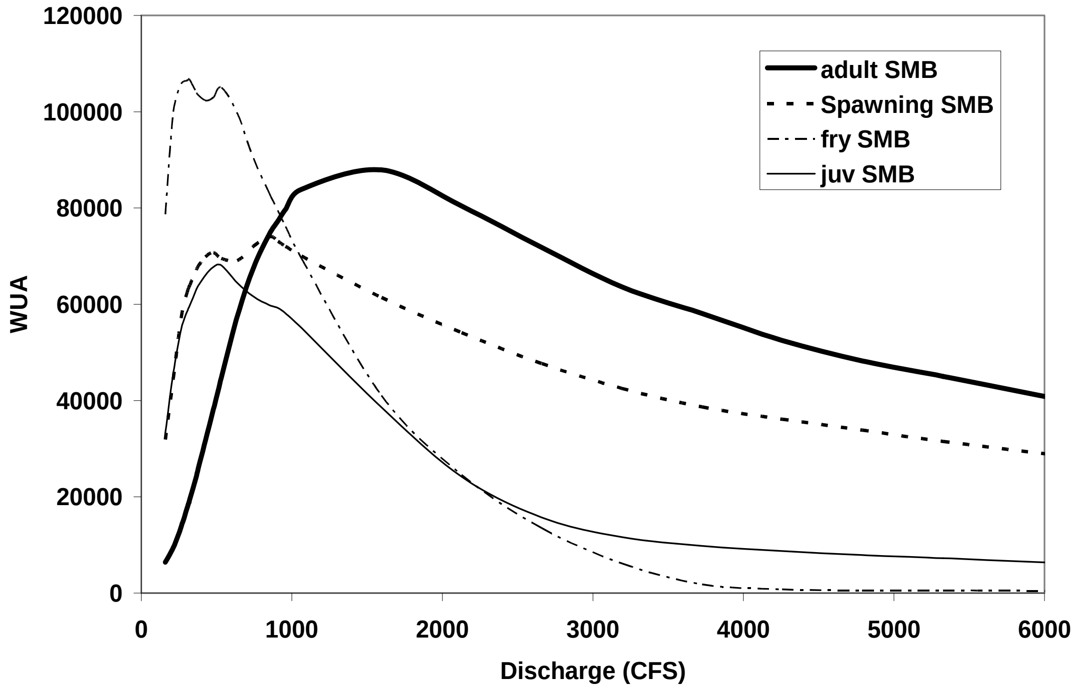


Figure 32: **Saluda River Instream Flow Study – Oh Brother Rapids Riffle, Smallmouth Bass Habitat Suitability**

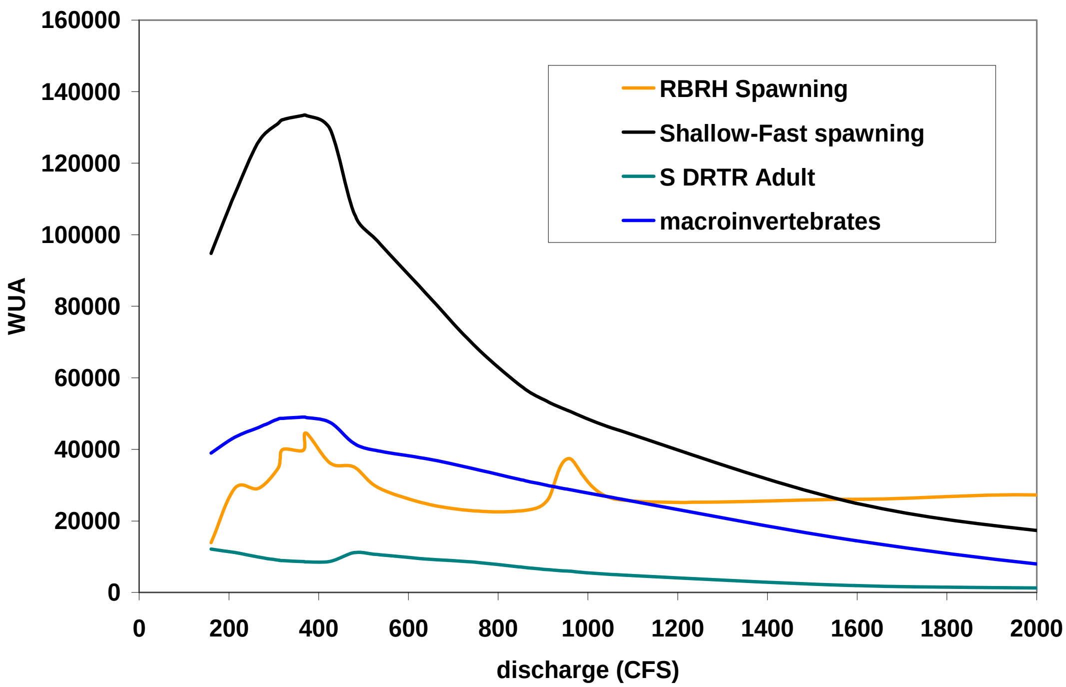


Figure 33: **Saluda River Instream Flow Study – Oh Brother Rapids Riffle, Shallow-Fast Guild Habitat Suitability**

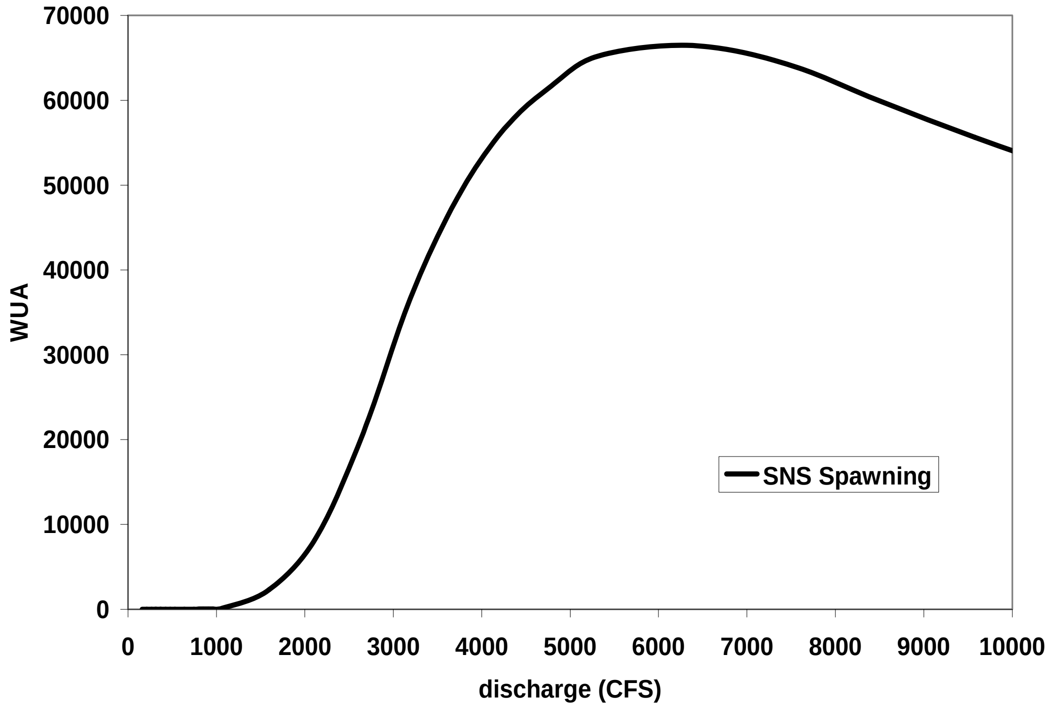


Figure 34: Saluda River Instream Flow Study – Oh Brother Rapids Riffle, Shortnose Sturgeon Spawning/Incubation Habitat Suitability

Table 13: Saluda Instream Flow Study – Oh Brother Riffle, Habitat Suitability-Discharge Relationship

DISCHARGE (CFS)	WETTED AREA	Juv BRT	Adult BRT	Juv. RBT	Adult RBT	Spawning SMB	Fry SMB	Juv SMB	Adult SMB	RBRH Spawning	Shallow-Fast Spawning	S DRTR Adult	Macroinvertebrates	[illegible]
160	186,316	19,529	2,795	15,271	47,062	31,916	78,688	33,288	6,439	13,905	94,785	12,132	38,969	
213	216,462	25,284	4,372	17,168	63,408	44,607	99,971	45,717	9,465	29,126	111,342	11,184	43,354	
266	225,065	31,010	6,121	18,759	78,808	57,330	105,790	54,916	13,862	29,126	126,011	9,921	46,139	
310	235,139	35,604	7,762	19,825	90,237	62,872	106,484	58,818	18,148	34,834	131,093	8,999	48,479	
319	237,910	36,519	8,111	20,058	92,802	63,671	106,740	59,474	19,062	39,908	132,139	8,907	48,697	
366	243,592	41,494	10,112	21,370	105,053	67,082	103,953	63,112	24,312	39,782	133,371	8,622	49,027	
372	244,368	42,140	10,395	21,531	106,325	67,561	103,697	63,484	25,036	44,542	133,319	8,584	48,929	
426	251,102	47,635	12,925	22,922	116,806	69,873	102,311	66,020	31,673	36,151	129,436	8,698	47,533	
479	258,654	47,389	13,359	23,750	103,891	70,722	102,934	67,718	38,116	35,029	105,889	11,104	41,630	
532	263,132	50,545	15,285	24,308	108,538	69,529	105,037	68,064	44,700	29,321	98,133	10,602	39,620	
638	264,910	54,903	19,032	24,607	114,812	69,060	99,660	64,412	57,480	24,881	83,803	9,388	37,452	
745	265,512	57,900	22,873	24,254	120,614	72,023	90,308	61,601	67,494	22,832	69,239	8,512	34,607	
851	266,155	59,402	26,731	23,852	120,811	74,051	83,016	59,806	74,546	22,832	57,694	7,089	31,523	1
908	266,491	59,657	28,660	23,570	118,930	73,049	79,347	59,213	77,286	25,568	53,535	6,423	30,000	2
958	266,773	59,864	30,202	23,328	117,589	72,048	76,164	58,135	79,675	37,419	50,708	5,923	28,749	2
1,064	267,299	59,667	33,151	22,655	113,938	70,048	69,495	55,076	83,862	26,003	45,529	4,947	26,303	1
1,596	268,498	50,339	42,434	18,160	97,871	61,395	41,013	38,590	87,921	26,003	24,963	1,938	14,496	2,3
2,128	269,254	40,482	45,441	15,059	84,107	54,109	24,576	24,179	80,410	26,173	15,546	1,164	6,367	8,4
2,660	269,899	32,888	44,437	12,954	75,293	47,652	13,481	15,721	71,815	10,508	9,672	786	2,330	20,
3,192	270,466	26,267	41,263	11,641	70,428	42,490	6,147	11,643	63,625	10,302	5,474	491	594	36,
3,724	270,975	20,769	35,560	10,472	61,795	38,671	1,830	9,798	58,104	1,321	2,823	344	108	48,
4,788	271,834	13,350	24,938	8,844	50,271	33,859	555	7,913	48,224	1,597	657	102	28	61,
6,384	273,136	6,918	7,239	6,994	44,665	27,484	414	5,918	38,662	1,954	510	15	44	66,
7,448	273,891	4,347	3,157	6,393	41,204	23,329	347	4,605	34,270	2,165	704	35	64	64,
8,512	274,580	2,953	2,656	5,856	38,828	19,766	268	3,481	30,638	-	838	75	69	59,
10,640	275,408	1,291	2,473	5,048	35,118	16,473	87	2,400	24,647	-	1,033	169	39	51,

4.2.4 Reach No. 4 – Millrace Rapids to Shandon

4.2.4.1 Millrace Rapids

Millrace Rapids is a steep drop in the river at a location where a masonry dam once was located. The upper rapids descend through ledge before passing though the rubble and boulder remains of the dam. The lower Rapids contains steep shoal habitat with dense boulder cover. The upper rapids location was identified by the TWC as a critical passage route for migratory fish. A V-shaped segment of the ledges was reconnoitered at 500 cfs by the study team. One wing of this v-shape segment is comprised of a gently sloped, smooth ledge; the center of the V features a weir-type orifice opening, and the other wing of the V is a vertical ledge drop. At 500 cfs, a thin layer of water sheets over the sloping ledge, potential fish passage opportunity is via the right wing. This 60-80 ft-long area was portrayed by a three-dimensional survey rather than a linear transect. Figure 35 provides an isometric view of the study site bathymetry and transect configuration.

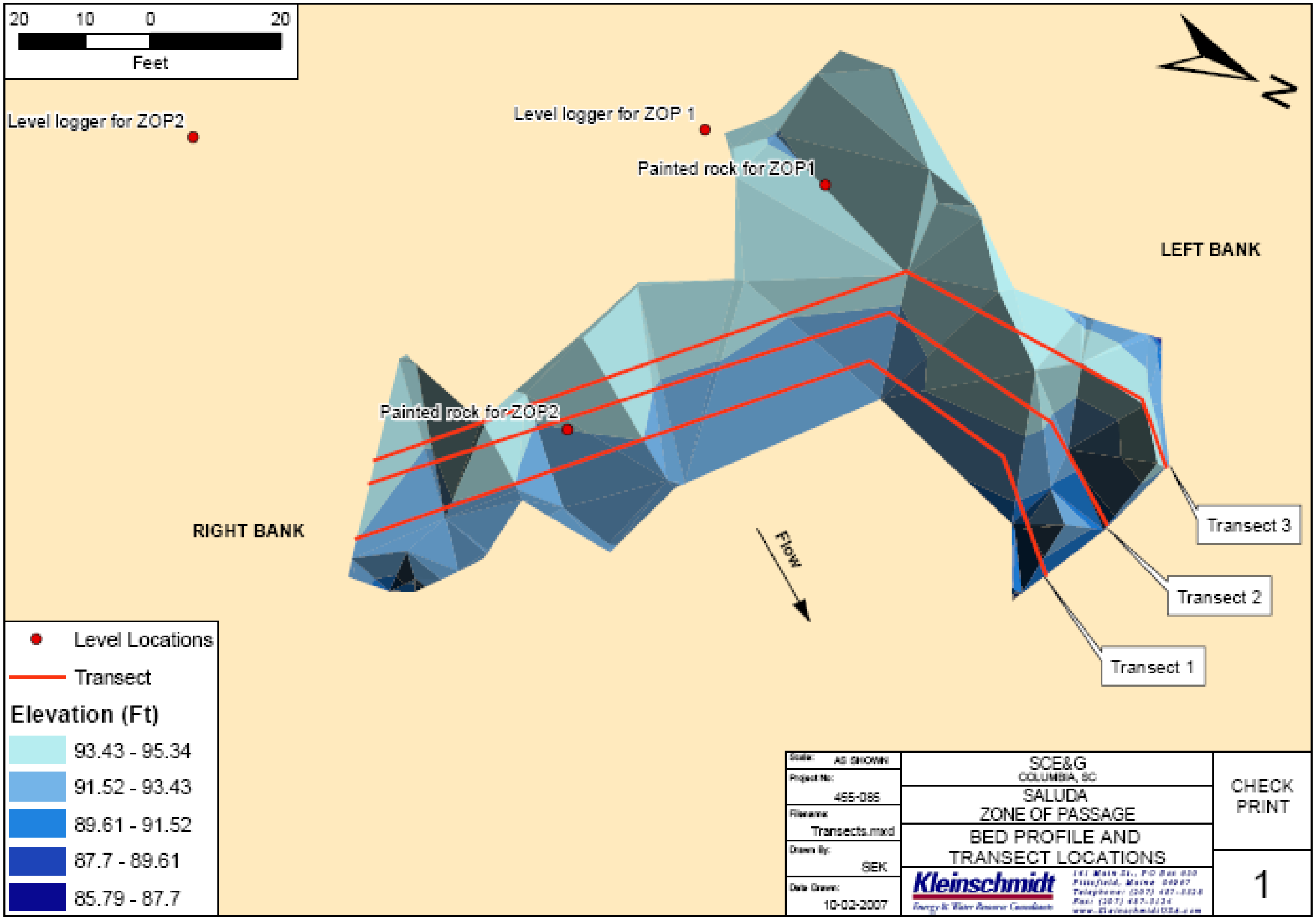


Figure 35: **Isometric 3-D View of Zone of Passage Study Site**

Orientation is Looking Upstream; Note the Positions of ZOP Transects 1, 2 and 3.

Hydraulic data

As viewed looking upstream, the left portion of each transect provides the most limiting depths; this is the section of the ledge outcrop that has a broad, gently sloped downstream face. Conversely, the right side of the study site generally maintains deeper water.

Depth

SCDHEC Zone of passage criteria were not met at any cross-section at 500 cfs (Figure 36), however depth increases as discharge increases at such a rate so that at 800 cfs, SCDHEC Zone of passage criteria are met at transects 1 and 2 (Figure 37) but not at transect 3. A flow of approximately 1,200-1,300 cfs is required to adequately deepen transect 3 to fully meet the DHEC criterion (Figure 38).

Velocity

Mean column velocity were projected to be relatively similar at any given flow between T-1 and T-3 (Table 14). Fish ascending the study site at 800 cfs would experience a graduated velocity range of approximately 4.8-5.0 ft/sec (1.5 to 1.6 m/sec); at 1,300 cfs fish ascending the study site would experience velocities ranging from 5.4 to 5.7 ft/sec (1.6-1.75 m/sec). Striped bass would ascend the LSR during March and April when ambient water temperature is approximately 16^{o}C. According to sprint speed criteria from the Conte Lab (Haro et al., 2004), an 18-inch long (FL) striped bass would have approximately a 78% probability of ascending a 25-meter distance of that gradient at that temperature, at 800 cfs (Table 15). The same-sized fish would have an approximately 66% chance of ascending the same area at 16^{o}C and 1,300 cfs. Using criteria for white sucker as a representative fluvial freshwater fish, a 16-inch long (FL) fish would have an approximately 43% probability of ascending a 25-meter distance of that gradient at an ambient summer water temperature of 24°C at 800 cfs. The same-sized fish would have an approximately 32% chance of ascending the same area at 24°C and 1,200 cfs.

Table 14: Lower Saluda River Instream Flow Study

Mean Column Velocity (ft/sec) at Three Transects in the Zone of Passage Study Site at a Range of Flows.

SECTION	500 CFS	800 CFS	1,300 CFS	1,600 CFS
T-3	4.3	4.8	5.4	5.7
T-2	4.4	5.0	5.7	5.9
T-1	4.3	4.6	5.4	5.8

Table 15: Percentage of Adult Striped Bass and White Sucker Ascending a Hydraulic Slope Similar to the Millrace Rapids Study Site

(Source: Haro et al., 2004)

STRIPED BASS	VALUE
Temp (°C)	16
FL (mm)	500

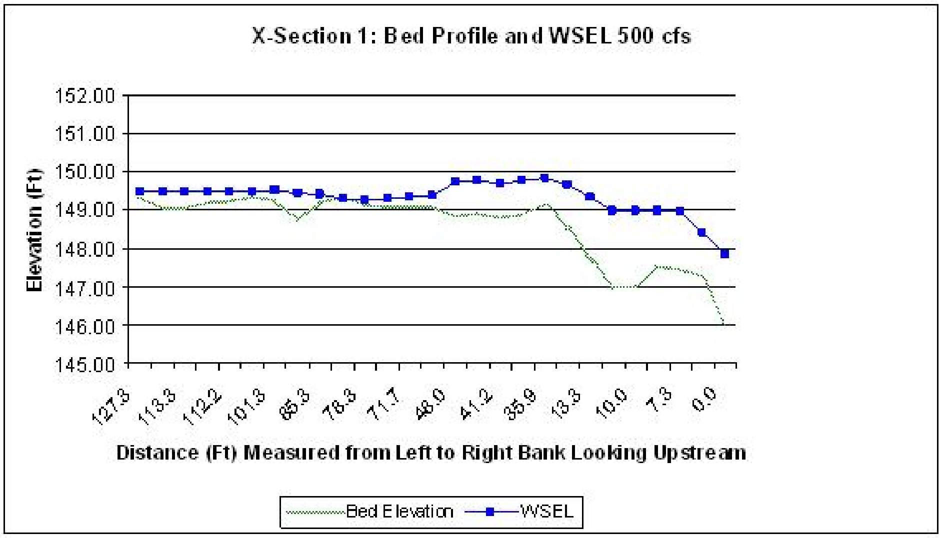
PROPORTION ASCENDING

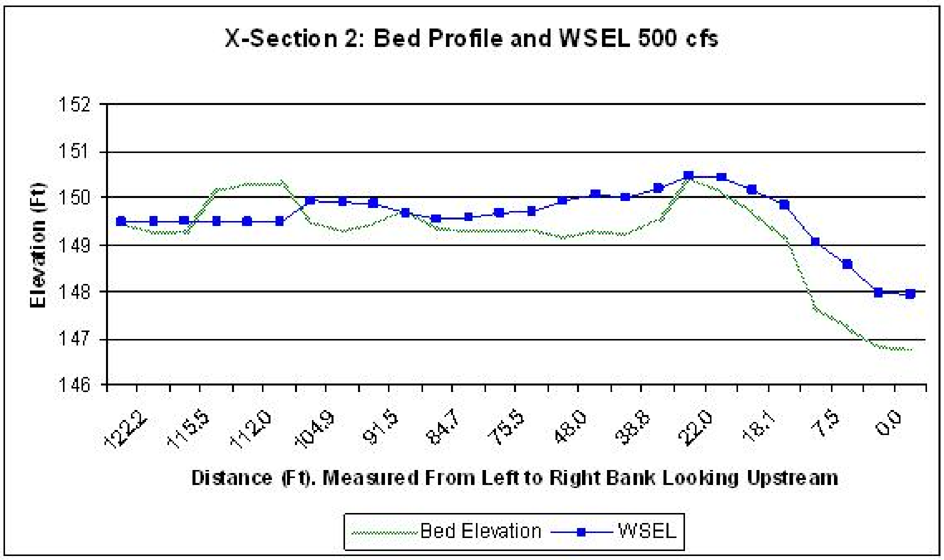
Water Velocity (m/sec)	Distance (m) 5	10	15	20	25	30
0.5	99%	98%	97%	95%	93%	91%
1	99%	97%	94%	91%	88%	84%
1.5	98%	94%	89%	84%	78%	72%
2	96%	89%	81%	71%	61%	49%
2.5	92%	80%	65%	48%	30%	14%
3	86%	64%	37%	13%	1%	0%
3.5	75%	36%	4%	0%	0%	0%
4	55%	3%	0%	0%	0%	0%
4.5	21%	0%	0%	0%	0%	0%

WHITE SUCKER	VALUE
Temp (°C)	24
FL (mm)	400

PROPORTION ASCENDING

Water Velocity (m/sec)	Distance (m) 5	10	15	20	25	30
0.5	99%	95%	90%	85%	78%	72%
1	97%	91%	83%	74%	64%	54%
1.5	95%	84%	71%	56%	43%	32%
2	91%	72%	52%	34%	21%	12%
2.5	83%	55%	30%	14%	5%	2%
3	71%	33%	10%	2%	0%	0%
3.5	53%	12%	1%	0%	0%	0%
4	31%	2%	0%	0%	0%	0%
4.5	11%	0%	0%	0%	0%	0%





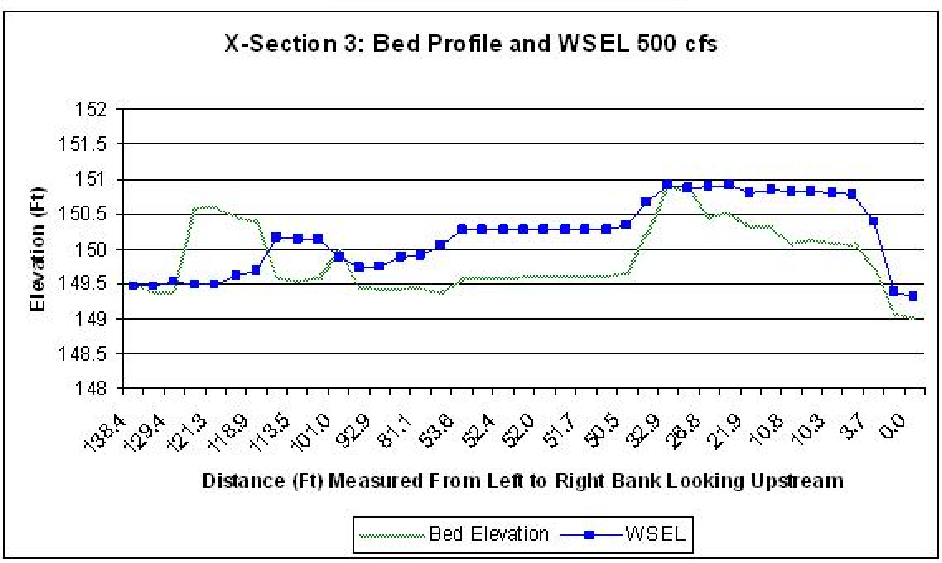
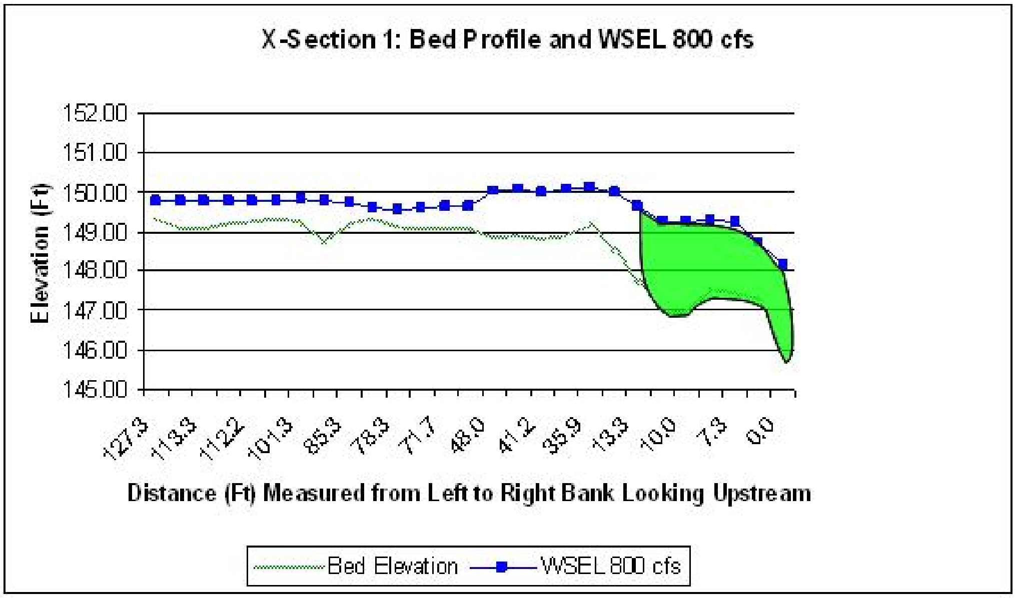


Figure 36: Transect View of Zone of Passage Study Site at 500 cfs Orientation is looking upstream.



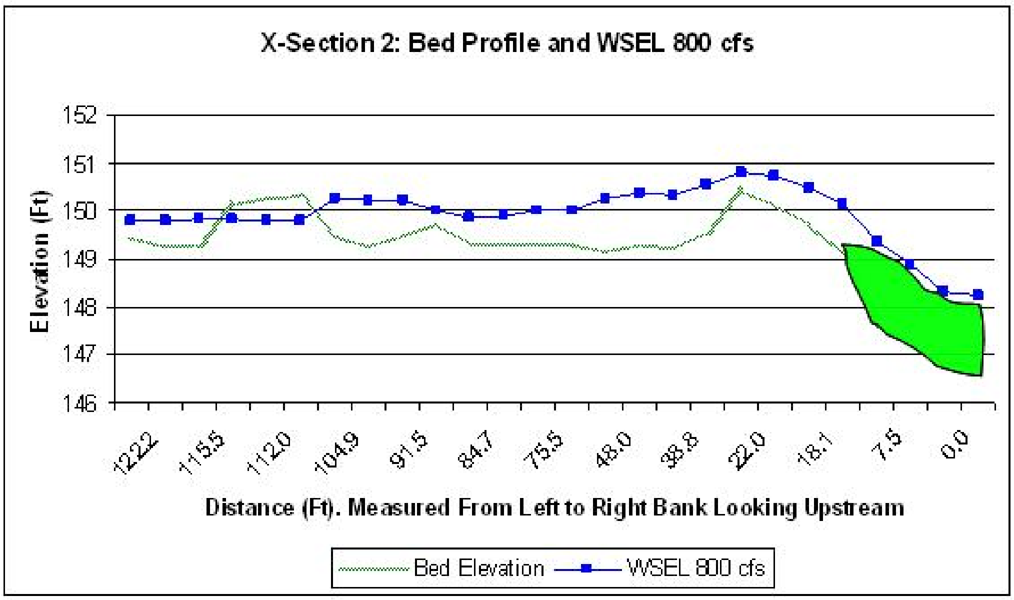


Figure 37: Transect View of Zone of Passage Study Site Transects 1 and 2 at 800 cfs

Orientation is looking upstream. Green shading indicates area meeting SCDHEC criterion.

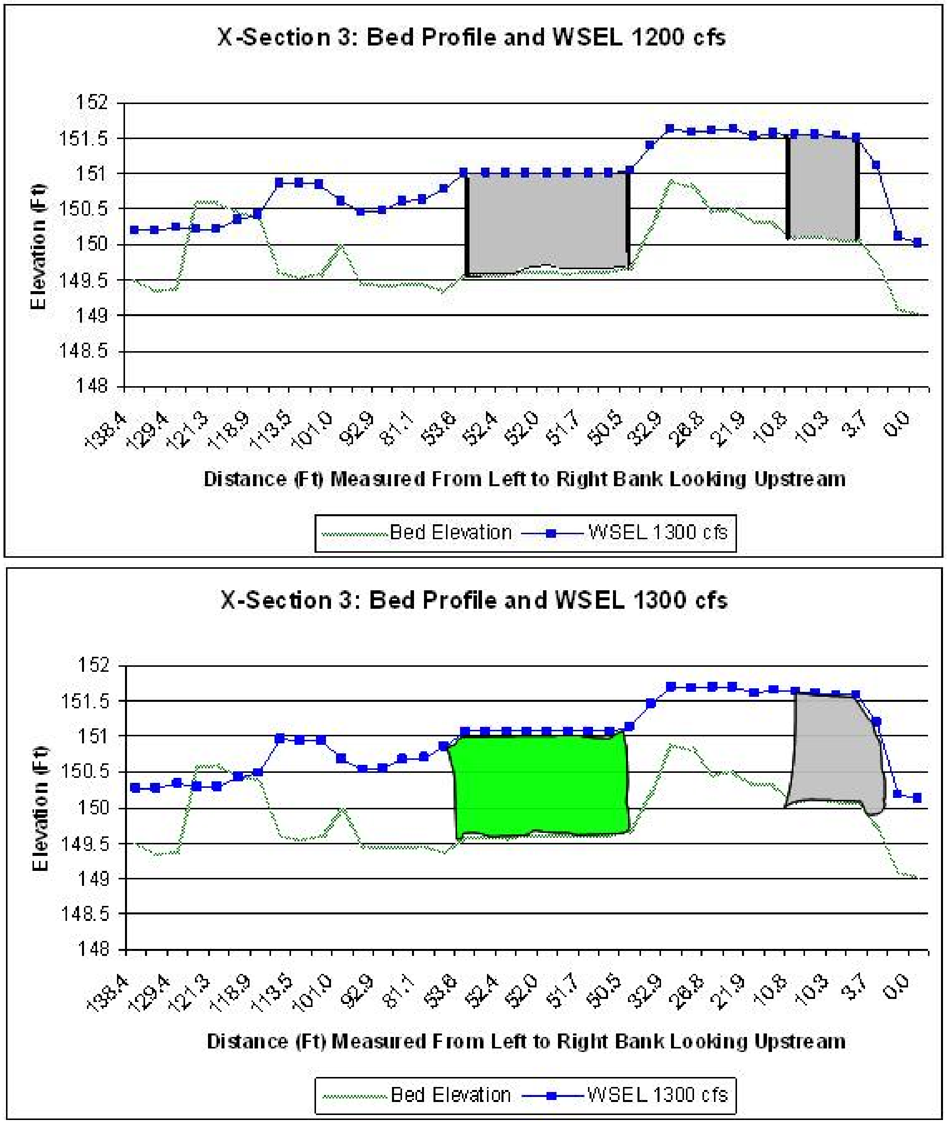


Figure 38: Transect View of Zone of Passage Study Site, Transect 3, Compared at 1,200 and 1,300 cfs

Orientation is looking upstream. Green shading indicates area meeting SCDHEC criterion. Gray shading indicates area that is slightly too shallow to meet SCDHEC criterion.

4.2.4.2 Riverbanks Zoo

The Saluda River passes through a lower-gradient segment featuring run and pool habitat. A deep run, located below the toe of Millrace Rapids is described by transect T-2. Table 16 and Figures 39-42 summarize results.

Habitat Data

Rainbow trout and brown trout. Habitat suitability for juveniles inflects at 700 cfs (rainbow trout) and 1,000 (brown trout) cfs. Rainbow trout juvenile suitability does not increase appreciably at higher flows; juvenile brown trout suitability exceeds 75% of optimal between 700 and approximately 7,000 cfs. Adult rainbow trout suitability ascends sharply to 688 cfs , has bimodal peaks, and is at least 75% of optimal beginning at approximately 1,100 cfs. Adult brown trout suitability very gradually increases in suitability to a broad peak between 6,000 and 10,000 cfs and exceeds 75% of optimal suitability at approximately 3,000 cfs.

Smallmouth bass. Juvenile habitat suitability increases rapidly to 400 cfs and then increases gradually to optimal at 1,200 cfs, before declining slightly at higher flows. Juvenile bass suitability maintains 75% of optimal suitability from 300 to approximately 6,000 cfs; adult bass habitat suitability increases rapidly to 688 cfs then remains relatively constant at higher flows. Fry lifestage suitability declines at flows greater than 700 cfs. Optimal spawning suitability occurs at 800 cfs but is maintained at least 75% of optimal suitability between approximately 400-3,000 cfs.

Deep-fast guild. Habitat suitability was based on five guild surrogates representing a range of habitat uses of interest to the TWC. Habitat suitability peaked between 400 cfs (redhorse fry) to 20,000 cfs (redhorse adult). Early lifestages represented by redhorse fry express relatively little overall habitat suitability, peak at 400 cfs and decline at higher flows. Redhorse adult reached an inflection point at 1,400 cfs and, maintained at least 75% of optimal habitat suitability at approximately 900 cfs. At least 75% of juvenile redhorse habitat suitability is maintained between 300 cfs and approximately 4,000 cfs. American shad maintained at least 75% of optimal habitat suitability between approximately 600 cfs and 4,000 cfs. The deep-fast spawning guild habitat suitability achieves an inflection point at approximately 700 cfs before reaching a plateau between 900 and 1,400 cfs, 75% of suitability is achieved between approximately 500 and 3,000 cfs.

Shortnose sturgeon. Suitability for this species rises rapidly to an inflection point at 1,400 cfs then remains relatively constant between 2,000 to 5,000 cfs, before gradually rising at higher flows.

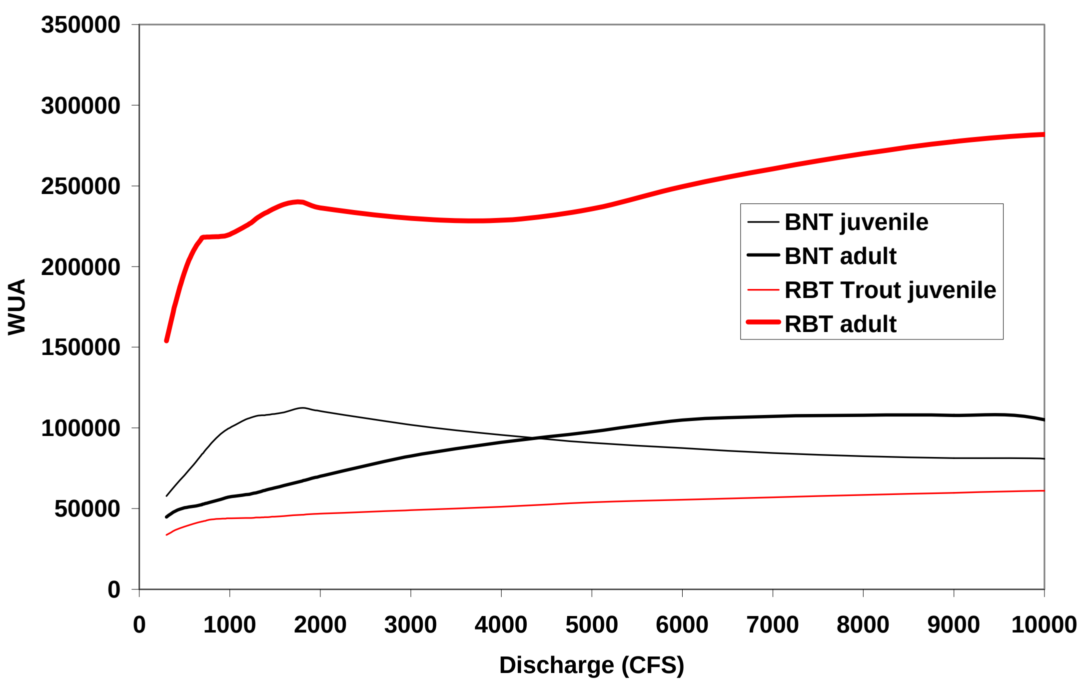


Figure 39: Saluda River Instream Flow Study – Reach 4 Run, Trout Habitat Suitability

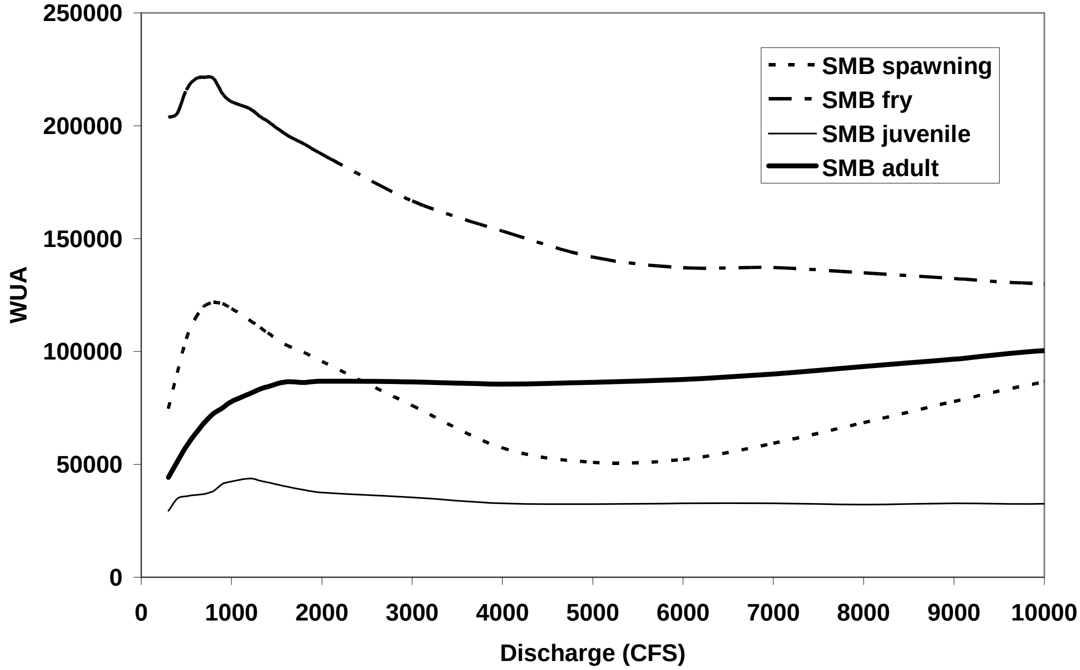


Figure 40: **Saluda River Instream Flow Study – Reach 4 Run, Smallmouth Bass Habitat Suitability**

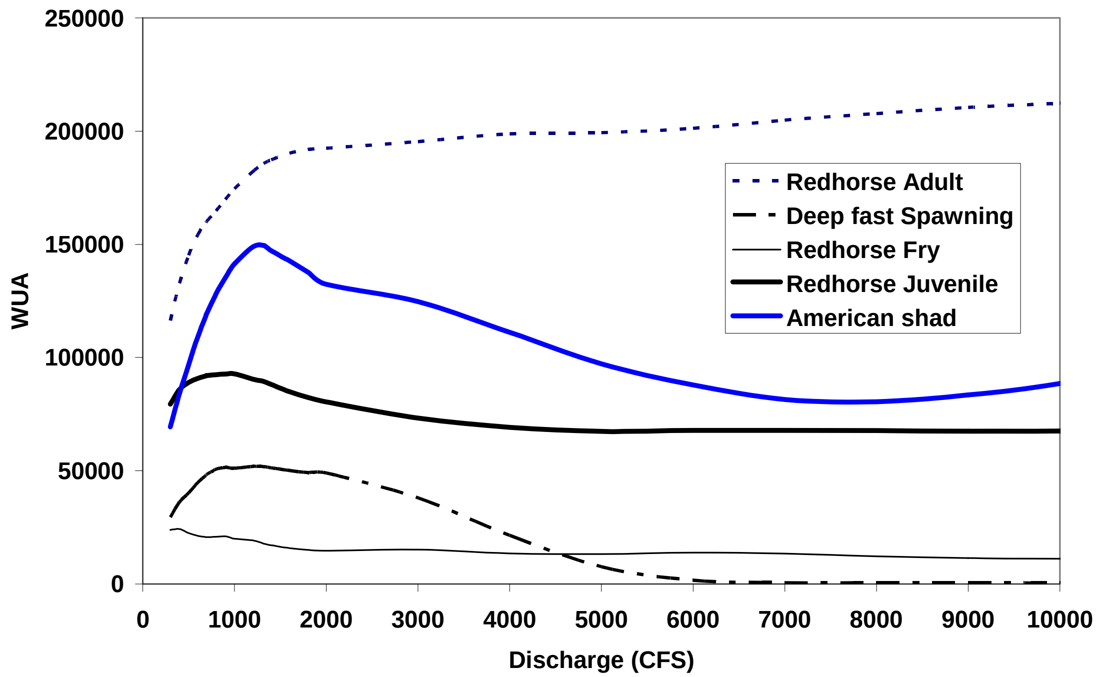


Figure 41: **Saluda River Instream Flow Study – Reach 4 Run, Deep-Fast Guild Habitat Suitability**

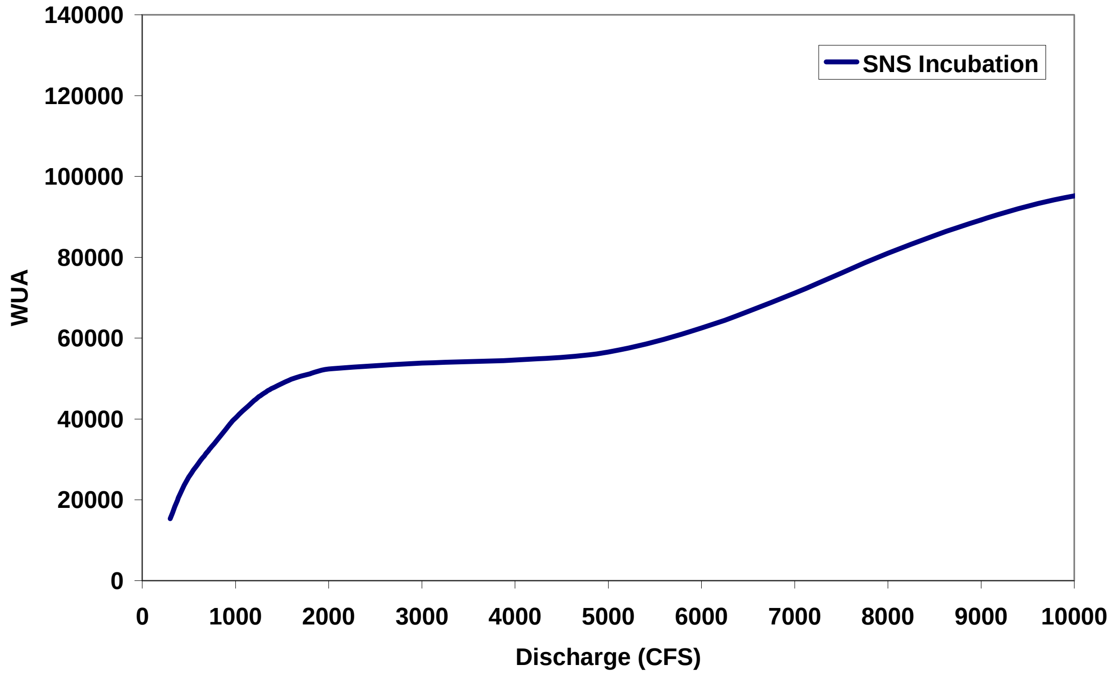


Figure 42: **Saluda River Instream Flow Study – Reach 4 Run, Shortnose Sturgeon Spawning/Incubation Habitat Suitability**

Table 16: Saluda Instream Flow Study – Reach 4 Run, Habitat Suitability-Discharge Relationship

DISCHARGE (CFS)	BRNT Juvenile	BRNT Adult	RBT Juvenile	RBT Adult	SMB Spawning	SMB Fry	SMB Juvenile	SMB Adult	Redhorse Adult	Deep Fast Spawning	Redhorse Fry	Redhorse Juvenile	American Shad
300	57,732	44,808	33,724	153,964	74,748	203,671	29,391	44,234	116,354	29,515	23,874	79,404	69,377
400	64,479	48,446	36,729	177,149	90,627	205,494	34,785	51,324	132,764	36,158	24,285	85,897	84,248
500	70,680	50,502	38,874	196,477	105,650	215,768	35,952	57,969	145,172	40,209	22,426	88,993	96,871
600	77,206	51,434	40,597	209,938	114,703	220,690	36,455	63,539	154,189	44,697	21,251	90,848	109,098
688	83,286	52,429	41,873	217,281	119,613	221,477	36,827	68,003	159,554	47,976	20,757	91,935	118,475
700	84,125	52,672	42,035	218,014	120,258	221,477	36,881	68,539	160,154	48,366	20,725	92,098	119,680
800	90,841	54,185	43,247	218,470	121,782	220,994	38,158	72,513	164,838	50,657	20,775	92,443	128,187
900	96,254	55,712	43,674	218,647	121,199	214,224	41,319	75,018	169,885	51,449	21,066	92,747	135,189
1,000	100,067	57,191	43,931	219,953	119,007	210,673	42,442	77,790	174,461	51,106	20,013	92,832	141,400
1,200	105,791	58,774	44,206	225,854	113,835	207,620	43,794	81,313	182,136	51,909	19,293	90,468	148,838
1,400	108,030	61,480	44,751	233,372	108,225	201,944	42,023	84,351	187,280	51,270	17,104	88,079	147,158
1,600	109,651	64,307	45,392	238,506	103,062	196,151	40,266	86,560	190,258	50,071	15,784	84,914	142,710
1,800	112,432	67,175	46,276	239,927	99,652	192,037	38,689	86,252	191,924	49,233	14,977	82,380	137,722
2,000	110,448	70,047	46,884	236,408	95,604	187,420	37,540	86,791	192,453	49,018	14,678	80,367	132,325
4,000	95,584	91,063	51,216	228,705	57,220	153,276	32,787	85,579	198,815	21,393	13,472	69,198	111,174
6,000	87,536	104,795	55,484	249,638	52,207	137,099	32,764	87,632	201,250	1,591	13,825	67,813	87,931
8,000	82,405	107,925	58,454	269,996	68,511	134,896	32,174	93,304	207,803	566	12,237	67,766	80,500
10,000	80,943	105,135	60,990	281,819	86,474	130,056	32,566	100,402	212,417	325	11,161	67,605	88,583
12,000	76,214	74,702	61,755	286,795	99,083	129,350	34,184	104,475	216,168	-	11,121	68,732	102,736
14,000	70,239	66,209	61,111	291,255	108,225	125,113	37,086	107,620	220,266	211	11,872	70,556	116,886
16,000	66,748	66,440	60,867	298,097	113,448	128,873	37,270	110,325	223,682	621	10,335	71,321	128,472
18,000	63,761	64,479	60,871	305,241	114,559	128,422	37,484	112,366	228,094	1,190	9,423	71,299	135,810
20,000	60,370	52,781	60,737	308,423	116,001	127,198	34,922	113,811	230,158	1,618	9,617	72,773	142,960

4.2.4.3 Deep Pool Adjacent to Riverbanks Zoo

A deep riverine pool (Pool 2) is located downstream from the run. This pool contains a side-channel along the left bank (looking downstream) and is backwatered by a boulder-filled glide at the head of Shandon Rapids. Bed profile and waters surface elevations for calibration flows are shown in Appendix C. Examination of bed profile data relative to water surface elevation revealed that at the lowest calibration flow (approximately 500 cfs), this reach provides adequate depths for striped bass and other pool dwelling species, with a maximum channel depth of approximately 9 ft. An increase in water surface elevation of approximately 2 ft was observed when flow increased from 500 to 1,600 cfs[9]. Increases in water depth in this reach likely results in a small increase in foraging habitat along the river margins as the boulder field located along river margins and in the side channel become wetted.

4.2.4.4 Shandon

Shandon is located where the river widens above the confluence with the Broad River flood plain; it contains a glide with extensive object cover formed by the head of an alluvial delta of large boulders. This site is more than twice as wide as most other study. A single transect (T-1) is located in this area. Table 17 and Figures 43-46 summarize results.

Habitat Data

Rainbow trout and brown trout. Habitat suitability for juveniles peaks at 1,316 cfs for both species. Rainbow and brown trout juvenile suitability remains at least 75% of optimal between 300 cfs and approximately 3,500 cfs (rainbow trout) to nearly 5,000 cfs (brown trout). Adult rainbow trout suitability exhibits a sharp peak at 800-1,000 cfs but is at least 75% of optimal between approximately 300 and 3,000 cfs. Adult brown trout suitability reaches an inflection point at 1,400 cfs before

[9] A water surface elevation was not collected for the 10,000 cfs calibration flow at this site.

broadly peaking at 5,000 cfs. At least 75% of optimal suitability exists between 1,200 and approximately 11,000 cfs.

Smallmouth bass. Juvenile and adult suitability reach optima at 800 and 3,000 cfs respectively. Juvenile suitability optimizes at 800 to 900 cfs; at least 75% of optimal is maintained between approximately 300 and 4,000 cfs. Adult suitability exhibits a plateau between 2,000 and 5,000 cfs; 75% of optimal is exceeded between approximately 1,000 and 12,000 cfs. Fry lifestage suitability sharply declines at flows greater than 300 cfs; 75% of optimal suitability is exceeded up to approximately 1,000 cfs. Optimal spawning suitability occurs between 500 and 1,600 cfs, however, spawning suitability is relatively limited.

Shallow-slow guild. Habitat suitability was based on two guild surrogates that represent habitat use for species and lifestages of interest to the TWC. Shallow-slow guild fry habitat suitability declines between 300 and 2,000 cfs and then increases slightly between 5,000 to 8,000 cfs before declining again. Habitat suitability for redbreast sunfish spawning increases between 300 and 800 cfs before gradually declining. A secondary increase occurs between 8,000 and 12,000 cfs.

Shortnose sturgeon. Suitability for this species rises steadily to a peak at 18,000 cfs, and 75% of optimal is maintained by flows exceeding 10,000 cfs.

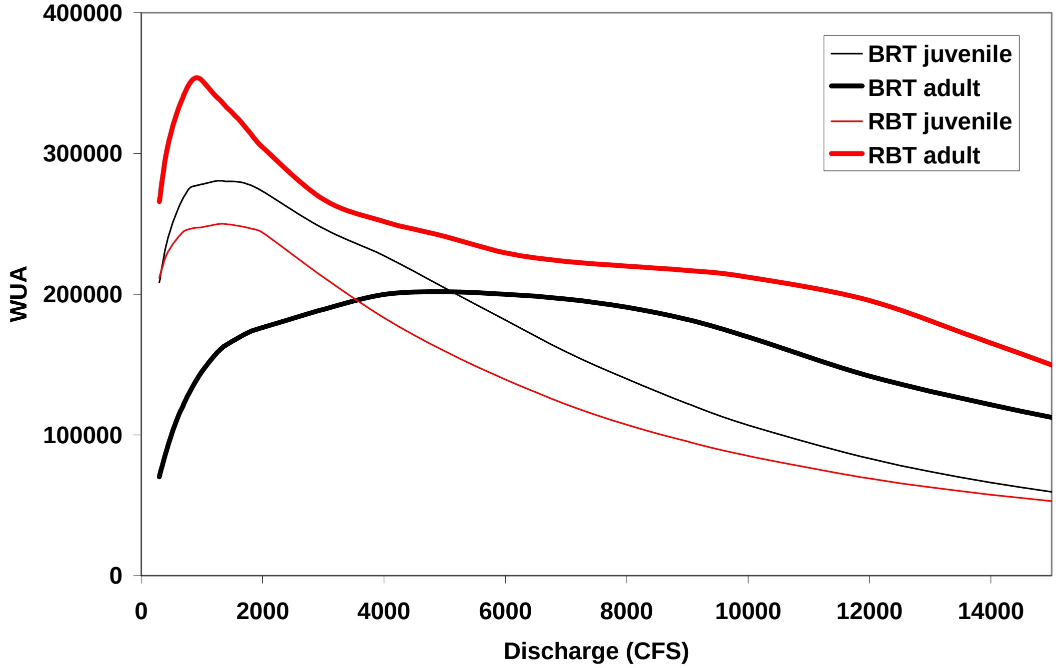


Figure 43: Saluda River Instream Flow Study – Reach 1 Shandon Glide, Trout Habitat Suitability

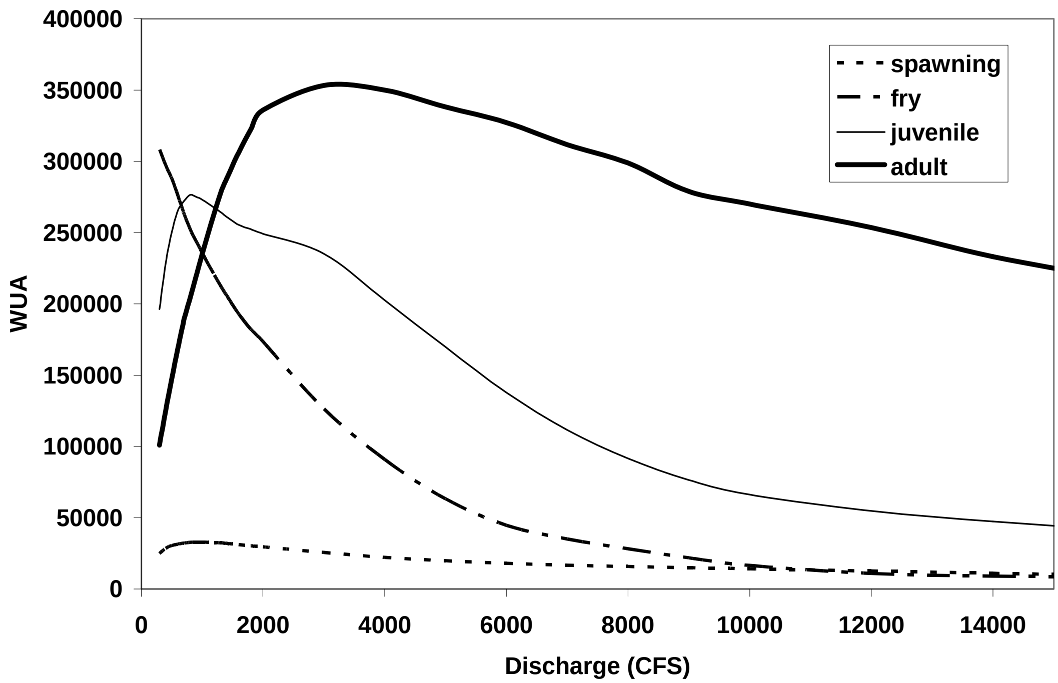


Figure 44: Saluda River Instream Flow Study – Reach 1 Shandon Glide, Smallmouth Bass Habitat Suitability

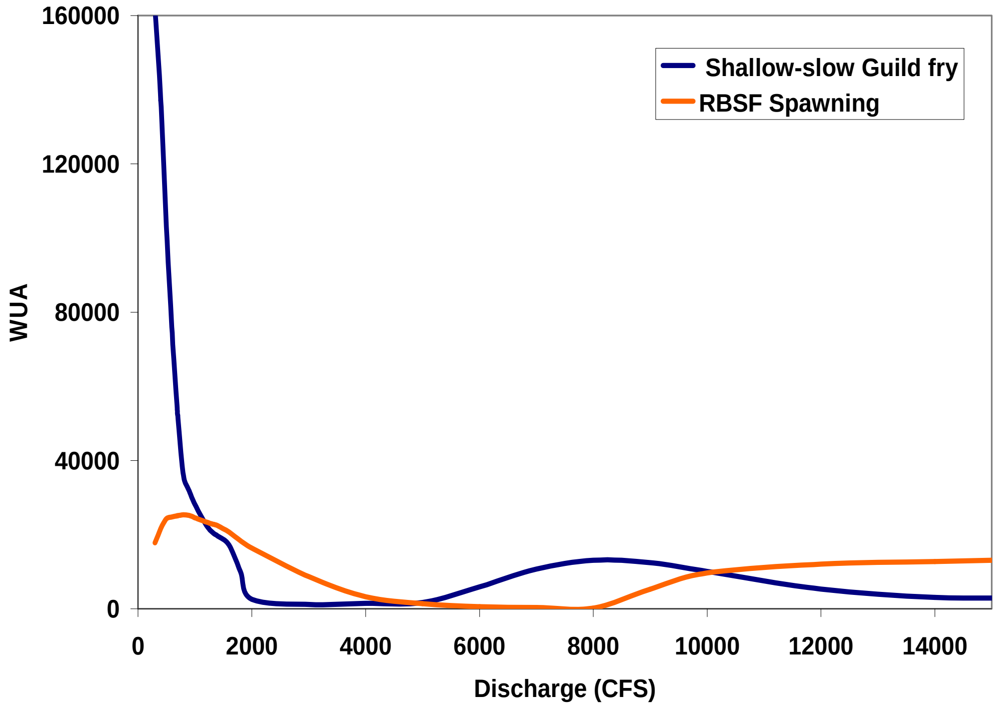


Figure 45: Saluda River Instream Flow Study – Reach 1 Shandon Glide, Shallow-Slow Guild Habitat Suitability

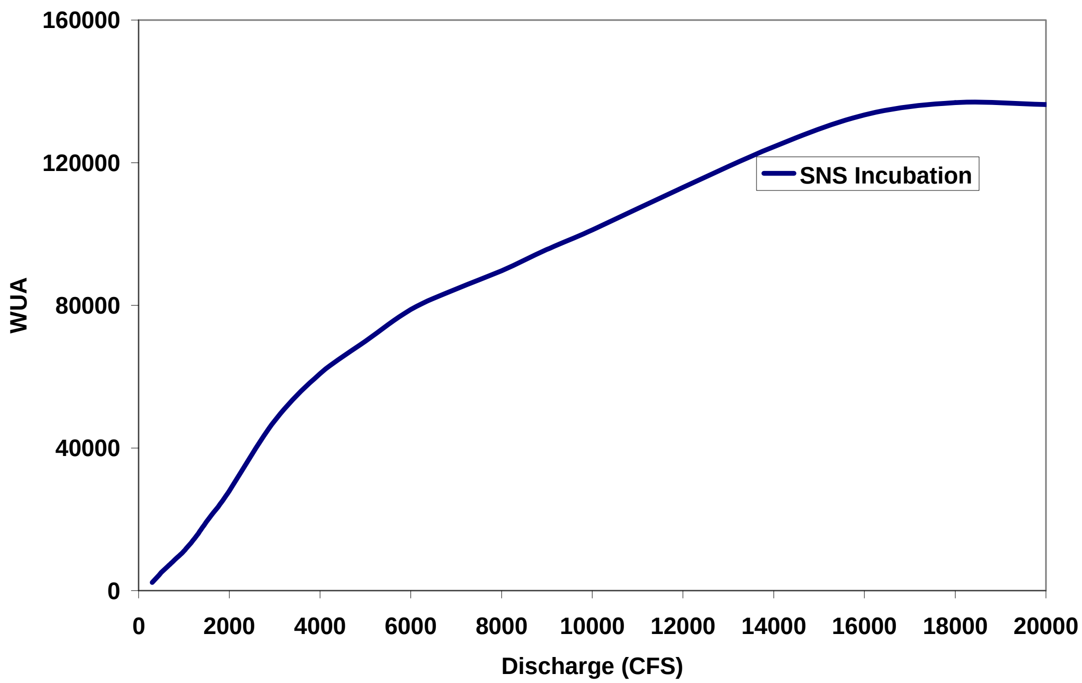


Figure 46: Saluda River Instream Flow Study – Reach 1 Shandon Glide, Shortnose Sturgeon Spawning/Incubation Habitat Suitability

Table 17: Saluda Instream Flow Study – Reach 4 Shandon Glide, Habitat Suitability-Discharge Relationship

DISCHARGE (cfs)	BRT Juvenile	BRT Adult	RBT Juvenile	RBT Adult	SMB Spawning	SMB Fry	SMB Juvenile	SMB Adult	Shallow-Slow Guild Fry	RBSF Spawning	SNS Incubation
300	208,449	70,223	211,519	265,799	24,819	308,186	196,279	100,895	161,733	17,778	2,256
400	232,912	86,496	226,338	297,250	28,448	297,216	228,417	125,026	137,135	21,664	3,678
500	248,275	100,469	234,336	316,299	30,437	287,842	250,195	147,525	103,156	24,247	5,043
600	259,664	111,973	239,995	330,146	31,461	275,710	265,386	168,795	74,405	24,784	6,288
688	268,276	120,629	244,280	340,082	32,064	264,859	271,488	186,327	54,028	25,086	7,338
700	268,935	121,788	244,732	341,378	32,159	263,352	271,963	188,497	51,869	25,116	7,490
800	275,604	130,662	246,502	350,085	32,670	252,522	276,386	203,766	35,982	25,351	8,667
900	277,139	138,339	247,131	353,770	32,897	243,931	275,160	219,420	31,771	25,155	9,822
1,000	278,124	145,061	247,643	351,889	32,905	235,743	273,013	235,067	28,168	24,544	11,113
1,200	280,157	156,136	249,385	341,954	32,504	220,237	267,510	263,865	22,569	23,407	14,073
1,316	280,596	161,204	250,081	337,215	32,218	211,656	263,967	279,295	20,512	22,818	16,005
1,400	280,189	163,958	249,769	333,198	31,919	205,881	261,092	287,643	19,621	22,401	17,561
1,600	279,899	169,057	248,606	324,471	31,123	192,966	255,450	306,078	17,207	20,642	21,094
1,800	277,502	173,551	246,795	314,330	30,280	181,991	252,342	322,367	10,034	18,365	24,323
2,000	273,125	176,337	243,651	304,277	29,534	173,552	249,224	335,858	2,518	16,370	27,950
3,000	246,721	189,183	212,160	267,456	25,642	126,394	235,110	353,253	1,150	8,677	47,639
4,000	227,386	199,830	183,266	251,622	22,083	90,772	202,651	349,938	1,421	3,230	60,820
5,000	204,423	201,735	159,650	241,045	19,781	63,257	169,746	338,278	1,652	1,417	69,991
6,000	181,611	200,057	139,361	229,392	17,923	44,505	137,764	327,138	5,923	572	78,804
7,000	159,081	196,456	121,761	223,238	16,684	35,085	111,506	311,710	10,704	332	84,607
8,000	139,769	190,785	107,182	220,012	15,760	28,254	91,675	298,779	13,105	164	89,674
9,000	122,318	182,098	95,412	216,970	14,954	21,906	76,378	278,910	12,435	5,289	95,643
10,000	106,901	169,655	85,111	212,143	14,208	16,552	66,064	269,989	10,056	9,644	101,153
12,000	83,242	141,753	69,100	195,480	12,523	10,803	54,734	253,532	5,306	12,031	113,076
14,000	66,154	121,348	57,435	165,237	10,986	9,028	47,371	233,168	3,068	12,736	124,461
16,000	53,842	103,509	49,140	135,100	9,543	8,503	41,578	217,585	2,877	13,346	133,410
18,000	44,348	83,641	42,679	112,291	8,273	8,353	37,422	203,984	2,439	13,660	136,894
20,000	36,861	68,866	37,451	102,045	7,031	8,127	33,263	192,809	1,607	14,922	136,323

4.3 Pool Transects

ADCP-derived bed profiles and corresponding water surface elevations for the pool transects downstream of the dam and adjacent to Riverbanks Zoo are shown in Appendix C.

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 indicate to those negotiating a water management plan for the LSR how these data may help determine instream flows that are suitable for meeting 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 integrate results to form recommendations that satisfy all biological goals (MESC, 2001). A number of techniques are commonly employed to resolve this types 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 indicative of habitat/flow changes;
- delete species/lifestages with redundant flow-WUA relationships;
- combine species in a post-modeling guilding such as cumulative multi-species 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 LSR study area is comprised of four independent study reaches, each with distinct geomorphic characteristics. Within each reach, different mesohabitat types were modeled. The WUA relationships within each reach tend to differ 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 of habitat suitability per 1,000 ft of similar stream reach. For reaches and mesohabitats shared by all species/lifestages (such as smallmouth bass, rainbow trout and brown trout), WUA results within each study site are commonly weighted and summed across the study area according to relative contributing reach length of each modeled mesohabitat type. This information can be obtained directly from mesohabitat mapping measurements.

Critical Habitat - A particular reach, mesohabitat type or study site which is strategic because it is where a critical lifestage function occurs is prioritized during the time of year it is required, such as a spawning area during spring time. 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.

These data quantify the effects of flows on aquatic habitat suitability in the LSR for the aquatic community and its managed fish resources. The data are indices to be used to estimate the extent that various project water management proposals may affect aquatic habitat suitability in the context of watershed hydrology and the strategic needs of other competing uses, which in the case include Lake Murray lake levels, water quality, recreation, and hydroelectric power generation. These data should be used in conjunction with hydrologic, operational and other models to evaluate the costs and benefits of providing alternate flows to the lower Saluda River.

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APPENDIX A

TECHNICAL TEAM STUDY SCOPING

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY SALUDA HYDRO PROJECT RELICENSING INSTREAM FLOW/AQUATIC HABITAT TECHNICAL WORKING COMMITTEE

SCE&G Offices at Carolina Research Park
May 3, 2006

Final csb 6-2-06

ATTENDEES:

Bill Argentieri, SCE&G
Shane Boring, Kleinschmidt Associates
Jeni Summerlin, Kleinschmidt Associates
Dick Christie, SCDNR
Amanda Hill, USFWS
Scott Harder, SCDNR
Steve Summer, SCANA Services
Tom Eppink, SCANA Services
Jim Glover, SCDHEC
Ron Ahle, SCDNR
Sam Drake, L. Murray Assoc.

ACTION ITEMS:

- Distribute 1989-90 Lower Saluda IFIM Study Report to TWC
Shane Boring/Jeni Summerlin
- Draft list of target species for IFIM studies on Lower Saluda
Amanda Hill/Ron Ahle
- Compile and distribute Congaree floodplain studies to TWC
Shane Boring
- Contact NPS to determine status of ESWM process on Congaree River
Shane Boring/Bill Argentieri
- Provide clarification regarding GIS coverages needed to satisfy Comprehensive Habitat Assessment
Dick Christie/Amanda Hill
- Coordinate with Tommy Boozer regarding available GIS-based habitat maps for L. Murray
Bill Argentieri
- Draft framework for white paper assessing potential for self-sustaining trout fishery in LSR
Shane Boring/Jeni Summerlin
- Contact Gerrit Jobsis and Jeff Isely to make presentation on existing IFIM Study
Shane Boring

DATE OF NEXT MEETING: **June 14, 2006 at 9:30 am**

Location: SCE&G Offices at Carolina Research Park
111 Research Drive
Columbia, SC 29203

MEETING NOTES:

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.

Shane Boring opened the meeting at approximately 10:20 AM. Shane reminded the group that, at the February 22nd Fish and Wildlife RCG meeting, the Technical Working Committees (TWCs) were formed and study requests were assigned to the TWCs[1]. It was noted that the purpose of today's meeting would be to review the study requests assigned to the Flow/Aquatic Habitat TWC (See Meeting Handout - Attachment A) and to begin assigning tasks toward addressing each request. Discussions regarding each of the study requests are summarized below.

Request for Instream Flow Studies[2]

Shane noted that Ron Ahle from SCDNR had provided the field datasheets, study plan, and final report for the 1989-90 Lower Saluda River (LSR) Instream Flow Study. A copy of the study plan was distributed to attendees (Attachment B) and the original data was returned to Ron. Shane noted that he would scan the final report and distribute it to the TWC via e-mail. He added that photocopies had been made of the field data should the TWC decide to use the existing data in the evaluating instream flow as part of the current relicensing. Ron Ahle proposed, and the group agreed, that having the authors of the 1989-90 IFIM study provide a presentation detailing the project methods and findings would be a reasonable first step in evaluating it's relevance in the current relicensing. Shane agreed to contact Gerrit Jobsis and Jeff Isely in hopes of scheduling a presentation for the next TWC meeting. Ron Ahle, Dick Christie, and Amanda Hill noted the importance of establishing target species in evaluating the existing IFIM data. Ron and Amanda agreed to collaborate on development of a list of target species.

Bill Argentieri noted that specific flows were recommended by SCDNR in their comments to the Initial Consultation Document [470 cfs for one-way downstream navigation; 590 cfs (July-November), 1170 cfs (January-April), and 880 cfs (May, June, & December) for seasonal aquatic habitat] and enquired as to how these flows were derived. Bill enquired specifically as to whether these flows were based on the 1989-90 LSR IFIM study. Dick Christie noted that the recommended flows were based on the SC Water Plan and were not related to the 1989-90 study. He added that the flow recommendations were offered in lieu of a site-specific IFIM study for LSR, adding that the agency certainly encourages a site-specific study.

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[1] See February 22nd, 2006, Fish and Wildlife RCG meeting notes for study request summaries and assignments.
[2] Subheading correspond to Study Requests in attached meeting handout.

Scott Harder recommended that Acoustic Doppler (AD) technology be considered for any site-specific studies, adding that it could provide fine-scale data and is considerably less labor-intensive. Steve Summer agreed, noting that AD technology is being considered for evaluating impacts of operating unit 5 on stripped bass habitat during the DO "crunch" period in late summer.

Request for Floodplain Flow Evaluations

Shane noted that there are a number of recent and ongoing studies that have potential to assist in addressing this issue. Specifically, Shane noted that there is a USC graduate student currently researching the impacts of hydro dam operations in the Santee Basin on Congaree River flows and subsequently the vegetative communities of Congaree National Park (NP). Bill Argentieri noted an existing study that examined the influence of the Saluda on overall flows in the Congaree, adding that he believed the study concluded that the Saluda contributes approximately 1/3 of the Congaree's flow. Shane agreed to gather as many of these studies as possible and distribute to the TWC. The group agreed that the best course of action is to coordinate with the National Park Service to determine what data/studies exist. Following review of existing data and studies, the TWC will convene to determine a course of action for this issue.

Ecologically Sustainable Water Management (ESWM) Request

Dick Christie noted that SCDNR was involved with the development of an ESWM framework for the Savannah River, adding that the process involved numerous experts working together through a series of workshops to develop recommendations for the basin. Ron Ahle noted that result of any instream and/or floodplain flow studies conducted as part of this relicensing (see above, as well as items 1&2 of attached handout) would undoubtedly provide important information for development of an ESWM framework and suggested that it may be beneficial to complete these studies prior to beginning ESWM discussions. Amanda Hill noted that the ESWM process provides a framework to develop a flow regime that balances the various water uses in the basin. Dick noted that The Nature Conservancy (TNC) has managed development of ESWM in other basin and suggested contacting them to provide additional information regarding the process. After further discussion, the group agreed that the NPS should be contacted to determine exactly how they would like SCE&G to contribute to the ESWM process and how far along they are in the development process.

Request for Sediment Regime and Transport Studies

Shane enquired as to whether the group was aware of any existing sedimentation data for the LSR. Steve Summer noted that he was not aware of any specific studies, but noted that substrate was one of the factors considered in the 1989-90 LSR IFIM study. Ron Ahle suggested a good starting point for addressing this issue might be to revisit the transect locations from the previous study to determine whether there have been changes in substrate at these sites. Several group members noted that, while this is undoubtedly a good first step, the scope of the study request appears to go beyond just substrate. It was noted by some attendees that this is a very broad study request and it is unclear exactly what is being requested (i.e. the proposed study objectives(s)).

Request for Comprehensive Habitat Assessment

Shane noted that SCE&G's aerial photography for Lake Murray and video flyover for the LSR have potential for providing a fairly thorough assessment of the aquatic habitat in the project area. Amanda Hill acknowledged this, but added that they are looking for a GIS-based approach. Bill Argentieri noted that the shoreline GIS maps developed by Tommy Boozer's group includes Environmentally Sensitive Areas and thus may include the level of detail being requested. Dick Christie and Amanda Hill both noted that they needed to give further consideration to what is needed and would report back to the group at the next meeting. Bill agreed to coordinate with Tommy Boozer to determine the suitability of the shoreline maps in helping to address this issue.

Request for Study to Determine Feasibility of Self-Sustaining LSR Trout Population

Dick Christie noted that, while SCDNR certainly encourages improvement in water quality and/or habitat that might result in improvements to the existing put, grow and take trout fishery (i.e., improved growth and/or survival), establishment of a reproducing trout population is not one of the agency's management goals for the LSR. Amanda Hill noted that USFWS would certainly support any enhancements to the existing fishery, but added that USFWS is "not in the business of promoting reproducing populations of non-native species." After some additional discussion, it was determined that, despite the fact that a reproducing population is not within agency management objectives, stakeholders requesting this study (Trout Unlimited) are due a fair evaluation of the proposal. As such, the group agreed to author a white paper summarizing the biotic and abiotic factors necessary for establishment of a self-sustaining population; summarizing potential benefits of existing and proposed water quality and/or habitat enhancements on the existing put, grow, and take fishery (including incidental reproduction); and outlining agency management objectives relative to trout for the LSR. Kleinschmidt staff will compile an initial framework for the white paper and distribute to the TWC for input.

Date/Location of Next Meeting

The group agreed to have the next Instream Flow/Aquatic Habitat TWC meeting on June 14, 2006 at the Research Park at 9:30 am. Shane noted that he would issue an electronic meeting invitation to confirm the date with individual members and provide directions to the meeting site. The meeting adjourned at approximately 1:00 PM.

Attachment A

May 3, 2006, Instream Flow/Aquatic Habitat TWC Meeting Handout

Saluda Hydro Relicensing
Instream Flow/Aquatic Habitat Technical Working Committee Meeting
May 3, 2006 – Carolina Research Park

Members:

Shane Boring
Ron Ahle
Steve Summer
Hal Beard
Alan Stuart
Amanda Hill
Gerrit Jobsis
Wade Bales
Brandon Kulik
Dick Christie
Prescott Brownell

Study Requests to be Addressed:

1) **Instream Flow Studies**: Requested for the Saluda River and the Confluence area. An assessment on how Project operations affect stream flows, and which flow regimens would best meet the needs of the biota.

   Requested by: CCL/American Rivers, City of Columbia Parks and Recreation, SCDNR*, LSSRAC, National Marine Fisheries Service, SC Council Trout Unlimited, USFWS

   [IFIM requested by SCDNR in lieu of implementing an instantaneous flow of at least 470 cfs needed to support one-way downstream navigation, and flows of 590 cfs (July – November), 1170 cfs (Jan-April), and 880 cfs (May, June and December) to provide seasonal aquatic habitat]

2) **Floodplain Flow Evaluations**:[1] A study was requested in order to evaluate the flows necessary for incremental levels of floodplain inundation for the Lower Saluda, Congaree River, and Congaree National Park. It is requested that it include an inventory of floodplain vegetation as well, in order to classify and characterize the vegetative species composition and structure of the floodplain areas within the zone of operational influence of the river reaches.

   Requested by: CCL/American Rivers *(requested floodplain inundation study as well as floodplain vegetation component)*, LSSRAC *(requested floodplain vegetation component only)* National Park Service

   **In relation to this study, SCDNR requests that the hydrologic record associated with the operation of the project be compared to the unregulated hydrology that would have occurred under a natural flow regime over the life of the project. Including an estimate of the timing, duration and magnitude of flood events that occurred and that would have occurred in absence of the project.*

   Requested by: SCDNR

3) **Ecologically Sustainable Water Management (ESWM)**: Described by the National Park Service as a "inclusive, collaborative, and consensus-based process to determine a scientifically based set of river flow prescriptions in order to protect downstream resources while balancing upstream benefits." The NPS notes that they believe this process can be readily adapted to the Saluda Project and have already began gathering information and developing an interactive GIS tool to provide information regarding the effect of various Saluda operational scenarios on the degree of inundation at the Congaree National Park. NPS seeks "partnership" with SCE&G as well as stakeholders in implementing this ESWM process.

   Requested by: National Park Service

4) **Sediment Regime and Sediment Transport Studies:** A request has been made that a study be performed on the sediment regimen in the Project area as well as the Project effects on the sediment regimen of the lower Saluda River. Should include such things as sediment composition, bedload movement, gravel deposition, sediment storage behind dams, and bedload changes below the dam; and project effects on downstream geomorphometry, sediment availability and streambank erosion, and the possible addition of gravel to mitigate for project impacts. Also, the effects of the Project operations on habitat requirements for spawning fishes.

   Requested by: CCL/American Rivers, USFWS

5) **Comprehensive Habitat Assessment**: To provide quantitative and qualitative data in GIS format of available and potential spawning, rearing, and foraging habitats (i.e., riffles, shoals, open water, shallow coves, littoral zones) for diadromous and resident fishes in Lake Murray, the Saluda River and its major tributaries, and the Lower Saluda River below the Project.

   Requested by: National Marine Fisheries Service, USFWS

6) **A Study to Determine the Factors Needed for a Self Sustaining Trout Fishery**: The purpose of this study should be to determine the factors needed for a self sustaining trout fishery that can reproduce and thrive year round, and how the operation can be modified to meet the habitat needs. Dissolved oxygen, flows, spawning and rearing habitat, the aquatic food base, especially in the shallow, rocky foraging areas, and actual water chemistry should be key items in such an assessment.

   Requested by: SC Council Trout Unlimited

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
INSTREAM FLOW/AQUATIC HABITAT
TECHNICAL WORKING COMMITTEE

SCE&G Offices at Carolina Research Park
June 14, 2006

Final 6/23/2006

ATTENDEES:

Bill Argentieri, SCE&G
Alan Stuart, Kleinschmidt Associates
Jeni Summerlin, Kleinschmidt Associates
Dick Christie, SCDNR
Amanda Hill, USFWS
Scott Harder, SCDNR
Anthony Green, SCDNR
Randy Mahan, SCANA Services
Tom Eppink, SCANA Services
Kelly Miller, Kleinschmidt Associates
Ron Ahle, SCDNR
Gerrit Jobsis, Am. Rivers
Wade Bales, SCDNR

ACTION ITEMS:

- Contact Bud Bader with SCDNR to obtain possible inundation studies for the Congaree and/or LSR

Scott Harder

- Continue the search for Congaree River floodplain/inundation studies from NPS and other sources

Shane Boring

- Quantify habitat types in Lake Murray

Dick Christie/Amanda Hill

- Contact Brandon Kulik to determine his availability and set potential instream flow workshop dates

Alan Stuart

DATE OF NEXT MEETING: **TBA**

MEETING NOTES:

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.

Alan Stuart opened the meeting at approximately 9:30 AM and new attendees introduced themselves. Alan noted that the focus of the meeting would be to discuss: (1) the 1989-1990 IFIM study and it's relevance in the current relicensing project, (2) available inundation studies, (3) possibilities for a comprehensive habitat assessment for Lake Murray, and (4) establishment of an initial framework for addressing the potential self-sustaining trout fishery in the lower Saluda River (LSR).

Alan S. noted that the purpose of the Instream Flow Technical Working Committee (TWC) is to assess how project operations affect stream flows, and to evaluate which flow regimes would best meet the needs of the biota. Alan briefly reviewed action items from the May 11th Instream Flow TWC meeting and noted that Jeff Duncan from the National Park Service (NPS) is in the process of developing a strawman for the Ecologically Sustainable Water Management (ESWM) process on Congaree River.

Presentation on the 1989-1990 IFIM Study

Gerrit Jobsis presented Instream Flow Requirements for the Fishes of the Lower Saluda River that he, Jeff Isely, and Steve Gilbert conducted in 1989-1990[1]. Gerrit J. opened by discussing locations sampled on the lower Saluda River. He noted that the river was divided into three segments for the study: (1) dam to the base of Corley Island, (2) Corley Island to I-20 bridge, and (3) I-20 bridge to Mill Race Rapids. Gerrit then briefly discussed the habitat classifications used in the study and summarized the percentages of each present in each of the above segments under various flow conditions. Gerrit continued by explaining the target species (striped bass, rainbow trout, redbreast sunfish, margined madtom, Northern hogsucker, brown trout) and life stages (adult, spawning and fish passage) that were chosen for the study.

In summarizing the study results, Gerrit noted that flows in the Saluda ranged between 100 and 18,000 cfs during the study period. He explained that the flow range was modeled from 50 cfs to 10,000 cfs and added that analyzing WUA at flows above 6,000 cfs were less reliable. He added that, from the results, the recommended flow range of 300-1,000 cfs was developed for the Lower Saluda River. Gerrit pointed out that fish passage through Mill Race Rapids was limited but found that a flow of 1,326 cfs provided adequate passage for fish species. In closing, Gerrit added that he

[1]Copies of the study were distributed to attendees by Jeni Summerlin before the meeting began.

felt this was a sound study and that it provided the best information that technology would allow for the time.

The group began discussing possibilities of using the 1989-1990 IFIM Study for the Saluda Relicensing Project. Gerrit noted that he believes the sampling methods in this study are sound. He mentioned that there may be a problem with the velocity data, as it was collected at low flows. It was noted that most of the data files for this study are not available.

Ron Ahle noted that replicating this study may be difficult because the Saluda River may have changed overtime, such as the aquatic life present and sediment input. He also pointed out that it would be difficult to find the original transects that were used in the study. Gerrit noted that rebar was used to mark each transects throughout the course of the study.

Ron A. then presented a list of fish species that should be considered in the IFIM Study (attachment A). Ron A. explained that he used a guild approach to determine fish species of importance. He then listed potential stand alone species, which were broken down into three categories: diadromous fish, resident fish and other aquatic species.

Alan S. suggested, and the group agreed, to craft a strawman to evaluate specific factors using the 1989-1990 IFIM Study and Water Resource Report (attachment B). Alan S. noted that he would send the strawman and outline to Brandon Kulik, Kleinschmidt's instream flow expert, to determine if these factors can be analyzed with the data available. Alan also suggested and the group agreed to schedule a two or three day workshop with Brandon K. to explain the analysis of the IFIM data.

Distribution of Congaree Flood Plain Studies/Data

Copies of a study entitled *Hydrologic Variation of the Congaree River Near Congaree National Park, South Carolina* (Plewa and Grag 2005) was distributed to the group. Alan noted that Shane Boring is in the process of compiling existing inundation/floodplain studies from the National Park Service (NPS) and other sources that my help to determine any effects of project operations on the flood plains. Scott Harder noted that he would contact Bud Bader from SCDNR about available inundation studies. It was specifically noted that the studies should include frequency, duration, magnitude and timing of project operations.

Comprehensive Habitat Assessment Discussion

Dick Christie noted that he and Amanda Hill are in the process of identifying the habitat types their agencies would like to see mapped around Lake Murray. He noted that he would like to quantify these habitats using a GIS map or table. He explained that GIS maps and/or tables will show the

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percentages of habitats at different elevations. Dick C. noted that the list should be complete within four weeks, upon which time he will distribute the information for everyone to review before the next meeting.

Discussions on Initial Framework of White Paper Assessing Potential for Self-Sustaining Trout Fishery in LSR

Dick C. suggested that the group approach the trout fishery issues by first examining how to improve the habitat in the LSR, rather than trying to develop a self-sustaining trout population. Dick C. mentioned that, even if the habitat improves, the reproduction success of trout would be limited primarily by the warmwater predators found within the system. The group developed a strawman outlining issues that should to be considered for the LSR trout fishery (attachment C)

Date/Location of Next Meeting

Alan S. noted that he would contact Brandon K. about his availability and would schedule a potential IFIM workshop in August sometime. The meeting adjourned at approximately 2:00pm.

Attachment A

Recommended Target Species for Lower Saluda River IFIM Studies
(Source: SCDNR)

SOUTH CAROLINA DEPARTMENT OF NATURAL RESOURCES
Division of Wildlife and Freshwater Fisheries
Environmental Programs Office

Guild Approach
1) Shallow Slow Guild (<2 ft, <1 ft/sec); redbreast sunfish spawning
2) Shallow Fast Guild (<2 ft, >1 ft/sec); margined madtom, Saluda darter
3) Deep Slow Guild (>2 ft, <1 ft/sec); redbreast sunfish adult
4) Deep Fast Guild (>2 ft, >1 ft/sec); shorthead redhorse

Potential Stand Alone Species
1) Diadromous Fish
    a. American shad
    b. Blueback herring
    c. Striped bass
    d. Shortnose sturgeon
    e. American eel
2) Resident Fish
    a. Robust redhorse
    b. Highfin carpsucker
    c. Northern hogsucker
    d. Spotted sucker
    e. Brown trout
    f. Rainbow trout

3) Others
    a. Native mussels
    b. Benthic macro-invertebrates
    c. Spider lily

REMBERT C. DENNIS BUILDING * P.O. BOX 167 * COLUMBIA, SC 29202
TELEPHONE: (803) 734-2728 * FACSIMILE: (803) 734-6020

Attachment B

Framework for Evaluating Existing Lower Saluda River IFIM Study

Framework for Evaluating Existing Lower Saluda River IFIM Study

If possible, the group would like to evaluate each of the following using the 1995 IFIM Report and Water Resources Report (velocity data collected at 200 cfs).

- Effects of high discharges / Mitigation
- Base flow regime
- Thermal influences / longitudinal variation
- Seasonal variations
- Cover analyses
- Effects of Broad River on the confluence (confluence is defined as Shandon Rapids downstream to Senate Street).
- Scope of project influences (Saluda vs. confluence)
- Types of species to model
- Use the 1989 IFIM report using a wetted perimeter analysis to normalize the USGS gage records. Then run it through an IHA / RVA analysis
- Dissolved oxygen component of the IFIM

Attachment C

Draft Framework for Evaluating the Potential for a Reproducing Trout Fishery in the Lower Saluda River Trout Fishery

Draft Framework for Evaluating the Potential for a Reproducing Trout Fishery in the Lower Saluda River Trout Fishery

1. Species / Requirements / Needs

2. Current Habitat / Management Strategy

    a. Water Quality
    b. Substrate
    c. Food Preferences
    d. Flow Regime

3. Feasibility

    a. Trout predators (striped bass / other warm water species)
    b. Water quality limitations (metals dissolved oxygen)
    c. Flow regimes
    d. Harvesting of adult trout
    e. Available spawning habitat

4. Potential for success self-sustaining trout population with no augmentation

5. Potential for success self-reproducing trout population

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
INSTREAM FLOW/AQUATIC HABITAT
TECHNICAL WORKING COMMITTEE

SCE&G Offices at Carolina Research Park
September 7, 2006

ATTENDEES:

Bill Argentieri, SCE&G	Shane Boring, Kleinschmidt Associates
Randy Mahan, SCANA Services	Malcolm Leaphart, Trout Unlimited
Alan Stuart, Kleinschmidt Associates	Theresa Thom, National Park Service
Jeni Summerlin, Kleinschmidt Associates	Brandon Kulik, Kleinschmidt Associates
Dick Christie, SCDNR	Ron Ahle, SCDNR
Amanda Hill, USFWS	Gerrit Jobsis, Am. Rivers
Scott Harder, SCDNR	Hal Beard, SCDNR

ACTION ITEMS:

- Provide Brandon Kulik with HSI curves used in 1989-90 LSR IFIM Study

Gerrit Jobsis

- Check with USC Geography Dept. for GIS habitat coverages for the LSR

Theresa Thom

- Provide Theresa Thom with bibliography of Congaree floodplain flow studies found thus far

Shane Boring

- Discuss acceptability of SCDNR flow proposal with SCE&G management

Bill Argentieri

- Contact MaryAnn Taylor to discuss potential for using existing LIDAR photography to develop GIS-based habitat layers

Shane Boring

DATE OF NEXT MEETING: **October 16th, 2006, at Lake Murray Training Center, beginning at 9:30 am.**

Kleinschmidt
Energy & Water Resource Consultants

MEETING NOTES:

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.

Shane Boring opened the meeting at approximately 9:30 AM with a review of action items from the last meeting (June 14). Specifically, Shane noted that he had completed the literature review for studies with potential to help address the National Park Service (NPS) request for floodplain flow studies to assess the impact of project operations on Congaree National Park. Shane indicated he would compile the studies he found into a bibliography, which he would forward to Theresa Thom. Theresa Thom indicated that she would compare the bibliography to NPS studies/data that she is aware of and report back to the group. Scott Harder noted that he had spoken with Bud Badr and that Bud was not aware of any additional studies.

In reference to the request for a comprehensive habitat assessment of shallow aquatic areas of Lake Murray, Shane noted that he had received contact info for MaryAnn Taylor (GIS Analyst, SCANA) from Bill Argentieri and that he would be contacting her in the coming week to discuss the potential for using the existing LIDAR photography to develop GIS-based habitat layers. Shane noted that he would report back to the group at the next meeting regarding this issue.

Shane then noted that, since Brandon Kulik was in attendance, the remainder of the meeting would focus on utilizing his knowledge of IFIM studies to review the existing Saluda study, assess its applicability to the current relicensing, and to define goals of any future IFIM study, if deemed necessary.

IFIM Goals for the Saluda River

Brandon encouraged the group to make IFIM goals as specific as possible. After some discussion, the group outlined the following as potential goals of an IFIM study:

- Identify a minimum flow for the Lower Saluda River (LSR)
- Determine flows needed for target species and lifestages, as well as the downstream floodplain
    - Determine the range of flows acceptable to meet these criteria
    - Determine how project operations affect these flows
    - Mimic the natural hydrograph of the LSR
    - Consider impact of providing these flows on Lake Murray

Malcolm Leaphart requested that reproduction of trout be included in any new IFIM analysis. Alan Stuart noted that a white paper outlining the habitat requirements for trout spawning is being drafted by Kleinschmidt and will be distributed to the TWC for review within the next couple of weeks. Dick Christie noted that, in additional to summarizing the needed habitat, the paper will summarize the agency management objectives for the LSR as they relate to trout reproduction.

Dick Christie noted the need to clearly define the "impact area" for any IFIM studies, noting that it likely extends beyond the Project Boundary. Gerrit Jobsis agreed and emphasized the need to consider the downstream floodplain when developing the IFIM goals.

Discussions of Target Species

Shane noted that, at the June 14th meeting, Ron Ahle had distributed a draft list of IFIM targets, which included both species and guilds (Attachment A). He added, and Brandon agreed, that typically either a species-specific or guild approach is used for such studies. Ron clarified, noting that the list was intended to be a starting point and that his preference was to take a guild approach, but also include certain priority species (i.e. smallmouth bass and threadfin shad). Amanda Hill noted the importance of keeping diadromous species on the list USFWS, adding that it may be acceptable to remove American eel. Gerrit recommended going back and looking at the HSI curves for compatibility with the guild approach. Gerrit agreed to provide Brandon with the HSI curves used in the previous study.

In reference to the species list category "other", Shane enquired as to whether generalized (multi-species) HSI curves exist for categories such as benthic macroinvertebrates and mussels. Dick noted that there are HIS curves for EPT's. Gerrit added that there were generalized curves for freshwater mussels that were used for the Duke Power relicensing.

After considerable discussion, it was determined that defining the specific target species/guild may not be possible at today's meeting. It was determined that the existing IFIM study should be reviewed more thoroughly and a determination made as to whether an additional study is needed. The group agreed to revisit the issue of target species/guild after such a determination is made.

Discussion of Existing IFIM Study and Need for Additional Study

The group then discussed the memo prepared by Brandon Kulik providing a critical review of the existing IFIM study (Attachment B). Brandon pointed out several aspects of the study that he feels need further clarification, including:

- Choice of HIS curves and how they were weighted;
- Number of curves (too many curves resulted in difficult interpretation of result); and

- Applicability of transects to current conditions (i.e. potential changes in stream geomorphology).

The group then briefly discussed the accuracy of the existing transect information relative to current conditions. Gerrit noted potential changes in the areas of the transects due to sedimentation, and added that he felt instream aquatic vegetation has also increased. Ron Ahle noted that there has been considerable channel widening in the upper LSR due to streambank erosion. Several group members enquired as to whether there are GIS layers and/or aerial photography that could be used to determine the degree of change in the transect areas. Shane indicated that he had recently conducted a search and was unable to find any GIS data. Theresa Thom noted that she would check with the Geography Department at USC for potentially applicable GIS layers. Gerrit and Ron A. subsequently suggested a possible field visit to determine the degree to which transects have changed.

Brandon Kulik noted that the model in the previous study was calibrated at low flows, thus the accuracy of the model likely starts to decrease at flows greater than 1000 cfs. Gerrit noted that, during execution of the study, Jeff Isely did have problems with calibrations and thus limited the flow range to lower flows. Scott Harder added that SCDNR has concerns about model accuracy in riffle and pool areas at higher flows.

Dick Christie reiterated the flow proposal provided by SCDNR in their comments on the ICD. Specifically, he noted that SCE&G could forego an additional IFIM study if they implement the proposed flow of 1170 cfs during the month of January through April, 879 cfs during May and June, 586 during July through November, and 879 cfs during December. Dick added that these flows are based on the SC State Water Plan and were developed using the 20%, 30%, 40% method (of mean annual flow). Several group members noted that, despite the many shortcoming that have been pointed out, the flows recommended in the existing IFIM study report (1326 cfs January – April; 950 cfs May – June; 575 cfs July – November; 950 cfs in December) are very similar those being proposed by SCDNR.

Gerrit Jobsis noted that he would have to give some consideration as to whether his group would be satisfied with the flows being proposed by SCDNR, adding that he would prefer the flows recommended through study of the Saluda River by the Water Resources Commission/Wildlife and Marine Resource Department (Bulak, J.S. and G.J. Jöbsis. 1989[1]) as this study provides site-specific information (i.e. on channel morphology, fish passage, hydrography). Bill Argentieri noted that the project is being operated much differently than when these site-specific recommendations were

[1] Bulak, J.S. and G.J. Jöbsis. 1989. *South Carolina instream flow studies: a status report*. South Carolina Wildlife and Marine Resources Department. 51 pages.

developed. Alan Stuart pointed out that the primary difference between the two proposals is the magnitude of the high flow period (1170 vs. 1326 cfs). Gerrit added that the higher flow in the report was based on providing passage for adult striped bass at Millrace Rapid, the most limiting area. He clarified that the recommendation was based on development of a stage – discharge relationship, which took into consideration a number of site-specific factors (i.e., wetted perimeter, depth needed for adult passage, natural hydrography). The existing IFIM study took measurements at Corley's Island and Millrace Rapids and verified that Millrace was the most limiting.

Gerrit added that the existing study does not take into the account potential negative impacts associated with infrequent higher flow (> 10,000 cfs), adding that this should be taken into account in any future studies. Attendees added that the frequency, duration, and magnitude of such flow should also be taken into consideration. Amanda Hill and Gerrit cited the potential for using a dual flow analysis to address this issue. Gerrit and others also raised interests in how project operations affect the Congaree River, e.g. striped bass and diadromous fish spawning, flows for floodplains and the Congaree National Park, that would not be addressed under the DNR proposal.

After some discussion, it was determined that there are too many uncertainties with the existing study. The group then began to discuss what the next steps should be considering this decision. It was determined that it is up to SCE&G to determine whether proposed flow regime is acceptable. Agency staff noted that if the proposed flows are deemed not acceptable, SCE&G will need to conduct an additional IFIM study. Bill Argentieri agreed to discuss the proposed flows with SCE&G management and report their decision back to the group. Bill requested, and the group agreed, to give SCE&C until mid to late-October to evaluate the proposal.

Date/Location of Next Meeting

The group agreed that the next Instream Flow TWC meeting will occur on October 16th, 2006 at the Lake Murray Training Center, starting at 9:30 AM. Shane B. will send out an electronic meeting announcement confirming date, time and location. The meeting adjourned at approximately 3:00pm.

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
IFIM/Aquatic Habitat TWC

SCE&G Training Center
October 16, 2006

Final acg 11-22-06

ATTENDEES:

Alison Guth, Kleinschmidt Associates	Bill Argentieri, SCE&G
Alan Stuart, Kleinschmidt Associates	Randy Mahan, SCANA Services, Inc.
Ron Ahle, SCDNR	Scott Harder, SCDNR
Dick Christie, SCDNR	Hal Beard, SCDNR
Shane Boring, Kleinschmidt Associates	Brandon Kulik, Kleinschmidt Associates
Malcolm Leaphart, TU	Gerrit Jobsis, American Rivers

HOMEWORK:

- Perform literature review for existing studies on widths and depths necessary for fish passage – *Brandon Kulik*
- Distribute draft IFIM study plan to group by email prior to 27th meeting – *Brandon Kulik*
- Send Catawba Wateree HSI curves to Brandon K - *SCDNR*
- Forward Brandon K. an example list of species to be considered under each guild - *SCDNR*
- Send Pee Dee HSI curves to Brandon K. – *Gerrit Jobsis*

UPCOMING AGENDA ITEMS:

- *Addressing the influences of Saluda Operations on the Congaree*

DATE OF NEXT MEETING: **November 27, 2006 at 9:30 a.m.**
Lake Murray Training Center

MEETING NOTES:

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.

Review of Homework Items from Previous Meeting:

Shane Boring opened the meeting and noted that the first discussion topic was to review action items from the previous meeting. Shane noted that Gerrit Jobsis was charged with finding the HSI curves used in 1989-90 LSR IFIM Study. Gerrit replied that they could be found in the study report. Shane also noted that he had talked to Theresa Thom regarding her homework assignment to check with USC Geography Dept. for GIS habitat coverages for the LSR. Shane explained that she was not able to find any GIS habitat layers. Shane also noted that he has contacted MaryAnn Taylor to discuss potential for using existing LIDAR photography to develop GIS-based habitat layers, as was his homework assignment. He noted that Clarence at Orbis was investigating this issue.

Discussion About the Meeting Topic:

The group then discussed the recommendations for instream flows that DNR presented in their ICD comments (1170 cfs during the month of January through April, 879 cfs during May and June, 586 during July through November, and 879 cfs during December). Bill Argentieri noted that SCE&G has reviewed the flow options presented. Bill noted that the flows that were proposed were apparently reflective of the USGS gage at the lower end of the confluence, adding about a hundred sq. miles to the drainage area. Bill explained that based on the 20/30/40 proposal, SCE&G came up with 493 740 and 986 cfs based on the gage directly below the dam. Bill also reiterated that at the last meeting Gerrit provided numbers from the study of the Saluda River by the Water Resources Commission/Wildlife and Marine Resource Department (Bulak, J.S. and G.J. Jöbsis. 1989) which are 575 950 and 1326 cfs. Gerrit noted that the numbers provided in the report are based on physical measurements from the Saluda river to meet the criteria for passage.

As the group began to discuss the existing DNR IFIM report in a little more detail, Dick Christie gave the group a little more background to the report. Dick noted that when the study was done in the 80's, there was only one gage on the lower Saluda River, the gage down by the zoo. He noted that mean daily flow was calculated from that gage. Dick noted that when DNR made the flow recommendations they were actually recommendations for that site in particular, so by default there is a little bit of inflow between the dam and that gage. Dick continued to explain that there may be room for calculating and that they would support the updating of the numbers if the group can come to terms of doing that. Dick asked Bill if SCE&G had developed their flow estimates by subtracting what was calculated to be the drainage area. Bill replied that they had. Gerrit noted that they have dealt with this in the past by using the monthly calculated inflow rather than annual averages, because the drainage areas would have less contribution in the summer.

The group then began to discuss what would be involved in performing a new site specific test. Gerrit suggested a real time analysis to look at the habitat available, looking at flows not based on annual average but on daily or hourly flows. Bill pointed out that the new study would probably not be performed before next year due to the low lake levels. Dick noted that the transects could probably be laid out and the low flow data could be obtained, while the high flow data could be reserved for times when the lake level is higher. Gerrit noted that he believed that the fish passage transects provided in the Bulak, J.S. and G.J. Jöbsis 1989 study were important to consider. He explained that a panel of experts was assembled to weigh in on what they felt was necessary for

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unimpeded fish passage. At that time the panel felt that a 10 ft wide, by 18 inch deep slot was necessary for this, or 10% of the channel width. Alan Stuart asked the group if there have been any studies preformed that further address passage. Brandon Kulik noted that he does know of a few studies that they could look into. Brandon also noted that a mesh model could be developed at the rapids that would allow the rapids to be modeled probably better than transects.

Dick noted that he was curious as to whether consideration was given to the time or timing on the flows for fish passage in the existing IFIM report. Hal Beard was asked to give an account of his experience fish sampling on the lower Saluda. Hal noted that based on the years that he has worked, both drought and normal, he has not seen an absence of striped bass in the river. However he noted that he could not comment as to the relative abundance of striped bass. He mentioned that he could compare the data he collected to flows.

Malcolm Leaphart asked for an reiteration as to why the flows had been requested for those particular times during the year. Dick noted that the 20/30/40 recommendation is based on a typical hydrograph and is also something that the utilities are able to implement.. Dick continued to explain that if you look at a typical hydrograph you will see the highest flows are in the spring, and that it is commonly understood that the fish have probably adapted to the hydrograph. Thus, the policy should be adapted to the hydrograph, to which the fish have adapted to.

Presentation and Review of Scoping Elements:

After a short break, Brandon gave a brief presentation on PHABSIM. (Can be viewed on the website). Alan suggested reviewing the video flyovers to help decide what areas to use in the study and what reach breaks to use. Brandon explained that during a study they would have to come up with commonly understood definitions of runs and riffles along the lower Saluda.

After lunch the group discussed the 7 basic instream flow study scoping elements, listed below.

BASIC INSTREAM FLOW STUDY SCOPING ELEMENTS

1. Specify habitat and resource management objectives
2. Define geographic boundary of study area
3. Define type of problem (*i.e*. diversion, maintenance of minimum flow, alteration of existing flow regime, *etc*)
4. Define macrohabitat influences (*e.g*. water quality, temperature, etc.)
5. Select and justify evaluation criteria
6. Define temporal periods and units
7. Define flow ranges and increments of interest

During discussions on item number 2, defining geographic boundary of study area, Gerrit noted that he believed the Congaree river was important to consider as well. Gerrit further asked that the group have an agenda item at an upcoming meeting to specifically address Saluda's potential influence on the Congaree.

Brandon moved to item number three, Define the type of problem. Dick explained that it could be defined as the alteration of an existing regulated flow. He also asked if there would be an evaluation of peaking included in the study. It was explained that peaking over a 12 hour period would have quite a different impact than peaking over a 1 hour period (Reserve usage). The group noted that the duration of high flows would be taken into account in a dual flow analysis.

The group progressed through the scoping elements, pausing for brief discussion on number 6. Ron noted that he preferred the idea of initially taking smaller temporal units and lumping them together if need be. Gerrit suggested using the same temporal periods for setting up life stages as used in the Pee Dee. Brandon noted that there were advantages to using monthly units, and asked the group if they would like the units to be smaller than that.

The group discussed how to look at the reserve component during this study. Brandon noted that if reserve is used for only a few hours there is probably some sort of measurable effect just below the powerhouse, however these effects will probably attenuate throughout the stretch of river. The group agreed that in order to best look at the reserve use is to have a few transects close to the dam.

On item 7, Alan noted that the flow range would be up to 20,000 cfs, or what the top-end of the potential upgrade is going to be.

Discussion of Proposed Target Species List:

The group then began to discuss the Proposed Target Species list and the group interactively changed a few items (attached below). Brandon noted that it would be helpful to begin mapping out the different life stages for diadromous fish at different months of the year, as well as what type of meso-habitat is necessary.

As the group discussed the proposed target species, the guild approach as well as potential stand alone species, it was noted that an HSI curve did not exist for the Saluda Darter, so a surrogate curve would have to be used for that species. The group noted that general HSI curves would be used, unless specific curves were needed for a species. A list of the individual species contained in each HSI curve will be made as well. The group emphasized keeping the amount of species considered at a manageable level that the group could comfortably handle. Alan asked the group if there were any species that are not on the target species list that should be. The group indicated that the list was satisfactory. Kleinschmidt Associates will look at combining some of the species, where applicable. Concurrently, the agencies will also look at obtaining HSI curves from Catawba

Wateree data. SCDNR will also send an example to Brandon of a list of species considered under each guild. Gerrit will forward the Pee Dee HSI curves to Brandon.

Brandon noted that he felt comfortable drafting a study plan with the information gleaned from the meeting and the group closed. Brandon noted that he would send out the study plan for review prior to the next meeting. The group scheduled the next meeting date for November 27th at the Training Center.

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
IFIM/Aquatic Habitat TWC

SCE&G Training Center
October 16, 2006

Final acg 11-22-06

SOUTH CAROLINA DEPARTMENT OF NATURAL RESOURCES
Division of Wildlife and Freshwater Fisheries
Environmental Programs Office

MEMORANDUM

To: L & LM TWC (Saluda Hydro Project)
From: Ron Ahle
Date: 5-05-06
Subject: Proposed Species List for IFIM Study

Guild Approach - use Catawba-Wateree and possibly Pee Dee curves
1) Shallow Slow Guild (<2 ft, <1 ft/sec); redbreast sunfish spawning
2) Shallow Fast Guild (<2 ft, >1 ft/sec); spottail shiner, ~~margined madtom~~,
3) Deep Slow Guild (>2 ft, <1 ft/sec); redbreast sunfish adult
4) Deep Fast Guild (>2 ft, >1 ft/sec); shorthead redhorse

Potential Stand Alone Species
1) Diadromous Fish
   a. American shad
   b. Blueback herring
   c. Striped bass
   d. Shortnose sturgeon
2) Resident Fish
   a. Robust redhorse (golden redhorse)
   ~~b. Highfin carpsucker~~
   c. Northern hogsucker
   d. Spotted sucker
   e. Brown trout
   f. Rainbow trout
   g. Threadfin/Gizzard shad
   h. Smallmouth bass
   i. Saluda darter (fantail darter)

3) Others
   a. Native mussels (wetted perimeter study)
   b. Benthic macro-invertebrates (EPT)

Deleted: Saluda darter

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Deleted: <#>Spider lily¶

REMBERT C. DENNIS BUILDING * P.O. BOX 167 * COLUMBIA, SC 29202
TELEPHONE: (803) 734-2728 * FACSIMILE: (803) 734-6020

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
INSTREAM FLOW/AQUATIC HABITAT TECHNICAL WORKING COMMITTEE

SCE&G Training Center
November 27, 2006

Final jms/bhk/csb 01-03-07

ATTENDEES:

Alan Stuart, Kleinschmidt Associates
Bill Argentieri, SCE&G
Brandon Kulik, Kleinschmidt Associates
Dick Christie, SCDNR
Gerrit Jobsis, American Rivers/CCL
Hal Beard, SCDNR
Jeni Summerlin, Kleinschmidt Associates
Milton Quattlebaum, SCANA Services
Randy Mahan, SCANA Services
Ron Ahle, SCDNR
Scott Harder, SCDNR
Shane Boring, Kleinschmidt Associates
Theresa Thom, National Park Service

ACTION ITEMS:

- Find out if Prescott has HSI curves for Atlantic/shortnose sturgeon

Amanda Hill

- Ask Steve Summer if he has any flow data for the LSR

Milton Quattlebaum

- Provide HSI curves for brown/rainbow trout from Savannah River/Catawba Wateree IFIM studies

Dick Christie

- Contact Jim Ruane about obtaining HSI curves for trout in the Chattahoochee River basin and research other potentially applicable trout curves

Brandon Kulik

- Research applicable smallmouth bass HSI curves

Brandon Kulik

- Edit the guild matrix and send out to committee members

Brandon Kulik

- Plan a meeting to discuss the guild matrix and *HSI* curves in more detail

Shane Boring

- Edit the draft IFIM study plan and send out to committee members

Brandon Kulik / Shane Boring

- Edit mesohabitat descriptions and send out to committee members

Brandon Kulik

DATE OF NEXT MEETING[1]: **December 19, 2006 at 9:30 a.m.**
Located at the Lake Murray Training Center

[1] this meeting will be to discuss issues pertaining to the Congaree River

MEETING NOTES:

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.

Review of Action Items from Previous Meeting:

Shane Boring opened the meeting and noted that the first discussion topic was to review action items from the previous meeting. Shane noted that Brandon Kulik sent the draft IFIM study plan to committee members for review; Gerrit Jobsis provided a link to the Pee Dee HSI curves; and Dick Christie sent the Catawba Wateree HSI curves to Brandon. Shane noted that the purpose of today's meeting is to: (1) review the draft IFIM study plan, (2) review the lower Saluda River (LSR) aerial video, (3) discuss the guild matrix and HSI curves, (4) discuss the classification, types, and definition of mesohabitats, and (5) discuss field site locations that study participants wish to visit on November 28th.

Review of Draft IFIM Study Plan:

Comments on the draft IFIM study plan can be viewed in track changes in Attachment A. A copy of the draft IFIM study plan was distributed and Shane asked committee members if they had any comments. There were several editorial and organizational recommendations made by SCDNR and American Rivers to better describe the context of river fishery resources, and clarify the scope and role of this study. Dick and Hal noted that recent DNR studies reveal that striped bass use the LSR as a thermal refuge (as much as 50% of the population), and that there may be potential for the river to be managed for smallmouth bass in the future, as smallmouth bass are colonizing the Broad River near the confluence with the Saluda and DNR anticipates that they will begin to inhabit the Saluda in the near future. Gerrit recommended that the project description include a reference to other historic operating regimes that the Saluda project has employed during the life of its current license besides the current operating mode (reserve).

Regarding the technical approach, Scott Harder asked about the number of velocity sets that will be taken at each transect. Brandon noted that velocity measurements will be taken on a transect basis. Brandon went on to explain that at least one velocity set will be taken at each transect. There will be three calibration flows (low, medium and high), and velocity data are collected at the middle calibration flow. In the case of transects with complex hydraulics (usually riffles and shoals) additional velocity sets will likely be collected at the low flow since hydraulic parameters such as friction coefficients and turbulence will likely be different due to the substrates and supercritical flows inherent in such sites. This is decided on a case-specific basis with input from a hydraulic engineer, In order to provide a suitable stage-discharge curve for the hydraulic model to project

Weighted Usable Area (WUA) for a flow range from 40 to over 20,000 cfs, the three calibration flows to be used are expected to be approximately:(350-500 cfs, 1200-1500 cfs, and 10,000 cfs. Scott inquired how error will be treated in the model. Brandon indicated that for each flow increment at each transect, the Velocity Adjustment Factor (VAF) obtained during each transect's calibration is used as an indicator of accuracy. If VAF's for some flow range is out of range, additional modeling or supplemental .flow data may be required. Brandon agreed to supplement the modeling discussion in the draft plan methodology with additional details.

In regards to the fish passage evaluation, Gerrit explained that the 1990 IFIM study that he participated in came up with a 1300 cfs fish passage flow based on SCDNR criteria for Millrace Rapids. This was based on data obtained at a location in Millrace Rapids chosen by Steve De Kozlowski. Gerrit questioned the need to redo this part of the study, because the criteria will not change much, and he believes that the river channel characteristics have not changed much. Brandon noted that the study plan was written so as not to foreclose on the need to conduct a new analysis, but that the full study team would make the final decision. Another option might be to obtain and review the original data sets and Steve De Kozlowski input if practical. Dick Christie felt that the study should take advantage of new fish passage hydraulic criteria that may be specifically applicable to anadromous fish species. Brandon added that he had obtained these criteria from Alex Haro of the Conte Anadromous Fish Laboratory in Turners Falls, MA, and that they rate, temperature, fish swimming strength, slope and water velocity in ascending rapids.

Hal Beard asked how braided sections in the LSR will be evaluated. Brandon indicated to the extent the team desires that these be modeled, that each channel braid selected will be treated as a separate stream channel, with separate transects. Manual flow gauging will be required during calibration to provide an estimate of how water flows through each braid. Scott inquired as to how the Acoustic-Doppler Current Profiler (ADCP) will be used with the large amounts of vegetation in the LSR. Brandon explained that if these mats of vegetation are extensive, they may effect the model simulation, in that they act as ephemeral objective cover and may change the velocity relative to unvegetated periods. Brandon specifically noted that vegetation will certainly be considered when evaluating the mesohabitats. Hal noted that vegetation in the LSR has increased over the years; about 70% of the river has vegetation, specifically from Twelvemile Creek to the I-20 Bridge. Vegetation is most pronounced in areas of lower velocity and comparatively less pronounced in rapids and riffles. Hal mentioned that the group may want to consider talking to Cindy Aulbach. She conducts fly-over's for SCE&G to evaluate vegetation in the LSR.

Review of Lower Saluda River Aerial Video:

To gain a better understanding of the different types of habitats, the group viewed flows of the LSR at 540 and 840 cfs video graphed from a helicopter flying from downstream to upstream during spring 2005. Gerrit noted that transects at Corley Island, Oh Brother Rapids and Shandon Rapids should be evaluated. Through discussion, the group separated the LSR into four segments: (1) Lake Murray Dam to Rawls Creek; (2) Rawls Creek to I-26 Bridge; (3) I-26 Bridge to Millrace Rapids; and (4) Millrace Rapids to the confluence of the lower Saluda and Broad river's. The group noted that segment (2) was extremely uniform in width, depth, and channel shape.

Classification, Types and Definition of Mesohabitats:

Comments on the guild matrix can be viewed in track changes in Attachment B. Brandon explained that in order to simplify the WUA analysis, the TWC had agreed to sort species and life stages into habitat-use guilds. Brandon noted that for purposes of this straw man, the guild groups (shallow-slow, shallow-fast, *etc*) categories were the commonly-used categories developed by Mark Bain. Brandon explained that life stages of each species were assigned to habitat use guilds based on life history and habitat preference using Dilts et al. (2003) *Application of New Approaches to Instream Flow: Use of Two Dimensional Modeling and Habitat-Use Guilds in a Southeastern Stream* as a generalized model. He asked that the TWC review this approach for reasonableness and welcomed any river- or species-specific refinements that the group cared to recommend.

Gerrit pointed out that spawning and adult life stages of shortnose sturgeon should be added to the guild matrix. He mentioned that the Catawba Wateree, Pee Dee, and Santee Cooper may have developed HSI curves for shortnose/Atlantic sturgeon. Amanda Hill noted that Prescott Brownell may have developed these curves. Amanda recommended adding spawning life stage for striped bass. Dick indicated that there has been no indication of spawning striped bass in the LSR. He clarified that striped bass use the LSR as a thermal refuge area rather than for spawning. Dick noted that if striped bass spawning is included, we may be able to use HSI curves from the Savannah River or Catawba Wateree. There was a brief discussion about the type of HSI curves that could be used for brown trout and Shane noted Dick had observed that it may not be feasible to use Catawba Wateree curves because it would not be reflective of the LSR. In response to a question, Brandon noted that USFWS "bluebook" adult and juvenile HSI trout curves have been criticized as non-transferable curves, at least in most eastern rivers. He was aware of some recent trout curve development in Pennsylvania and New England that may have potential transferability. Hal noted that SCDNR is more concerned with adult trout from a resource perspective; they would like to include some southeastern trout HSI curves. Alan Stuart noted that TVA may have developed HIS curves for trout in the Chattahoochee basin. Gerrit mentioned that the USFWS HSI curves for trout are from 1984/1985. He mentioned that Jim Ruane may be able to provide some information on these curves. It was generally agreed that if Brandon could find and circulate these HSI curves for committee members to review that satisfactory adult curves could be identified by the group. Brandon will also research and summarize smallmouth bass HSI criteria.

Shane inquired if committee members were satisfied with the guild approach. The group noted that they were comfortable with this guild approach, but certain species should be stand alone. Specifically, Dick noted that smallmouth bass, spottail shiner, gizzard and threadfin shad species are not easily categorized into specific guilds. Gerrit noted that the group should reexamine each species and how they are categorized into each guild, specifically the northern hogsucker. Brandon noted that he would update the guild matrix and send out to committee members for review. Shane noted, and the group agreed, that a meeting devoted entirely to finalizing the guilds is needed.

Classification, Types and Definition of Mesohabitats:

Brandon displayed various mesohabitats definitions for the group and noted that it is important to reach a common understanding of these definitions. These definitions are in part a way to link life stages to habitat-use guilds, but is primarily a tool to facilitate habitat mapping. The distribution and abundance of mesohabitats in each reach will in turn be used as a mechanism to select study sites and transects at a later stage. He pointed out that the definition of each mesohabitat was adopted from the Catawba Wateree, and Santee Cooper studies and Dunn and Leopold, 1998. Brandon read through each habitat type and a few comments were made.

The group agreed to meet at the guard shack located at the Saluda Hydro Dam at 9:30AM to visit specific sites of interest, gain a common understanding of the river from a habitat perspective, and test and refine the definitions of mesohabitats on the LSR.

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
Instream Flow/Aquatic Habitat Technical Working Committee
SCE&G's Lake Murray Training Center
January 22, 2007

Final CSB 03-30-07

ATTENDEES:

Bill Argentieri, SCE&G
Alan Stuart, Kleinschmidt Associates
Milton Quattlebaum, SCANA Services
Jeni Summerlin, Kleinschmidt Associates
Amanda Hill, USFWS
Ron Ahle, SCDNR
Gerrit Jobsis, AR/CCL
Shane Boring, Kleinschmidt Associates
Brandon Kulik, Kleinschmidt Associates
Hal Beard, SCDNR
Scott Harder, SCDNR

ACTION ITEMS

- Incorporate comments into the Instream Flow Study Plan and send out to all committee members for review

Shane Boring

- Determine whether HSI curves are available for gizzard shad in riverine systems, and if so, distribute to TWC

Shane Boring/Brandon Kulik

- Email Prescott Brownell about whether it would be applicable to use the Catawba-Wateree shortnose sturgeon HSI curves for the Saluda IFIM study

Amanda Hill

- Compile potential source HSI substrate curves and distribute to TWC prior to Feb. 21 meeting

Shane Boring/Brandon Kulik

- Construct plots of finalized HSI curves (Depth/Velocity for smallmouth bass, rainbow trout, brown trout)

Shane Boring/Brandon Kulik

NEXT MEETING

February 21, 2007 at 9:30am
Location: Lake Murray Training Center[1]

[1] This meeting date was later cancelled.

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
Instream Flow/Aquatic Habitat Technical Working Committee
SCE&G's Lake Murray Training Center
January 22, 2007

Final CSB 03-30-07

MEETING NOTES:

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.

Shane Boring opened the meeting at approximately 10:00 AM and noted that the purpose of today's meeting will be to discuss: (1) HSI criteria for guilds, (2) HSI criteria for stand-alone species, and (3) the next steps that need to be taken for the IFIM study. He briefly reviewed the action items from the previous meeting. Shane noted that he was currently incorporating comments made on the IFIM study plan and would send it back out to committee members within the next week for comments.

Review of HSI Criteria for Guilds

Shane noted that the species guild matrix had been revised based on comments from the previous IFIM meeting and distributed a revised matrix. The group then reviewed the updated matrix, and after several additional revisions, agreed that the following guild approach was acceptable:

Deep Slow Guild

species	life stage	SI curve source
American shad	YOY	Catawba-Wateree
blueback herring	spawning	
blueback herring	YOY	
Norrthern hogsucker	adult	
redbreast sunfish	adult	
robust redhorse	juvenile	
robust redhorse	adult	
spotted sucker	juvenile	
spotted sucker	adult	

Deep Fast Guild

species	life stage	SI curve source
American shad	YOY	Catawba-Wateree
American shad	spawning	
Norrthern hogsucker	spawning	
Norrthern hogsucker	fry/YOY	
Norrthern hogsucker	juvenile	
shorthead redhorse	adult	

spottail shiner	adult	

Deep Fast Guild

species	**life stage**	**SI curve source**
benthic macroinver.	juvenile	Catawba-Wateree
robust redhorse	spawning	
saluda darter	adult	
spottail shiner	spawning	
spotted sucker	spawning	

Deep Fast Guild

species	**life stage**	**SI curve source**
redbreast sunfish	spawning	Catawba-Wateree
robust redhorse	fry/YOY	
spotted sucker	juvenile	
spotted sucker	fry/YOY	

There was a brief discussion about whether to add threadfin shad to the list of target species. It was noted that HSI curves were not available for threadfin shad, but that gizzard shad could potentially serve as a surrogate. Alan Stuart and others noted that the existing gizzard shad HSI curves were developed for reservoir habitats, not riverine systems. After some discussion, it was determined that availability of appropriate riverine HSI curves for gizzard shad should be evaluated prior to determining whether this species can serve as an appropriate surrogate for threadfin shad. The group agreed to withhold a determination on whether or not threadfin shad should be included until after this information is evaluated.

Review of Habitat Suitability Criteria (HSC) for Stand-Alone Species

Brandon Kulik noted that a memorandum regarding HSC for stand-alone species was sent out on January 16, 2007 to all committee members (Attachment A). He noted that this memorandum summarized HSC curves for smallmouth bass, rainbow trout, and brown trout from a number of potential source studies for purposes of evaluating transferability to the lower Saluda study. He noted that TWC members should consider their field experience/observations regarding the target species and the lower Saluda River in evaluating applicability of the potential source curves. The group examined the HSC curves for each species and lifestage for both depth and velocity. The group agreed to use the following HSC curves for the following species:

Species	Life Stage	Parameter	SI Curve Source
brown trout	adult	Depth	Combination: Housatonic (poor), Deerfield
	adult	Velocity	Lackawaxen, w/modifications
brown trout	fry/YOY	Depth	Deerfield
	fry/YOY	Velocity	Deerfield
brown trout	juvenile	Depth	Combination: Deerfield, Raleigh
	juvenile	Velocity	Combination: Lackawaxen, Deerfield
brown trout	spawning	Depth	Raleigh
	spawning	Velocity	Raleigh w/modifications
rainbow trout	adult	Depth	Deerfield
		Velocity	Deerfield (abundant)
rainbow trout	fry/YOY	Depth	Raleigh
		Velocity	Raleigh
rainbow trout	juvenile	Depth	Lackawaxen
		Velocity	Lackawaxen
rainbow trout	spawning	Depth	Raleigh
		Velocity	Raleigh
smallmouth bass	adult	Depth	Combination: Groshens & Orth, Bain
		Velocity	Combination: Groshens & Orth, Deerfield (abundant)
smallmouth bass	juvenile	Depth	Combination: Bain, Deerfield w/modifications
		Velocity	Deerfield (abundant)
smallmouth bass	spawning	Depth	Lockhart
		Velocity	Lockhart
smallmouth bass	YOY	Depth	Combination: Groshens & Orth, Bain
		Velocity	Combination: Deerfield, Bain

Zone of Passage for Striped Bass

Brandon suggested that the minimal flow limiting passage requirement for a fish would be an adequate amount of water so that the body of the fish is submerged. A maximum flow limiting factor for passage would be a high velocity that exceeds the fish's sustained swimming strength. Gerrit noted that there are striped bass passage standards for South Carolina. He explained that according to the standard, river must be 18 inches in depth for a 20 pound striped bass, with a 10 ft width, covering 10 % of the channel. Hal Beard noted that he thinks there may only be one year in

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which striped bass were not able to make it up the lower Saluda River past Millrace Rapids. Hal noted that it may have occurred in the months of May/April of 1991. This was because Saluda Hydro was not releasing. Brandon presented a spreadsheet model from the USGS Conte Lab paper (Attachment B) that described limiting velocities for striped bass passage based on fish size and ambient water temperature.

Next Steps

Brandon noted that the group would need to also agree upon appropriate substrate HSC curves. The group agreed that discussion of potential source curves for substrate would be appropriate for the February 21st TWC meeting. Brandon and Shane agreed to draft and similar memo summarizing potential source curves and distribute to the group prior to the meeting.

Brandon noted that Shane will be going out in the field to characterize mesohabitats on the lower Saluda River. Shane added that they hope to have the mesohabitat characterization completed and available for review by the TWC by late March.

Brandon mentioned that they have not yet been able to contact Prescott Brownell regarding HSC curves for shortnose sturgeon. After some discussion, the group agreed that the Catawba-Wateree IFIM study would be the most likely source for shortnose sturgeon curves. Amanda Hill noted that she would e-mail Prescott regarding transferability of the Catawba-Wateree curves; she recommended contacting Pace Wilbur at NOAA-Fisheries if we were not able to contact Prescott.

Next Meeting

The group noted that the next TWC meeting had been scheduled for February 21st, 2007 at Lake Murray Training Center. The meeting adjourned at approximately 3:10 PM.

Attachment A

Memo Summarizing Potential Source Habitat Suitability Curves for Depth and Velocity for Smallmouth Bass and Rainbow and Brown Trout Lifestages

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
Instream Flow/Aquatic Habitat Technical Working Committee
Via Conference Call
April 10, 2007

Final CSB 05-22-07

ATTENDEES:

Dick Christie, SCDNR
Alan Stuart, Kleinschmidt Associates
Milton Quattlebaum, SCANA Services
Jeni Summerlin, Kleinschmidt Associates
Mike Waddell, Trout Unlimited
Gerrit Jobsis, AR/CCL
Shane Boring, Kleinschmidt Associates
Brandon Kulik, Kleinschmidt Associates
Hal Beard, SCDNR

ACTION ITEMS

- Gather and distribute substrate HSC plots and legends from Catawba-Wateree study for brown trout fry/spawning/juveniles to TWC

  Dick Christie / Shane Boring

- Finalize HSC curves based on TWC input and incorporate as an appendix to the Saluda IFIM Study Plan

  Shane Boring/Brandon Kulik

NEXT MEETING

TBD

MEETING NOTES:

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.

Shane Boring opened the meeting at approximately 9:00 AM. Shane noted that, at the January 22nd meeting of the Instream Flow/Aquatic Habitat Technical Working Committee (TWC), the TWC had agreed upon Habitat Suitability Criteria (HSC) for depth and velocity for several target species (smallmouth bass, brown trout, and rainbow trout adults). Shane added that the purpose of today's meeting would be to finalize the HSC selection process by selecting substrate criteria for these species.

Shane enquired as to whether there was any follow-up discussion regarding the depth/velocity criteria selection process or other TWC housekeeping items in need of attention. Hal Beard noted that, at the previous meeting, there was an action item assigned to determine whether HSC curves were available for gizzard shad in riverine systems. Hal added that, after discussing this issue with colleagues at SCDNR, he did not think this species was as much of a priority as he had once thought.

Dick Christie reminded the group that DNR manages the lower Saluda as a put-grow-take trout fishery, and as such, he and other DNR staffers had requested at previous TWC meetings that the habitat modeling for trout focus on adult lifestages (i.e. not include spawning, juvenile, fry). He added that, while DNR certainly welcomes any improvements to water quality or habitat that might benefit these early-lifestages, flow recommendations resulting from the IFIM process should not come at the detriment of providing quality growing conditions for stocked adult and sub-adult trout. Dick added that, while looking at early lifestages in the modeling might be good to have for informational purposes, these lifestages were not within the DNR's management strategy for the lower Saluda. Mike Waddell noted that Trout Unlimited does not agree with DNR's strategy of managing only for adult lifestages.

The group then turned their attention to the memo prepared by Shane Boring and Brandon Kulik (Attachment A), which summarized potential source HSC for substrate from a number of regional studies. After reviewing the source HSC plots for applicability to the lower Saluda, TWC members agreed on substrate HSC for the following species and lifestages:

Species	Life Stage	Curve Source	Modifications
brown trout	adult	Deerfield	Change 'Ledge' to 'Irregular Bedrock' and change SI of this category to 1.0
	juvenile	Deerfield	Change 'Ledge' to 'Irregular Bedrock' and change SI of this category to 1.0
	Fry	Deerfield	Change 'Ledge' to 'Irregular Bedrock'
	Spawning	Deerfield	
rainbow trout	Adult	Deerfield	Change 'Ledge' to 'Irregular Bedrock' and change SI of this category to 1.0; Lower SI for 'Roots, Snags, Undercut banks, Overhead Cover' to 0.2
smallmouth bass	Adult	Deerfield	Change 'Ledge' to 'Irregular Bedrock'
	Juvenile	Deerfield	Change 'Ledge' to 'Irregular Bedrock'
	YOY	Deerfield	Change 'Ledge' to 'Irregular Bedrock'
	spawning	Deerfield	Change 'Ledge' to 'Irregular Bedrock'

The group was not able to reach consensus on an acceptable substrate HSC for rainbow trout juveniles, fry or spawning due to limited source information (i.e., only the Raleigh et al. "Blue Book" value were presented). Mike Waddell, expressed interest in evaluating the curves used in the Catawba-Wateree IFIM Study before making a final selection for these lifestages. Dick Christie noted that these curves were presented in the Catawba-Wateree Final IFIM Report, but added that the legends needed to interpret the plots were not included. Dick agreed to contact the authors regarding the legends. Shane agreed to distribute the curves to the TWC once all of the information is gathered.

The meeting adjourned at approximately 11:00 AM.

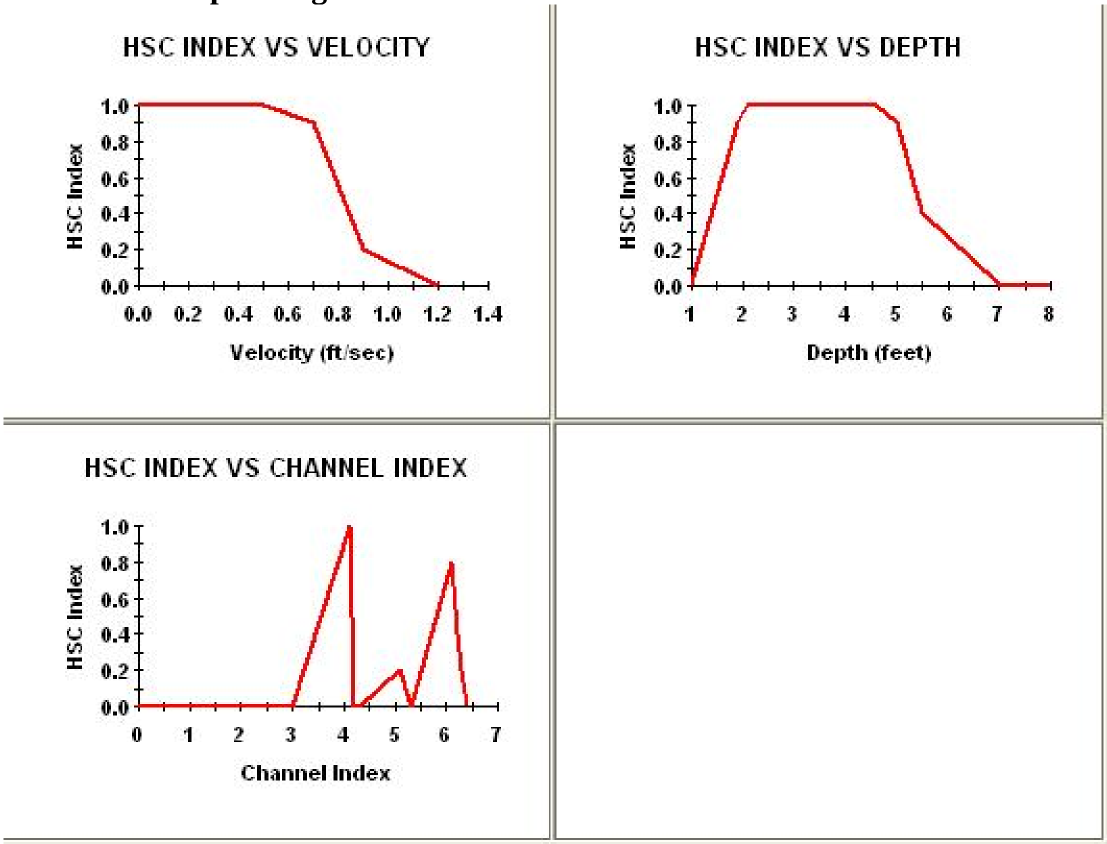
Attachment A

Memo Summarizing Potential Source Habitat Suitability Curves for Substrate for Smallmouth Bass and Rainbow and Brown Trout Lifestages

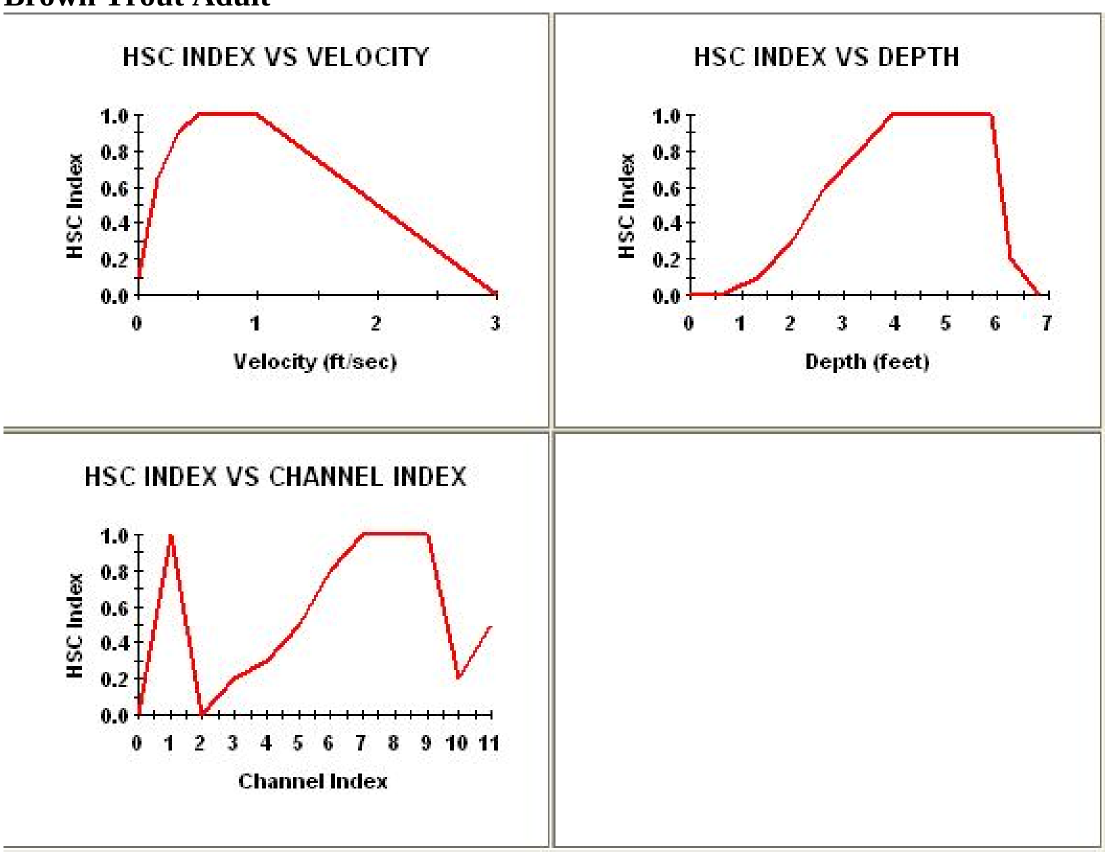
APPENDIX B

HABITAT SUITABILITY INDEX DATA

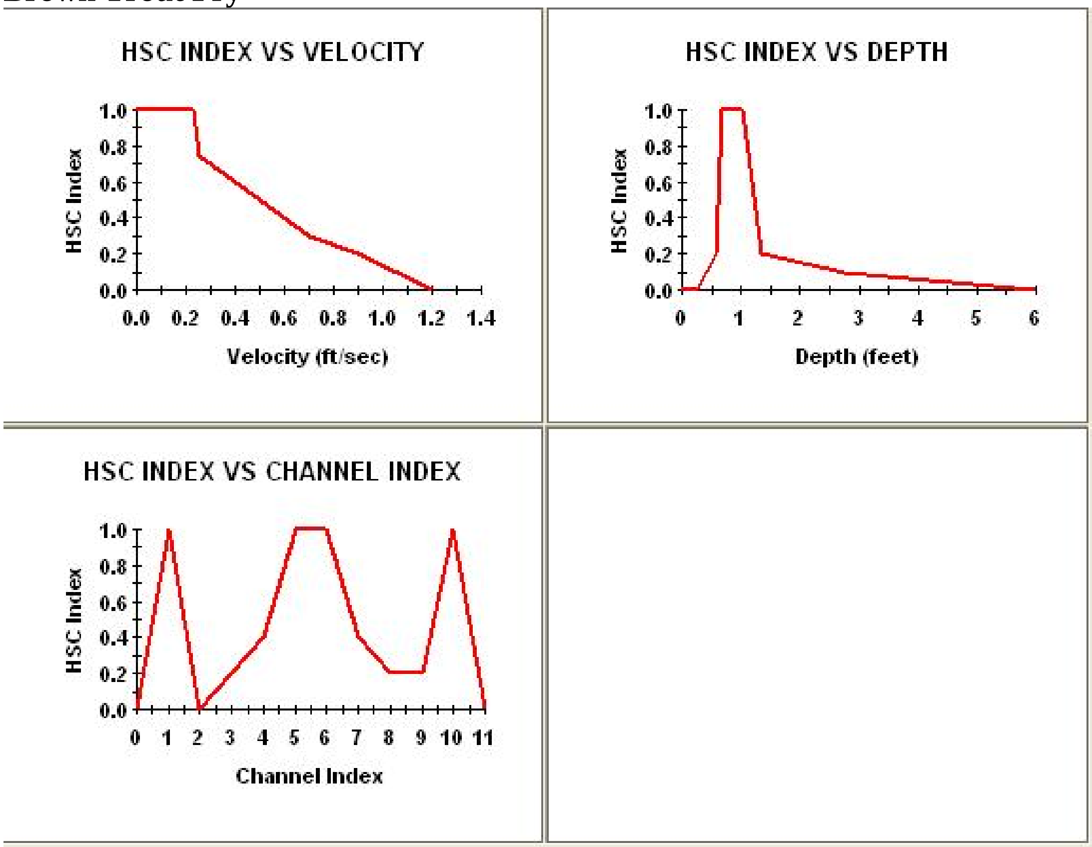
Brown Trout Spawning



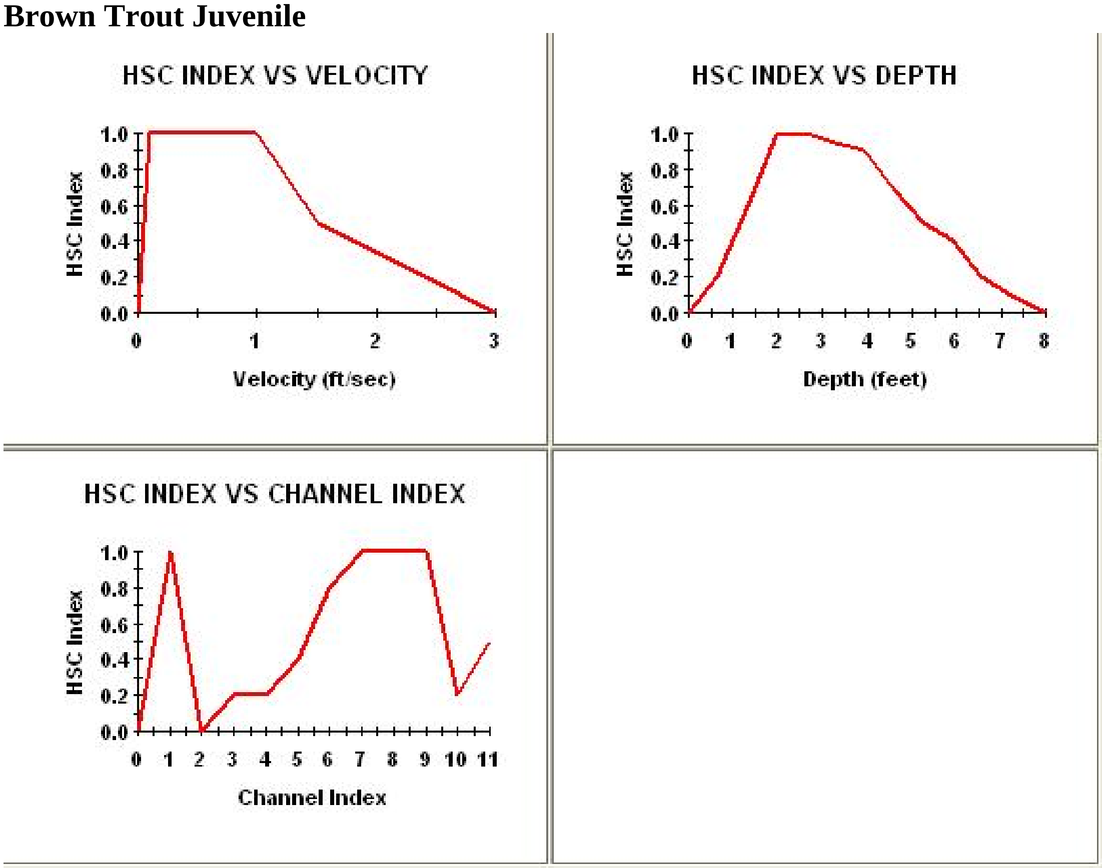
Brown Trout Adult



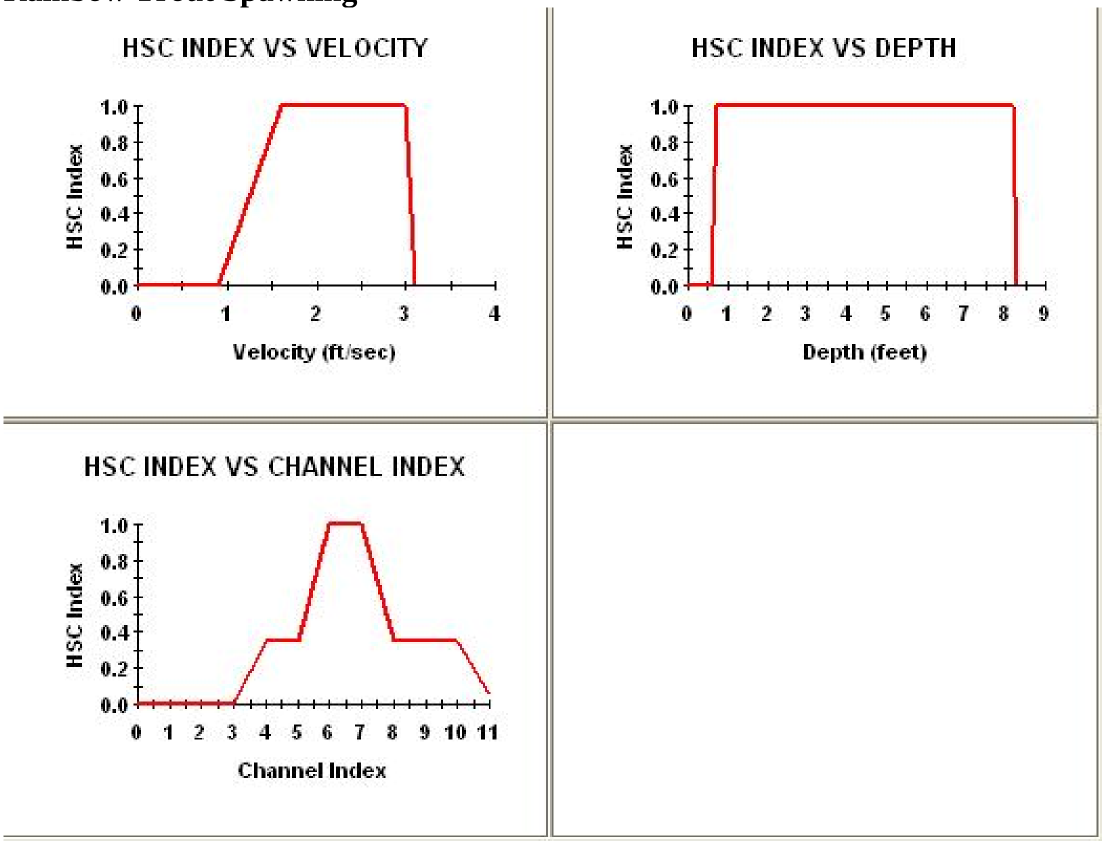
Brown Trout Fry



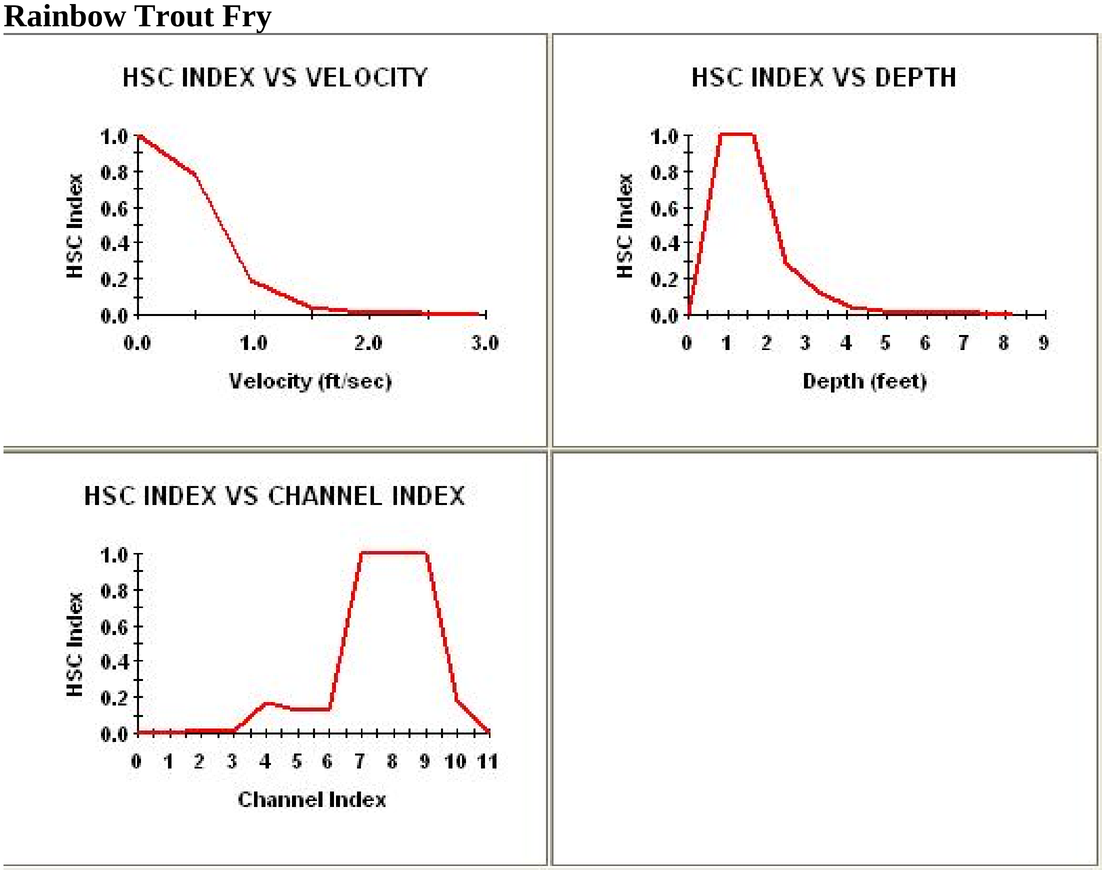
Brown Trout Juvenile



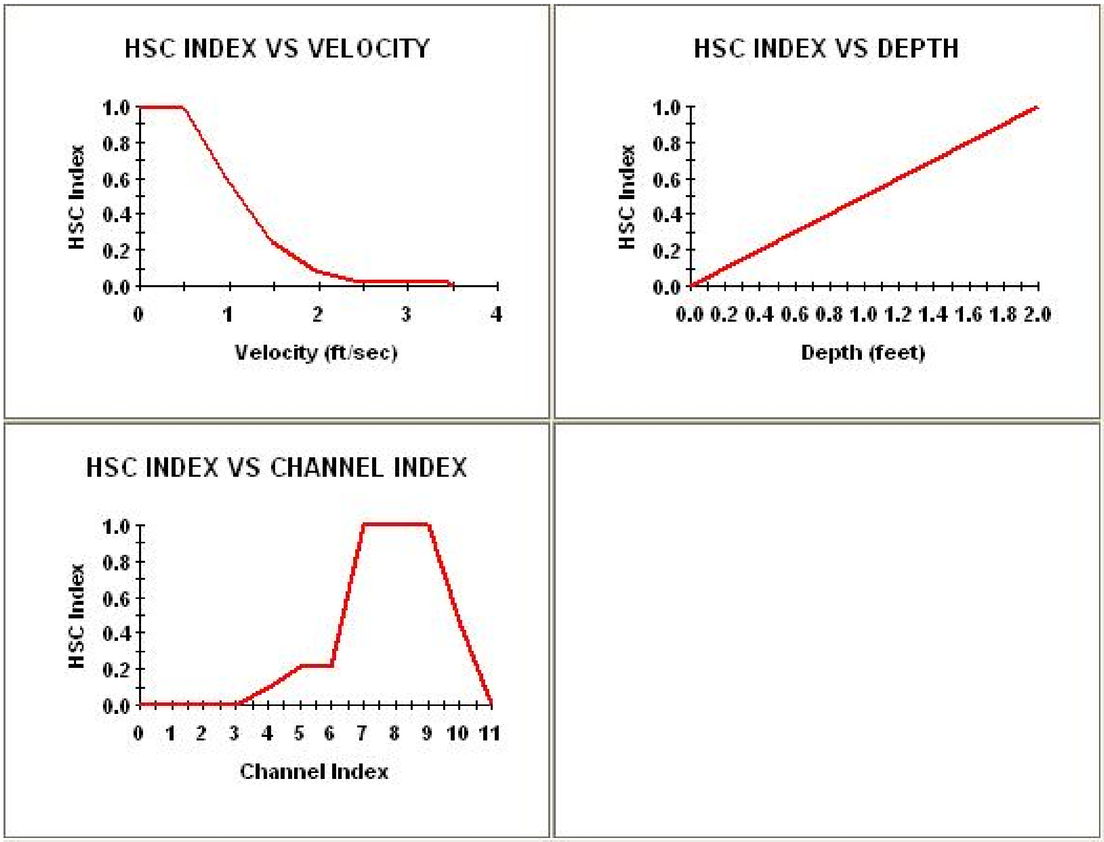
Rainbow Trout Spawning



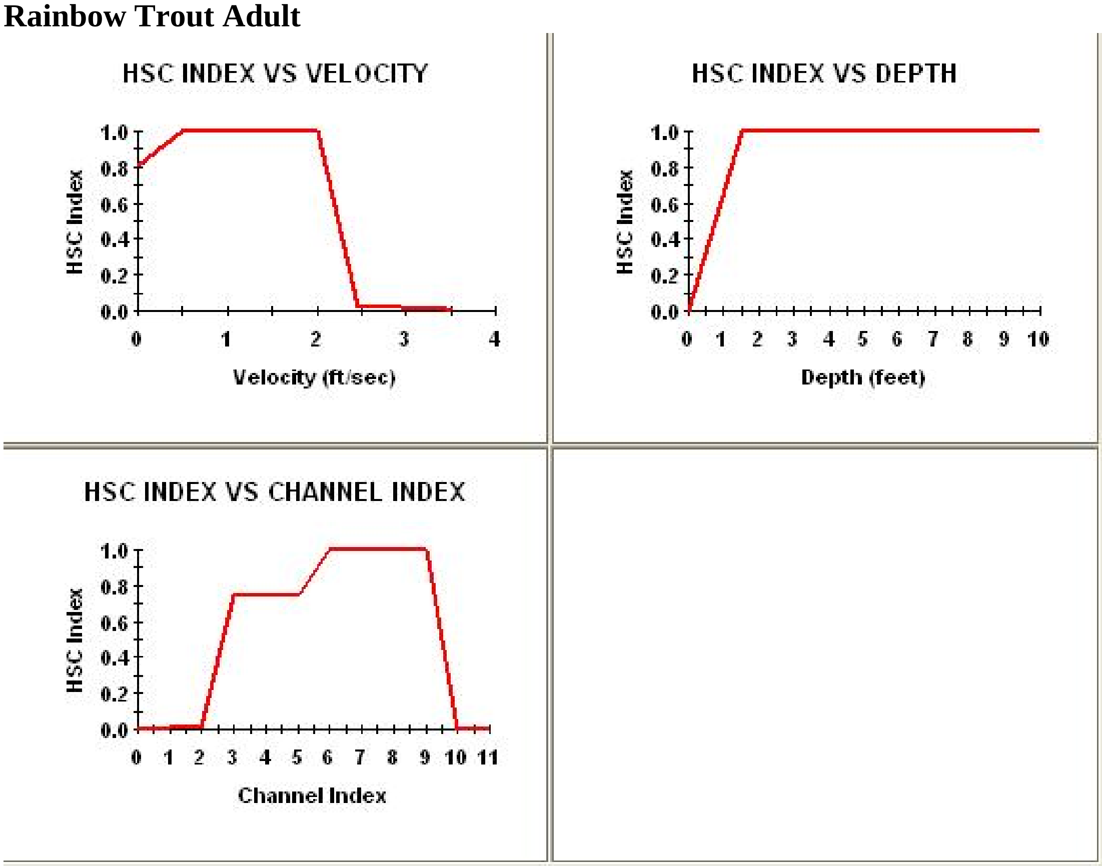
Rainbow Trout Fry



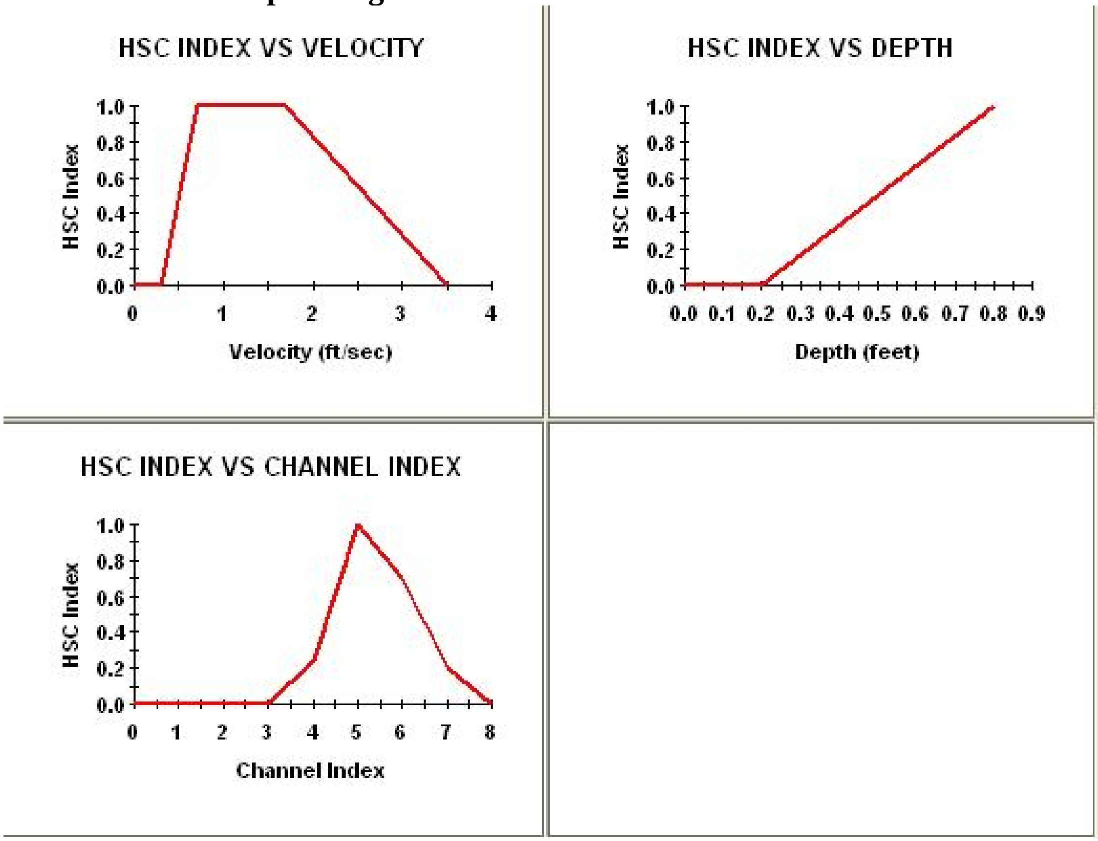
Rainbow Trout Juvenile



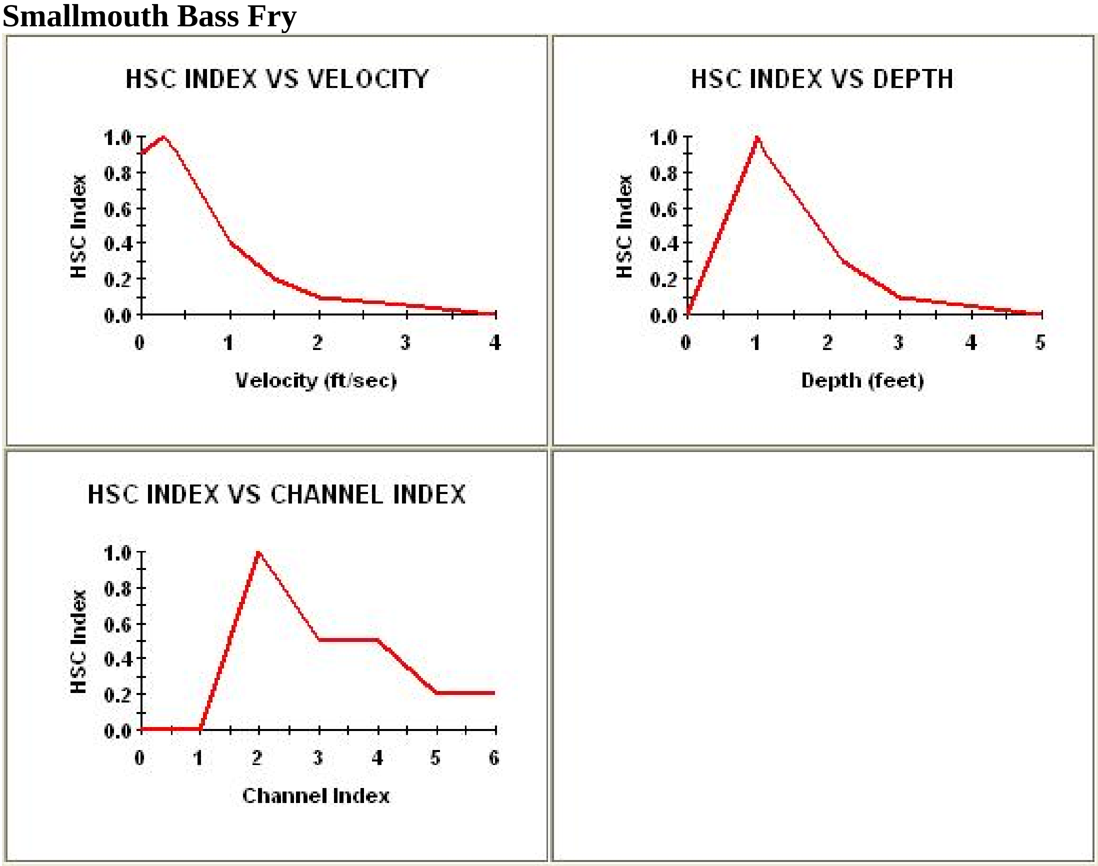
Rainbow Trout Adult



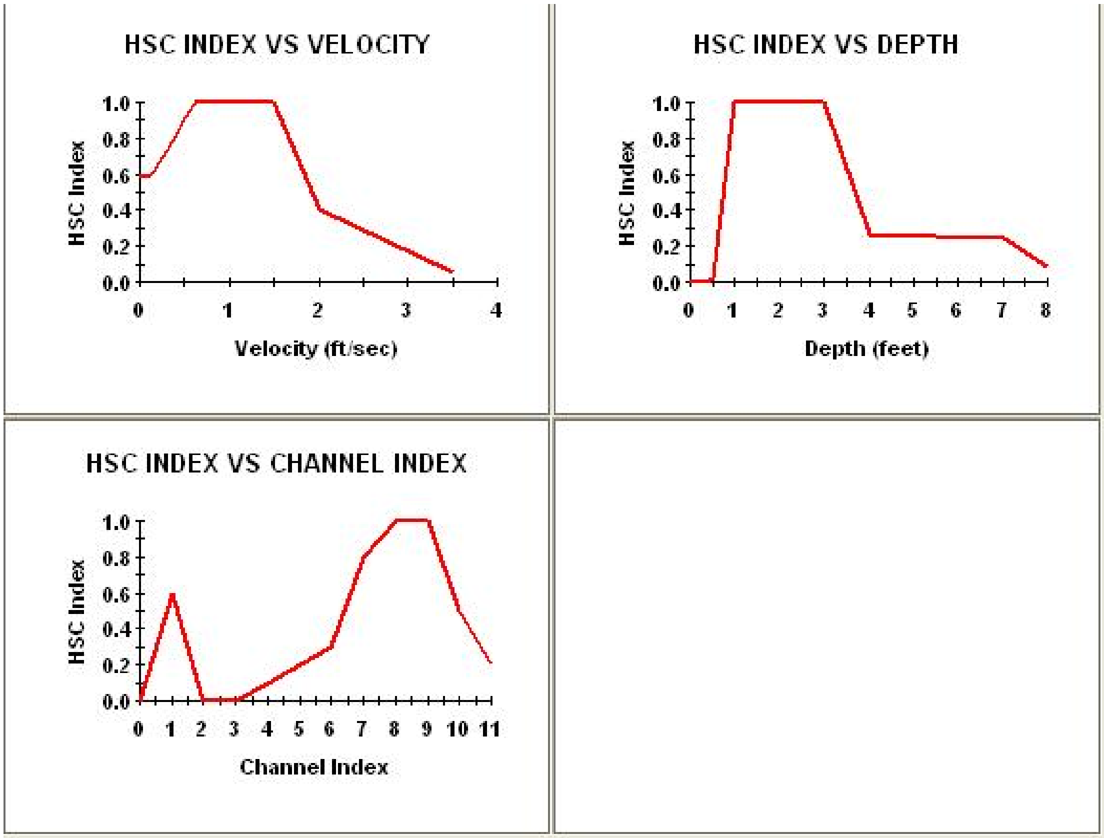
Smallmouth Bass Spawning



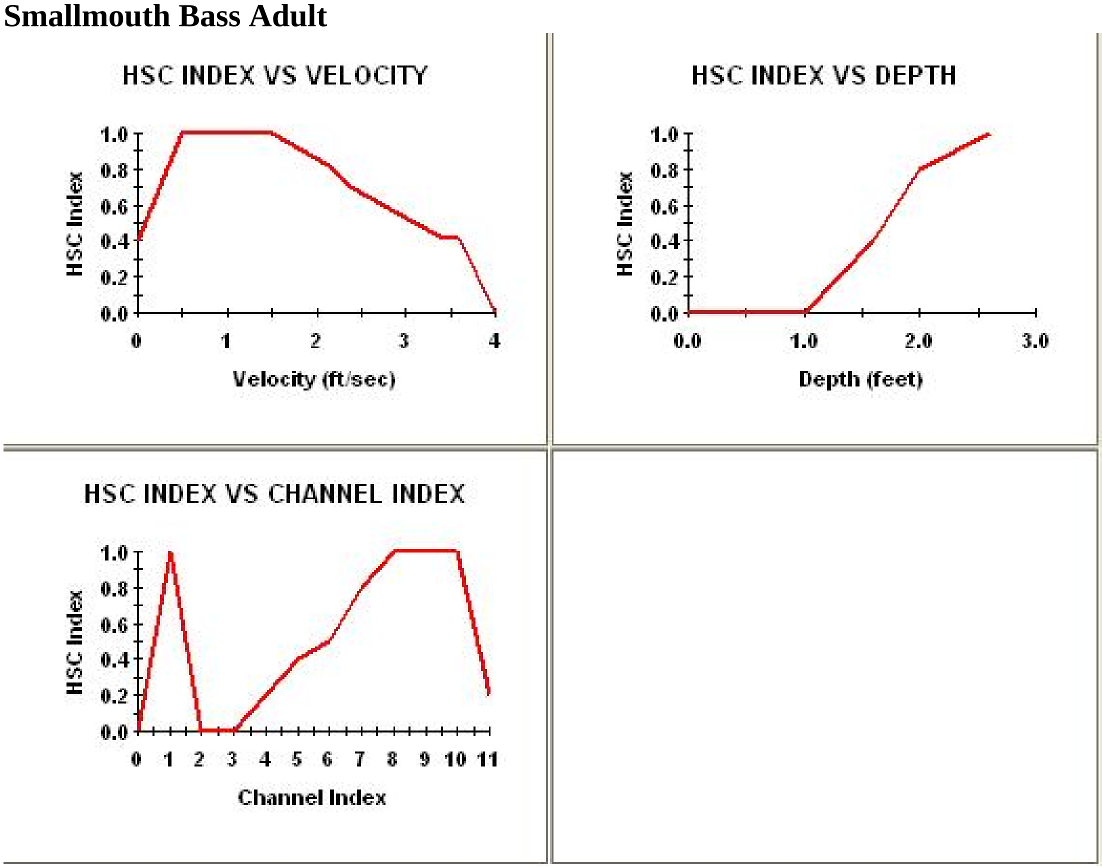
Smallmouth Bass Fry



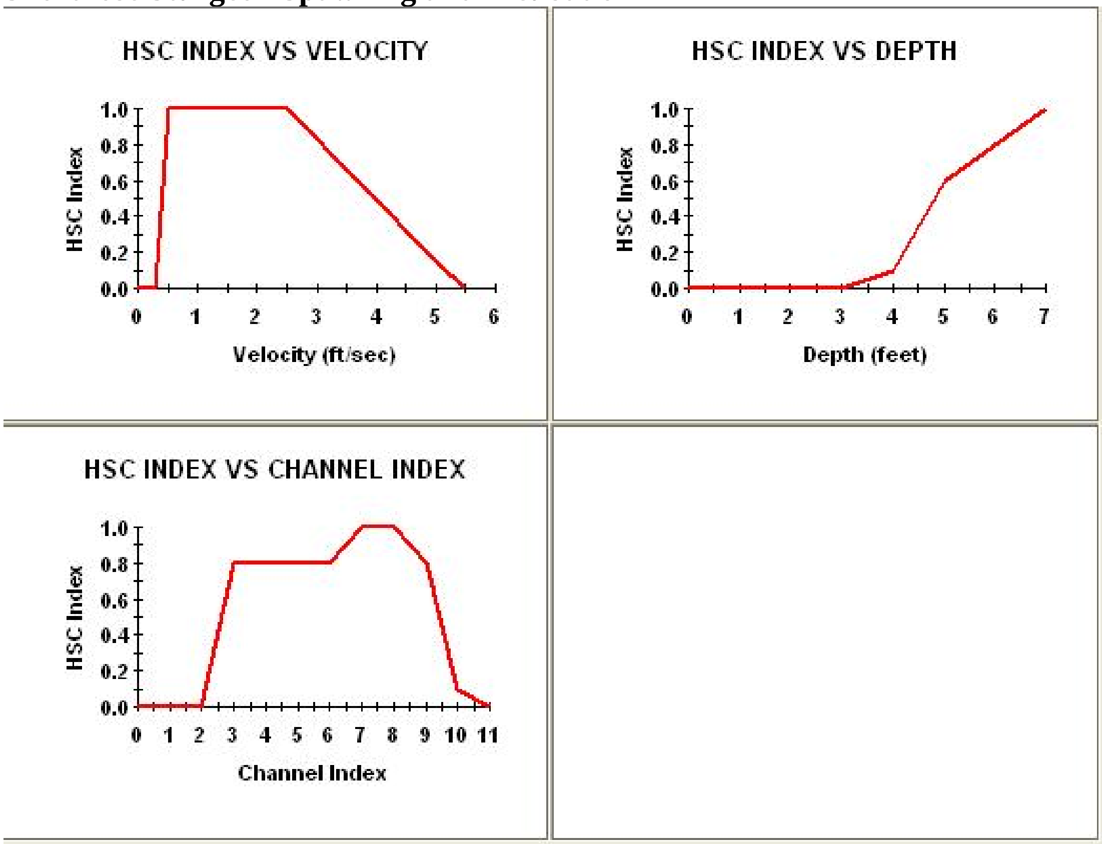
Smallmouth Bass Juvenile



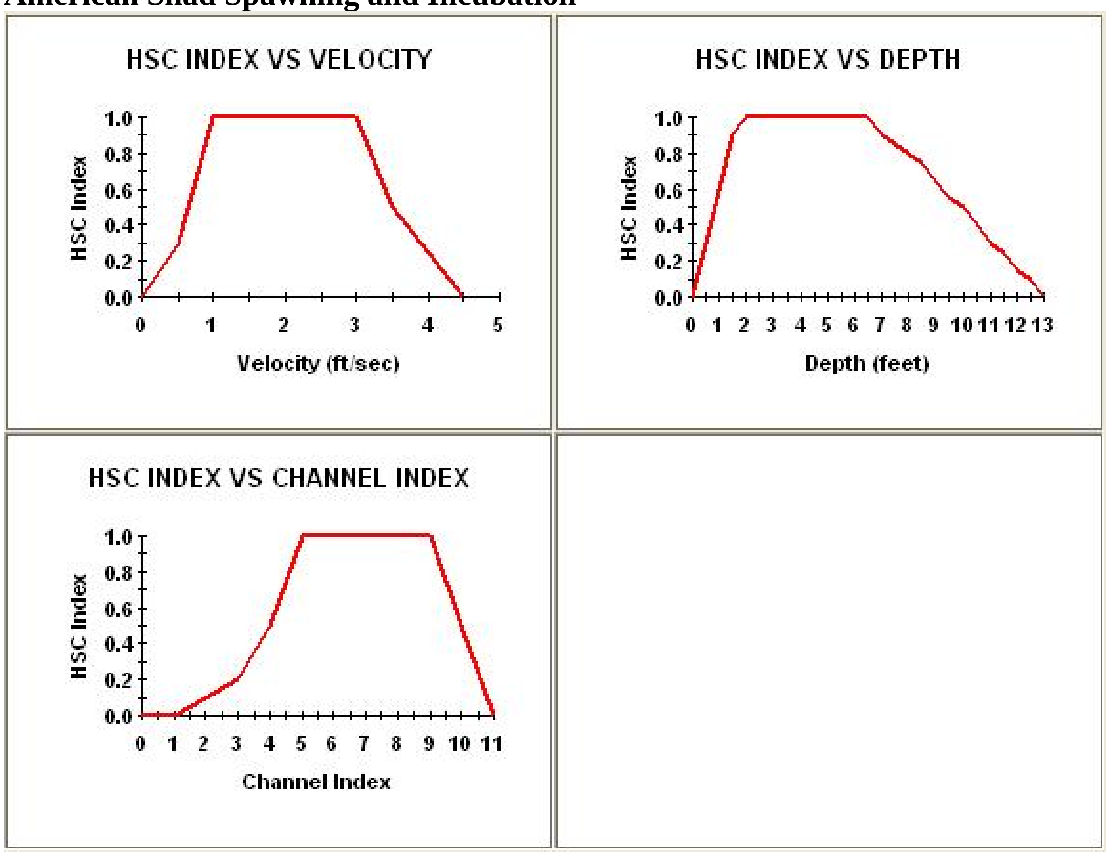
Smallmouth Bass Adult



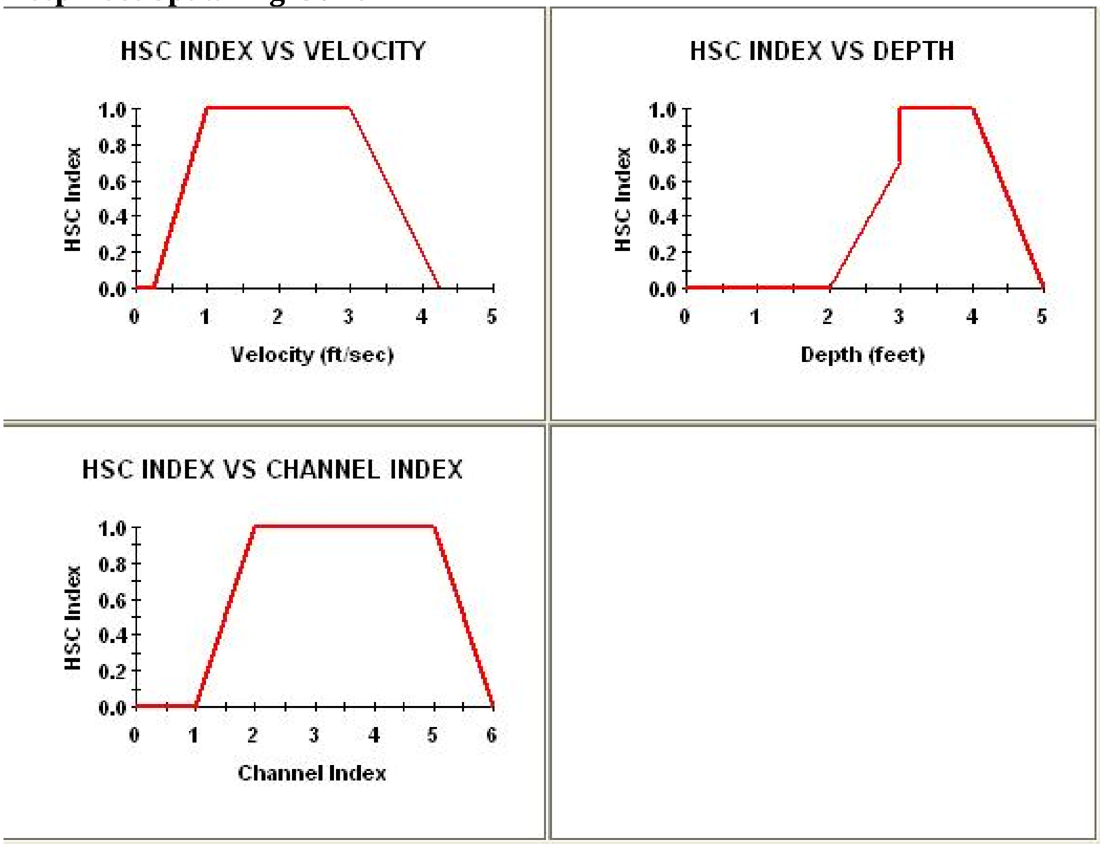
Shortnose Sturgeon Spawning and Incubation



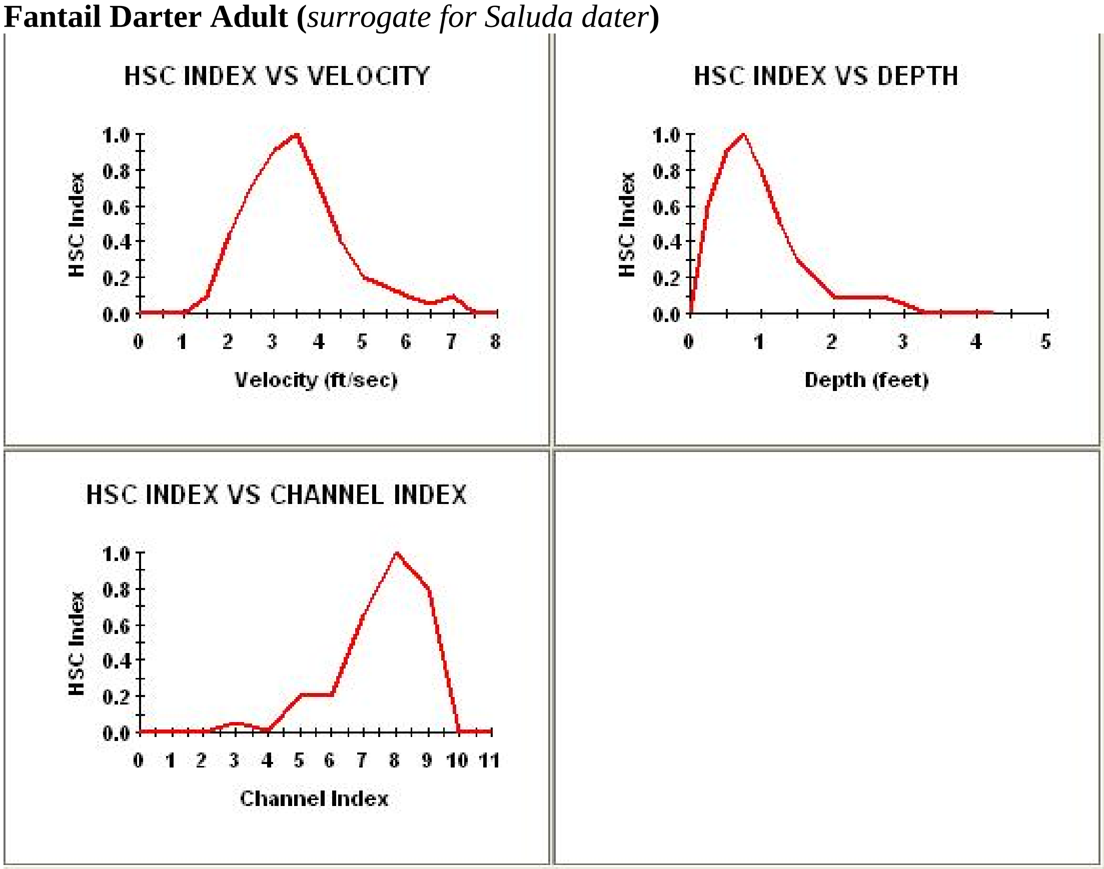
American Shad Spawning and Incubation



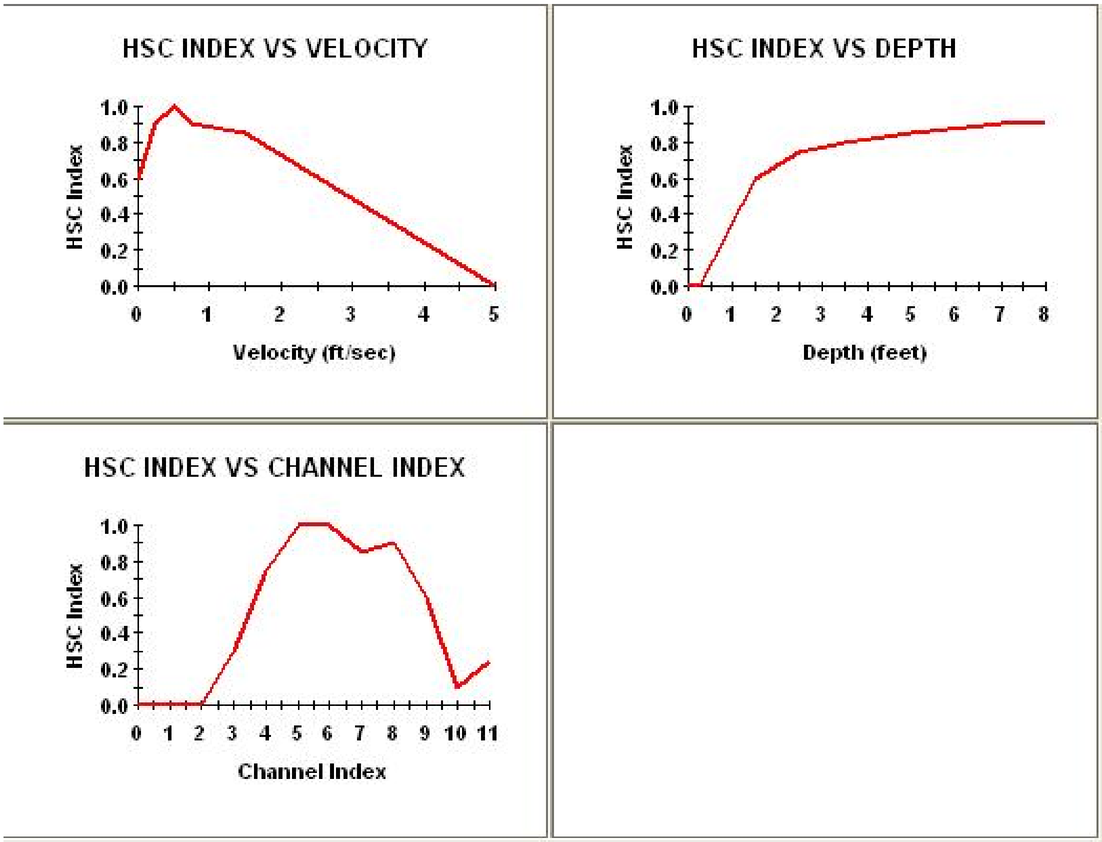
Deep-Fast Spawning Guild



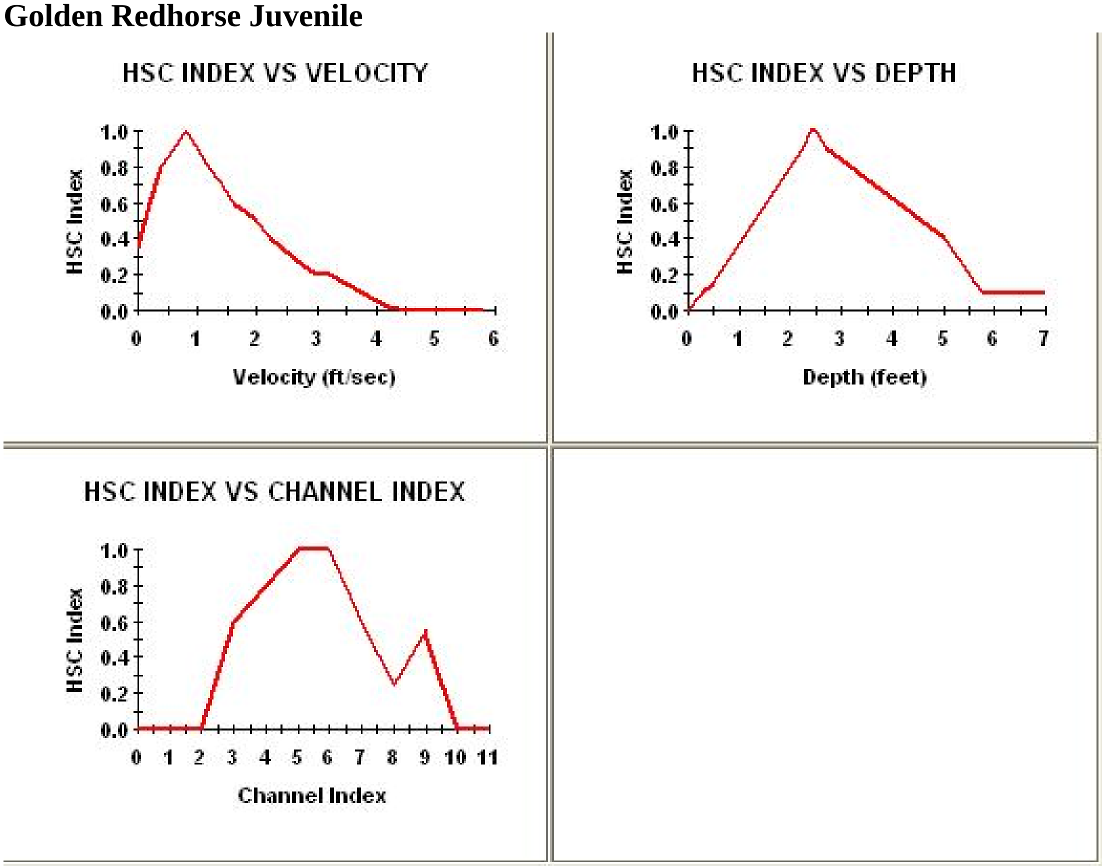
Fantail Darter Adult (*surrogate for Saluda dater*)



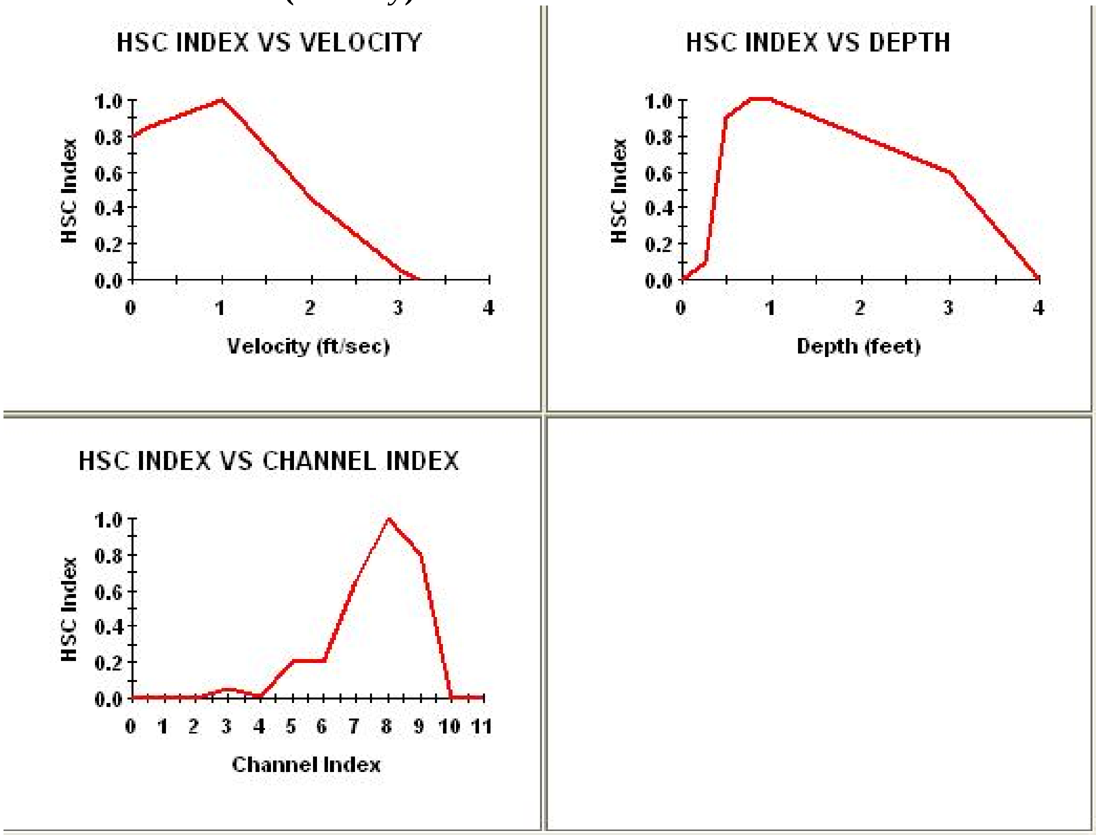
Golden Redhorse Adult



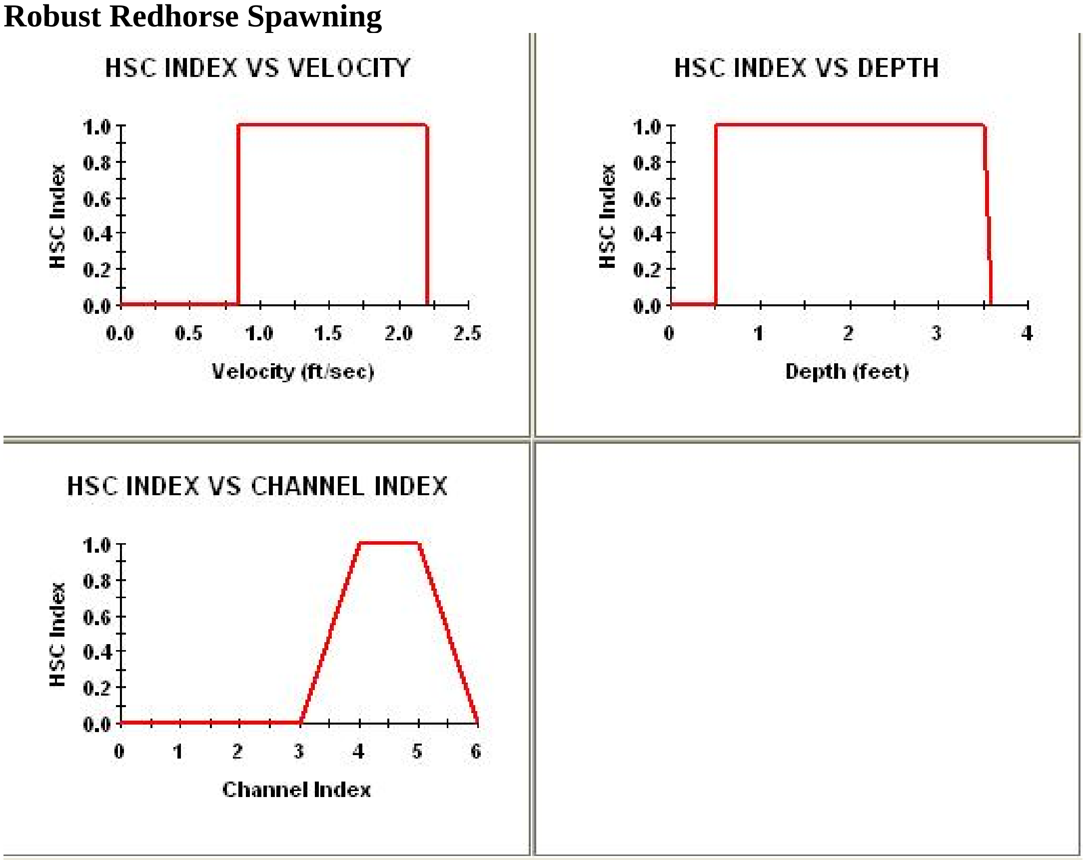
Golden Redhorse Juvenile



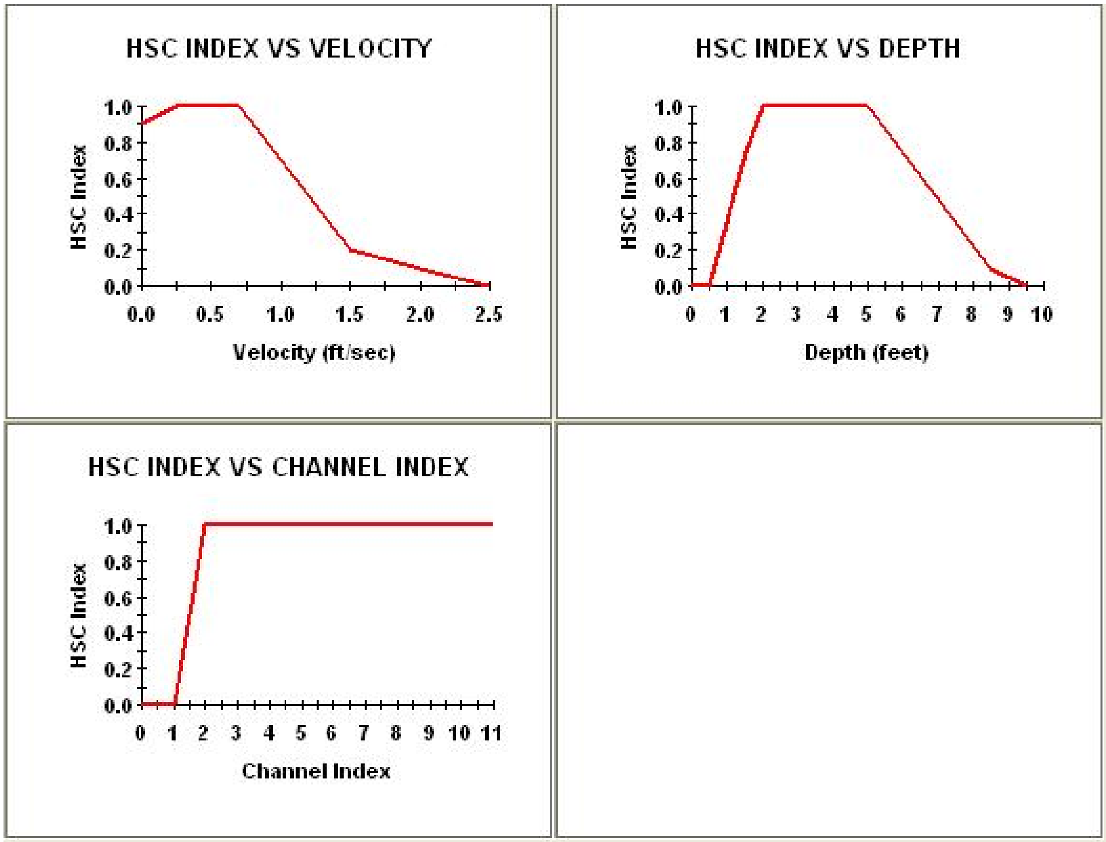
Macroinvertebrates (*diversity*)



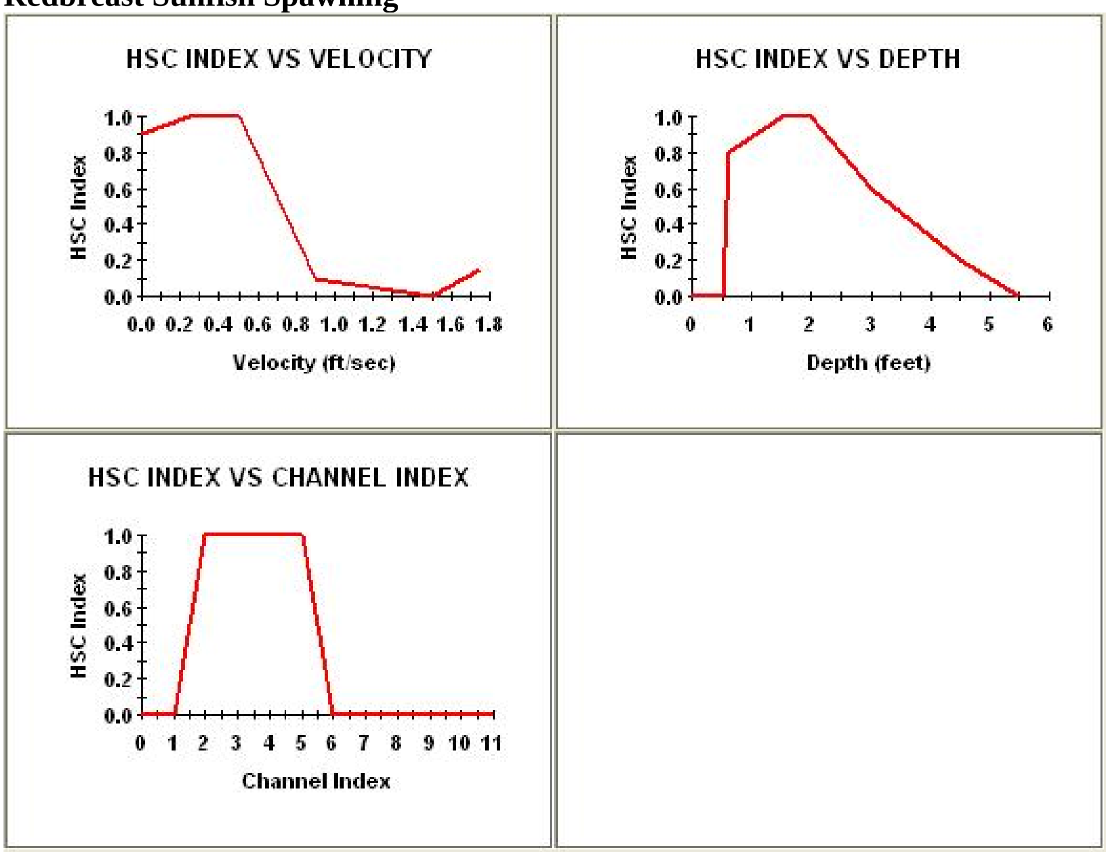
Robust Redhorse Spawning



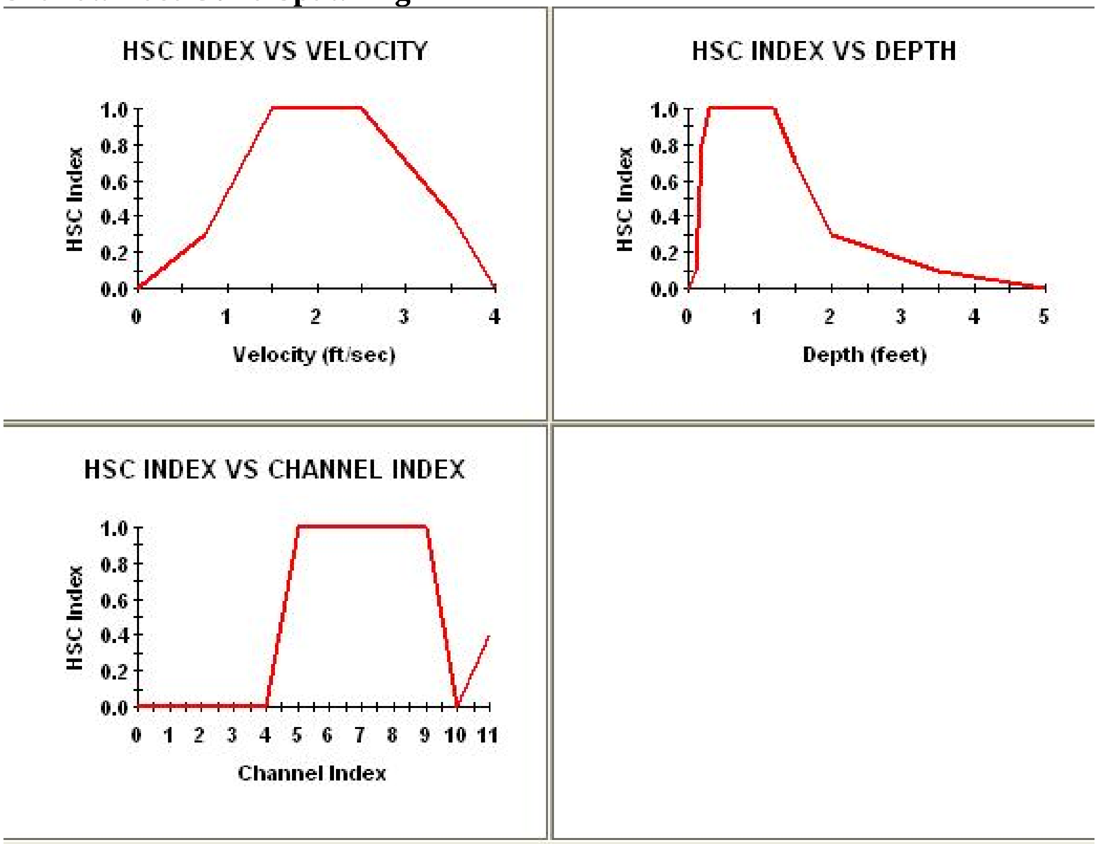
Redbreast Sunfish Adult



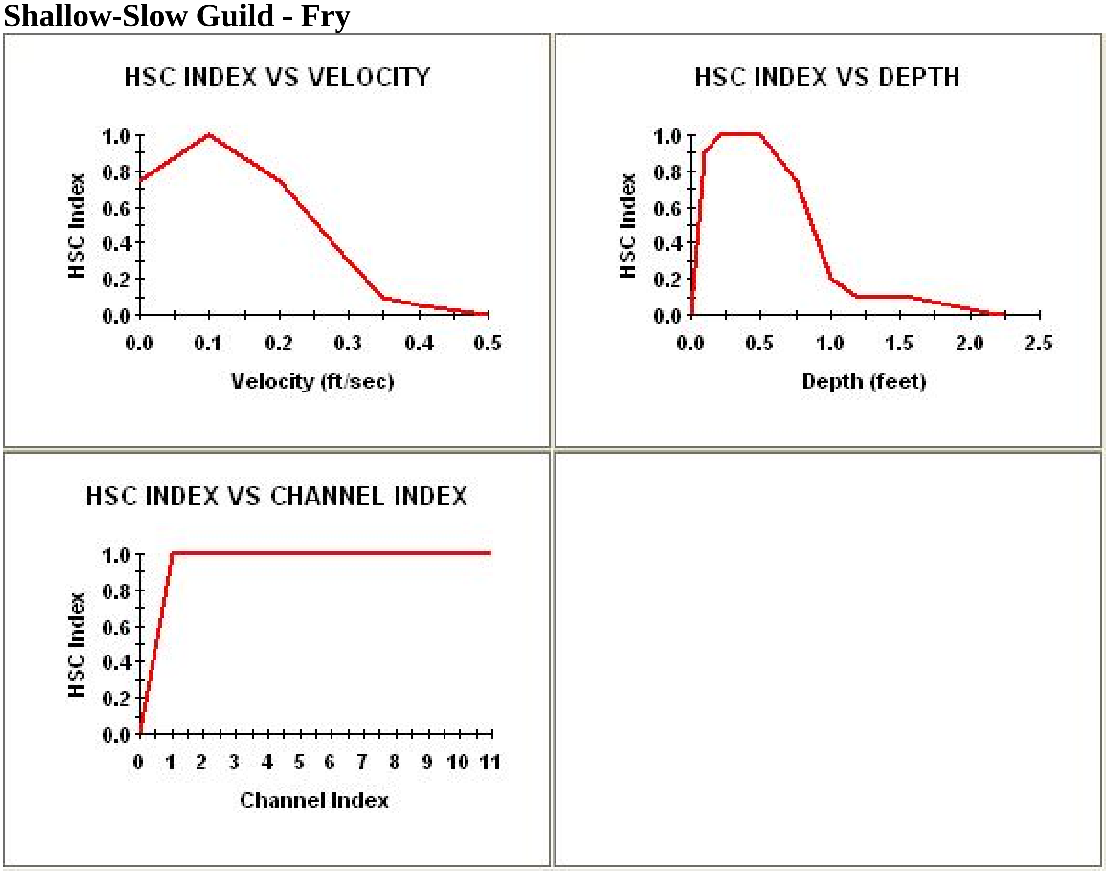
Redbreast Sunfish Spawning



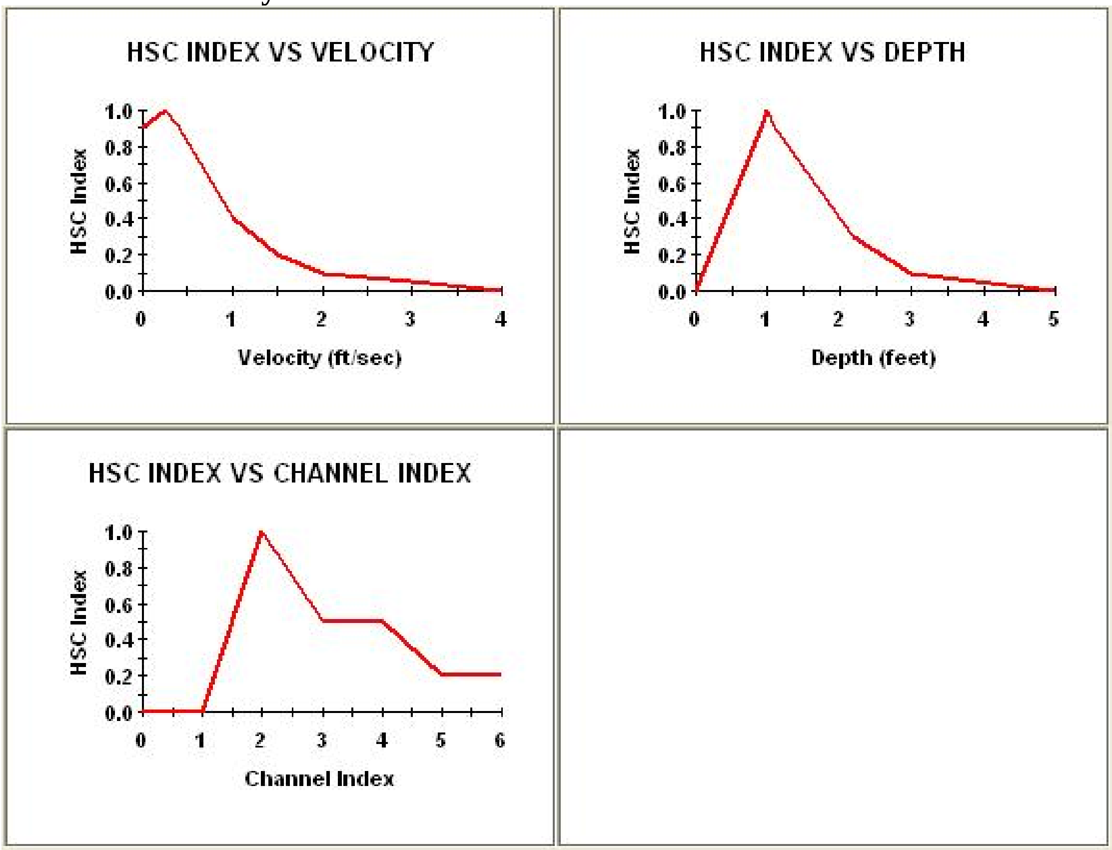
Shallow-Fast Guild Spawning



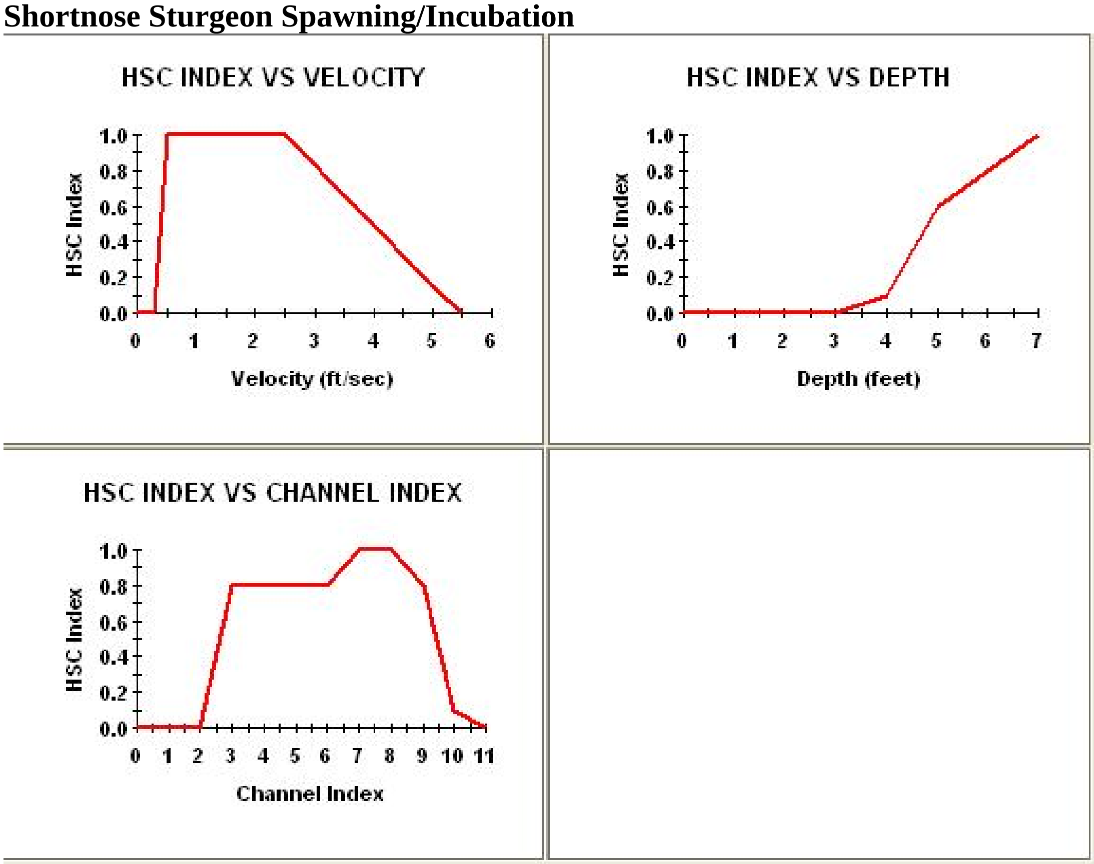
Shallow-Slow Guild - Fry



Silver Redhorse Fry



Shortnose Sturgeon Spawning/Incubation

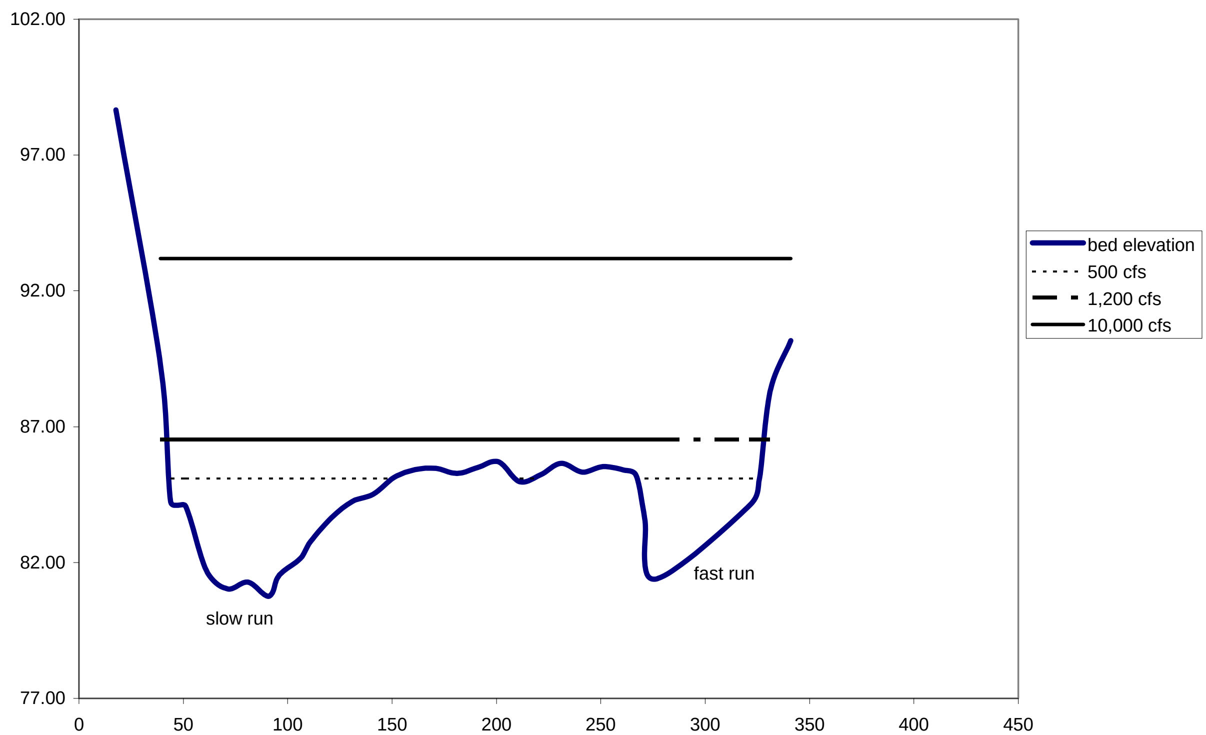


APPENDIX C

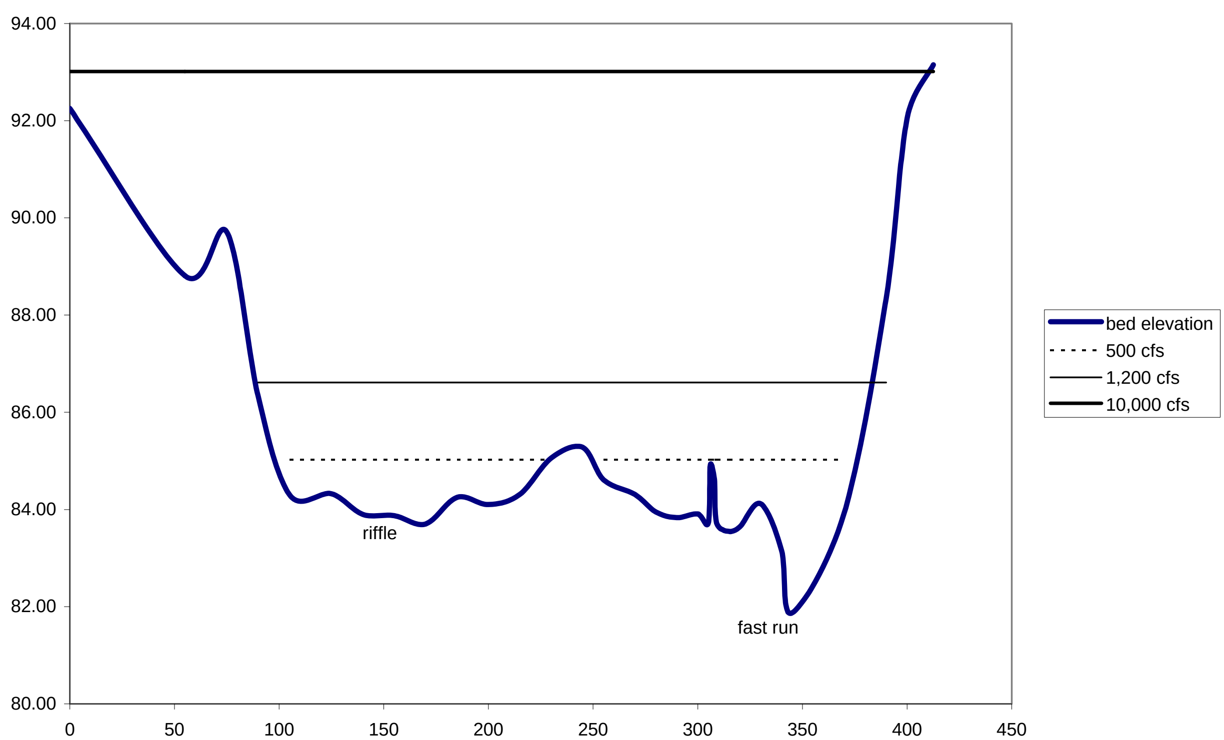
STREAM BED AND WATER SURFACE

PROFILES OF STUDY TRANSECTS

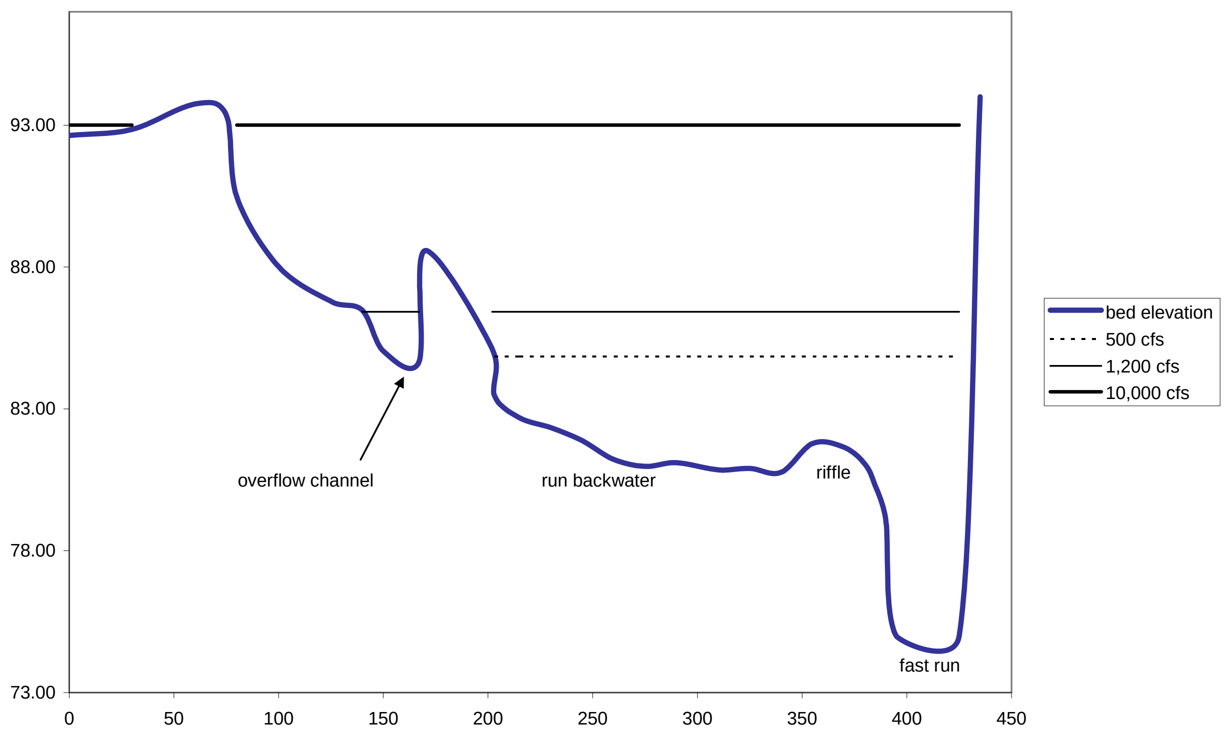
Transect 21 Glide-Run Complex (Toenail)



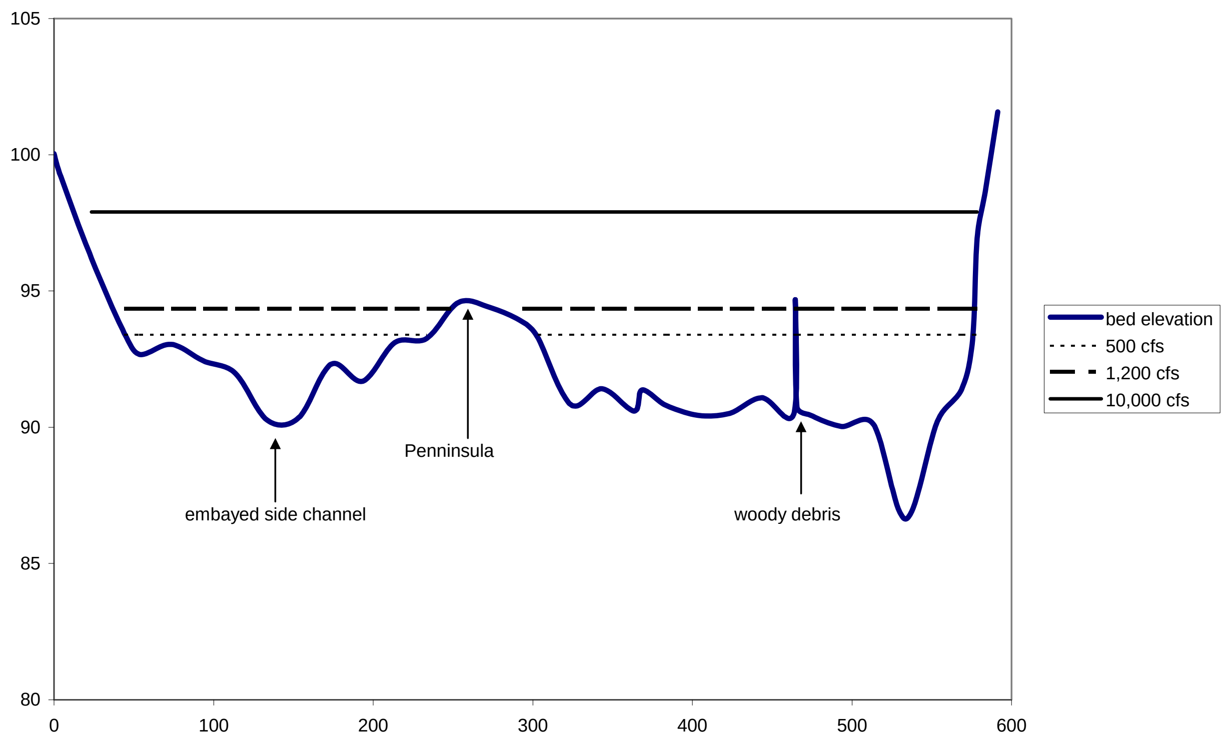
Transect 20 Riffle-Run Complex (Toenail)



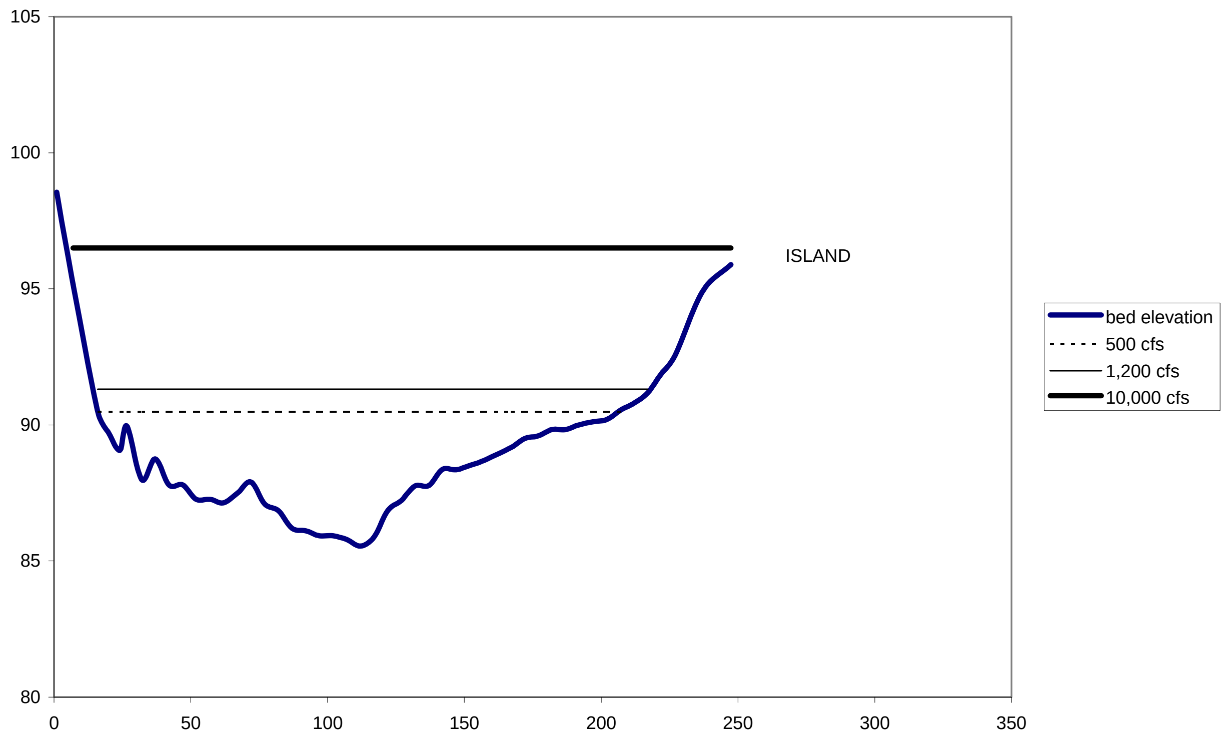
Transect 19 Riffle-Run Complex (Toenail)



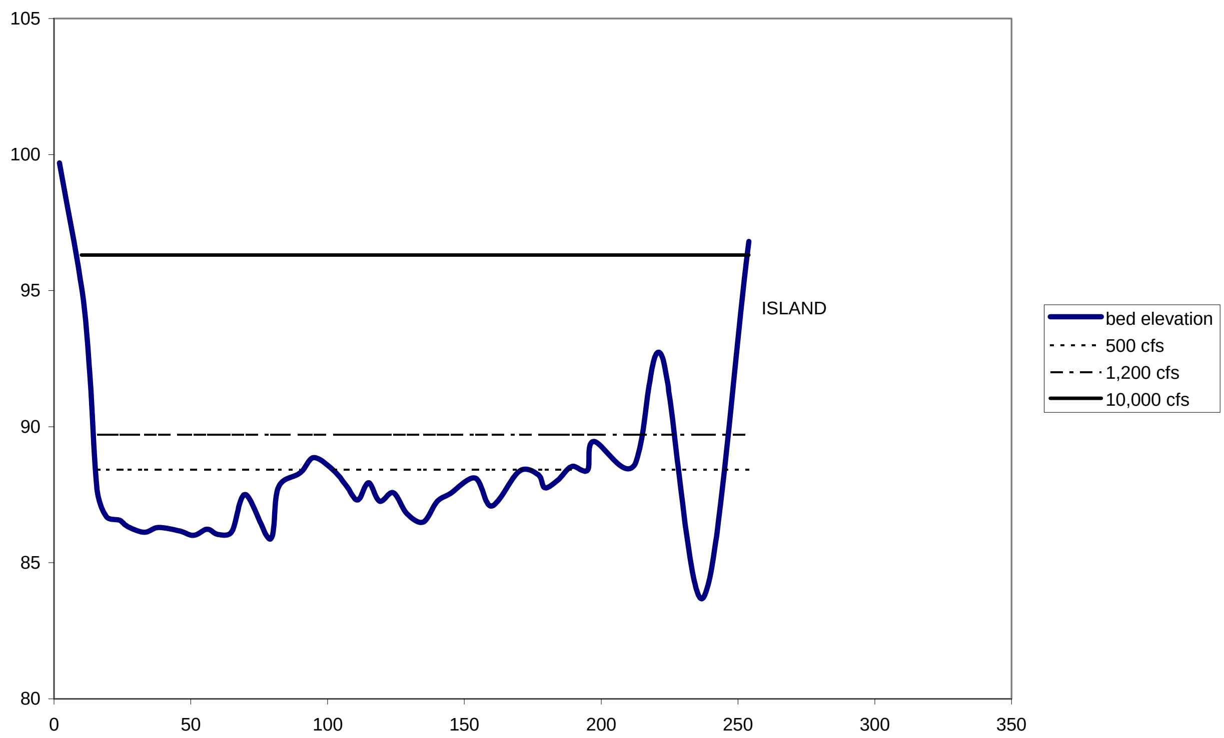
Transect 18 Reach 1 Run with Point Bar



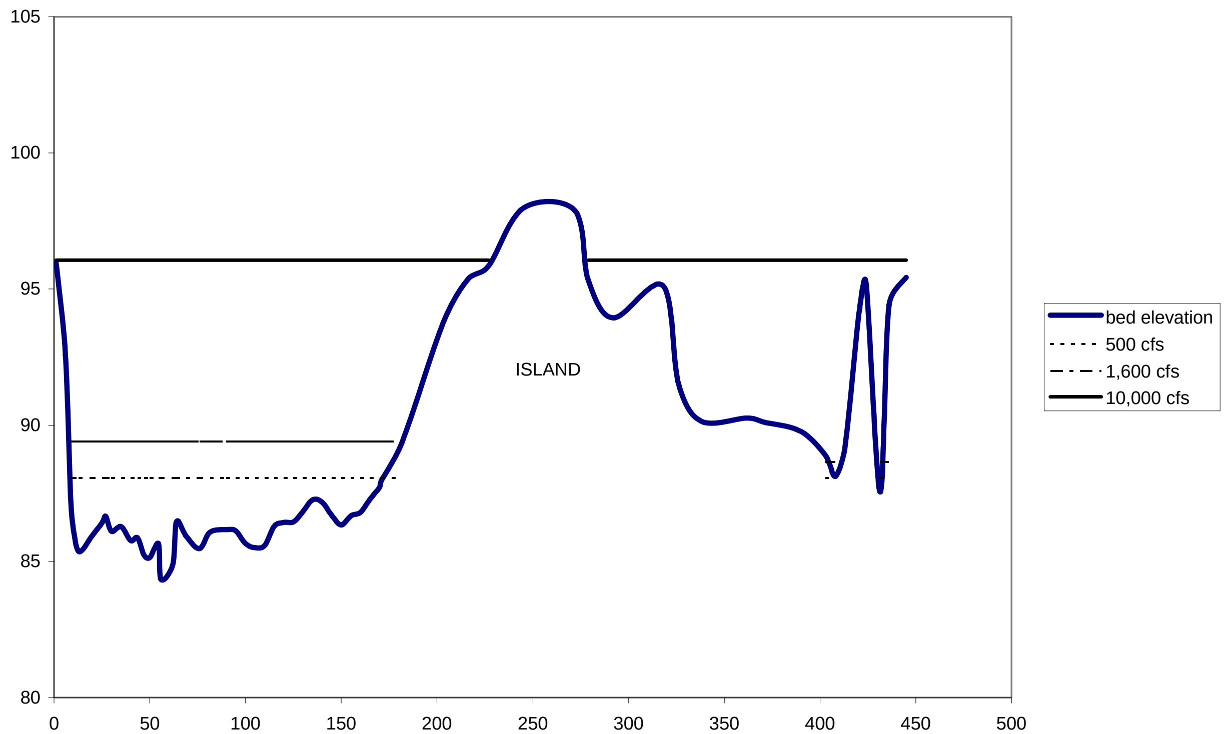
Transect 17 Glide (Sandy Beach)



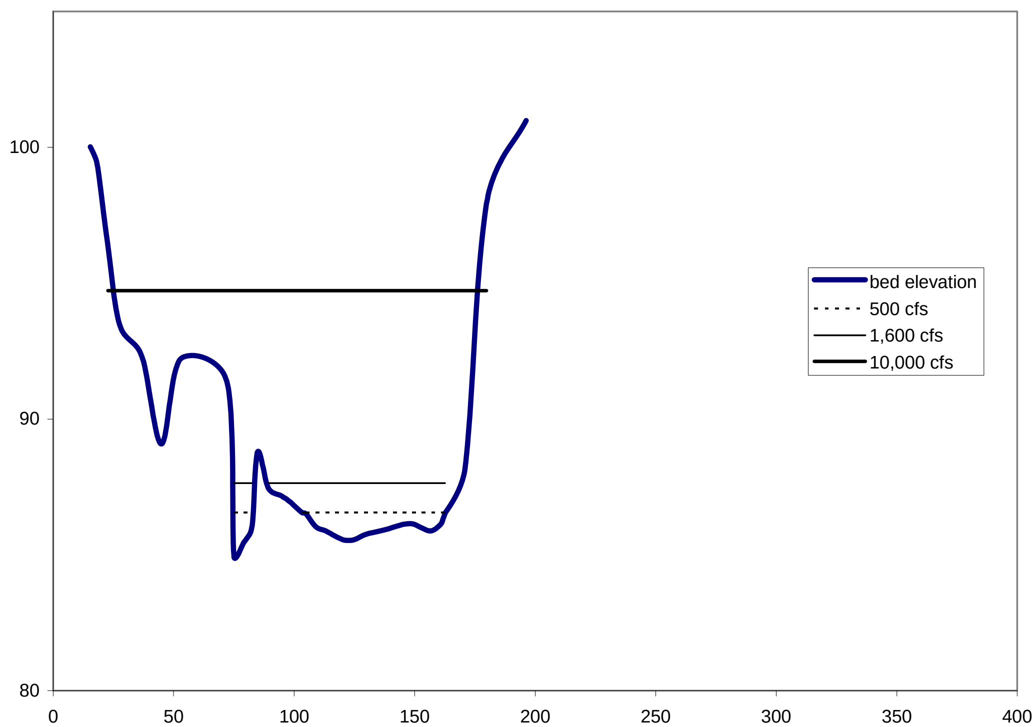
Transect 16 Shoal (Sandy Beach)



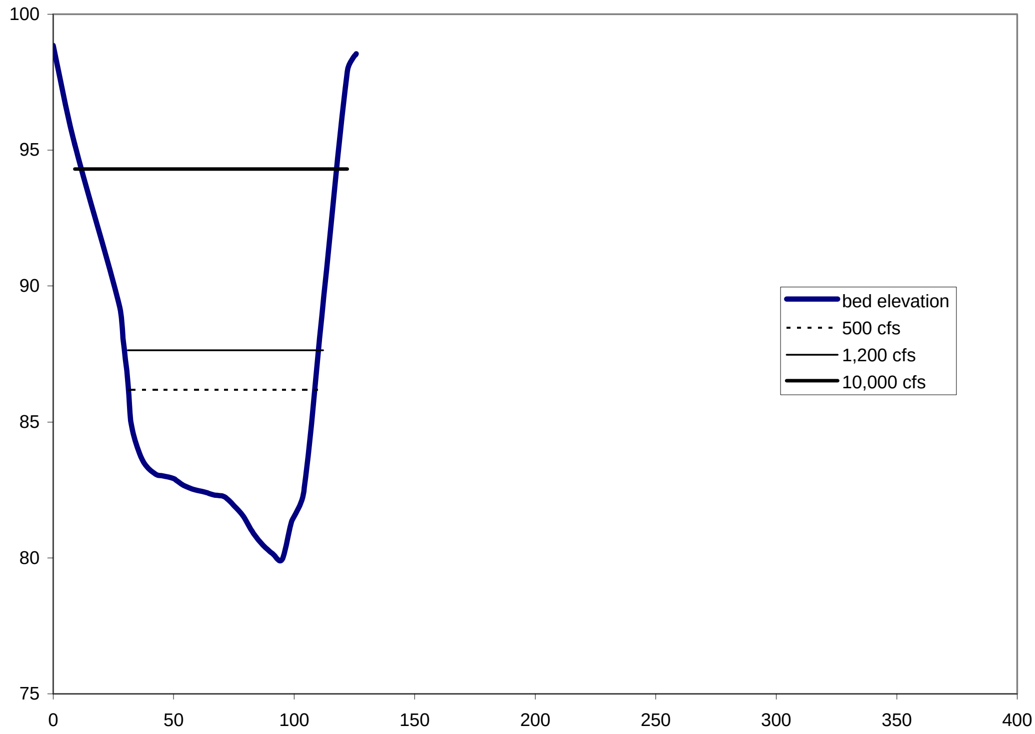
Transect 15 Riffle (Sandy Beach)



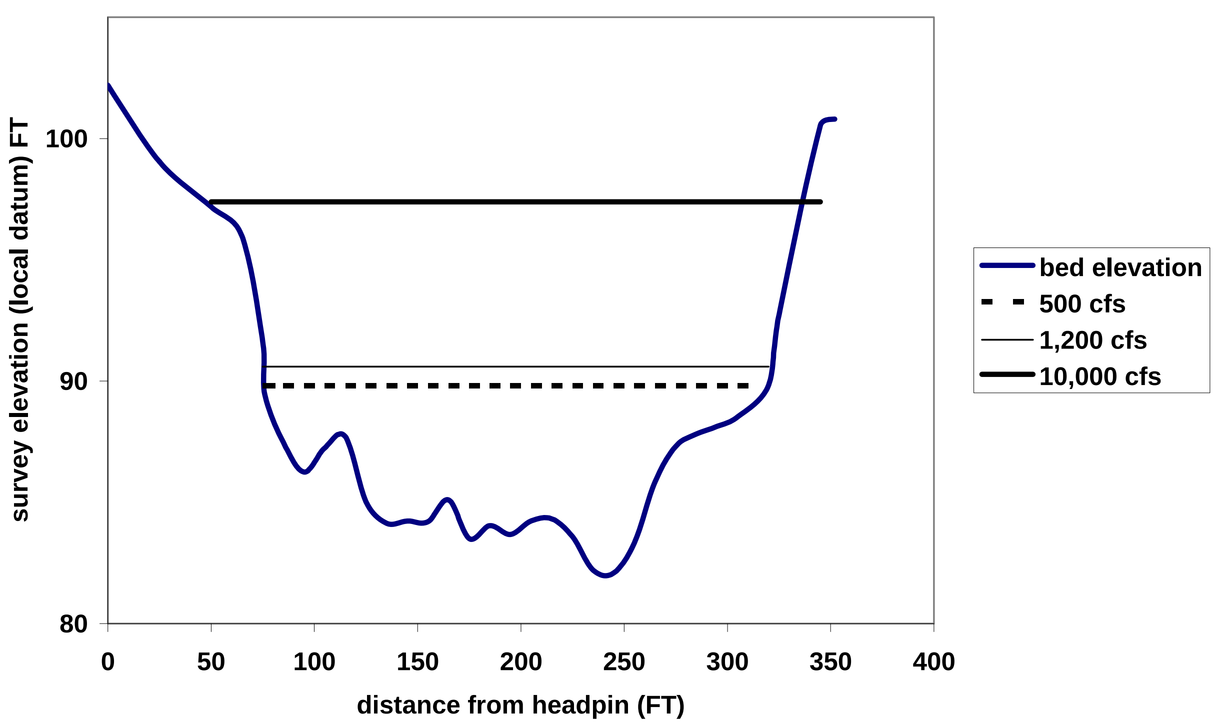
Transect 14 side channel glide (Corely Island)



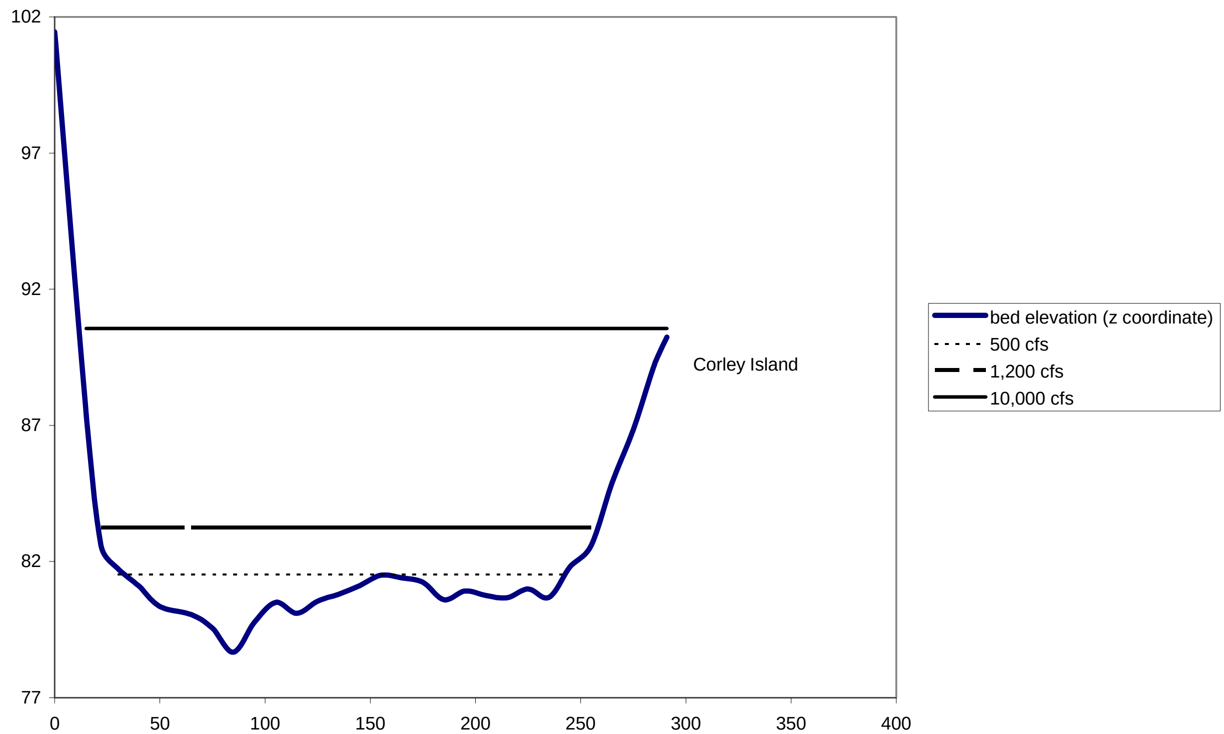
Transect 13 side channel glide (Corley Island)



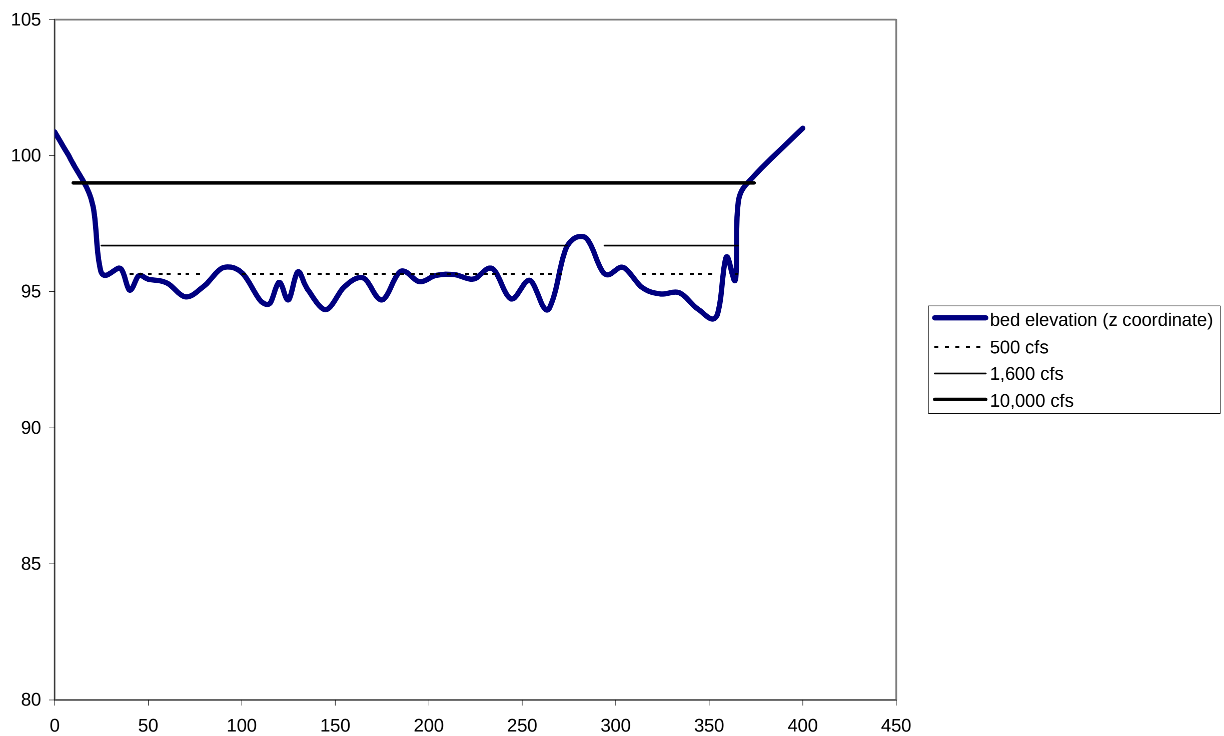
Saluda River IFIM Study Transect 12 (Reach 2 Run)

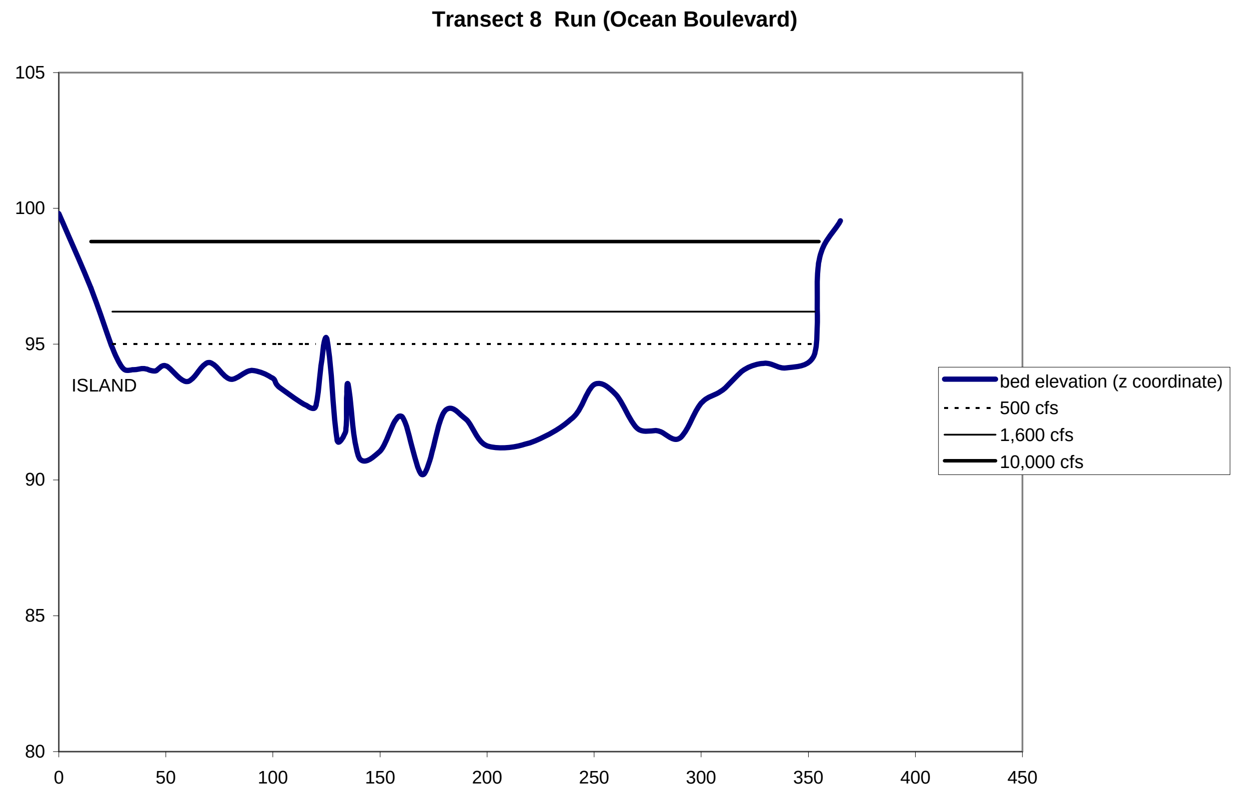


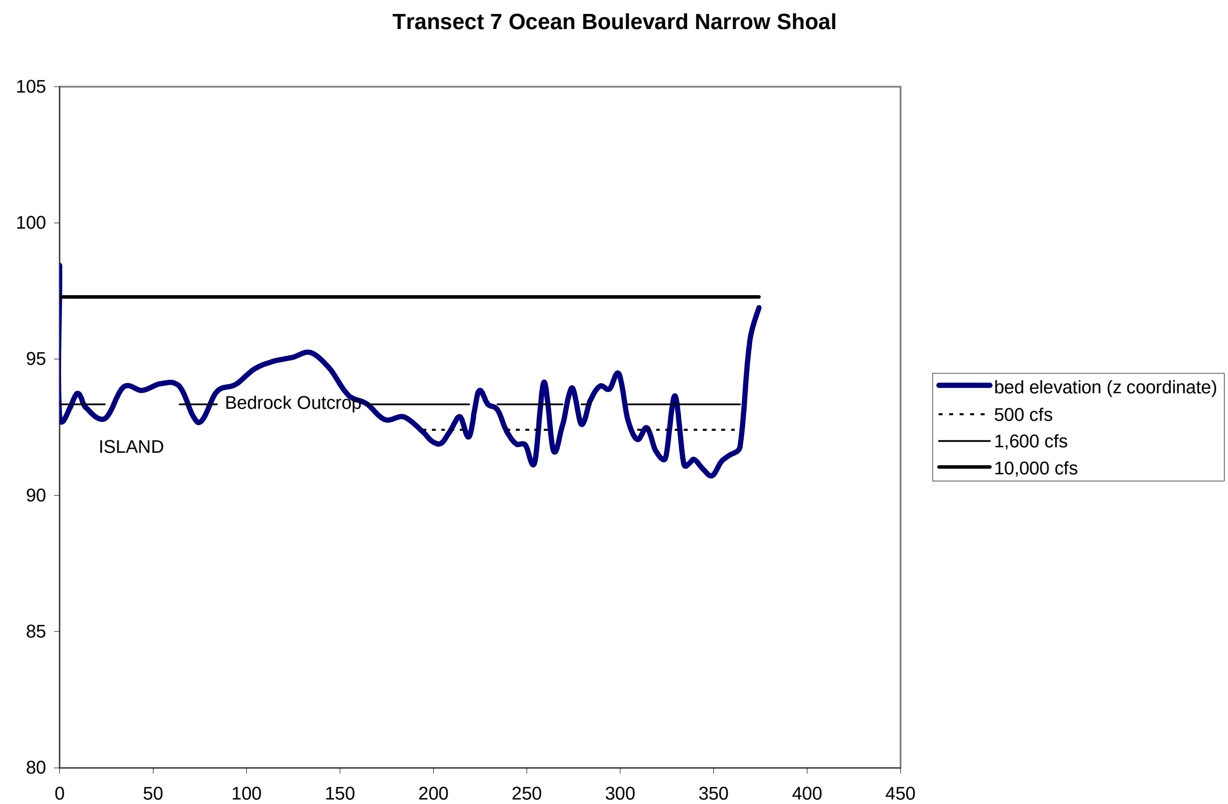
Transect 10 Riffle (Corley Island)



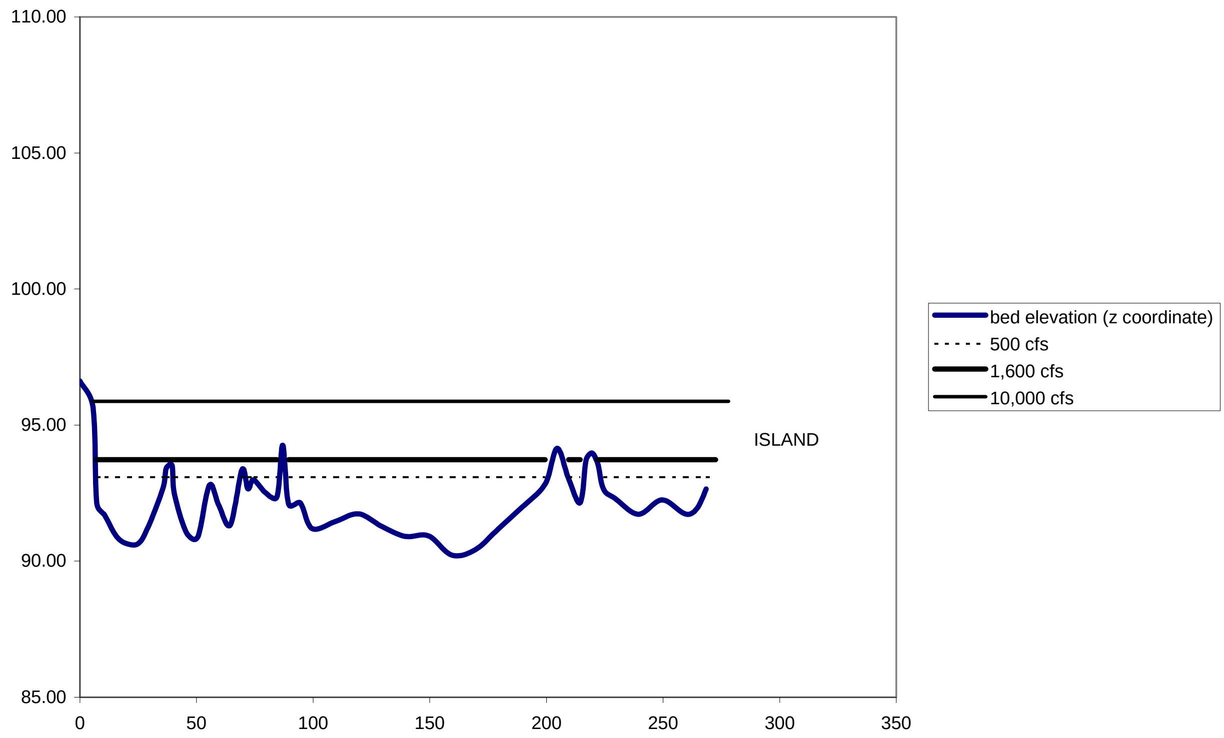
Transect 9 Wide Run (Ocean Boulevard)



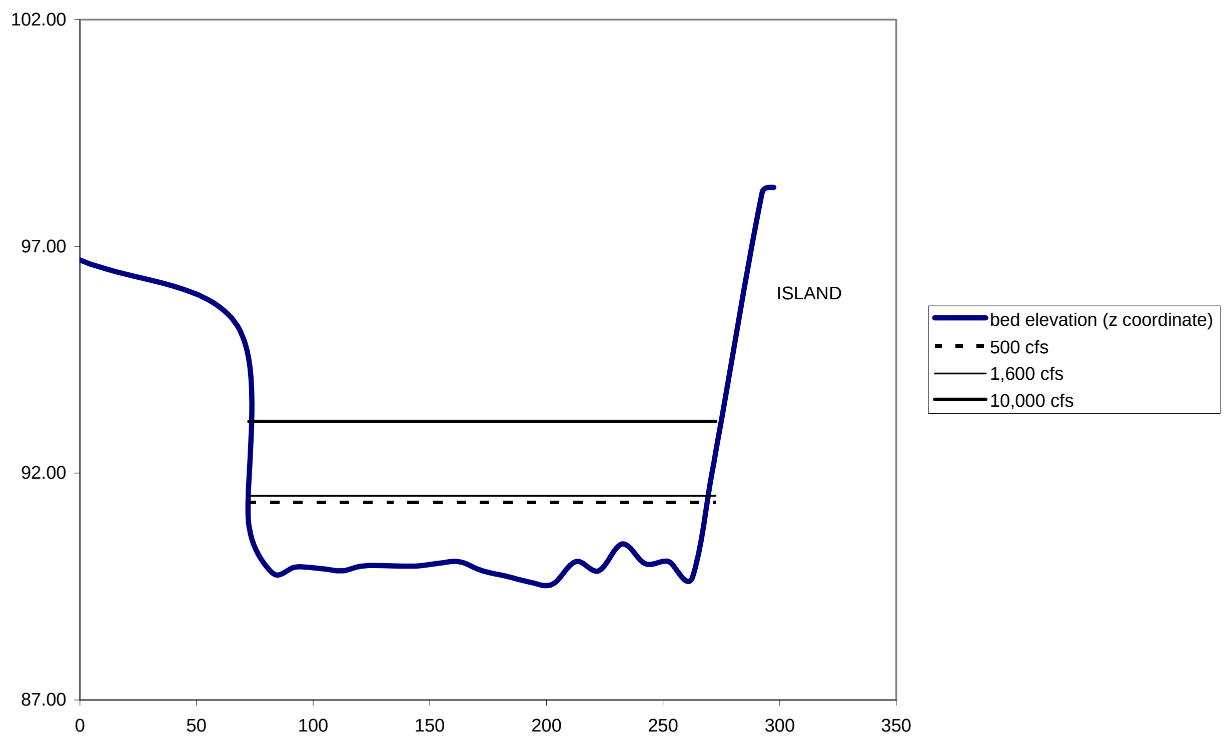

Transect 8 Run (Ocean Boulevard)
105
100
95
90
85
80
0
50
100
150
200
250
300
350
400
450
ISLAND
bed elevation (z coordinate)
500 cfs
1,600 cfs
10,000 cfs


Transect 7 Ocean Boulevard Narrow Shoal
105
100
95
90
85
80
0
50
100
150
200
250
300
350
400
450
Bedrock Outcrop
ISLAND
bed elevation (z coordinate)
500 cfs
1,600 cfs
10,000 cfs

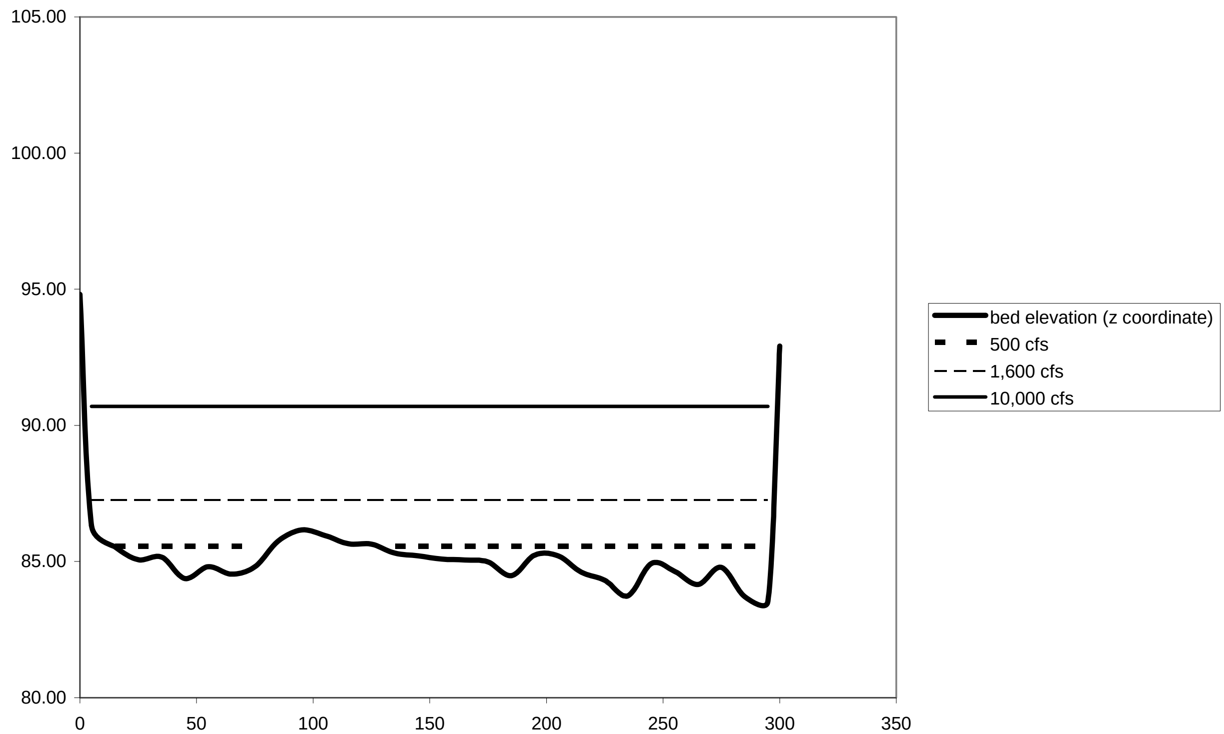
Transect 6 Boulder Riffle (Oh Brother)



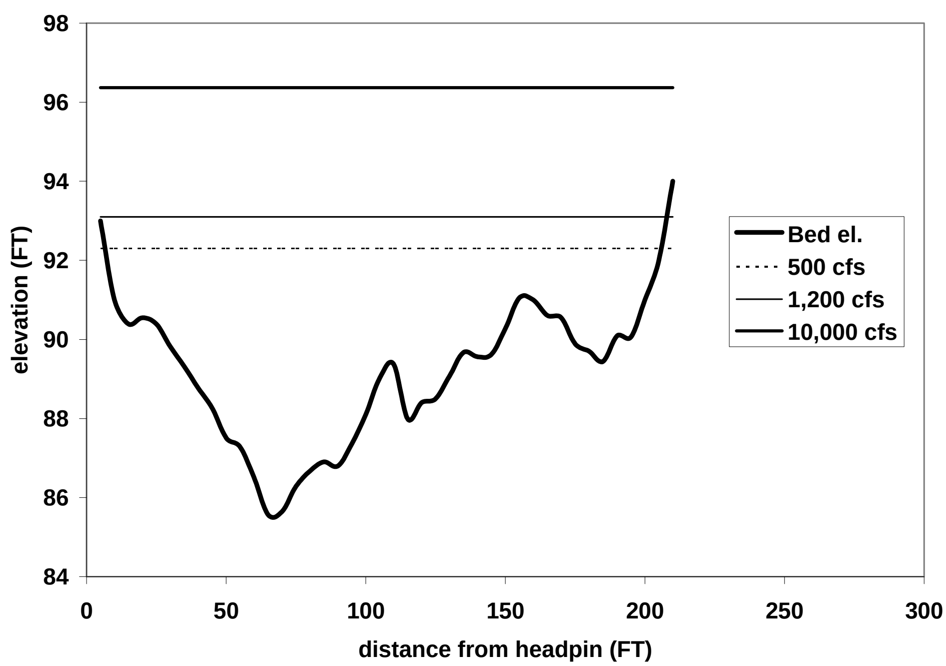
Transect 5 Cobble Riffle (Oh Brother)



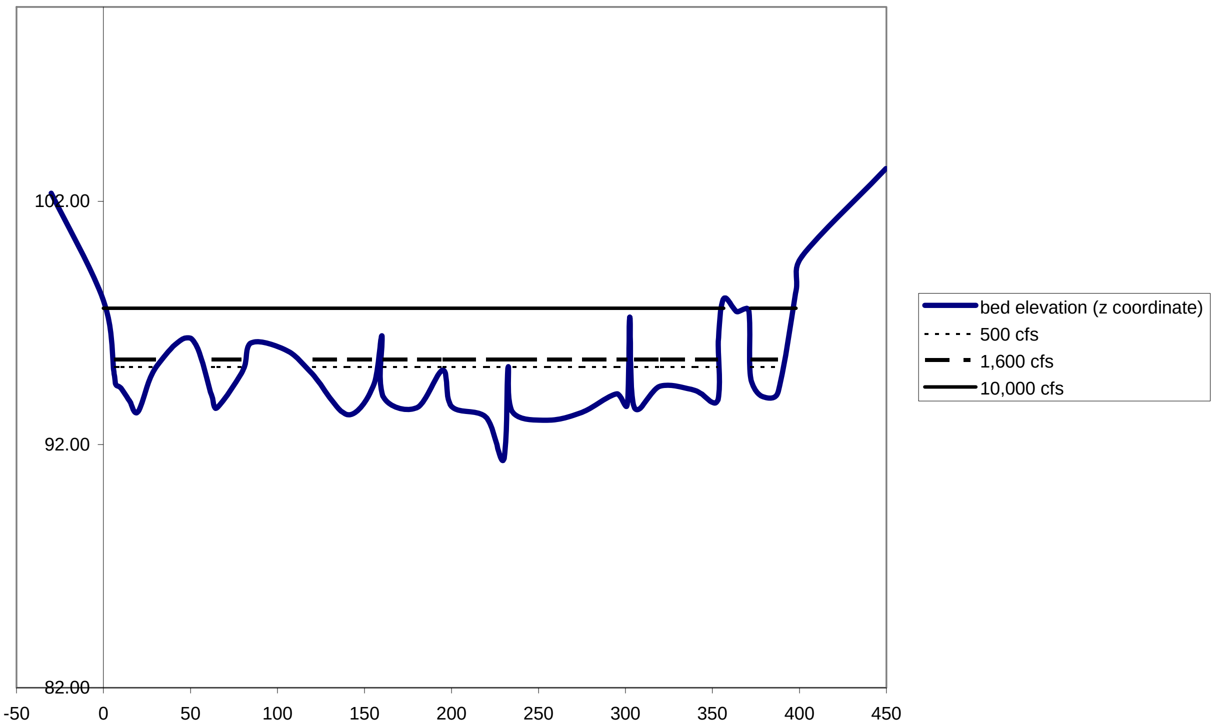
Transect 4 Gravel Riffle (Lower Oh Brother)



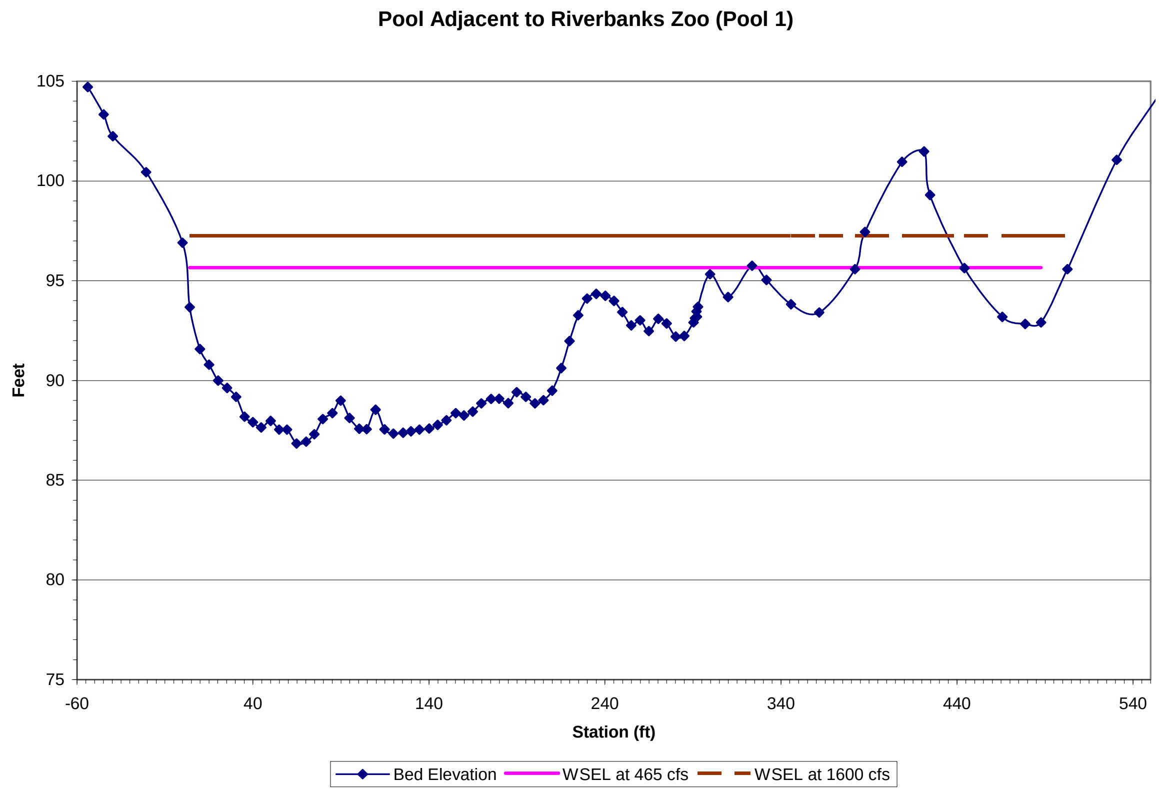
Transect 2 Run (below Millrace).

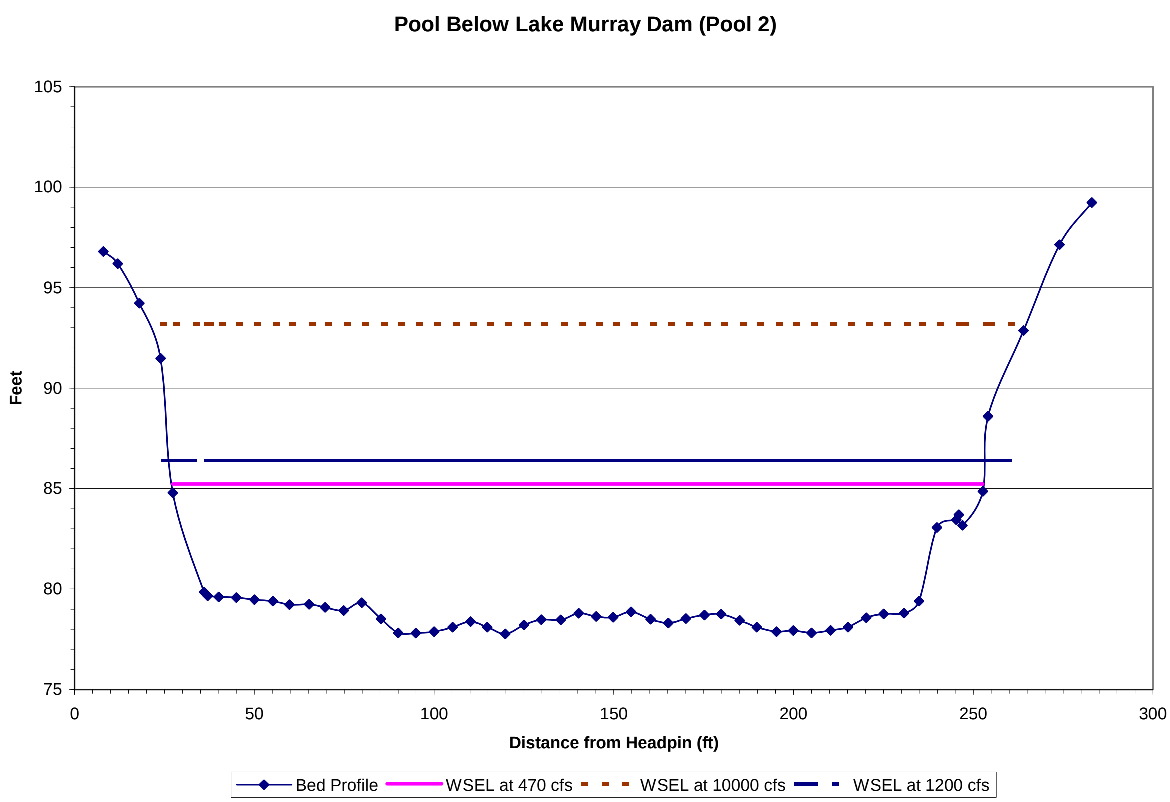


Transect 1 Glide (Shandon)



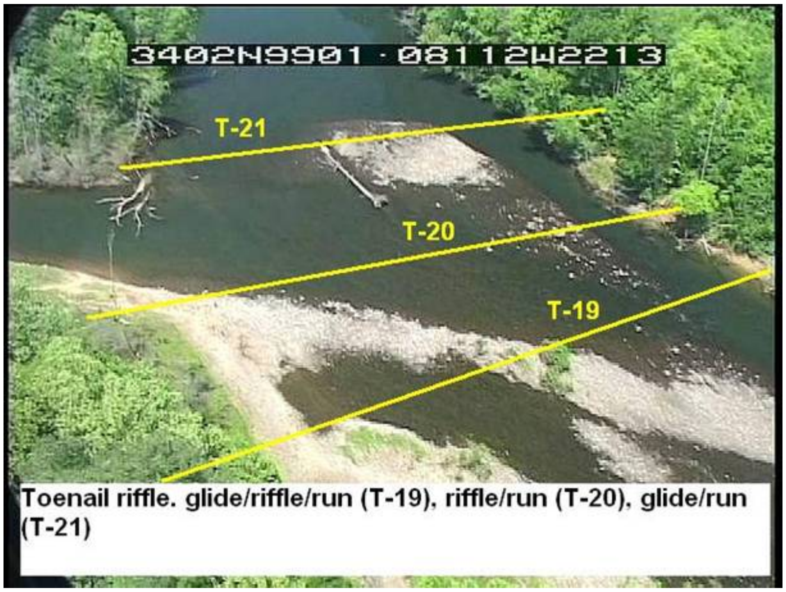
POOL TRANSECT BED PROFILES





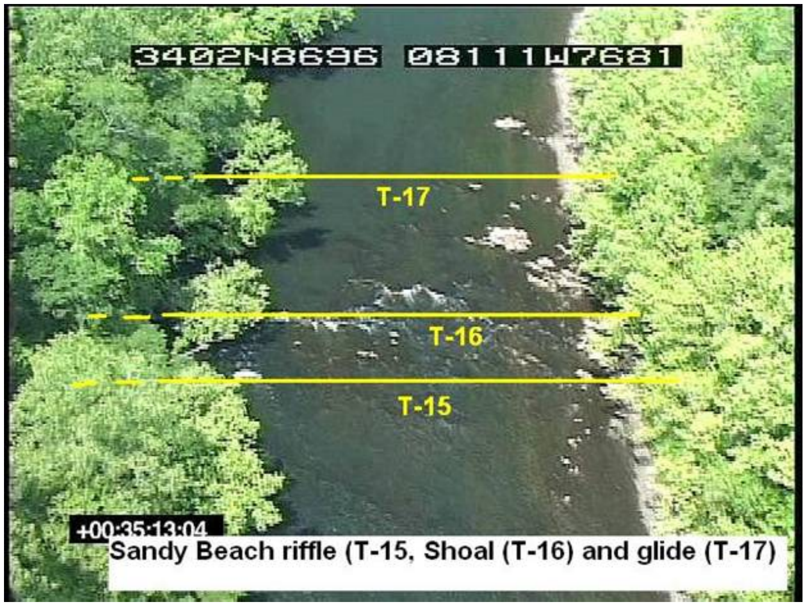
APPENDIX D

PHOTOGRAPHS OF STUDY SITES


3402N9901 · 08112W2213
T-21
T-20
T-19
Toenail riffle. glide/riffle/run (T-19), riffle/run (T-20), glide/run (T-21)


3402N9553 · 08112W0232
Point bar with run above Sandy Beach T-18


3402N9488 08112W0132
+00:38:19;09
side-arm backwater of T-18



Sandy Beach riffle (T-15, Shoal (T-16) and glide (T-17)

Corley side channel glide T-13 and T-14

Corley run T-12

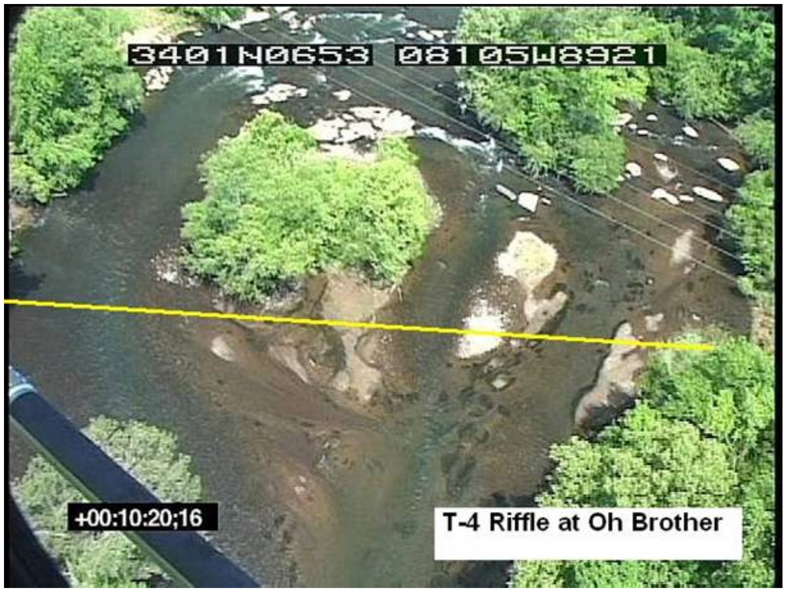

3402N8519 08110W3649
T-11
T-10
+00:27:50;09
T-10 Riffle and T-11 Glide at Corley Island


3401N1742 08105W9195
T-9
T-8
+00:08:51;20
T-8 Run and T-9 Shoal at Ocean Blvd


3401N1157 08105W8922
+00:08:38;03
Shoal (T-7) at Ocean Boulevard


3401N2658 08106W0534
+00:11:11;23
T-6 Riffle at Oh Brother


3401N2030 08106W0587
+00:11:01;16
T-5 Riffle at Oh Brother


3401N0653 08105W8921
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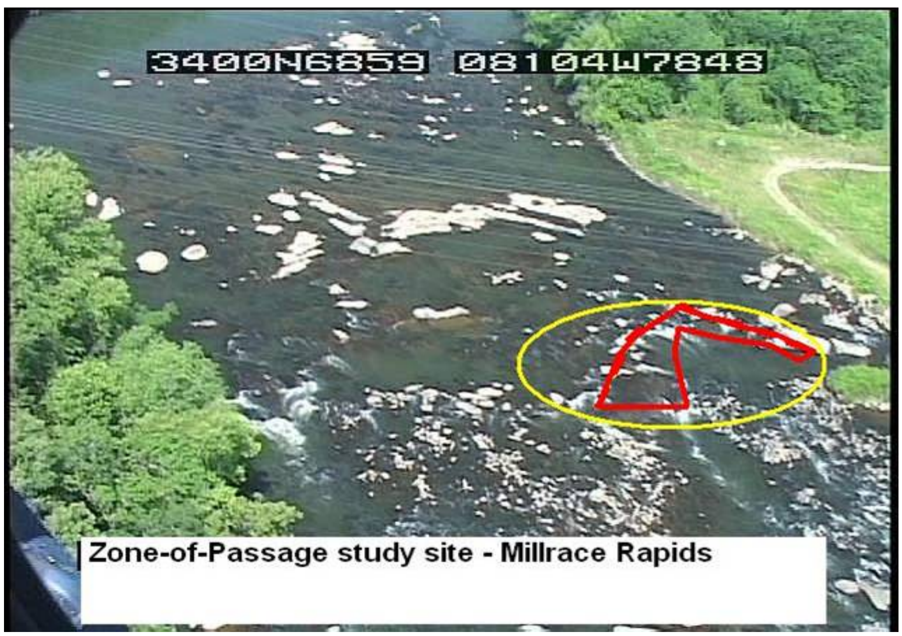
T-4 Riffle at Oh Brother


3400N6144 08104W7379
+00:04:46;15
T-2 Millrace Run


3400N4262 08103W9464
+00:02:18;18
T-1 Shandon Glide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Zone-of-Passage study site - Millrace Rapids

Overview of Zone-of-Passage Study Site

Close-Up Side View of Zone-of-Passage Study Site

APPENDIX E

OVERBANK INUNDATION MODELING

OVERBANK INUNDATION MODELING

The TWC requested modeling information for flows as high as 20,000 cfs. In-channel PHASBIM results are reported in Section 4 of this report. However, flows up to 20,000 cfs exceed the bankfull elevation of the stream channel and inundate the riparian zone. This was depicted using a HECRAS model calibrated to the instream habitat transects. The following is a table showing the depth and surface area at each cross section for each flow rate and a plot of each transect at the various flow rates:

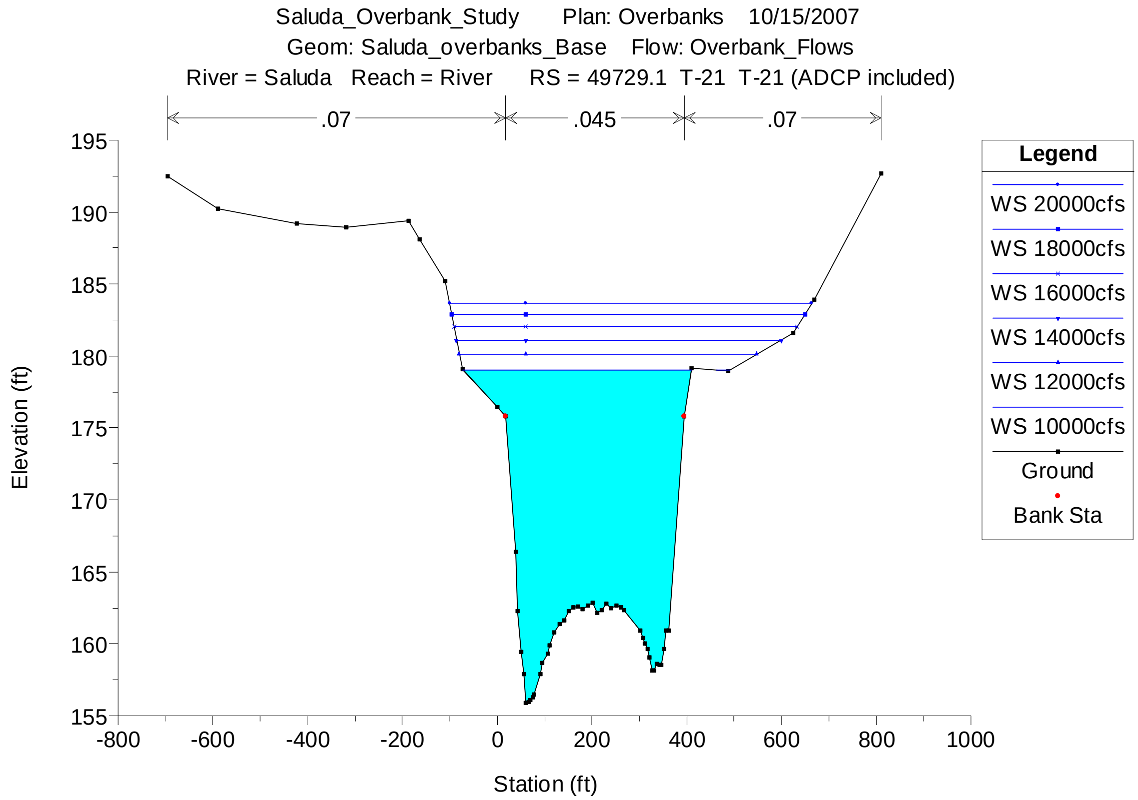
Table 1: Overbank Flood Model Results

Hec-Ras Station Transect #	Flow Rate	Min Ch El (ft)	W.S. Elev (ft)	Flow Area (sq ft)	Top Width (ft)
49729.1 T-21	10000cfs	155.87	179.01	6589.81	511.16
	12000cfs	155.87	180.10	7236.81	627.62
	14000cfs	155.87	181.10	7890.89	684.98
	16000cfs	155.87	182.02	8543.94	724.30
	18000cfs	155.87	182.86	9159.97	745.26
	20000cfs	155.87	183.65	9754.37	764.95
49516.9 T-20	10000cfs	164.27	178.90	3638.97	524.66
	12000cfs	164.27	179.98	4349.30	678.80
	14000cfs	164.27	180.98	5035.45	701.30
	16000cfs	164.27	181.90	5690.91	722.13
	18000cfs	164.27	182.74	6303.43	741.07
	20000cfs	164.27	183.52	6893.21	758.86
49422.0 T-19	10000cfs	164.79	178.90	4906.81	614.73
	12000cfs	164.79	179.99	5612.36	690.69
	14000cfs	164.79	180.98	6322.25	737.35
	16000cfs	164.79	181.90	7020.99	780.56
	18000cfs	164.79	182.74	7690.78	819.85
	20000cfs	164.79	183.52	8350.08	856.76
48286.2 T-18	10000cfs	159.44	178.86	9373.68	843.80
	12000cfs	159.44	179.94	10297.45	861.84
	14000cfs	159.44	180.93	11173.94	953.65
	16000cfs	159.44	181.85	12107.08	1045.56
	18000cfs	159.44	182.69	12990.27	1067.04
	20000cfs	159.44	183.47	13837.83	1090.94
46870.9 T-17	10000cfs	166.20	178.25	2085.43	272.30
	12000cfs	166.20	179.29	2429.35	454.19
	14000cfs	166.20	180.26	2884.44	485.79
	16000cfs	166.20	181.16	3335.98	518.94
	18000cfs	166.20	181.98	3774.63	551.32

Hec-Ras Station Transect #	Flow Rate	Min Ch El (ft)	W.S. Elev (ft)	Flow Area (sq ft)	Top Width (ft)
	20000cfs	166.20	182.75	4212.09	581.82
46756.5 T-16	10000cfs	163.66	178.30	3027.28	461.46
	12000cfs	163.66	179.35	3537.47	507.09
	14000cfs	163.66	180.32	4045.15	538.49
	16000cfs	163.66	181.22	4542.18	566.12
	18000cfs	163.66	182.04	5016.32	593.56
	20000cfs	163.66	182.80	5503.53	721.96
47046.0 T-15	10000cfs	164.41	178.65	4241.24	748.22
	12000cfs	164.41	179.73	5062.05	777.25
	14000cfs	164.41	180.72	5844.18	805.68
	16000cfs	164.41	181.63	6590.38	829.96
	18000cfs	164.41	182.46	7289.33	852.08
	20000cfs	164.41	183.24	7962.66	872.86
0 T-14	10000cfs	165.38	177.06	1300.26	151.80
	12000cfs	165.38	177.99	1443.25	153.52
	14000cfs	165.38	178.87	1580.60	162.90
	16000cfs	165.38	179.68	1718.13	217.41
	18000cfs	165.38	180.42	1917.05	298.50
	20000cfs	165.38	181.09	2128.87	323.94
246.7 T-13	10000cfs	160.75	177.07	1260.82	118.02
	12000cfs	160.75	178.01	1373.66	122.03
	14000cfs	160.75	178.89	1482.63	125.78
	16000cfs	160.75	179.69	1672.66	379.66
	18000cfs	160.75	180.43	1990.18	515.82
	20000cfs	160.75	181.11	2351.23	543.34
42140.0 T-12	10000cfs	159.11	177.01	3905.44	325.71
	12000cfs	159.11	177.93	4211.27	445.17
	14000cfs	159.11	178.80	4514.46	540.30
	16000cfs	159.11	179.61	4822.63	712.00
	18000cfs	159.11	180.34	5154.94	840.55
	20000cfs	159.11	181.01	5487.48	992.34
38754.2 T-11	10000cfs	164.87	177.00	3535.68	356.89
	12000cfs	164.87	177.92	3873.69	372.74
	14000cfs	164.87	178.80	4205.98	387.69
	16000cfs	164.87	179.61	4540.73	429.16
	18000cfs	164.87	180.35	4861.15	436.78
	20000cfs	164.87	181.03	5159.43	444.78
38508.1 T-10	10000cfs	161.76	176.92	3423.64	296.66
	12000cfs	161.76	177.84	3698.68	301.17
	14000cfs	161.76	178.71	3961.83	305.43
	16000cfs	161.76	179.52	4209.58	309.39

Hec-Ras Station Transect #	Flow Rate	Min Ch El (ft)	W.S. Elev (ft)	Flow Area (sq ft)	Top Width (ft)
	18000cfs	161.76	180.25	4437.58	312.98
	20000cfs	161.76	180.92	4650.25	328.80
12337.3 T-9	10000cfs	148.43	161.40	2999.22	439.36
	12000cfs	148.43	162.03	3278.59	450.53
	14000cfs	148.43	162.56	3522.63	460.06
	16000cfs	148.43	163.06	3754.54	470.48
	18000cfs	148.43	163.53	3975.83	481.36
	20000cfs	148.43	163.96	4188.28	491.59
0 T-8	10000cfs	151.43	161.25	2493.84	453.79
	12000cfs	151.43	161.89	2785.70	468.00
	14000cfs	151.43	162.43	3041.61	480.11
	16000cfs	151.43	162.93	3286.18	491.41
	18000cfs	151.43	163.40	3519.64	501.96
	20000cfs	151.43	163.84	3744.20	522.41
11940.1 T-7	10000cfs	148.62	161.36	2930.83	719.31
	12000cfs	148.62	161.99	3388.64	736.60
	14000cfs	148.62	162.52	3787.10	746.50
	16000cfs	148.62	163.02	4163.40	755.54
	18000cfs	148.62	163.49	4518.85	763.97
	20000cfs	148.62	163.93	4855.78	771.52
12441.1 T-6	10000cfs	148.15	161.36	2067.34	307.73
	12000cfs	148.15	161.97	2260.71	319.71
	14000cfs	148.15	162.50	2431.47	331.08
	16000cfs	148.15	162.98	2595.45	341.64
	18000cfs	148.15	163.44	2752.45	350.58
	20000cfs	148.15	163.86	2903.33	358.93
1583.5 T-5	10000cfs	155.85	161.11	823.22	193.45
	12000cfs	155.85	161.73	943.03	196.50
	14000cfs	155.85	162.25	1045.40	198.97
	16000cfs	155.85	162.73	1141.70	201.25
	18000cfs	155.85	163.18	1232.22	203.36
	20000cfs	155.85	163.59	1317.48	205.33
1178.7 T-4	10000cfs	154.40	161.26	1594.25	296.06
	12000cfs	154.40	161.89	1781.17	296.77
	14000cfs	154.40	162.43	1940.73	297.37
	16000cfs	154.40	162.93	2089.72	297.93
	18000cfs	154.40	163.39	2228.94	298.46
	20000cfs	154.40	163.83	2359.57	299.41
4849.4 T-2	10000cfs	137.42	145.76	1407.22	401.31
	12000cfs	137.42	146.18	1576.74	417.04
	14000cfs	137.42	146.56	1736.71	431.35

Hec-Ras Station Transect #	Flow Rate	Min Ch El (ft)	W.S. Elev (ft)	Flow Area (sq ft)	Top Width (ft)
	16000cfs	137.42	146.91	1890.28	444.65
	18000cfs	137.42	147.23	2036.02	456.99
	20000cfs	137.42	147.54	2179.04	469.05
0 T-1	10000cfs	118.24	124.46	1260.67	389.43
	12000cfs	118.24	124.90	1434.00	398.14
	14000cfs	118.24	125.30	1594.00	401.86
	16000cfs	118.24	125.68	1747.37	405.37
	18000cfs	118.24	126.05	1897.99	408.79
	20000cfs	118.24	126.40	2041.63	412.03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Geom: Saluda_overbanks_Base Flow: Overbank_Flows
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.07
.045
.07
Elevation (ft)
Station (ft)
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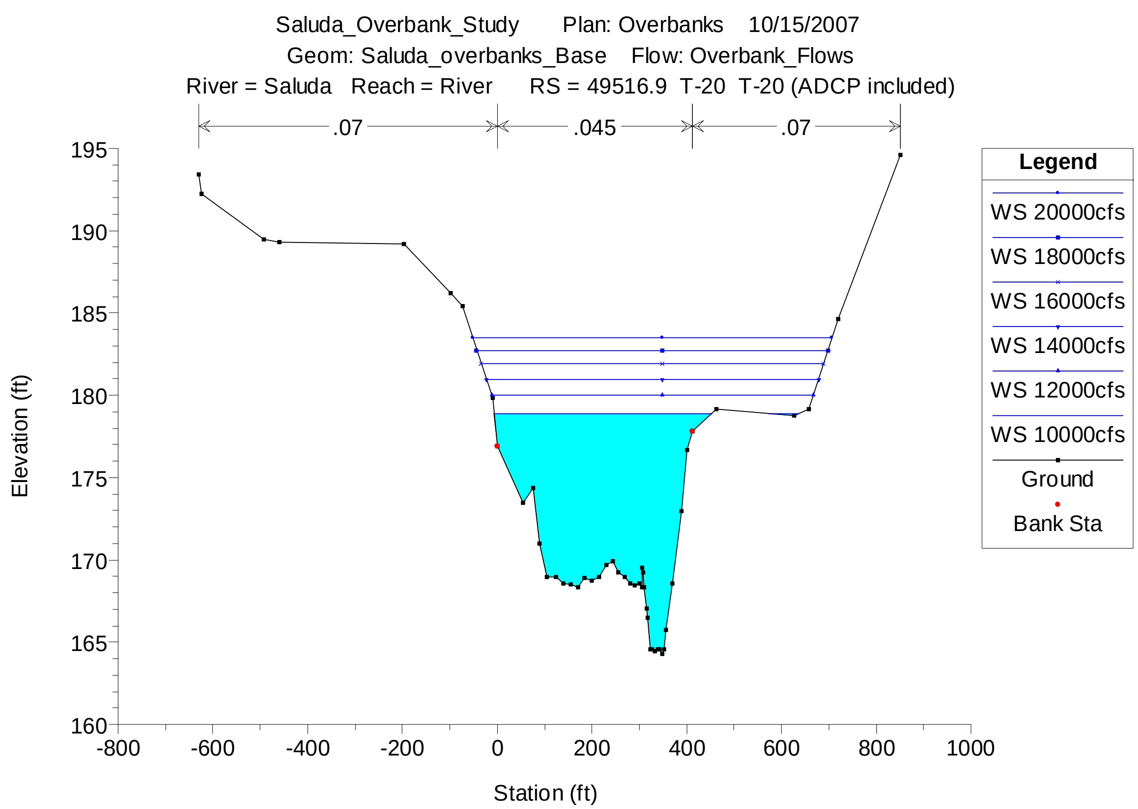
WS 16000cfs
WS 14000cfs
WS 12000cfs
WS 10000cfs
Ground
Bank Sta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.045
.07
Elevation (ft)
Station (ft)
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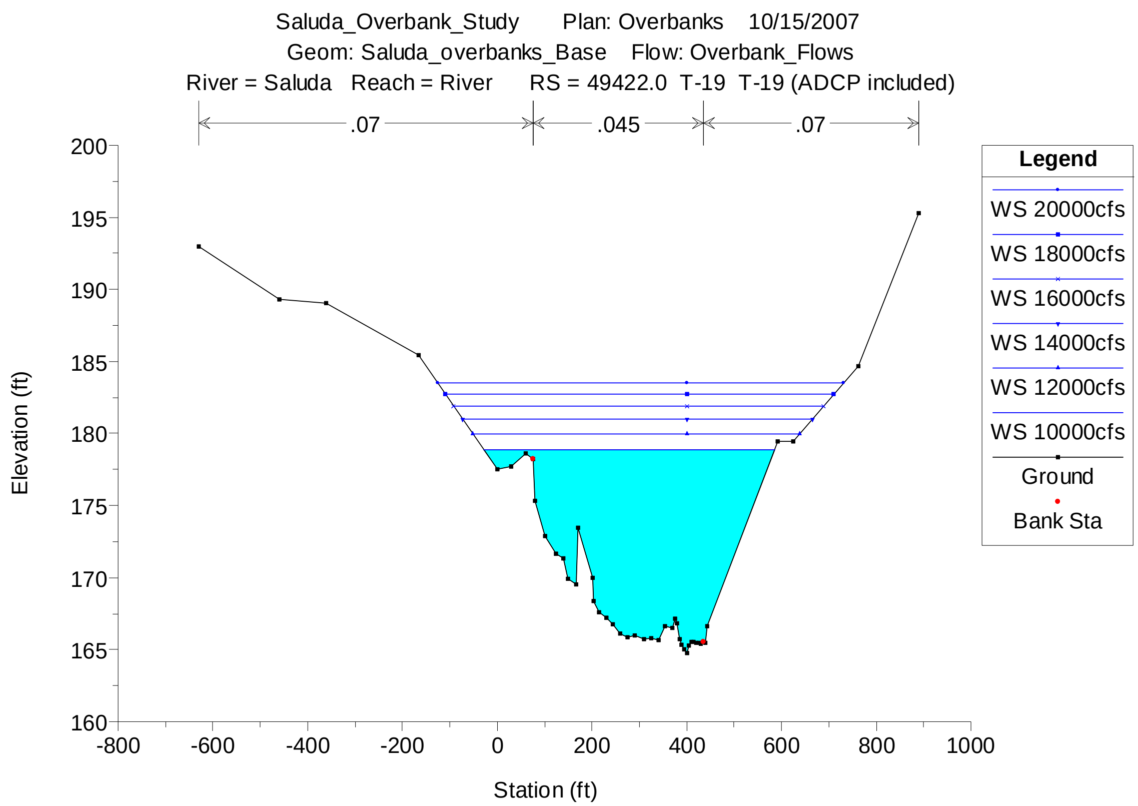
WS 12000cfs
WS 10000cfs
Ground
Bank Sta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.07
.045
.07
Elevation (ft)
Station (ft)
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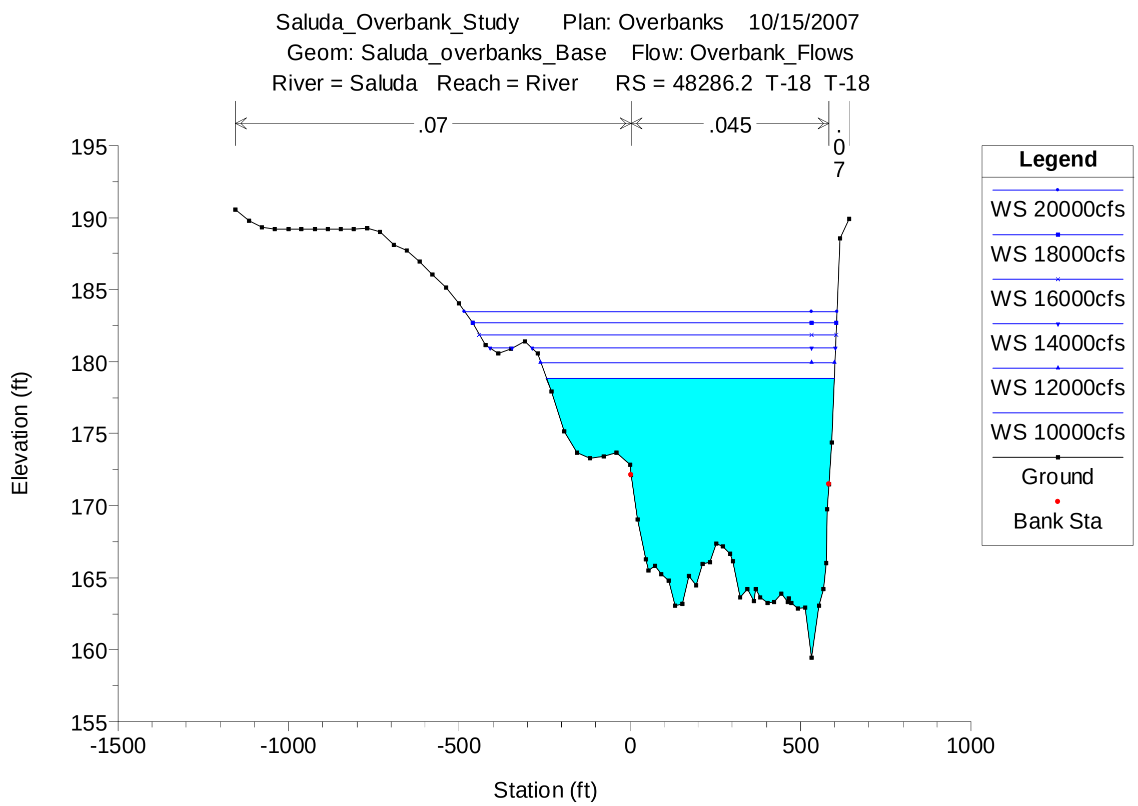
Ground
Bank Sta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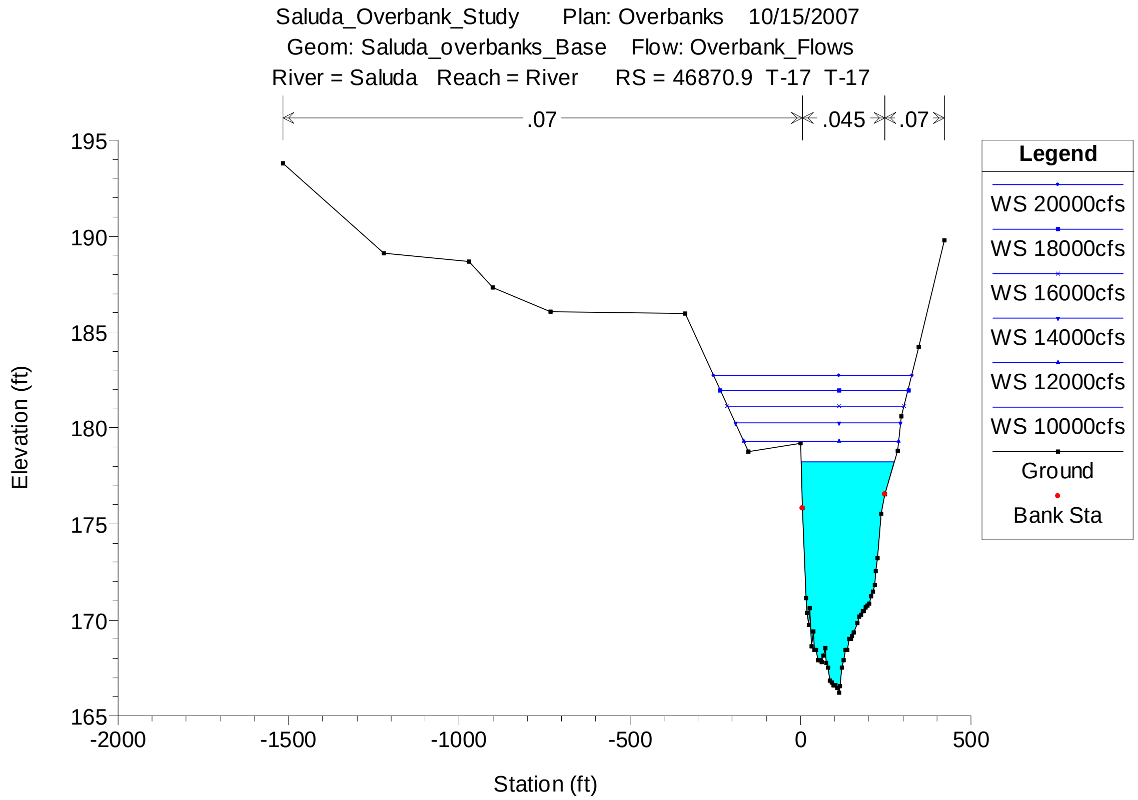
Bank Sta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.045
.07
Legend
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WS 16000cfs
WS 14000cfs
WS 12000cfs
WS 10000cfs
Ground
Bank Sta
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Station (ft)
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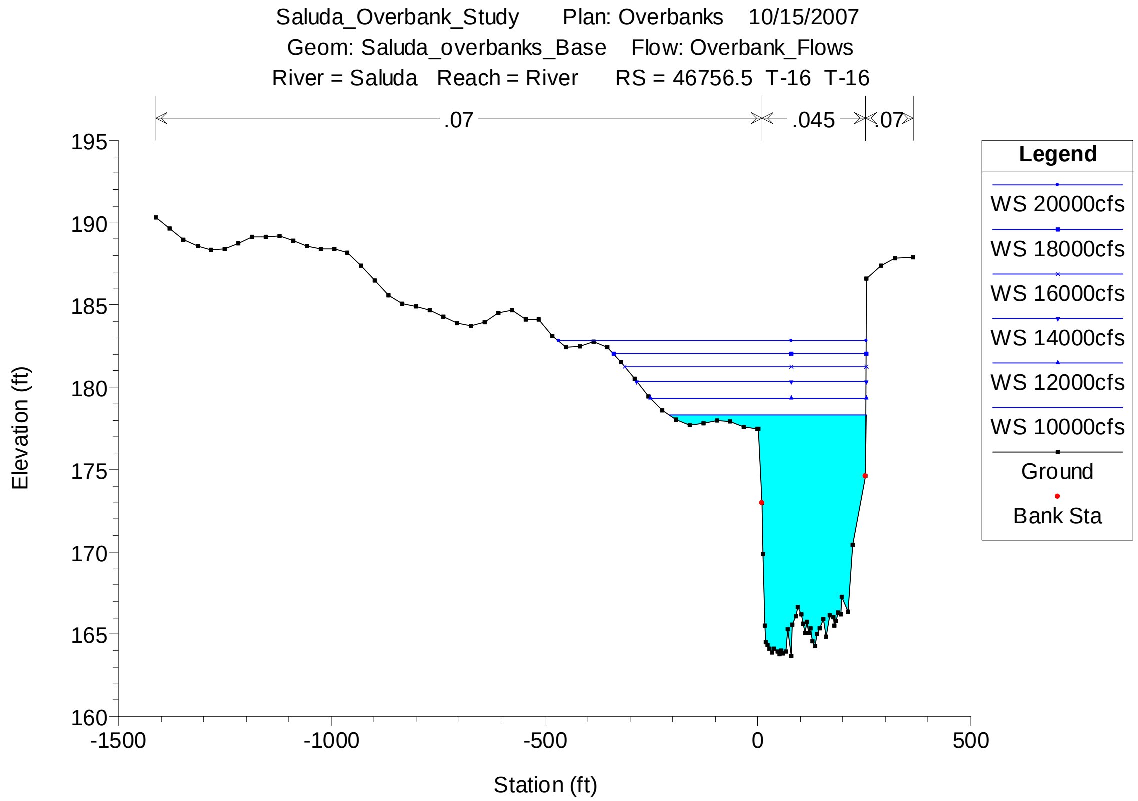
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WS 16000cfs
WS 14000cfs
WS 12000cfs
WS 10000cfs
Ground
Bank Sta
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Station (ft)
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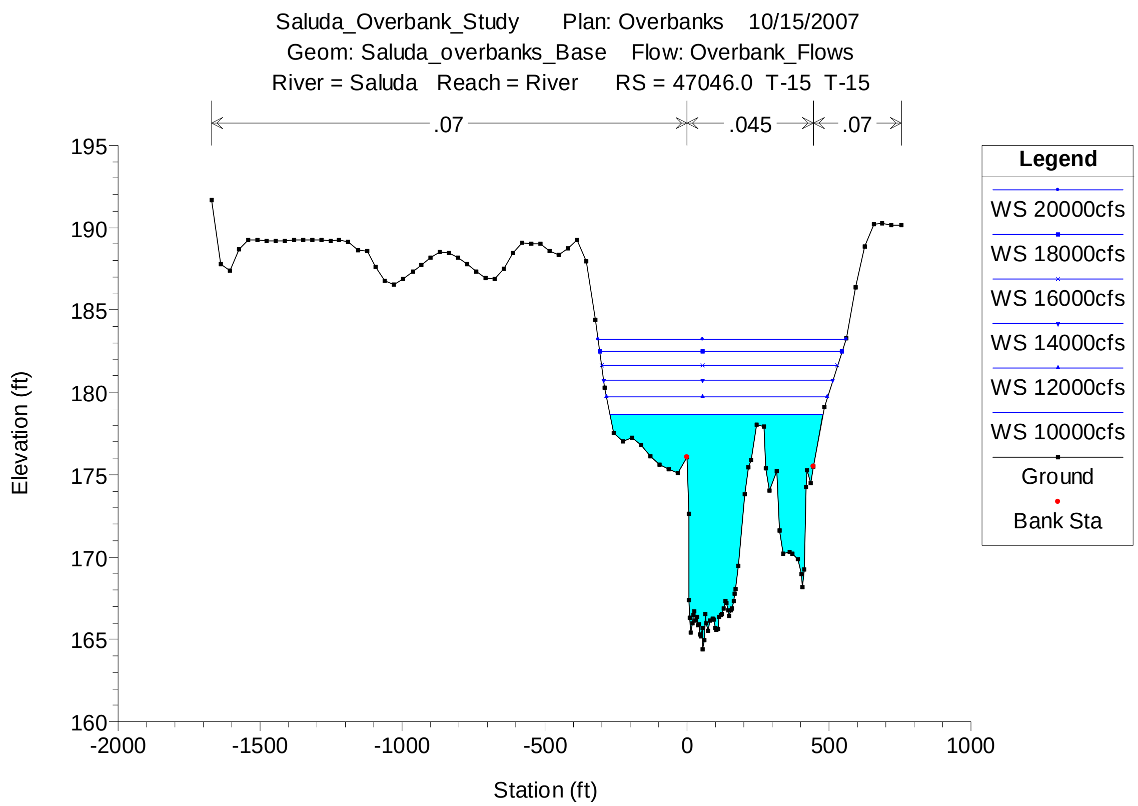
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.07
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WS 16000cfs
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WS 10000cfs
Ground
Bank Sta
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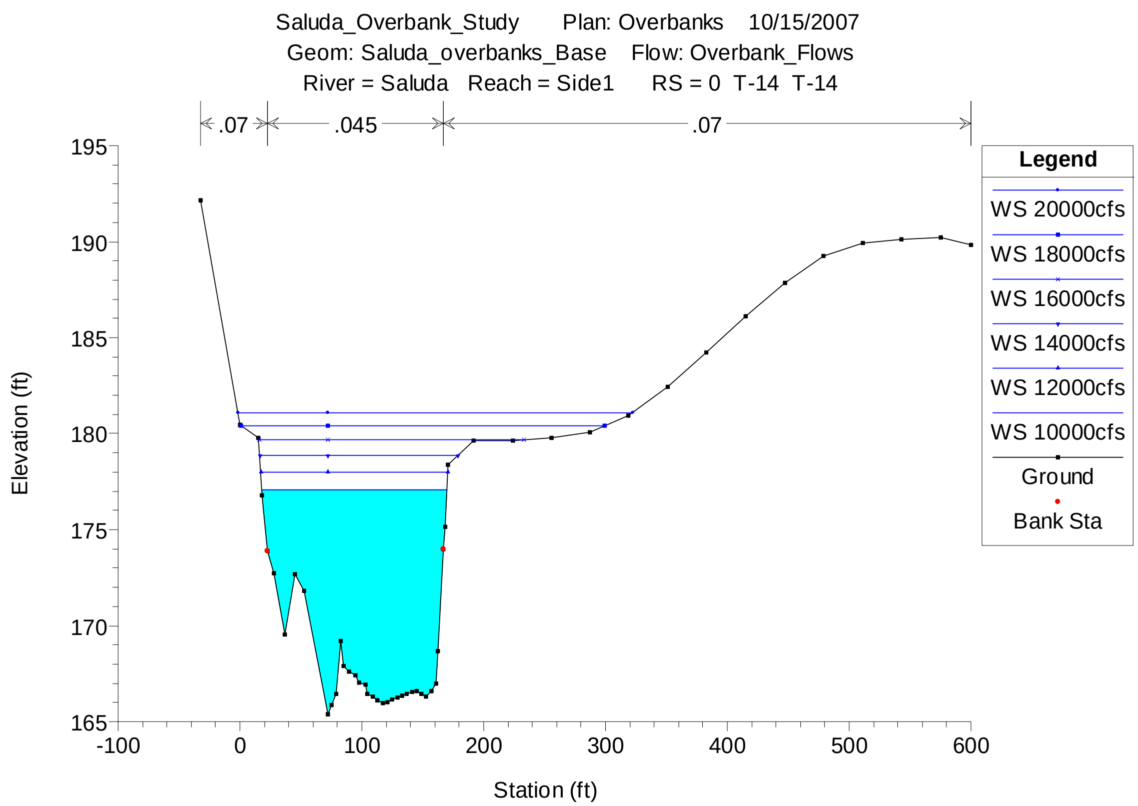
Station (ft)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.07
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WS 16000cfs
WS 14000cfs
WS 12000cfs
WS 10000cfs
Ground
Bank Sta
Elevation (ft)
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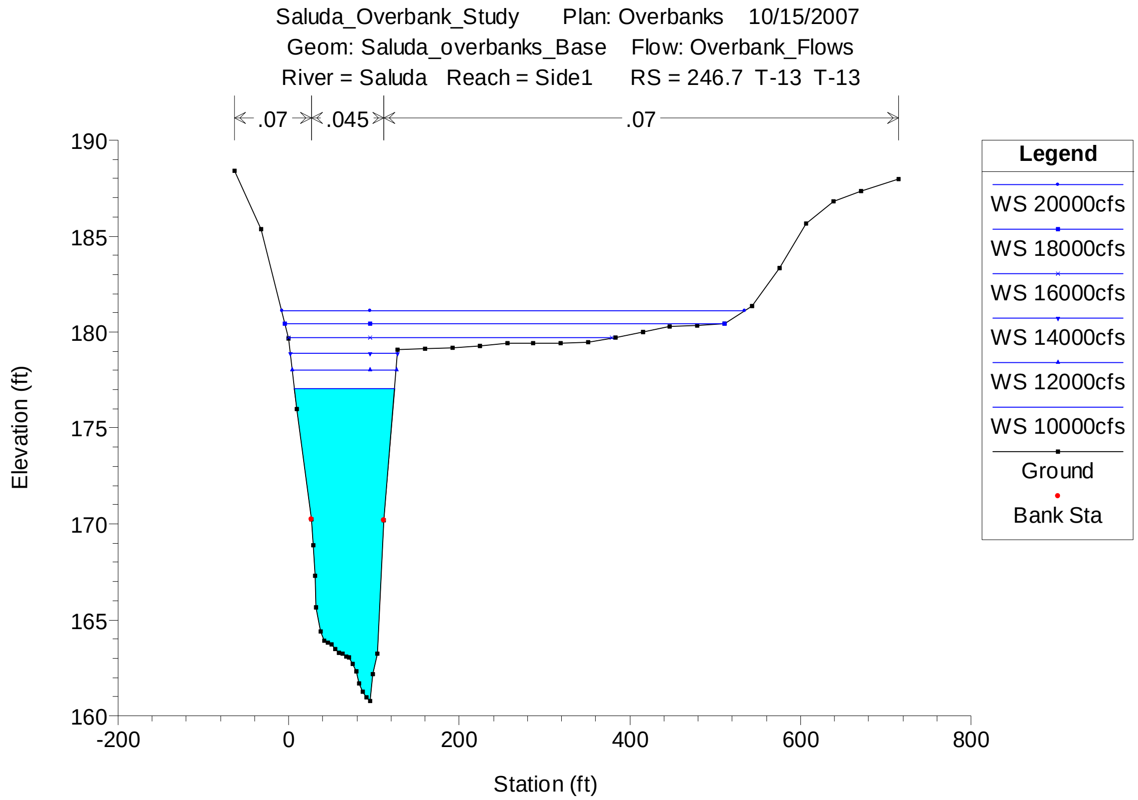
Station (ft)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.07
.045
.07
Elevation (ft)
190
185
180
175
170
165
160
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200
400
600
800
Station (ft)
Legend
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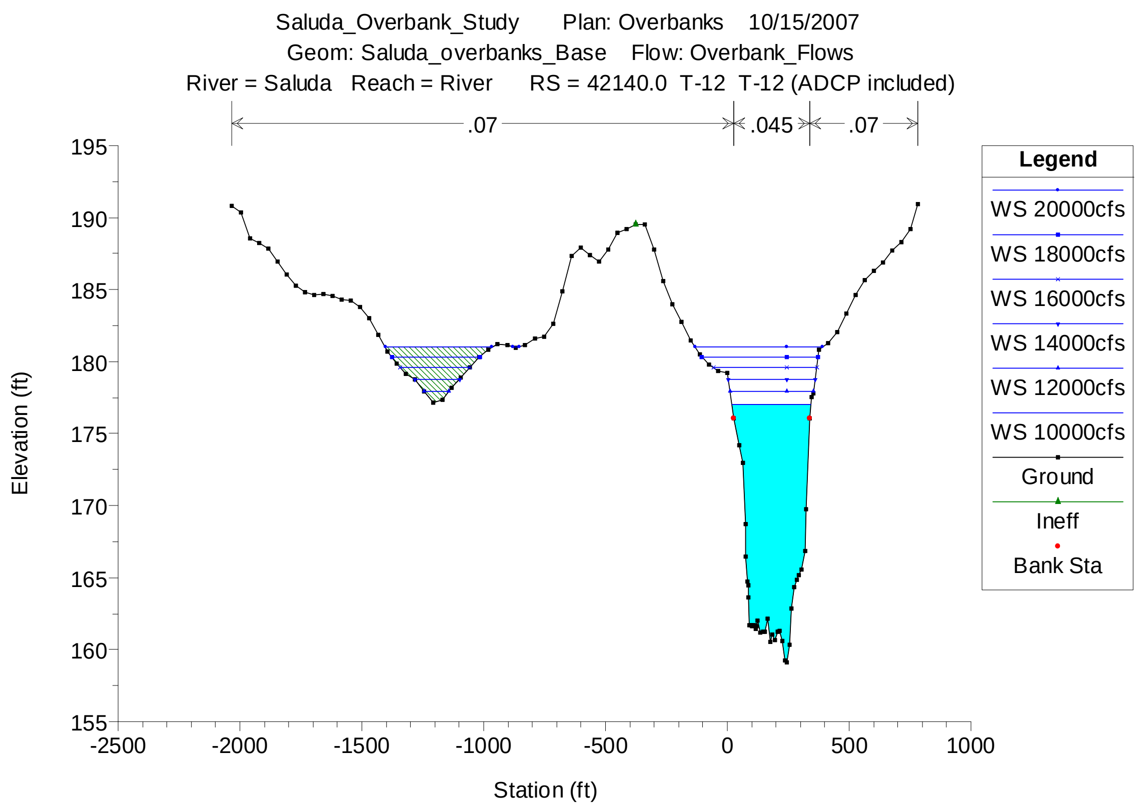
WS 18000cfs
WS 16000cfs
WS 14000cfs
WS 12000cfs
WS 10000cfs
Ground
Bank Sta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.07
.045
.07
Elevation (ft)
195
190
185
180
175
170
165
160
155
-2500
-2000
-1500
-1000
-500
0
500
1000
Station (ft)
Legend
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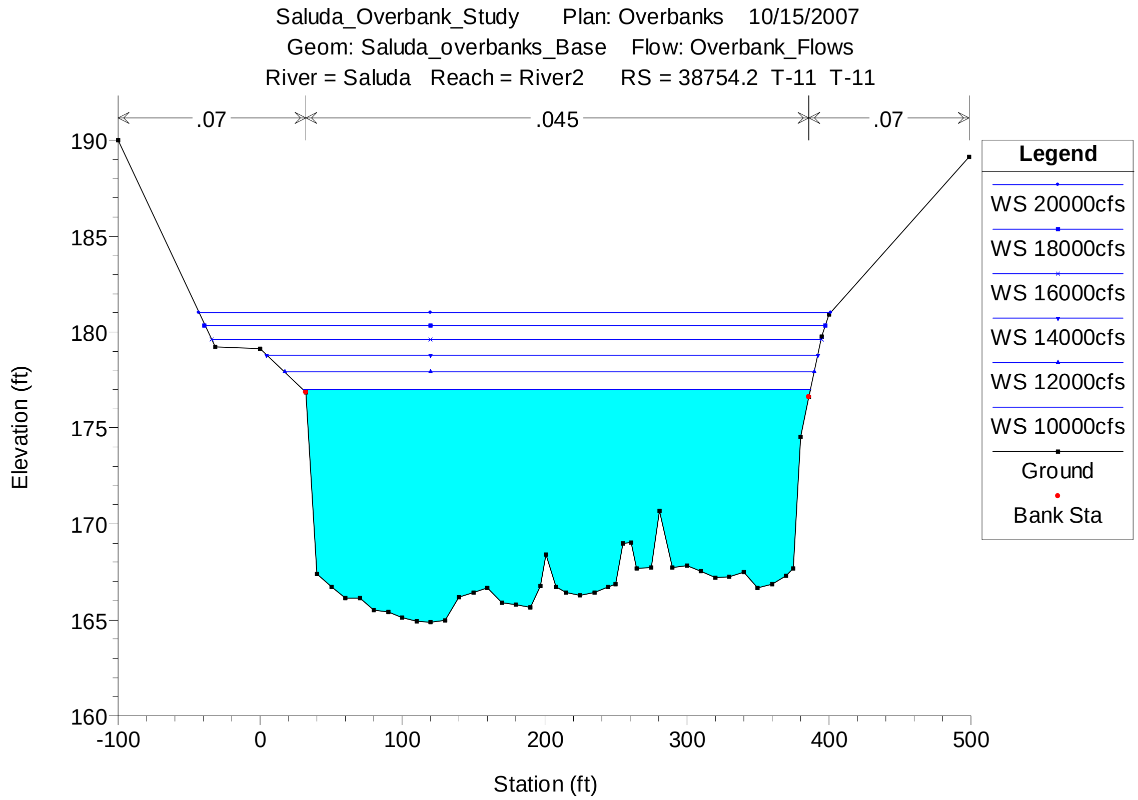
WS 18000cfs
WS 16000cfs
WS 14000cfs
WS 12000cfs
WS 10000cfs
Ground
Ineff
Bank Sta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.07
.045
.07
Elevation (ft)
Station (ft)
Legend
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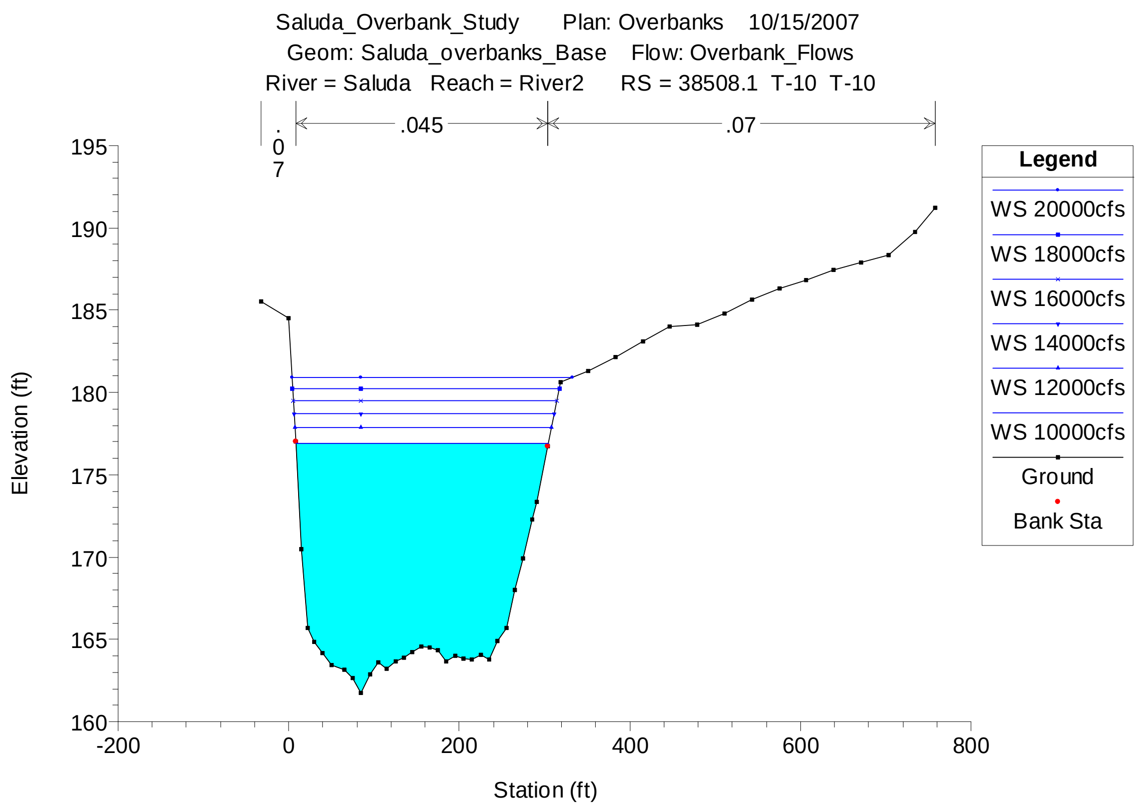
WS 14000cfs
WS 12000cfs
WS 10000cfs
Ground
Bank Sta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.045
.07
Elevation (ft)
Station (ft)
Legend
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WS 16000cfs
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WS 12000cfs
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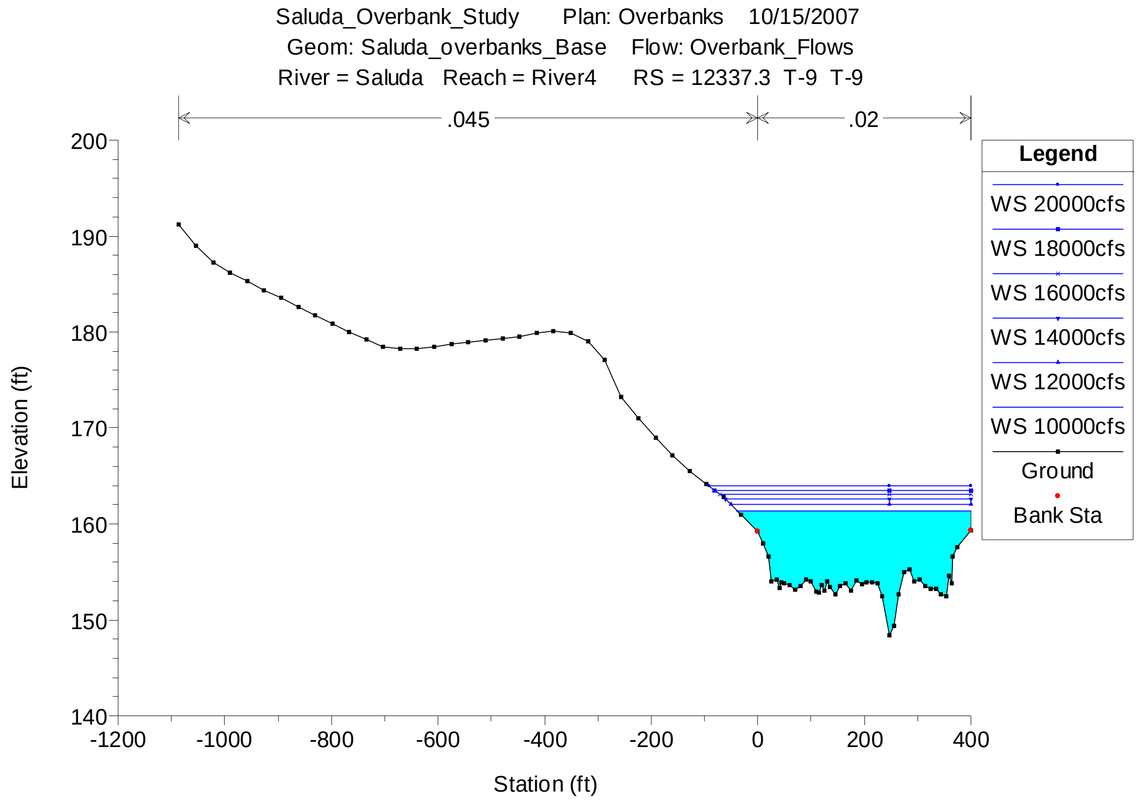
Ground
Bank Sta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.045
.02
Legend
WS 20000cfs
WS 18000cfs
WS 16000cfs
WS 14000cfs
WS 12000cfs
WS 10000cfs
Ground
Bank Sta
Elevation (ft)
Station (ft)
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140
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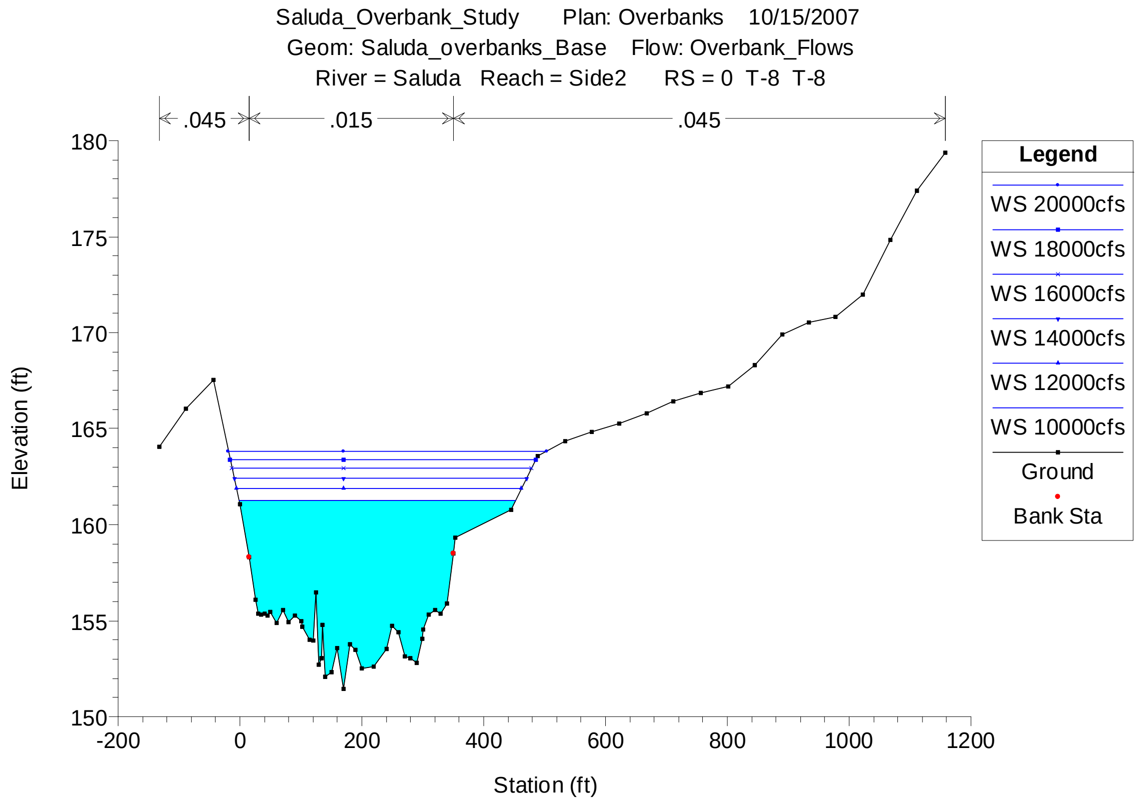
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.045
.015
.045
Legend
WS 20000cfs
WS 18000cfs
WS 16000cfs
WS 14000cfs
WS 12000cfs
WS 10000cfs
Ground
Bank Sta
Elevation (ft)
Station (ft)
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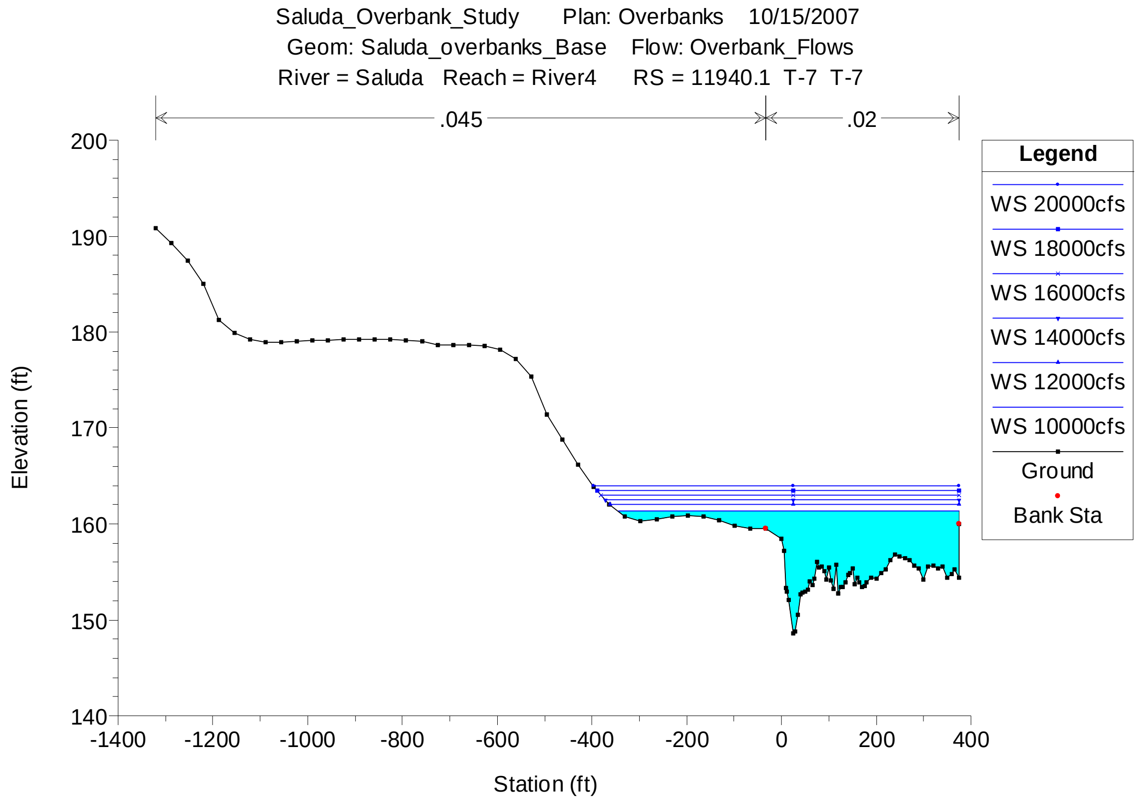
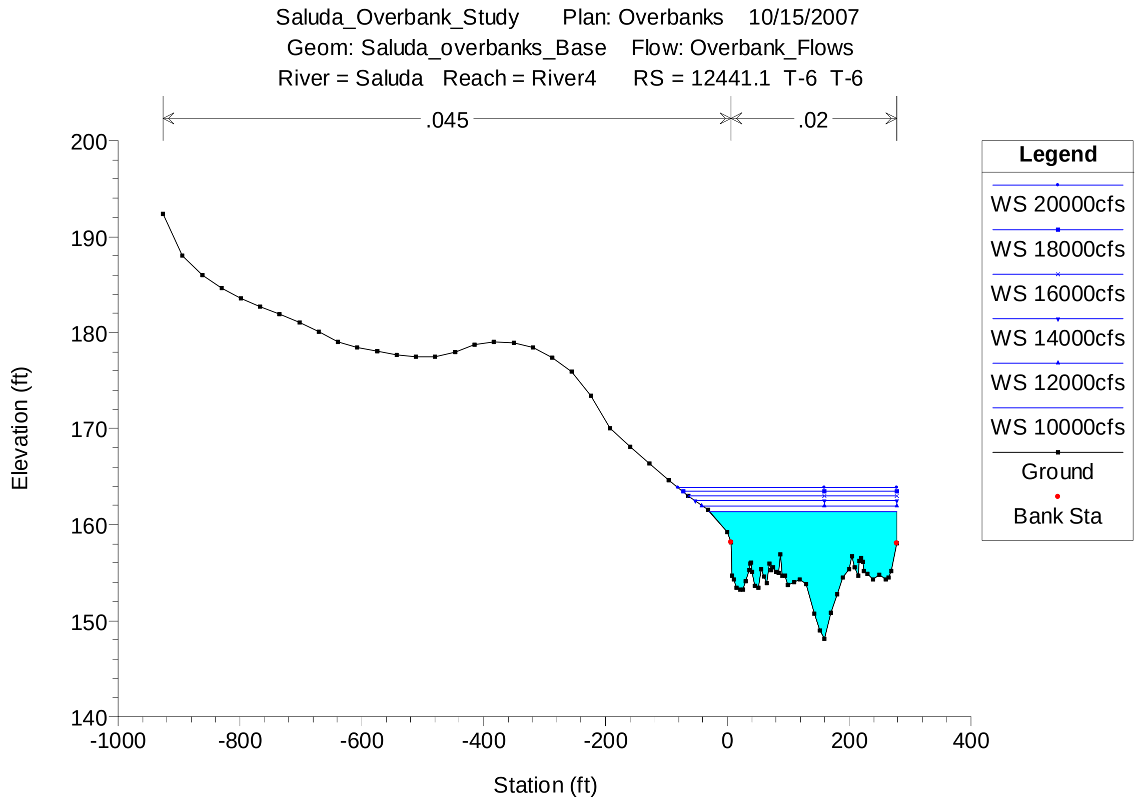
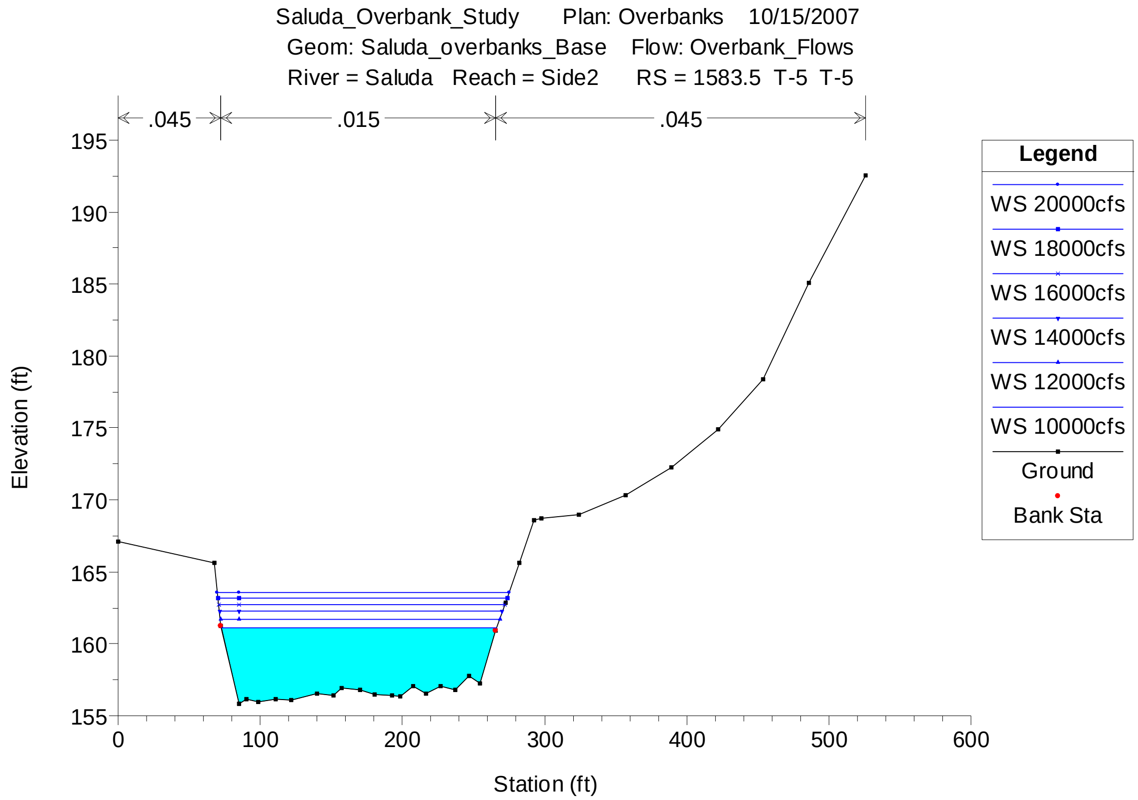
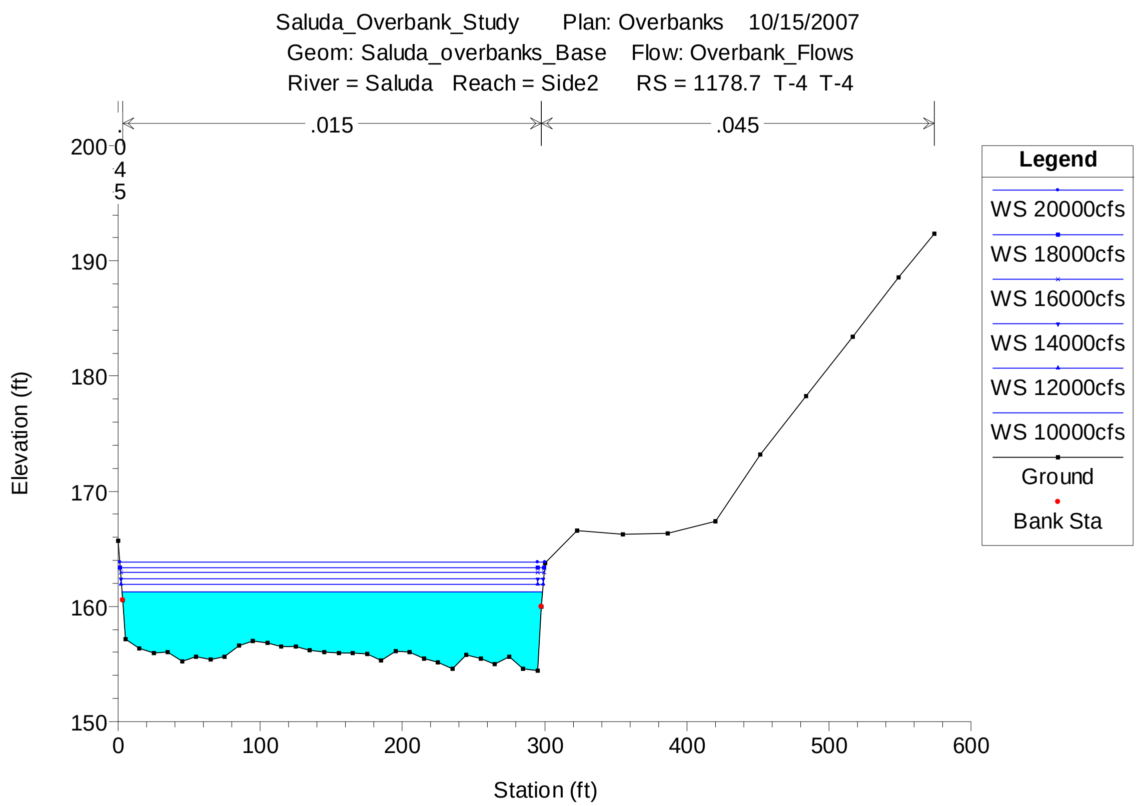
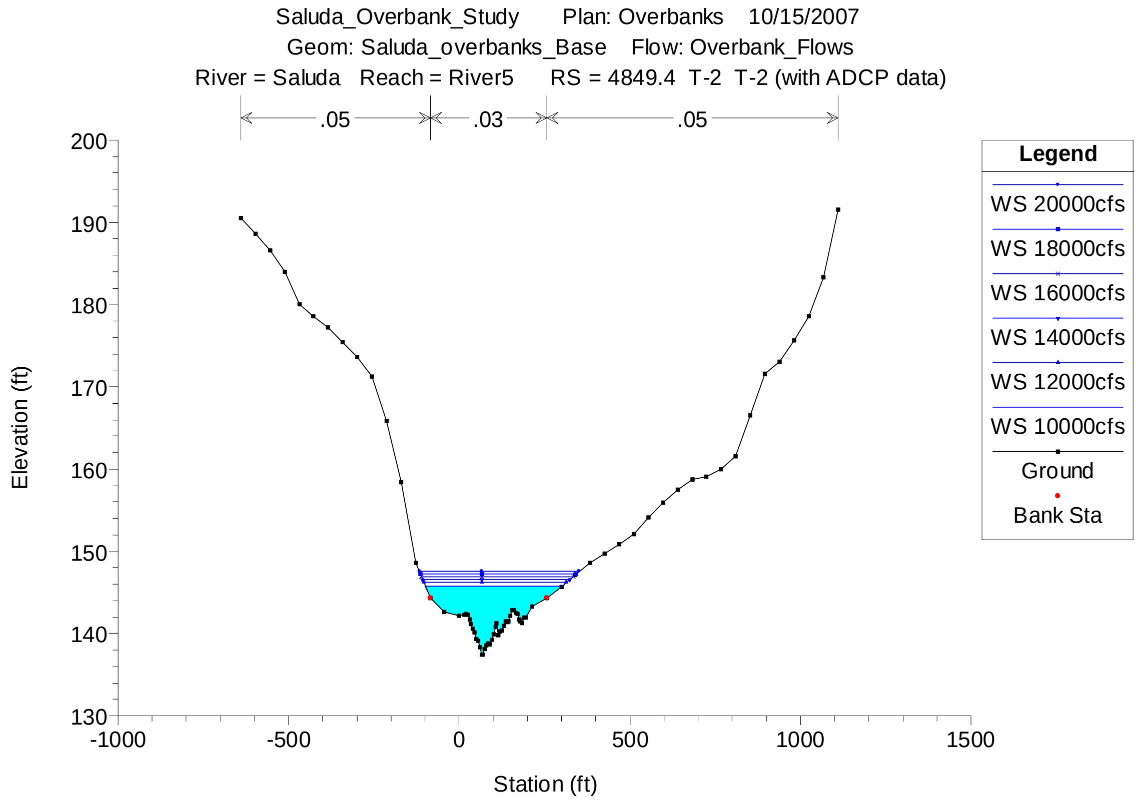
1200

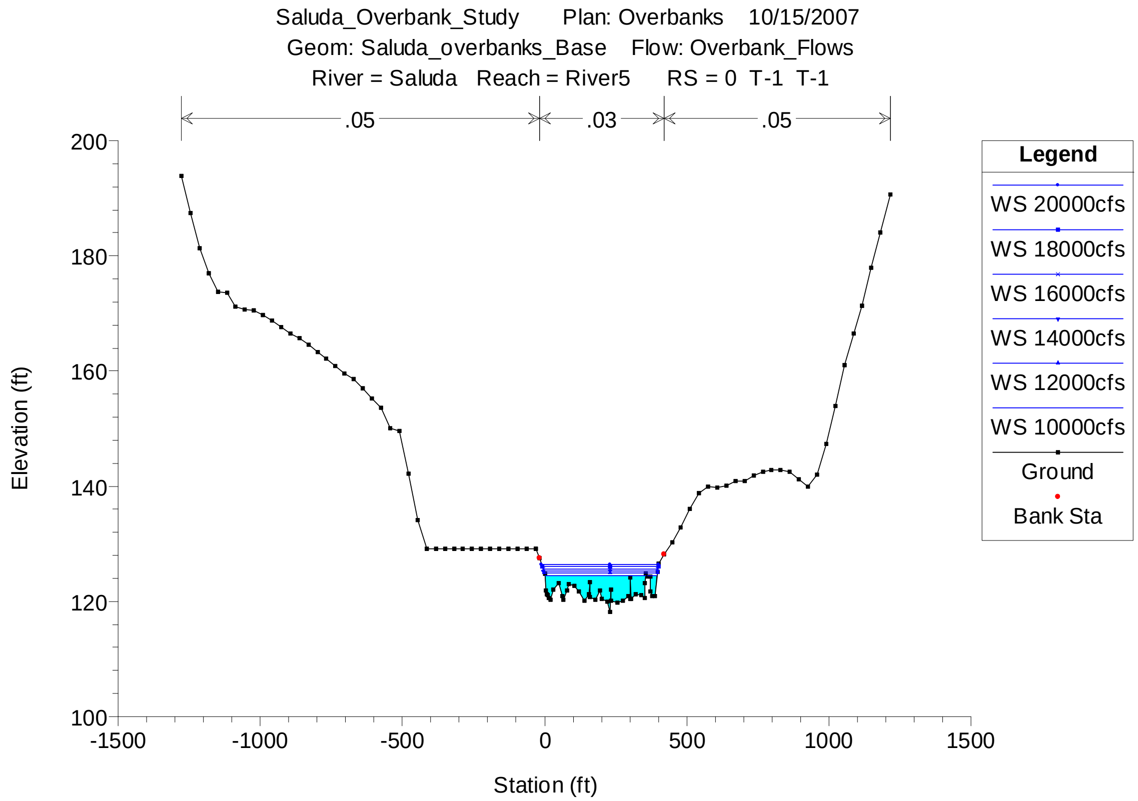

Saluda_Overbank_Study Plan: Overbanks 10/15/2007
Geom: Saluda_overbanks_Base Flow: Overbank_Flows
River = Saluda Reach = River4 RS = 11940.1 T-7 T-7
.045
.02
Legend
WS 20000cfs
WS 18000cfs
WS 16000cfs
WS 14000cfs
WS 12000cfs
WS 10000cfs
Ground
Bank Sta
Elevation (ft)
Station (ft)

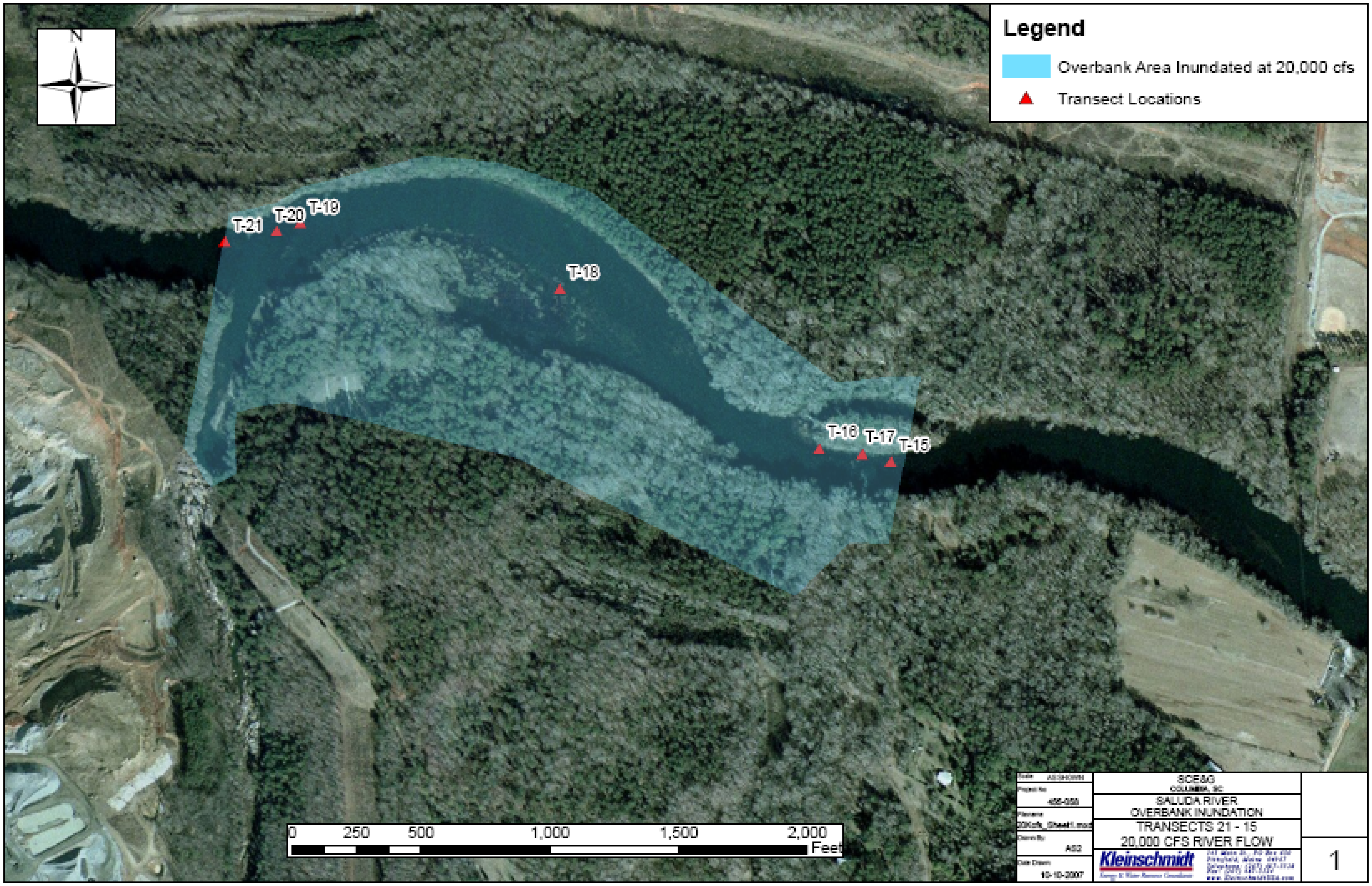

Saluda_Overbank_Study Plan: Overbanks 10/15/2007
Geom: Saluda_overbanks_Base Flow: Overbank_Flows
River = Saluda Reach = River4 RS = 12441.1 T-6 T-6
.045
.02
Legend
WS 20000cfs
WS 18000cfs
WS 16000cfs
WS 14000cfs
WS 12000cfs
WS 10000cfs
Ground
Bank Sta
Elevation (ft)
Station (ft)


Saluda_Overbank_Study Plan: Overbanks 10/15/2007
Geom: Saluda_overbanks_Base Flow: Overbank_Flows
River = Saluda Reach = Side2 RS = 1583.5 T-5 T-5
.045
.015
.045
Elevation (ft)
Station (ft)
Legend
WS 20000cfs
WS 18000cfs
WS 16000cfs
WS 14000cfs
WS 12000cfs
WS 10000cfs
Ground
Bank Sta

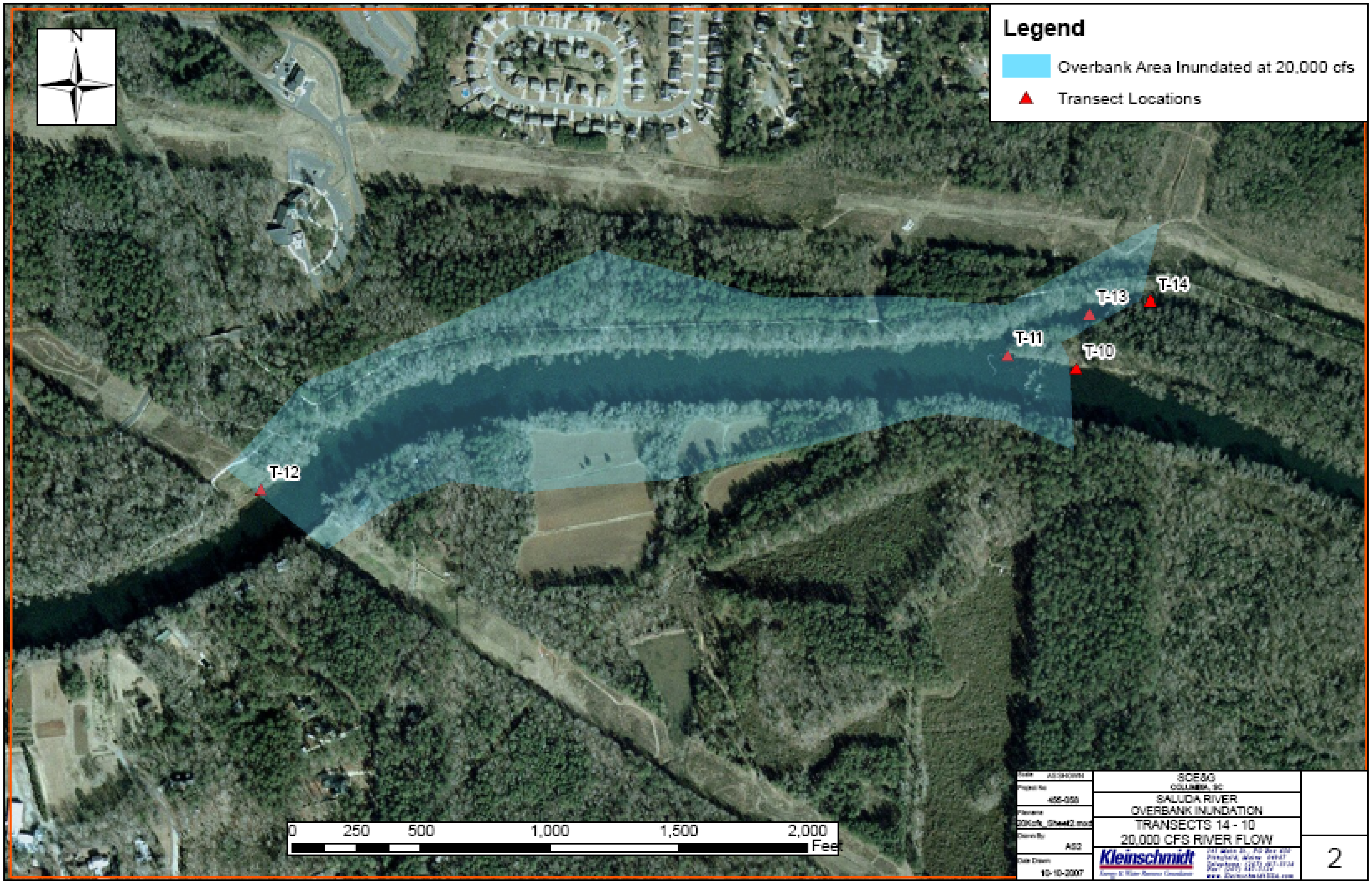

Saluda_Overbank_Study Plan: Overbanks 10/15/2007
Geom: Saluda_overbanks_Base Flow: Overbank_Flows
River = Saluda Reach = Side2 RS = 1178.7 T-4 T-4
.015
.045
Elevation (ft)
Station (ft)
Legend
WS 20000cfs
WS 18000cfs
WS 16000cfs
WS 14000cfs
WS 12000cfs
WS 10000cfs
Ground
Bank Sta

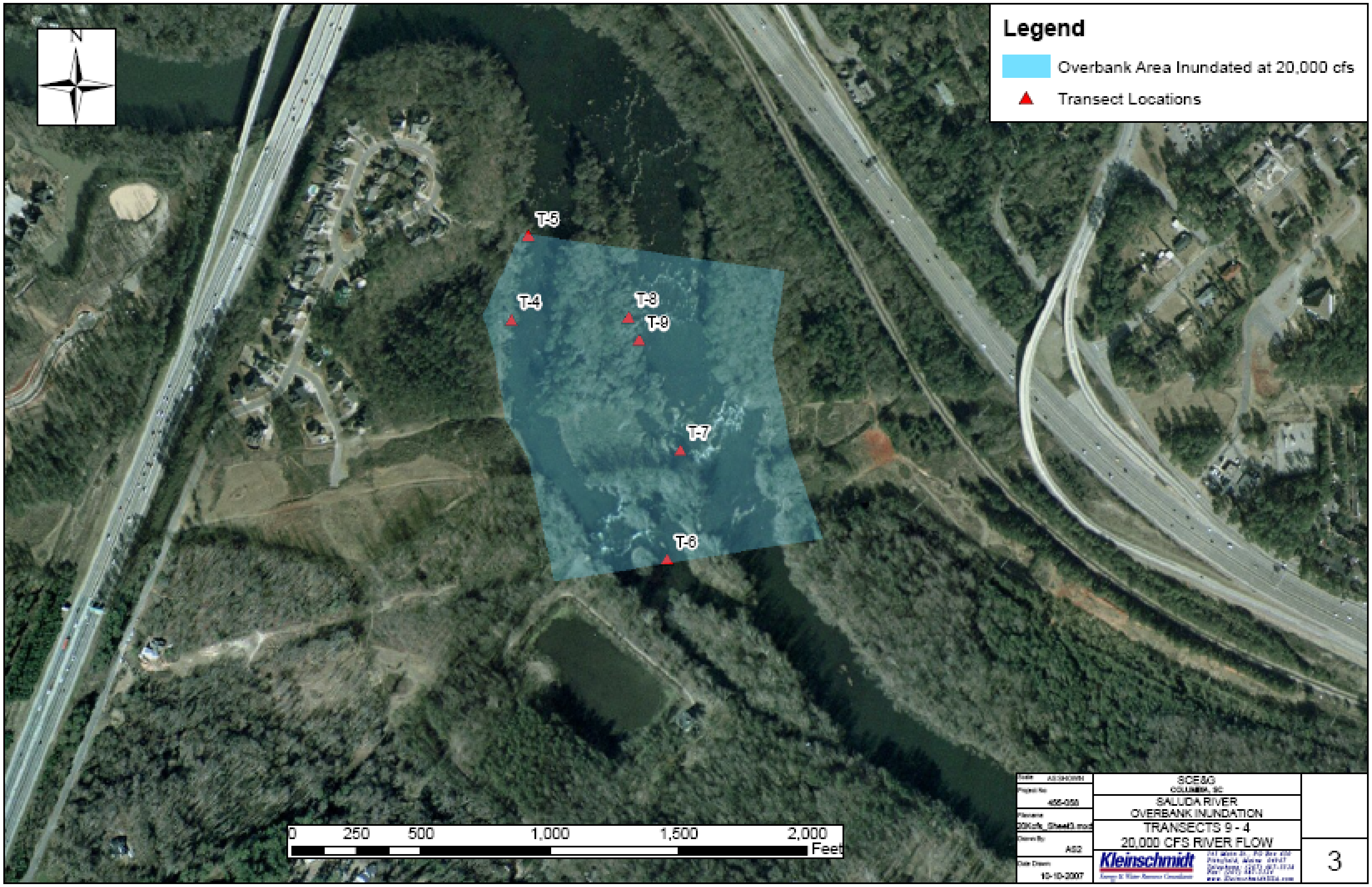

Saluda_Overbank_Study Plan: Overbanks 10/15/2007
Geom: Saluda_overbanks_Base Flow: Overbank_Flows
River = Saluda Reach = River5 RS = 4849.4 T-2 T-2 (with ADCP data)
.05
.03
.05
Elevation (ft)
Station (ft)
Legend
WS 20000cfs
WS 18000cfs
WS 16000cfs
WS 14000cfs
WS 12000cfs
WS 10000cfs
Ground
Bank Sta


Saluda_Overbank_Study Plan: Overbanks 10/15/2007
Geom: Saluda_overbanks_Base Flow: Overbank_Flows
River = Saluda Reach = River5 RS = 0 T-1 T-1
.05
.03
.05
Elevation (ft)
Station (ft)
Legend
WS 20000cfs
WS 18000cfs
WS 16000cfs
WS 14000cfs
WS 12000cfs
WS 10000cfs
Ground
Bank Sta



N
Legend
Overbank Area Inundated at 20,000 cfs
Transect Locations
T-21
T-20
T-19
T-18
T-16
T-17
T-15
0
250
500
1,000
1,500
2,000
Feet
Scale AS SHOWN
Project No.
455-058
Filename
20Kcfs_Sheet1.mxd
Drawn By
ASS
Date Drawn
10-10-2007
SCE&G
COLUMBIA, SC
SALUDA RIVER
OVERBANK INUNDATION
TRANSECTS 21 - 15
20,000 CFS RIVER FLOW
Kleinschmidt
1


N
Legend
Overbank Area Inundated at 20,000 cfs
Transect Locations
T-14
T-13
T-11
T-10
T-12
0
250
500
1,000
1,500
2,000
Feet
SCE&G
SALUDA RIVER
OVERBANK INUNDATION
TRANSECTS 14 - 10
20,000 CFS RIVER FLOW
Kleinschmidt
2


N
Legend
Overbank Area Inundated at 20,000 cfs
Transect Locations
T-5
T-4
T-8
T-9
T-7
T-6
0
250
500
1,000
1,500
2,000
Feet
SCE&G
SALUDA RIVER
OVERBANK INUNDATION
TRANSECTS 9 - 4
20,000 CFS RIVER FLOW
Kleinschmidt
10-10-2007
3

Legend
Overbank Area Inundated at 20,000 cfs
Transect Locations
N
T-2
T-1
0
250
500
1,000
1,500
2,000
Feet
SCE&G
SALUDA RIVER
OVERBANK INUNDATION
TRANSECTS 2 & 1
20,000 CFS RIVER FLOW
10-10-2007
Kleinschmidt
4

APPENDIX F

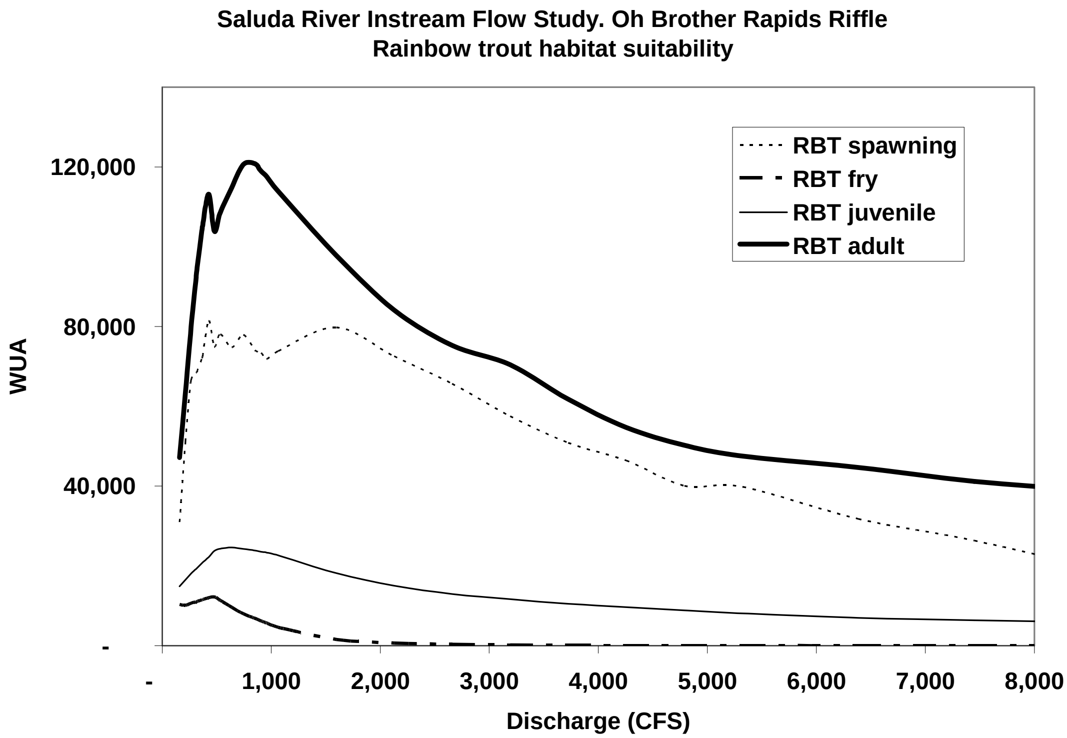
ADDITIONAL ANALYSES

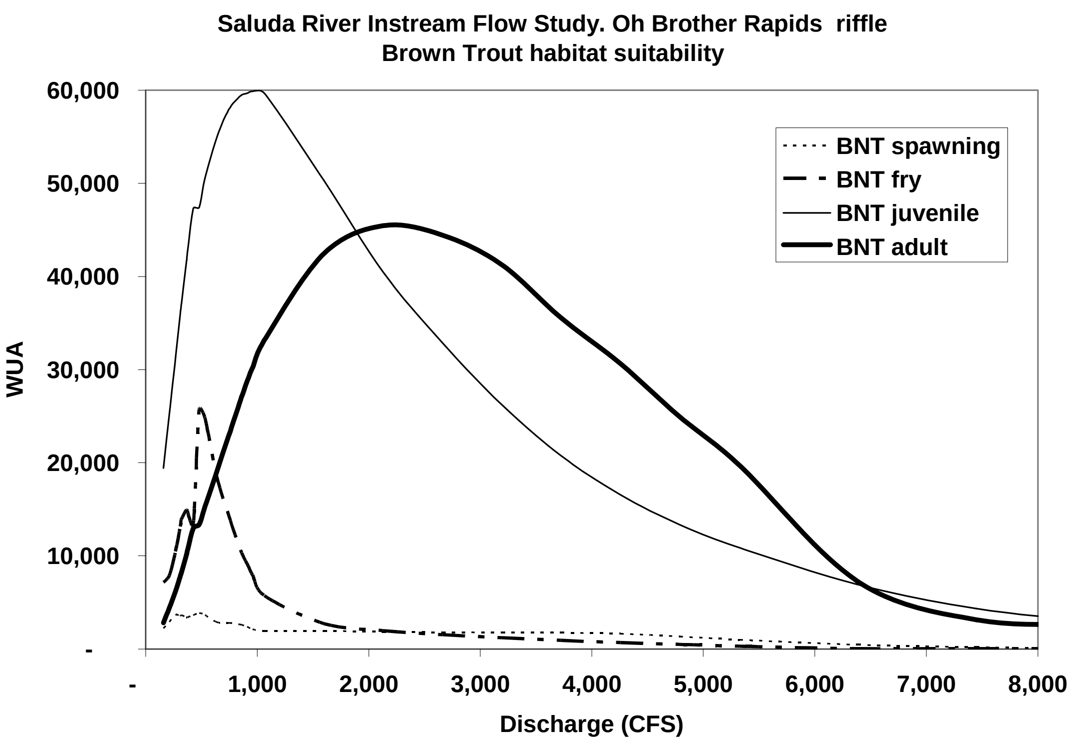
SALUDA INSTREAM FLOW STUDY
SUPPLEMENTAL TROUT HABITAT SUITABILITY ANALYSIS

During the scoping of the LSR instream flow study, the TWC requested that adult and sub-adult (*i.e*. juvenile) life stages of brown trout and rainbow trout be analyzed to provide habitat suitability information consistent with current SCDNR fishery management practices for this species in the study area. One TWC member, Trout Unlimited, also expressed interest in the potential for managing the study area for naturally reproducing trout. This entails modeling of two additional lifestages, spawning and fry/YOY.

The spawning lifestage would occur in riffle habitat possessing an abundance of clean, unimbedded gravel bars; fry/YOY habitat would be in shallow, riffle habitat contiguous and downstream from spawning areas. Such areas are limited in the study area, but may marginally exist at Toenail Riffle - the glide-riffle-run complex near the overflow channel confluence (Transects 20-21), and in the Oh Brother Rapids (transects 4,5 and 6) study sites.

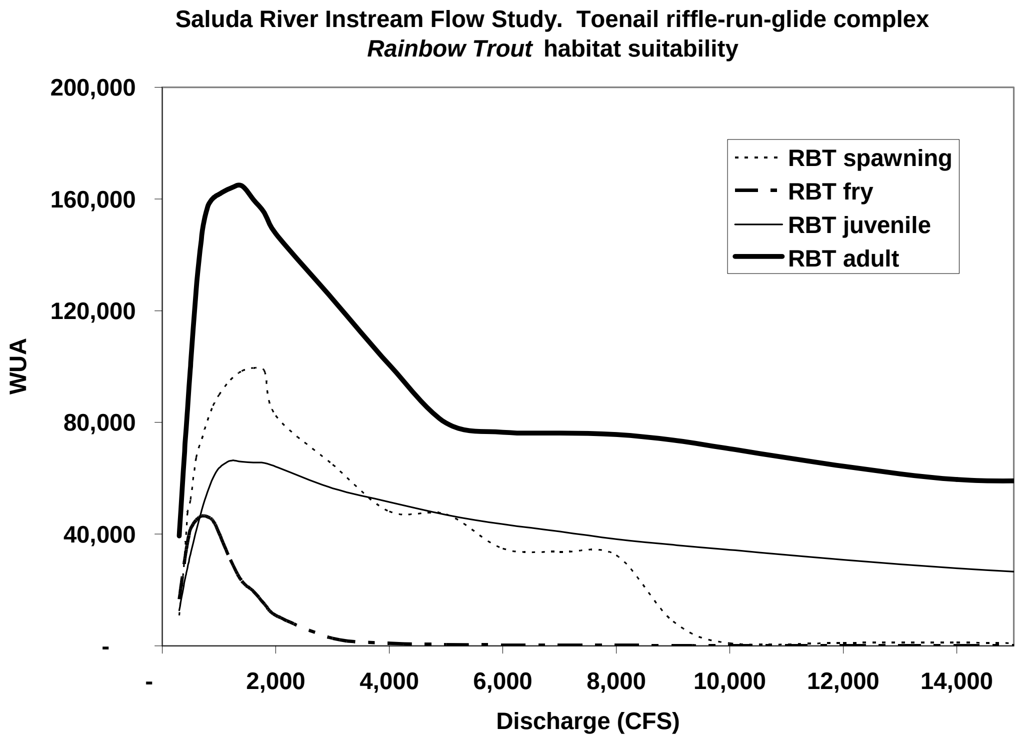
The attached figures and tables document the habitat-flow relationships at these sites. For purposes of comparison, modeling results for all four lifestages of each trout species are provided.

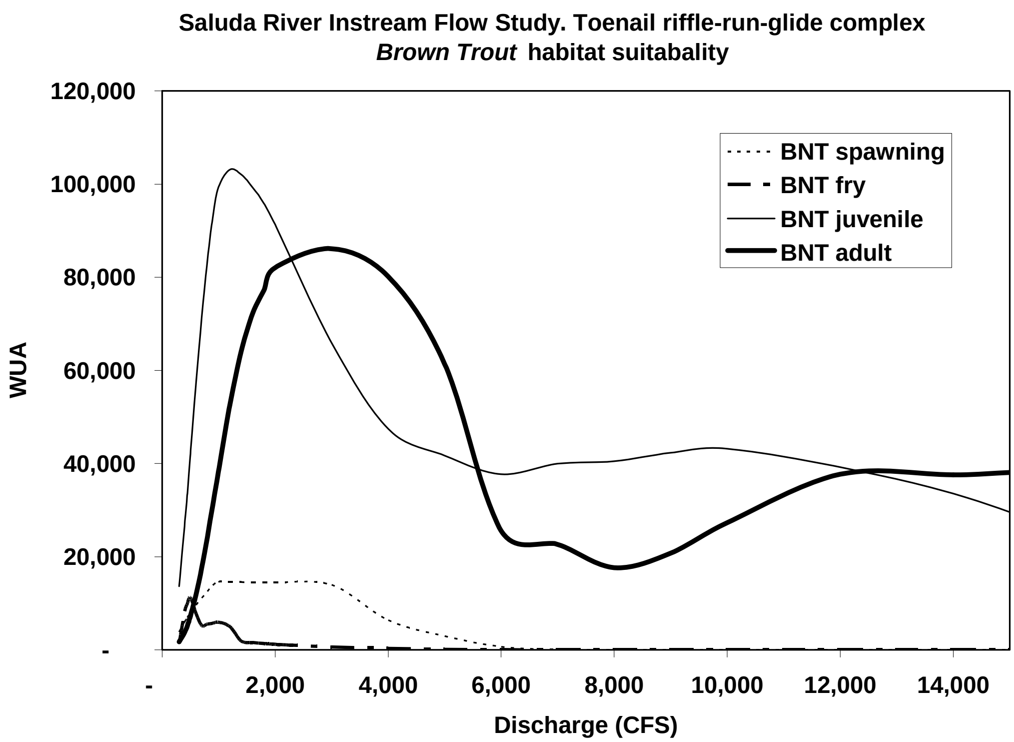

Saluda River Instream Flow Study. Oh Brother Rapids Riffle
Rainbow trout habitat suitability
RBT spawning
RBT fry
RBT juvenile
RBT adult
120,000
80,000
40,000
-
WUA
-
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
Discharge (CFS)


Saluda River Instream Flow Study. Oh Brother Rapids riffle
Brown Trout habitat suitability
BNT spawning
BNT fry
BNT juvenile
BNT adult
60,000
50,000
40,000
30,000
20,000
10,000
-
WUA
-
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
Discharge (CFS)

Saluda River Instream Flow Study – Oh Brother Rapids-Riffle, Habitat Suitability for Four Life Stages of Brown Trout and Rainbow Trout

DISCHARGE (cfs)	BNT Spawning	BNT Fry	BNT Juvenile	BNT Adult	DISCHARGE (cfs)	RBT Spawning	RBT Fry	RBT Juvenile	RBT Adult
160	2,208	7,161	19,414	2,822	**160**	30,997	10,342	14,877	47,141
213	2,899	7,875	25,257	4,418	**213**	51,159	10,056	16,513	63,548
266	3,670	10,452	31,187	6,174	**266**	66,602	10,622	18,090	79,877
310	3,525	13,147	36,003	7,818	**310**	68,437	10,959	19,208	91,890
319	3,646	13,889	36,925	8,166	**319**	68,584	11,066	19,447	94,352
366	3,375	14,967	41,685	10,161	**366**	72,034	11,487	20,735	104,325
372	3,392	14,882	42,286	10,443	**372**	72,546	11,533	20,886	105,293
426	3,633	13,379	47,285	12,959	**426**	81,469	12,007	22,199	113,133
479	3,873	25,724	47,389	13,359	**479**	74,965	12,211	23,750	103,891
532	3,654	24,766	50,545	15,285	**532**	78,048	11,366	24,308	108,538
638	2,883	18,505	54,903	19,032	**638**	74,758	9,637	24,607	114,812
745	2,824	14,293	57,900	22,873	**745**	77,901	8,018	24,254	120,614
851	2,629	10,559	59,402	26,731	**851**	74,046	6,820	23,852	120,811
908	2,382	9,204	59,657	28,660	**908**	73,370	6,198	23,570	118,930
958	2,133	7,942	59,864	30,202	**958**	71,823	5,662	23,328	117,589
1,064	1,943	5,731	59,667	33,151	**1,064**	73,808	4,613	22,655	113,938
1,596	1,962	2,737	50,339	42,434	**1,596**	79,765	1,562	18,160	97,871
2,128	1,853	1,976	40,482	45,441	**2,128**	72,535	659	15,059	84,107
2,660	1,809	1,544	32,888	44,437	**2,660**	65,620	344	12,954	75,293
3,192	1,784	1,209	26,267	41,263	**3,192**	57,479	181	11,641	70,428
3,724	1,758	935	20,769	35,560	**3,724**	50,847	102	10,472	61,795
4,256	1,654	694	16,556	30,648	**4,256**	46,372	72	9,668	54,726
6,384	450	53	6,918	7,239	**6,384**	31,786	21	6,994	44,665
8,512	35	30	2,953	2,656	**8,512**	19,270	17	5,856	38,828
10,640	-	15	1,291	2,473	**10,640**	2,306	-	5,048	35,118


Saluda River Instream Flow Study. Toenail riffle-run-glide complex
Rainbow Trout habitat suitability
200,000
160,000
120,000
80,000
40,000
-
WUA
-
2,000
4,000
6,000
8,000
10,000
12,000
14,000
Discharge (CFS)
RBT spawning
RBT fry
RBT juvenile
RBT adult


Saluda River Instream Flow Study. Toenail riffle-run-glide complex
Brown Trout habitat suitabality
120,000
100,000
80,000
60,000
40,000
20,000
-
WUA
-
2,000
4,000
6,000
8,000
10,000
12,000
14,000
Discharge (CFS)
BNT spawning
BNT fry
BNT juvenile
BNT adult

Saluda River Instream Flow Study - Toenail Rapids-Riffle, Habitat Suitability for Four Life Stages of Brown Trout and Rainbow Trout

DISCHARGE (cfs)	BNT Spawning	BNT Fry	BNT Juvenile	BNT Adult	DISCHARGE (cfs)	RBT Spawning	RBT Fry	RBT Juvenile	RBT Adult
300	3,835	1,341	13,621	1,706	**300**	10,848	16,707	12,743	39,356
400	6,015	8,294	27,161	3,800	**400**	32,794	31,181	23,554	71,117
446	6,915	9,898	33,576	5,184	**446**	47,567	36,959	27,917	84,710
500	7,903	11,203	42,097	7,272	**500**	52,315	41,773	32,836	100,109
600	9,588	7,721	57,402	11,922	**600**	67,328	45,041	41,176	127,468
700	11,119	5,147	71,340	17,604	**700**	74,110	46,521	48,686	147,071
800	12,521	5,513	83,642	24,188	**800**	80,701	46,188	55,124	157,068
900	13,871	5,699	92,955	31,147	**900**	85,963	44,751	60,187	160,274
1,000	14,584	5,924	99,309	38,296	**1,000**	89,860	40,234	63,658	161,731
1,200	14,571	4,932	103,115	52,521	**1,200**	95,230	30,826	66,314	163,789
1,400	14,536	1,851	102,064	64,072	**1,400**	98,301	23,197	65,887	164,735
1,605	14,513	1,566	99,250	72,279	**1,605**	99,462	19,504	65,630	159,869
1,800	14,501	1,348	95,840	77,183	**1,800**	98,407	14,972	65,506	155,050
2,000	14,421	1,174	91,297	82,055	**2,000**	82,441	10,949	64,214	147,636
3,000	13,952	600	65,909	86,119	**3,000**	64,911	2,694	56,464	124,137
4,000	6,321	285	47,405	80,148	**4,000**	48,128	928	51,510	100,638
5,000	2,940	66	41,690	61,367	**5,000**	47,100	421	46,876	79,785
6,000	648	27	37,708	25,575	**6,000**	34,839	288	43,596	76,477
7,000	48	-	39,945	22,620	**7,000**	33,681	222	40,948	76,191
8,000	0	-	40,474	17,633	**8,000**	32,429	156	38,190	75,723
9,000	-	-	42,305	20,764	**9,000**	8,777	46	36,173	73,671
10,000	-	-	43,180	27,290	**10,000**	925	36	34,362	70,549
12,000	-	-	39,234	37,692	**12,000**	1,059	-	30,827	64,350
14,000	-	-	33,526	37,557	**14,000**	1,247	-	27,774	59,562
16,000	-	-	25,275	37,523	**16,000**	645	-	25,388	59,179
18,000	-	-	16,956	28,637	**18,000**	719	-	23,136	59,082
20,000	-	-	12,379	26,716	**20,000**	702	-	20,988	59,016

APPENDIX G

DISCHARGE RANGES PROVIDING 80% OF MAXIMUM WUA FOR TARGET SPECIES AND GUILDS

APPENDIX G

DISCHARGE RANGES PROVIDING 80% OF MAXIMUM WUA FOR TARGET SPECIES AND GUILDS

LIST OF TABLES

1.0 SHANDON

Discharge	BNT adult	BNT fry	BNT juvenile	BNT spawning	RBT adult	RBT fry	RBT juvenile	RBT spawning	Shallow Slow	Shallow Slow Spawning	Shallow-slow Fry/YOY	RBSF Spawning	SMB adult	SMB fry	SMB juvenile	SMB spawning	SNS Spawning
300	35%	65%	74%	48%	75%	100%	85%	7%	100%	84%	100%	70%	29%	100%	71%	75%	2%
400	43%	90%	83%	58%	84%	100%	91%	19%	86%	96%	85%	85%	35%	96%	83%	86%	3%
500	50%	98%	88%	67%	89%	97%	94%	32%	65%	100%	64%	96%	42%	93%	91%	93%	4%
600	56%	100%	93%	75%	93%	92%	96%	45%	48%	97%	46%	98%	48%	89%	96%	96%	5%
700	60%	86%	96%	81%	96%	88%	98%	56%	36%	90%	32%	99%	53%	85%	98%	98%	5%
800	65%	73%	98%	87%	99%	83%	99%	65%	26%	85%	22%	100%	58%	82%	100%	99%	6%
900	69%	54%	99%	93%	100%	79%	99%	73%	24%	82%	20%	99%	62%	79%	100%	100%	7%
1000	72%	41%	99%	96%	99%	74%	99%	80%	22%	78%	17%	97%	67%	76%	99%	100%	8%
1400	81%	21%	100%	99%	94%	59%	100%	100%	13%	71%	12%	88%	81%	67%	94%	97%	13%
1800	86%	25%	99%	100%	89%	45%	99%	96%	7%	63%	6%	72%	91%	59%	91%	92%	18%
2000	87%	21%	97%	99%	86%	39%	97%	95%	1%	60%	2%	65%	95%	56%	90%	90%	20%
3000	94%	8%	88%	76%	76%	18%	85%	93%	1%	49%	1%	34%	100%	41%	85%	78%	35%
4000	99%	4%	81%	35%	71%	10%	73%	76%	1%	44%	1%	13%	99%	29%	73%	67%	44%
5000	100%	3%	73%	18%	68%	6%	64%	68%	1%	40%	1%	6%	96%	21%	61%	60%	51%
6000	99%	2%	65%	5%	65%	4%	56%	66%	4%	37%	4%	2%	93%	14%	50%	54%	58%
7000	97%	1%	57%	8%	63%	3%	49%	60%	1%	36%	7%	1%	88%	11%	40%	51%	62%
8000	95%	1%	50%	11%	62%	2%	43%	63%	8%	35%	8%	1%	85%	9%	33%	48%	66%
9000	90%	4%	44%	16%	61%	2%	38%	65%	8%	31%	8%	21%	79%	7%	28%	45%	70%
10000	84%	5%	38%	20%	60%	2%	34%	62%	1%	27%	6%	38%	76%	5%	24%	43%	74%
12000	70%	7%	30%	28%	55%	2%	28%	64%	4%	20%	3%	47%	72%	4%	20%	38%	83%
14000	60%	4%	24%	36%	47%	2%	23%	64%	3%	17%	2%	50%	66%	3%	17%	33%	91%
16000	51%	2%	19%	43%	38%	1%	20%	68%	3%	15%	2%	53%	62%	3%	15%	29%	97%
18000	41%	1%	16%	49%	32%	1%	17%	63%	2%	15%	2%	54%	58%	3%	14%	25%	100%
20000	34%	1%	13%	55%	29%	1%	15%	62%	1%	16%	1%	59%	55%	3%	12%	21%	100%

2.0 REACH 4 RUN

Discharge	American Shad	BNT adult	BNT juvenile	Deep-Fast Spawning	RBT adult	RBT juvenile	Redhorse Adult	Redhorse Fry	Redhorse Juvenile	Shallow Slow	SMB adult	SMB fry	SMB juvenile	SMB spawning	SNS Spawning
300	93%	93%	68%	54%	73%	95%	78%	79%	87%	67%	66%	100%	56%	57%	34%
400	113%	98%	70%	58%	80%	99%	86%	81%	96%	39%	74%	95%	66%	73%	44%
500	130%	100%	71%	63%	86%	100%	92%	74%	99%	24%	82%	91%	69%	85%	52%
600	147%	99%	72%	72%	89%	99%	96%	64%	100%	19%	87%	87%	68%	94%	59%
700	160%	98%	72%	80%	92%	97%	98%	57%	100%	16%	91%	82%	67%	98%	65%
800	172%	98%	72%	86%	90%	96%	99%	49%	98%	16%	95%	80%	65%	100%	71%
900	181%	97%	70%	92%	86%	94%	99%	43%	97%	18%	97%	78%	63%	100%	76%
1000	189%	96%	68%	95%	84%	92%	100%	39%	96%	19%	99%	75%	61%	98%	82%
1400	199%	92%	57%	100%	78%	83%	99%	30%	90%	18%	100%	59%	55%	89%	95%
1800	184%	89%	49%	94%	73%	76%	96%	26%	82%	6%	95%	49%	50%	81%	99%
2000	177%	86%	46%	91%	69%	73%	94%	22%	78%	5%	89%	45%	46%	78%	100%
3000	155%	72%	37%	76%	54%	65%	82%	15%	63%	2%	76%	30%	31%	60%	90%
4000	133%	62%	30%	61%	45%	61%	72%	10%	54%	1%	65%	21%	22%	46%	83%
5000	107%	56%	25%	41%	42%	58%	64%	7%	48%	3%	58%	15%	19%	40%	79%
6000	90%	53%	21%	28%	42%	55%	58%	5%	44%	4%	52%	12%	19%	38%	73%
7000	77%	51%	18%	18%	42%	53%	54%	6%	41%	12%	48%	14%	17%	37%	68%
8000	73%	49%	18%	15%	43%	53%	51%	12%	39%	52%	44%	33%	16%	38%	63%
9000	71%	45%	20%	17%	45%	55%	49%	23%	39%	82%	42%	50%	15%	37%	58%
10000	73%	41%	24%	19%	48%	59%	50%	38%	40%	95%	41%	63%	15%	35%	56%
12000	79%	32%	32%	17%	59%	69%	57%	74%	46%	100%	39%	85%	25%	31%	53%
14000	89%	27%	49%	10%	73%	80%	69%	100%	58%	10%	37%	87%	66%	42%	56%
16000	96%	32%	67%	4%	85%	90%	81%	91%	61%	5%	44%	88%	93%	60%	58%
18000	121%	38%	84%	0%	95%	94%	87%	71%	61%	6%	56%	89%	100%	79%	58%
20000	148%	49%	100%	0%	100%	96%	90%	54%	60%	5%	67%	88%	100%	90%	55%

3.0 OCEAN BOULEVARD

Discharge	BNT adult	BNT fry	BNT juvenile	BNT spawning	Macro-invertebrates	RBT adult	RBT fry	RBT juvenile	RBT spawning	Redhorse Spawning	Saluda Darter Adult	Shallow-Fast Spawning	SMB adult	SMB fry	SMB juvenile	SMB spawning	SNS Spawning
140	24%	64%	53%	0%	46%	31%	73%	69%	0%	0%	7%	12%	30%	92%	57%	4%	0%
187	30%	82%	63%	2%	86%	46%	92%	80%	1%	0%	7%	16%	35%	100%	64%	17%	0%
234	37%	92%	71%	5%	97%	58%	100%	87%	1%	0%	13%	25%	39%	100%	78%	40%	0%
281	43%	97%	80%	9%	100%	67%	94%	93%	2%	0%	20%	32%	43%	98%	91%	51%	0%
328	49%	95%	87%	12%	100%	75%	84%	96%	5%	0%	33%	41%	46%	95%	98%	55%	0%
374	54%	84%	93%	16%	98%	81%	75%	99%	7%	0%	42%	45%	50%	91%	100%	58%	1%
421	59%	68%	96%	20%	94%	87%	66%	99%	12%	0%	49%	46%	54%	86%	100%	60%	1%
468	64%	55%	97%	24%	89%	93%	59%	100%	17%	0%	52%	48%	57%	81%	100%	62%	1%
655	79%	26%	100%	39%	86%	100%	38%	99%	30%	0%	71%	60%	70%	76%	93%	73%	3%
842	88%	28%	96%	54%	88%	98%	25%	95%	40%	0%	89%	74%	77%	65%	89%	82%	5%
936	91%	29%	93%	61%	90%	99%	21%	92%	38%	0%	97%	78%	79%	62%	87%	83%	6%
1404	100%	27%	82%	86%	83%	93%	14%	79%	58%	0%	100%	100%	85%	58%	85%	89%	10%
1872	96%	13%	75%	93%	84%	99%	10%	68%	71%	0%	64%	92%	91%	41%	80%	90%	14%
2340	89%	9%	69%	92%	75%	96%	11%	61%	77%	100%	43%	76%	96%	41%	71%	84%	19%
2808	80%	6%	63%	96%	75%	94%	7%	54%	89%	100%	32%	63%	99%	29%	66%	86%	23%
3276	73%	5%	55%	92%	58%	91%	4%	47%	97%	0%	22%	53%	100%	22%	63%	85%	29%
3744	69%	4%	49%	87%	43%	86%	2%	42%	98%	27%	15%	38%	100%	17%	53%	83%	36%
4212	64%	3%	43%	87%	32%	75%	2%	37%	100%	27%	10%	25%	98%	14%	43%	81%	42%
4674	60%	3%	38%	89%	23%	65%	1%	33%	100%	27%	6%	19%	95%	11%	36%	79%	50%
5616	46%	2%	29%	95%	11%	48%	1%	27%	87%	13%	3%	11%	87%	7%	26%	82%	66%
6552	34%	2%	24%	100%	4%	34%	1%	23%	79%	13%	0%	6%	80%	5%	20%	89%	80%
7488	27%	1%	21%	88%	1%	26%	0%	21%	55%	41%	0%	3%	73%	3%	16%	92%	89%
8424	22%	1%	20%	82%	0%	20%	0%	18%	46%	29%	0%	2%	66%	2%	14%	95%	96%
9360	19%	1%	19%	78%	0%	18%	0%	17%	31%	29%	0%	1%	61%	1%	13%	100%	100%

4.0 OH BROTHER RAPIDS

Discharge	BNT adult	BNT fry	BNT juvenile	BNT spawning	Macro - invertebrates	RBT adult	RBT fry	RBT juvenile	RBT spawning	Redhorse Spawning	Saluda Darter Adult	Shallow-Fast Spawning	SMB adult	SMB fry	SMB juvenile	SMB spawning	SNS Spawning
160	6%	28%	32%	57%	79%	39%	85%	60%	38%	31%	100%	71%	7%	74%	49%	43%	0%
213	10%	31%	42%	75%	88%	53%	82%	67%	63%	65%	92%	83%	11%	94%	67%	60%	0%
266	14%	41%	52%	95%	94%	66%	87%	74%	82%	65%	82%	94%	16%	99%	81%	77%	0%
319	18%	54%	62%	94%	99%	78%	91%	79%	84%	90%	73%	99%	22%	100%	87%	86%	0%
372	23%	58%	71%	88%	100%	87%	94%	85%	89%	100%	71%	100%	28%	97%	93%	91%	0%
426	29%	52%	79%	94%	97%	94%	98%	90%	100%	81%	72%	97%	36%	96%	97%	94%	0%
479	29%	100#	79%	100%	85%	86%	###	97%	92%	79%	92%	79%	43%	96%	99%	96%	0%
532	34%	96%	84%	94%	81%	90%	93%	99%	96%	66%	87%	74%	51%	98%	100%	94%	0%
745	50%	56%	97%	73%	71%	100%	66%	99%	96%	51%	70%	52%	77%	85%	91%	97%	0%
958	66%	31%	100%	55%	59%	97%	46%	95%	88%	84%	49%	38%	91%	71%	85%	97%	0%
1064	73%	22%	100%	50%	54%	94%	38%	92%	91%	58%	41%	34%	95%	65%	81%	95%	0%
1596	93%	11%	84%	51%	30%	81%	13%	74%	98%	58%	16%	19%	100%	38%	57%	83%	3%
2128	100%	8%	68%	48%	13%	70%	5%	61%	89%	59%	10%	12%	91%	23%	36%	73%	13%
2660	98%	6%	55%	47%	5%	62%	3%	53%	81%	24%	6%	7%	82%	13%	23%	64%	31%
3192	91%	5%	44%	46%	1%	58%	1%	47%	71%	23%	4%	4%	72%	6%	17%	57%	55%
3724	78%	4%	35%	45%	0%	51%	1%	43%	62%	3%	3%	2%	66%	2%	14%	52%	73%
4256	67%	3%	28%	43%	0%	45%	1%	39%	57%	3%	2%	1%	60%	1%	13%	49%	85%
4788	55%	2%	22%	35%	0%	42%	0%	36%	49%	4%	1%	0%	55%	1%	12%	46%	93%
5326	43%	1%	18%	25%	0%	39%	0%	33%	49%	4%	0%	0%	51%	1%	11%	43%	98%
6384	16%	0%	12%	12%	0%	37%	0%	28%	39%	4%	0%	0%	44%	0%	9%	37%	100%
7448	7%	0%	7%	5%	0%	34%	0%	26%	32%	5%	0%	1%	39%	0%	7%	32%	97%
8512	6%	0%	5%	1%	0%	32%	0%	24%	24%	0%	1%	1%	35%	0%	5%	27%	90%
9576	6%	0%	3%	0%	0%	30%	0%	22%	11%	0%	1%	1%	32%	0%	4%	24%	84%
10640	5%	0%	2%	0%	0%	29%	0%	21%	3%	0%	1%	1%	28%	0%	4%	22%	78%

5.0 CORLEY ISLAND SIDE CHANNEL

Discharge	BNT adult	BNT juvenile	RBSF Spawning	RBT adult	RBT juvenile	Shallow-slow Fry/YOY	SMB adult	SMB fry	SMB juvenile	SMB spawning	SNS Spawning
42	66%	100%	100%	62%	93%	61%	47%	100%	100%	0%	0%
56	82%	98%	85%	65%	95%	46%	52%	92%	90%	4%	0%
70	94%	96%	75%	69%	96%	48%	56%	79%	82%	16%	1%
84	98%	94%	72%	73%	96%	41%	59%	66%	80%	27%	2%
98	100%	89%	65%	77%	98%	35%	62%	59%	82%	37%	4%
112	97%	84%	60%	81%	99%	35%	66%	54%	86%	44%	7%
126	97%	79%	55%	85%	99%	52%	69%	48%	88%	51%	11%
140	96%	75%	52%	89%	100%	68%	73%	45%	90%	57%	14%
196	87%	63%	55%	96%	99%	100%	86%	41%	93%	77%	27%
252	61%	54%	57%	99%	95%	54%	94%	38%	92%	91%	37%
280	51%	50%	57%	100%	93%	46%	96%	36%	89%	94%	42%
420	31%	36%	53%	99%	81%	46%	100%	22%	61%	99%	59%
560	33%	28%	35%	95%	70%	83%	100%	11%	44%	100%	72%
700	33%	23%	21%	91%	59%	29%	100%	5%	51%	100%	85%
840	26%	20%	11%	90%	51%	69%	100%	2%	52%	99%	93%
980	14%	18%	5%	90%	45%	98%	99%	0%	57%	96%	97%
1120	11%	19%	1%	88%	39%	51%	99%	0%	63%	92%	99%
1260	8%	19%	0%	83%	35%	32%	98%	0%	65%	86%	100%
1400	9%	21%	0%	74%	32%	11%	96%	0%	62%	81%	100%
1680	13%	24%	0%	55%	27%	4%	92%	0%	58%	70%	99%
1960	17%	28%	0%	45%	24%	6%	87%	0%	53%	59%	97%
2240	20%	31%	0%	42%	21%	28%	83%	0%	40%	49%	93%
2520	21%	31%	0%	39%	19%	44%	79%	0%	32%	40%	89%
2800	21%	29%	0%	35%	18%	54%	73%	0%	32%	33%	84%

6.0 CORLEY ISLAND MAIN CHANNEL

Discharge	BNT adult	BNT juvenile	Macro - invertebrates	RBT adult	RBT juvenile	Redhorse Spawning	Saluda Darter Adult	Shallow-Fast Spawning	SMB adult	SMB fry	SMB juvenile	SMB spawning
258	1%	8%	14%	13%	11%	6%	67%	34%	2%	74%	10%	13%
344	2%	16%	49%	28%	22%	26%	82%	78%	8%	73%	21%	46%
430	5%	25%	66%	44%	33%	100%	97%	91%	16%	95%	44%	78%
516	11%	39%	93%	59%	41%	92%	100%	100%	24%	97%	65%	89%
602	18%	52%	100%	73%	48%	83%	97%	99%	35%	95%	85%	95%
688	26%	64%	96%	85%	55%	85%	86%	88%	46%	98%	99%	100%
774	35%	75%	95%	92%	63%	92%	73%	76%	56%	100%	100%	100%
860	42%	83%	100%	97%	71%	92%	59%	64%	67%	99%	95%	100%
1204	74%	100%	88%	97%	91%	90%	27%	36%	92%	79%	96%	95%
1548	94%	98%	68%	84%	97%	70%	18%	24%	99%	61%	83%	89%
1720	99%	96%	57%	76%	100%	68%	12%	19%	100%	52%	75%	86%
2580	100%	74%	21%	50%	89%	3%	1%	6%	93%	21%	44%	71%
3440	88%	56%	1%	45%	81%	1%	0%	1%	87%	8%	27%	57%
4300	69%	43%	0%	38%	75%	1%	0%	1%	78%	3%	24%	47%
5160	51%	36%	0%	31%	69%	0%	0%	0%	70%	2%	21%	38%
6020	27%	29%	0%	26%	61%	0%	0%	0%	65%	1%	18%	31%
6880	23%	24%	0%	25%	53%	0%	0%	0%	58%	1%	15%	26%
7740	22%	24%	0%	24%	48%	0%	0%	0%	49%	0%	12%	23%
8600	18%	22%	0%	24%	43%	0%	0%	0%	42%	0%	10%	22%
10320	19%	21%	0%	24%	36%	0%	0%	0%	34%	0%	10%	19%
12040	16%	19%	0%	24%	31%	0%	0%	0%	32%	0%	9%	16%
13760	18%	16%	0%	22%	26%	0%	0%	0%	31%	0%	8%	15%
15480	20%	14%	0%	20%	22%	0%	0%	0%	28%	0%	6%	14%
17200	13%	13%	0%	18%	19%	0%	0%	0%	26%	0%	6%	13%

7.0 *REACH 2 RUN*

Discharge	American shad spawning	BNT adult	BNT juvenile	RBT adult	RBT juvenile	Redhorse Adult	Redhorse Fry	Redhorse Juvenile	Shallow Slow	SMB adult	SMB fry	SMB juvenile	SMB spawning	SNS Spawning
300	58%	87%	98%	79%	90%	80%	100%	39%	100%	61%	100%	67%	29%	19%
400	81%	89%	100%	86%	97%	86%	93%	39%	77%	70%	93%	81%	45%	33%
500	105%	91%	98%	90%	99%	91%	86%	41%	52%	77%	89%	96%	58%	44%
600	129%	96%	96%	93%	100%	94%	75%	42%	46%	83%	85%	99%	69%	50%
700	150%	100%	93%	95%	100%	96%	65%	42%	8%	88%	81%	100%	74%	55%
800	168%	94%	89%	97%	99%	98%	61%	47%	26%	92%	71%	100%	78%	59%
900	179%	82%	82%	98%	97%	99%	51%	55%	17%	95%	62%	96%	81%	62%
1000	187%	70%	74%	99%	94%	100%	41%	67%	15%	97%	54%	91%	84%	66%
1400	198%	53%	50%	100%	82%	100%	21%	99%	8%	100%	31%	71%	94%	79%
1800	200%	53%	38%	100%	72%	98%	16%	94%	4%	98%	18%	47%	98%	88%
2000	199%	52%	33%	99%	67%	96%	13%	89%	7%	97%	14%	40%	100%	91%
3000	183%	23%	16%	81%	52%	87%	12%	77%	12%	87%	3%	25%	99%	100%
4000	149%	10%	10%	64%	46%	79%	15%	66%	4%	77%	0%	19%	86%	99%
5000	110%	5%	7%	46%	41%	72%	19%	56%	7%	66%	0%	15%	71%	94%
6000	81%	2%	6%	33%	38%	64%	18%	46%	7%	58%	0%	14%	57%	86%
7000	62%	2%	5%	30%	36%	58%	16%	39%	5%	49%	0%	12%	46%	76%
8000	48%	2%	5%	29%	35%	53%	15%	32%	21%	46%	0%	11%	36%	68%
9000	35%	2%	6%	29%	34%	47%	19%	27%	4%	41%	0%	9%	28%	60%
10000	25%	3%	6%	28%	33%	43%	27%	24%	39%	36%	0%	9%	24%	52%
12000	13%	3%	8%	22%	32%	36%	34%	18%	42%	28%	0%	10%	18%	40%
14000	7%	4%	10%	18%	32%	31%	40%	15%	49%	25%	0%	12%	15%	30%
16000	4%	5%	13%	16%	32%	28%	50%	13%	18%	25%	0%	15%	12%	22%
18000	1%	7%	16%	14%	32%	26%	37%	12%	30%	25%	0%	14%	9%	17%
20000	1%	7%	20%	14%	32%	25%	31%	12%	31%	25%	0%	12%	6%	13%

8.0 SANDY BEACH

Discharge	BNT adult	BNT juvenile	Macro - invertebrates	RBT adult	RBT juvenile	Redhorse Spawning	Saluda Darter Adult	Shallow Slow	Shallow-Fast Spawning	SMB adult	SMB fry	SMB juvenile	SMB spawning	SNS Spawning
300	35%	77%	100%	72%	85%	72%	100%	29%	100%	29%	100 %	76%	86%	0%
400	50%	92%	98%	79%	96%	90%	40%	23%	88%	47%	93%	87%	95%	1%
500	64%	99%	91%	84%	100%	99%	58%	19%	79%	62%	81%	92%	99%	2%
600	76%	98%	83%	100 %	91%	100%	48%	25%	67%	78%	74%	100%	100%	3%
700	85%	97%	73%	86%	91%	94%	43%	46%	58%	83%	62%	92%	97%	4%
800	91%	92%	63%	84%	84%	86%	38%	54%	51%	90%	57%	89%	94%	5%
900	95%	88%	54%	82%	77%	73%	34%	60%	45%	94%	51%	83%	91%	7%
1000	98%	83%	46%	78%	69%	65%	28%	46%	40%	97%	47%	77%	88%	10%
1400	98%	70%	23%	56%	46%	25%	13%	16%	31%	100 %	28%	52%	84%	22%
1800	86%	61%	13%	47%	36%	29%	10%	100%	26%	95%	46%	34%	72%	42%
2000	80%	61%	16%	48%	38%	20%	8%	91%	26%	92%	74%	31%	71%	54%
3000	71%	75%	24%	55%	44%	21%	3%	7%	24%	82%	73%	36%	100%	90%
4000	70%	87%	20%	49%	38%	60%	1%	5%	17%	76%	46%	34%	98%	100%
5000	84%	79%	15%	43%	27%	73%	0%	5%	14%	67%	26%	33%	93%	97%
6000	95%	71%	7%	43%	20%	43%	0%	8%	11%	58%	17%	26%	92%	88%
7000	96%	61%	3%	44%	17%	13%	0%	57%	9%	54%	11%	19%	89%	83%
8000	89%	51%	2%	44%	15%	0%	0%	59%	8%	50%	9%	15%	83%	85%
9000	84%	50%	2%	38%	13%	10%	0%	19%	9%	48%	7%	17%	75%	87%
10000	77%	55%	2%	28%	11%	10%	0%	39%	11%	47%	3%	23%	68%	86%
12000	55%	65%	1%	10%	6%	10%	0%	14%	9%	48%	2%	24%	55%	86%
14000	57%	53%	0%	8%	5%	0%	0%	3%	8%	45%	1%	25%	44%	83%
16000	53%	46%	0%	7%	5%	0%	0%	70%	7%	41%	0%	21%	33%	78%
18000	56%	48%	0%	5%	4%	0%	0%	1%	8%	39%	0%	16%	24%	73%
20000	56%	45%	0%	3%	4%	0%	0%	0%	8%	38%	0%	17%	16%	67%

9.0 POINT BAR RUN

Discharge	Am shad YOY	BNT adult	BNT juvenile	RBSF Adult	RBT adult	RBT juvenile	Shallow Slow	SMB adult	SMB fry	SMB juvenile	SMB spawning	SNS Spawning
300	32%	50%	93%	83%	87%	97%	90%	58%	100%	79%	51%	4%
400	43%	62%	99%	93%	91%	100%	98%	73%	92%	89%	66%	8%
500	55%	72%	100%	98%	93%	97%	95%	81%	85%	96%	81%	12%
600	66%	81%	99%	100%	95%	91%	100%	85%	78%	99%	91%	15%
700	74%	87%	97%	100%	97%	86%	95%	89%	71%	100%	93%	17%
800	81%	92%	95%	98%	97%	82%	85%	91%	66%	100%	94%	18%
900	88%	96%	93%	97%	98%	77%	75%	93%	58%	98%	95%	20%
1000	93%	98%	90%	96%	98%	73%	71%	95%	50%	95%	96%	22%
1400	97%	93%	67%	88%	99%	55%	80%	99%	29%	77%	100%	32%
1800	99%	81%	48%	81%	100%	40%	78%	100%	20%	66%	98%	46%
2000	99%	77%	43%	81%	98%	36%	61%	98%	17%	63%	96%	54%
3000	100%	56%	25%	81%	60%	22%	19%	87%	7%	54%	73%	91%
4000	95%	37%	14%	80%	24%	17%	12%	75%	5%	43%	49%	100%
5000	78%	22%	9%	80%	21%	15%	9%	65%	3%	36%	29%	94%
6000	50%	19%	7%	79%	20%	12%	7%	51%	2%	31%	16%	84%
7000	32%	17%	7%	77%	18%	12%	7%	36%	2%	28%	13%	72%
8000	20%	15%	6%	75%	15%	11%	10%	31%	2%	26%	11%	56%
9000	15%	14%	6%	73%	13%	10%	11%	29%	1%	25%	10%	41%
10000	14%	13%	5%	71%	13%	10%	11%	29%	1%	23%	8%	29%
12000	12%	11%	5%	67%	12%	10%	8%	27%	1%	20%	6%	18%
14000	8%	10%	5%	63%	12%	10%	7%	27%	1%	17%	4%	15%
16000	6%	9%	5%	60%	12%	9%	6%	24%	1%	16%	3%	14%
18000	4%	8%	5%	57%	12%	9%	7%	24%	1%	16%	3%	12%
20000	3%	7%	5%	55%	11%	10%	8%	23%	1%	15%	3%	11%

10.0 TOENAIL RIFFLE

Discharge	BNT adult	BNT fry	BNT juvenile	BNT spawning	Macro - invertebrates	RBT adult	RBT fry	RBT juvenile	RBT spawning	Saluda Darter Adult	Shallow Slow	Shallow-Fast Spawning	SMB adult	SMB fry	SMB juvenile	SMB spawning
300	2%	12%	13%	26%	38%	24%	36%	19%	11%	85%	100%	67%	1%	86%	8%	47%
400	4%	74%	26%	41%	76%	43%	67%	36%	33%	100%	61%	90%	2%	93%	31%	83%
500	8%	100%	41%	54%	89%	61%	90%	50%	53%	93%	32%	100%	7%	96%	59%	97%
600	14%	69%	56%	66%	95%	77%	97%	62%	68%	84%	40%	99%	16%	97%	77%	100%
700	20%	46%	69%	76%	97%	89%	100%	73%	75%	72%	40%	95%	27%	100%	85%	100%
800	28%	49%	81%	86%	100%	95%	99%	83%	81%	60%	24%	85%	41%	96%	92%	100%
900	36%	51%	90%	95%	96%	97%	96%	91%	86%	54%	19%	75%	54%	90%	97%	100%
1000	44%	53%	96%	100%	91%	98%	86%	96%	90%	49%	14%	66%	64%	85%	100%	99%
1400	74%	17%	99%	100%	69%	100%	50%	99%	99%	32%	7%	40%	92%	65%	92%	94%
1800	90%	12%	93%	99%	48%	94%	32%	99%	99%	18%	11%	23%	100%	46%	74%	88%
2000	95%	10%	89%	99%	37%	90%	24%	97%	83%	14%	13%	19%	100%	39%	61%	84%
3000	100%	5%	64%	96%	7%	75%	6%	85%	65%	1%	6%	6%	91%	11%	26%	70%
4000	93%	3%	46%	43%	0%	61%	2%	78%	48%	0%	57%	2%	76%	3%	17%	64%
5000	71%	1%	40%	20%	0%	48%	1%	71%	47%	0%	80%	2%	69%	0%	18%	64%
6000	30%	0%	37%	4%	0%	46%	1%	66%	35%	0%	28%	2%	58%	0%	21%	62%
7000	26%	0%	39%	0%	0%	46%	0%	62%	34%	0%	15%	3%	53%	0%	20%	59%
8000	20%	0%	39%	0%	0%	46%	0%	58%	33%	0%	15%	3%	53%	0%	18%	56%
9000	24%	0%	41%	0%	0%	45%	0%	55%	9%	0%	12%	2%	53%	0%	16%	54%
10000	32%	0%	42%	0%	0%	43%	0%	52%	1%	0%	1%	2%	52%	0%	14%	52%
12000	44%	0%	38%	0%	0%	39%	0%	46%	1%	0%	0%	3%	51%	0%	14%	49%
14000	44%	0%	33%	0%	0%	36%	0%	42%	1%	0%	0%	2%	48%	0%	9%	47%
16000	44%	0%	25%	0%	0%	36%	0%	38%	1%	0%	0%	1%	45%	0%	8%	46%
18000	33%	0%	16%	0%	0%	36%	0%	35%	1%	0%	0%	1%	43%	0%	7%	45%
20000	31%	0%	12%	0%	0%	36%	0%	32%	1%	0%	0%	0%	42%	0%	6%	44%

APPENDIX H

RESULTS OF ADDITIONAL PHABSIM RUNS REQUESTED BY TWC AT DECEMBER 2007 INSTREAM FLOW WORKSHOP

APPENDIX H

RESULTS OF ADDITIONAL PHABSIM RUNS

REQUESTED BY TWC AT DECEMBER 2007 INSTREAM FLOW WORKSHOP

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APPENDIX H

RESULTS OF ADDITIONAL PHABSIM RUNS

REQUESTED BY TWC AT DECEMBER 2007 INSTREAM FLOW WORKSHOP

During review of the draft report, the TWC requested the following additional guilds to be modeled.

Shallow-slow guild: This guild was initially used to depict habitat use at study sties dominated by glide habitat (Corley Island side channel, and Shandon), however because this guild also represents habitat use in stream margins and transition zones that occur as patches in all study sites (Leonard and Orth, 1988) it was agreed that this guild would also be modeled in the other study sites.

Deep-fast guild. This guild was initially used to depict habitat use at study sites dominated by run habitat. The TWC agreed that under high flow conditions, riffle/shoal habitats could be characterized by deep-fast conditions, and thus this guild criterion should be applied to these mesohabitat types as well.

<u>Shallow-Slow Guild Results</u>

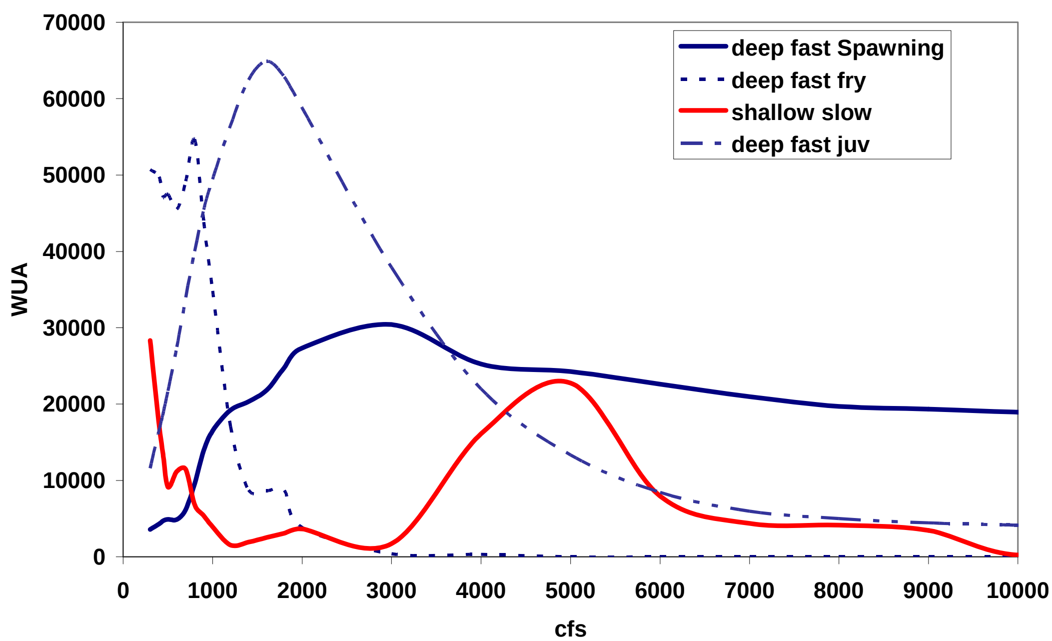

Figure H-1: Saluda River Instream Flow Study – Toenail Riffle, Supplemental Guild Habitat Suitability

Table H-1: Saluda River Instream Flow Study – Toenail Riffle, Supplemental Guild Habitat Suitability

DISCHARGE (CFS)	deep fast Spawning WUA		deep fast fry WUA		deep fast juvenile WUA		shallow slow WUA	
300	3587	12%	50711	93%	11597	18%	28344	100%
400	4303	14%	49761	91%	16551	26%	17274	61%
446	4711	15%	47119	86%	18774	29%	13435	47%
500	4918	16%	47498	87%	21730	33%	9155	32%
600	4888	16%	45521	83%	27468	42%	11204	40%
700	6211	20%	49193	90%	33964	52%	11452	40%
800	9588	32%	54635	100%	40008	62%	6809	24%
900	13925	46%	43835	80%	45453	70%	5402	19%
1,000	16513	54%	34812	64%	49428	76%	3929	14%
1,200	19235	63%	17101	31%	56487	87%	1551	5%
1,400	20325	67%	8745	16%	62458	96%	1935	7%
1,605	21830	72%	8670	16%	64876	100%	2524	9%
1,800	24745	81%	8679	16%	62852	97%	3100	11%
2,000	27363	90%	3812	7%	58792	91%	3651	13%
3,000	30411	100%	417	1%	37897	58%	1721	6%
4,000	25261	83%	324	1%	21984	34%	16105	57%
5,000	24257	80%	0	0%	13358	21%	22776	80%
6,000	22625	74%	0	0%	8437	13%	7945	28%
7,000	20982	69%	0	0%	5965	9%	4381	15%
8,000	19713	65%	0	0%	5016	8%	4149	15%
9,000	19342	64%	0	0%	4464	7%	3467	12%
10,000	18939	62%	0	0%	4146	6%	233	1%
12,000	18357	60%	0	0%	3688	6%	0	0%
14,000	17849	59%	0	0%	3396	5%	0	0%
16,000	17739	58%	0	0%	3200	5%	0	0%
18,000	17634	58%	0	0%	3003	5%	0	0%
20,000	17360	57%	0	0%	2814	4%	0	0%

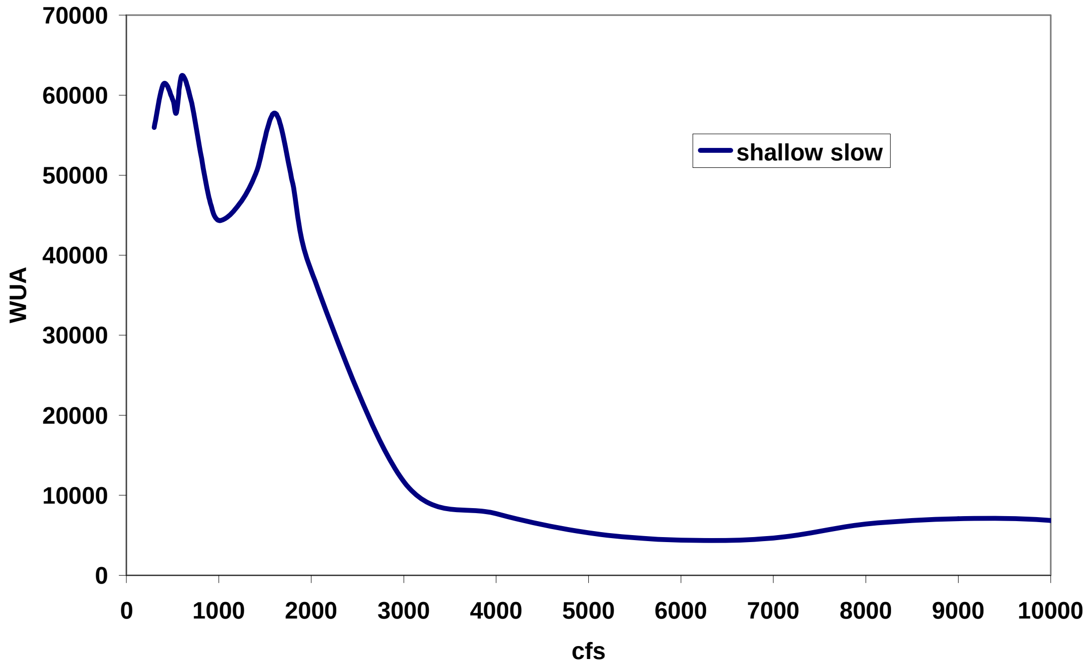

Figure H-2: Saluda River Instream Flow Study – Point Bar Run, Supplemental Guild Habitat Suitability

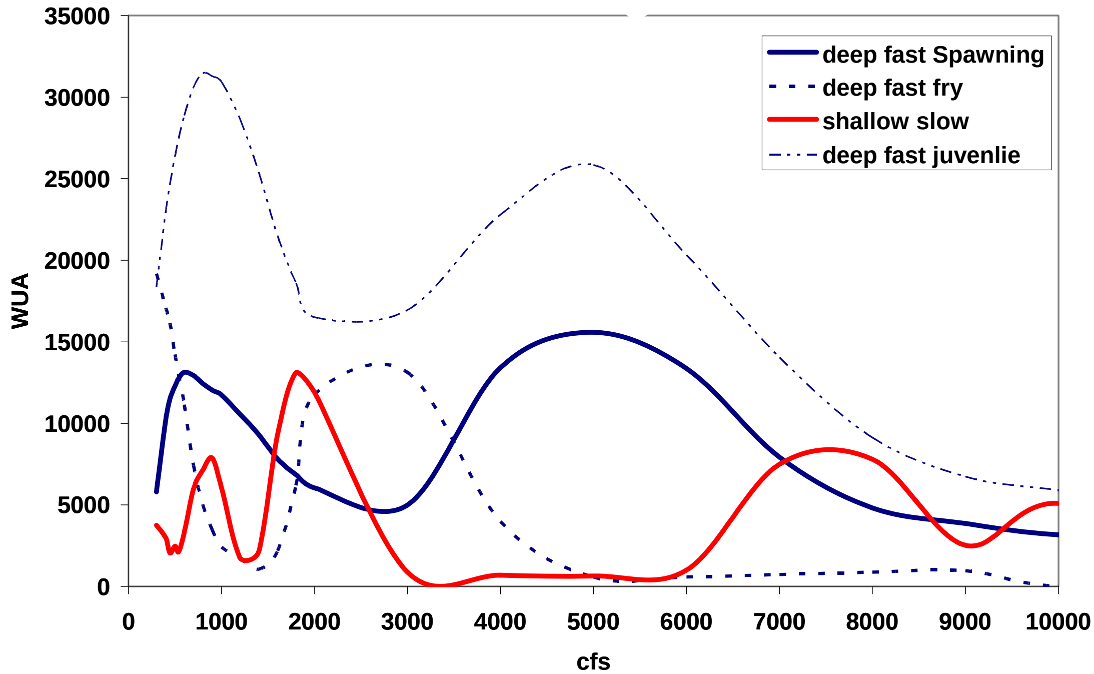

Figure H-3: Saluda River Instream Flow Study – Sandy Beach, Supplemental Guild Habitat Suitability

Table H-2: Saluda River Instream Flow Study – Point Bar Run, Supplemental Guild Habitat Suitability

DISCHARGE (CFS)	shallow slow WUA	
300	55981	90%
400	61379	98%
500	59434	95%
540	57826	93%
600	62462	100%
700	59314	95%
800	52843	85%
900	46960	75%
1,000	44338	71%
1,200	46068	74%
1,400	50188	80%
1,605	57774	92%
1,800	48925	78%
2,000	38073	61%
3,000	11697	19%
4,000	7734	12%
5,000	5328	9%
6,000	4413	7%
7,000	4670	7%
8,000	6404	10%
9,000	7057	11%
10,000	6856	11%
12,000	4903	8%
14,000	4589	7%
16,000	3526	6%
18,000	4277	7%
20,000	4861	8%

Table H-3: Saluda River Instream Flow Study – Sandy Beach, Supplemental Guild Habitat Suitability

DISCHARGE (CFS)	deep fast Spawning WUA		deep fast fry WUA		deep fast juvenile WUA		shallow slow WUA	
300	5800	37%	19188	100%	18336	58%	3749	29%
400	10208	66%	17082	89%	22946	73%	2988	23%
446	11510	74%	16159	84%	24655	78%	2053	16%
500	12291	79%	14219	74%	26374	84%	2459	19%
540	12750	82%	12982	68%	27469	87%	2125	16%
600	13143	84%	11150	58%	28876	92%	3321	25%
700	12927	83%	7405	39%	30600	97%	5999	46%
800	12438	80%	4969	26%	31467	100%	7144	54%
900	12040	77%	3462	18%	31280	99%	7876	60%
1,000	11735	75%	2418	13%	30934	98%	6059	46%
1,200	10549	68%	1722	9%	28618	91%	1742	13%
1,400	9310	60%	1055	5%	25404	81%	2141	16%
1,605	7806	50%	2194	11%	21463	68%	9370	71%
1,800	6859	44%	6193	32%	18601	59%	13109	100%
2,000	6043	39%	11762	61%	16508	52%	11890	91%
3,000	4995	32%	13130	68%	16945	54%	877	7%
4,000	13409	86%	3974	21%	22791	72%	697	5%
5,000	15579	100%	568	3%	25841	82%	640	5%
6,000	13361	86%	581	3%	20321	65%	999	8%
7,000	7929	51%	736	4%	14047	45%	7487	57%
8,000	4820	31%	878	5%	9130	29%	7797	59%
9,000	3868	25%	967	5%	6732	21%	2532	19%
10,000	3165	20%	0	0%	5909	19%	5105	39%
12,000	2746	18%	0	0%	4704	15%	1888	14%
14,000	1767	11%	0	0%	2910	9%	354	3%
16,000	1366	9%	0	0%	1767	6%	9227	70%
18,000	1191	8%	0	0%	1213	4%	109	1%
20,000	1231	8%	0	0%	1008	3%	0	0%

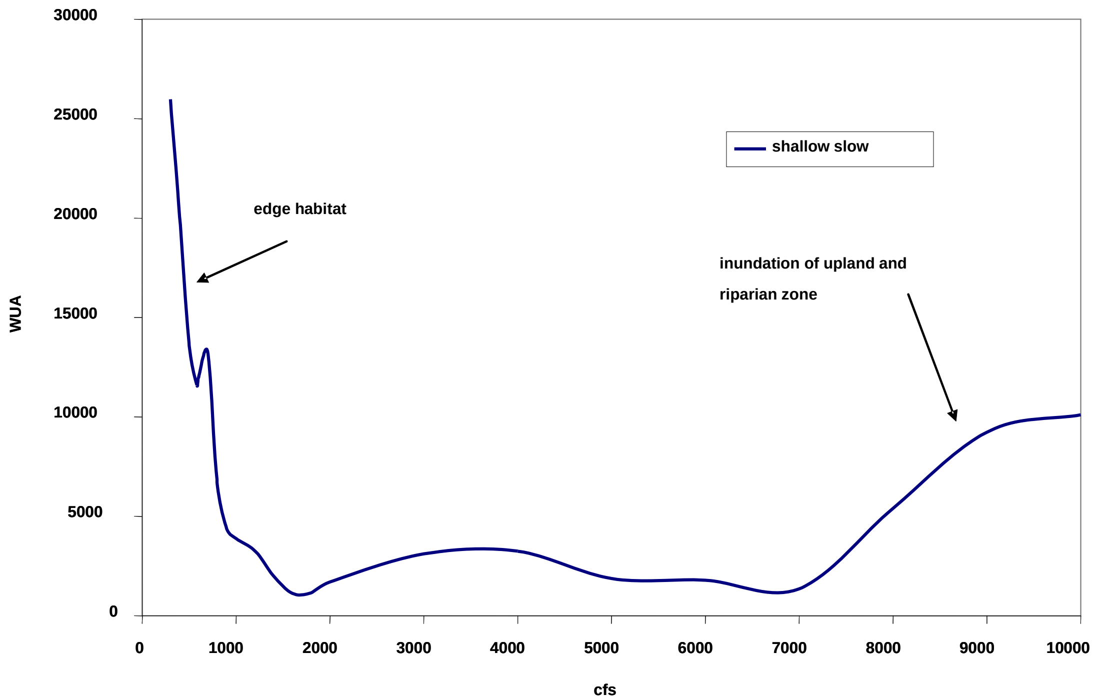

Figure H-4: Saluda River Instream Flow Study – Reach 2 Run, Supplemental Guild

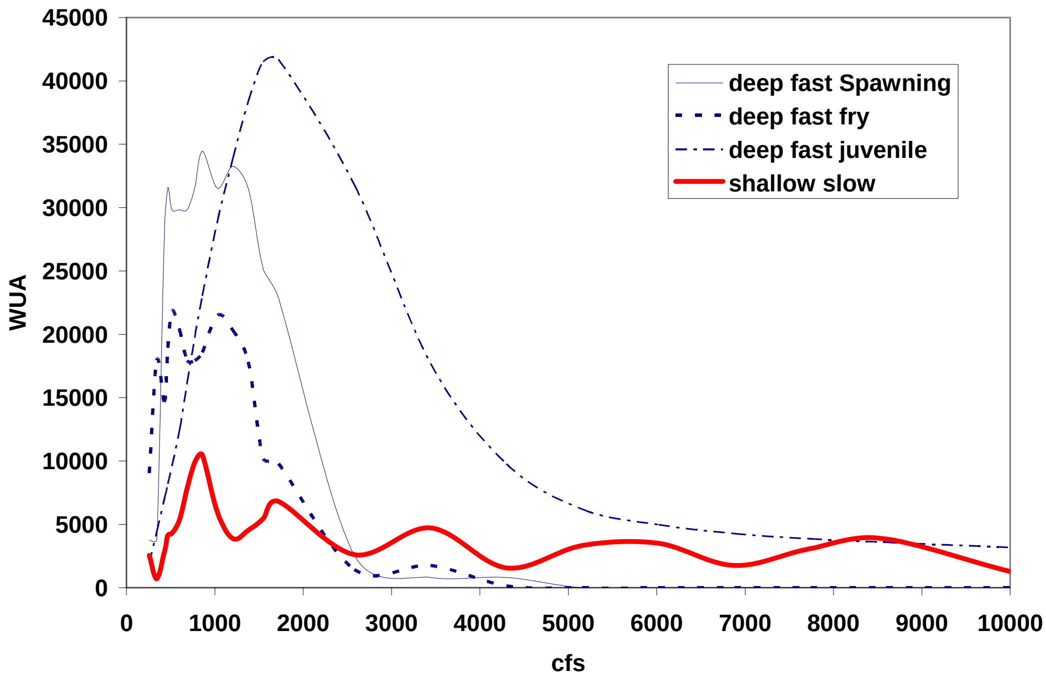

Figure H-5: Saluda River Instream Flow Study – Corley Main Channel, Supplemental Guild Habitat Suitability

Table H-4: Saluda River Instream Flow Study – Reach 2 Run, Supplemental Guild Habitat Suitability

DISCHARGE (CFS)	shallow slow WUA	
300	25987	100%
400	20073	77%
500	13582	52%
583	11601	45%
600	11980	46%
700	13254	51%
800	6713	26%
900	4384	17%
1,000	3893	15%
1,211	3237	12%
1,400	2013	8%
1,600	1131	4%
1,800	1148	4%
2,000	1699	7%
3,000	3103	12%
4,000	3239	12%
5,000	1876	7%
6,000	1783	7%
7,000	1350	5%
8,000	5396	21%
9,000	9232	36%
10,000	10103	39%
12,000	11043	42%
14,000	12756	49%
16,000	4803	18%
18,000	7756	30%
20,000	8163	31%

Table H-5: Saluda River Instream Flow Study – Corley Island Main Channel, Supplemental Guild Habitat Suitability

DISCHARGE (cfs)	deep fast Spawning WUA		deep fast fry WUA		deep fast juvenile WUA		shallow slow WUA	
258	3763	11%	9046	41%	1929	5%	2546	24%
344	3763	11%	17949	82%	4424	11%	700	7%
430	28459	83%	14654	67%	7029	17%	2833	27%
470	31579	92%	18926	87%	8191	20%	4141	40%
516	29842	87%	21876	100%	9600	23%	4284	41%
602	29842	87%	20304	93%	12474	30%	5377	51%
688	29842	87%	17927	82%	16177	39%	7828	75%
774	31579	92%	17922	82%	19781	47%	9902	95%
860	34445	100%	18568	85%	23040	55%	10453	100%
1,032	31525	92%	21510	98%	28922	69%	5948	57%
1,204	33262	97%	20301	93%	33865	81%	3874	37%
1,380	31525	92%	17804	81%	38368	92%	4529	43%
1,548	25112	73%	10180	47%	41507	100%	5448	52%
1,720	22863	66%	9790	45%	41685	100%	6802	65%
2,580	2547	7%	1442	7%	31781	76%	2612	25%
3,440	810	2%	1754	8%	17700	42%	4723	45%
4,300	810	2%	145	1%	9779	23%	1570	15%
5,160	0	0%	0	0%	6188	15%	3331	32%
6,020	0	0%	0	0%	4977	12%	3505	34%
6,880	0	0%	0	0%	4268	10%	1757	17%
7,740	0	0%	0	0%	3856	9%	3099	30%
8,600	0	0%	0	0%	3590	9%	3841	37%
10,320	0	0%	0	0%	3098	7%	826	8%
12,040	0	0%	0	0%	2620	6%	26	0%
13,760	0	0%	0	0%	2179	5%	2066	20%
15,480	0	0%	0	0%	1999	5%	4661	45%
17,200	0		0	0%	1825	4%	1464	14%

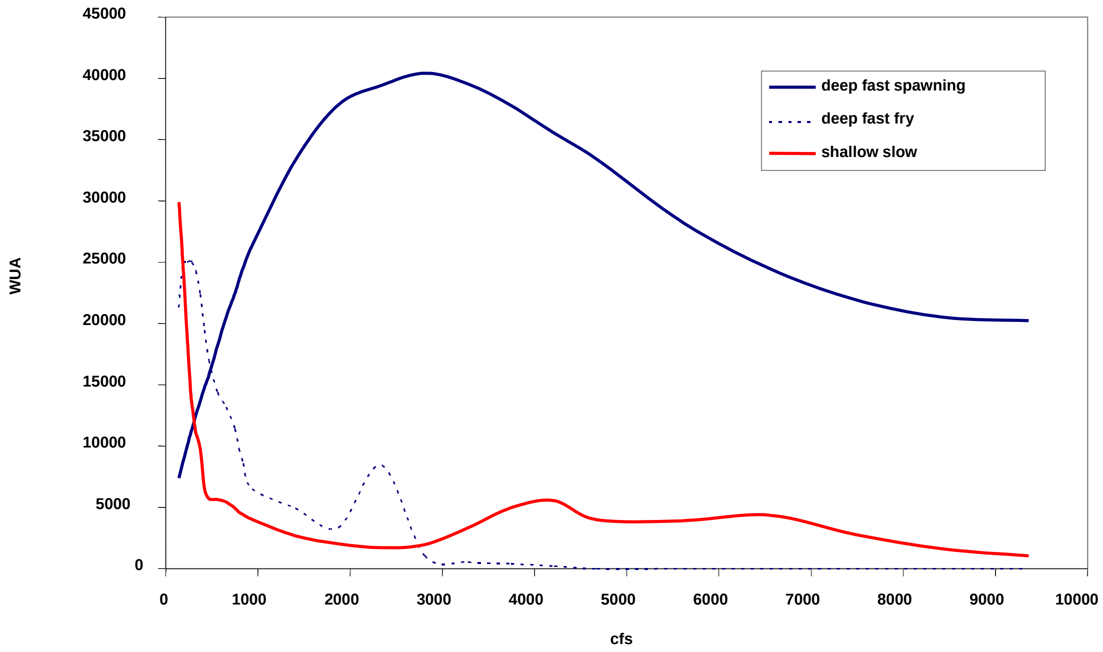

Figure H-6: Saluda River Instream Flow Study – Ocean Boulevard, Supplemental Guild Habitat Suitability

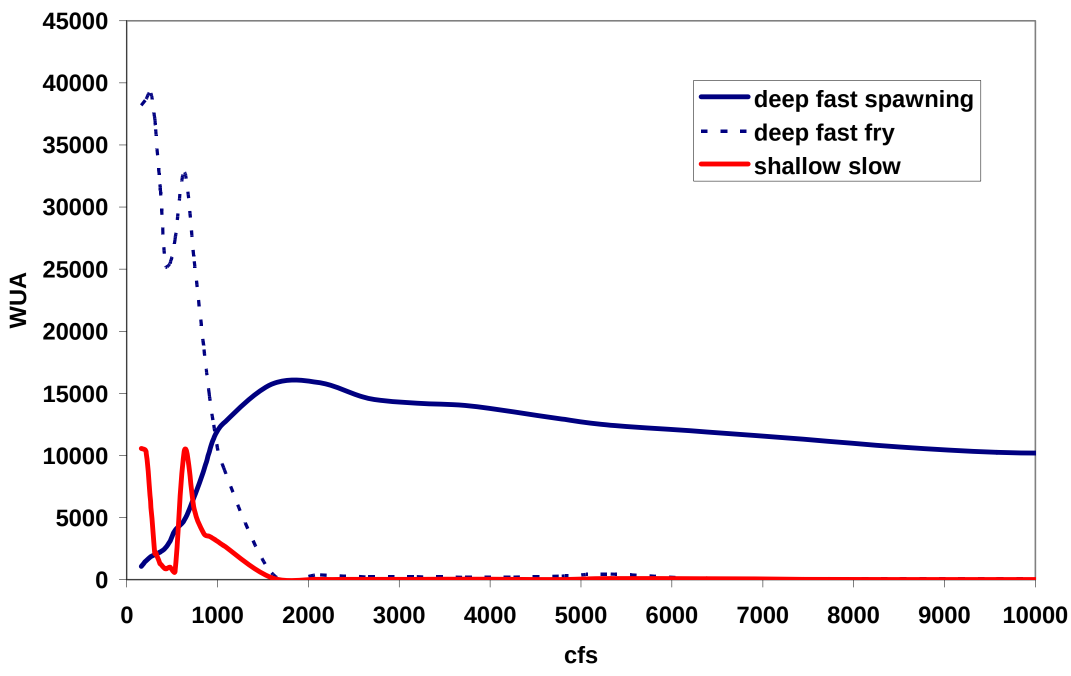

Figure H-7: Saluda River Instream Flow Study – Oh Brother Rapids, Supplemental Guild Habitat Suitability

Table H-6: Saluda River Instream Flow Study – Ocean Boulevard, Ssupplemental Guild Habitat Suitability

DISCHARGE (CFS)	deep fast spawning WUA		deep fast fry WUA		shallow slow WUA	
140	7380	18%	21288	85%	29906	100%
187	8718	22%	24933	99%	24934	83%
234	10027	25%	25013	100%	18772	63%
273	11119	28%	25118	100%	14174	47%
281	11343	28%	25012	100%	13509	45%
322	12427	31%	24371	97%	11216	38%
328	12583	31%	24271	97%	11011	37%
374	13694	34%	22379	89%	9721	33%
421	14784	37%	19458	77%	6537	22%
468	15796	39%	17002	68%	5713	19%
562	18181	45%	14396	57%	5639	19%
655	20504	51%	13192	53%	5447	18%
749	22468	56%	11420	45%	4935	17%
796	23555	58%	9800	39%	4605	15%
842	24600	61%	8594	34%	4396	15%
936	26349	65%	6508	26%	4015	13%
1,404	33330	82%	4911	20%	2687	9%
1,872	37859	94%	3355	13%	2028	7%
2,340	39432	98%	8427	34%	1711	6%
2,808	40422	100%	1053	4%	1956	7%
3,276	39570	98%	545	2%	3316	11%
3,744	37792	93%	404	2%	4968	17%
4,212	35533	88%	205	1%	5556	19%
4,674	33408	83%	6	0%	3994	13%
5,616	28218	70%	0	0%	3907	13%
6,552	24471	61%	0	0%	4370	15%
7,488	21924	54%	0	0%	2773	9%
8,424	20527	51%	0	0%	1608	5%
9,360	20220	50%	0	0%	1040	3%

Table H-7: Saluda River Instream Flow Study – Oh Brother Rapids, Supplemental Guild Habitat Suitability

DISCHARGE (CFS)	deep fast spawning WUA		deep fast fry WUA		shallow slow WUA	
160	1069	7%	38191	97%	10561	100%
213	1525	10%	38696	99%	10325	98%
266	1848	12%	39195	100%	6072	57%
310	2026	13%	37123	95%	2115	20%
319	2052	13%	36250	92%	2212	21%
366	2218	14%	31827	81%	1305	12%
372	2245	14%	31459	80%	1272	12%
426	2555	16%	25232	64%	872	8%
479	3131	20%	25485	65%	1007	10%
532	3974	25%	27400	70%	649	6%
638	4830	30%	32801	84%	10435	99%
745	6693	42%	25649	65%	5667	54%
851	8866	56%	18551	47%	3696	35%
908	10297	65%	14926	38%	3493	33%
958	11382	72%	12478	32%	3292	31%
1,064	12589	79%	9028	23%	2765	26%
1,596	15749	99%	553	1%	168	2%
2,128	15859	100%	398	1%	39	0%
2,660	14599	92%	235	1%	39	0%
3,192	14217	90%	245	1%	36	0%
3,724	14041	89%	199	1%	44	0%
4,256	13513	85%	210	1%	26	0%
4,788	12939	82%	297	1%	20	0%
5,326	12441	78%	461	1%	105	1%
6,384	11902	75%	83	0%	76	1%
7,448	11313	71%	89	0%	26	0%
8,512	10677	67%	94	0%	17	0%
9,576	10258	65%	100	0%	17	0%
10,640	10164	64%	104	0%	17	0%

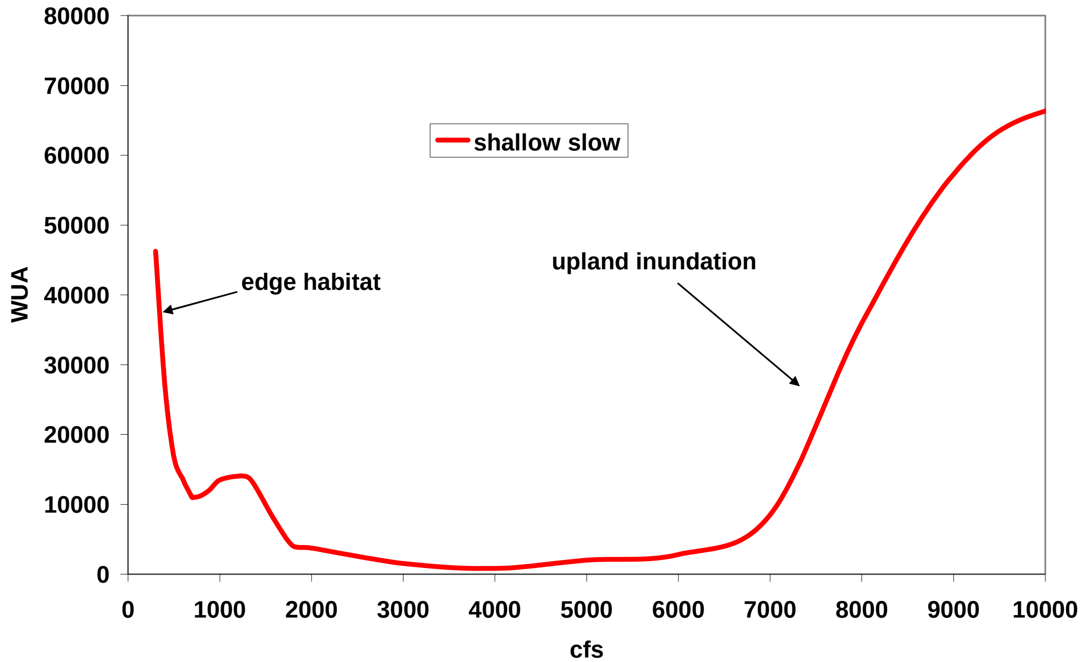

Figure H-8: Saluda River Instream Flow Study – Reach 4 Run, Supplemental Guild Habitat Suitability

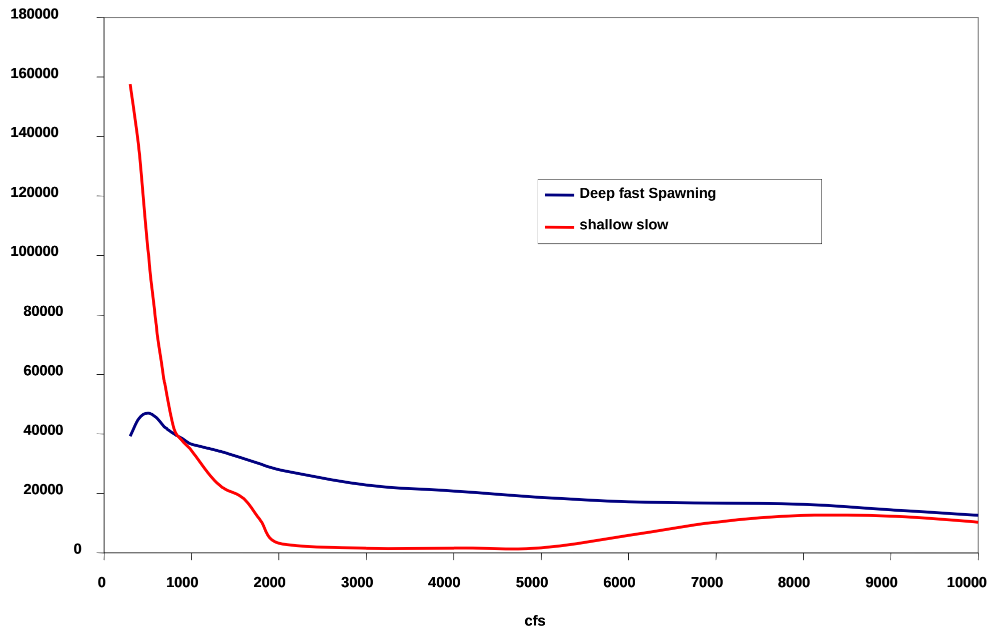

Figure H-9: Saluda River Instream Flow Study – Shandon, Supplemental Guild Habita Suitability

Table H-8: Saluda River Instream Flow Study – Shandon, Supplemental Guild Habitat Suitability

DISCHARGE (CFS)	shallow slow WUA	
300	46247	67%
400	27284	39%
500	16638	24%
600	13485	19%
688	11187	16%
700	10958	16%
800	11257	16%
900	12219	18%
1,000	13479	19%
1,200	14051	20%
1,316	13801	20%
1,400	12298	18%
1,600	7662	11%
1,800	4036	6%
2,000	3728	5%
3,000	1547	2%
4,000	799	1%
5,000	1997	3%
6,000	2803	4%
7,000	8485	12%
8,000	35981	52%
9,000	57281	82%
10,000	66345	95%
12,000	69499	100%
14,000	6883	10%
16,000	3717	5%
18,000	4103	6%
20,000	3655	5%

Table H-9: Saluda River Instream Flow Study – Reach 4 Run, Supplemental Guild Habitat Suitability

DISCHARGE CFS	Deep fast spawning WUA		shallow slow WUA	
300	39235	84%	157665	100%
400	45204	96%	135588	86%
500	46934	100%	103029	65%
600	45548	97%	76347	48%
688	42491	91%	58153	37%
700	42187	90%	56337	36%
800	40080	85%	41621	26%
900	38381	82%	37517	24%
1,000	36586	78%	34470	22%
1,200	35083	75%	26540	17%
1,316	34286	73%	22929	15%
1,400	33558	71%	21218	13%
1,600	31640	67%	18206	12%
1,800	29801	63%	10527	7%
2,000	28029	60%	3268	2%
3,000	22799	49%	1538	1%
4,000	20859	44%	1660	1%
5,000	18707	40%	1704	1%
6,000	17186	37%	5886	4%
7,000	16739	36%	10332	7%
8,000	16266	35%	12627	8%
9,000	14500	31%	12360	8%
10,000	12683	27%	10322	7%
12,000	9538	20%	5658	4%
14,000	7877	17%	4120	3%
16,000	7156	15%	4163	3%
18,000	7197	15%	3506	2%
20,000	7336	16%	2334	1%

Striped Bass

Striped bass enter the lower Saluda River in spring (late April) seeking thermal refuge for the summer months, and exit the river in September. The TWC subsequently requested PHABSIM modeling be performed for the adult lifestage of striped bass, using HSI criteria from Crance (1985). The HSI criteria indicate that depth is the overarching riverine habitat requirement for this species and lifestage. TWC review of depth profile data indicated that deep pool and run habitat were the two mesohabitats that could consistently provide adequate depths for adult striped bass consistently across a range of discharges. Review of the deep pool data (see section ___) showed that depth suitability of these pools for striped bass was high and unaffected by river flows (see TWC meeting notes of December 12, 2007). PHABSIM modeling results for reaches 2 and 4 runs are attached as Figures and Tables H-10 and H-11 respectively.

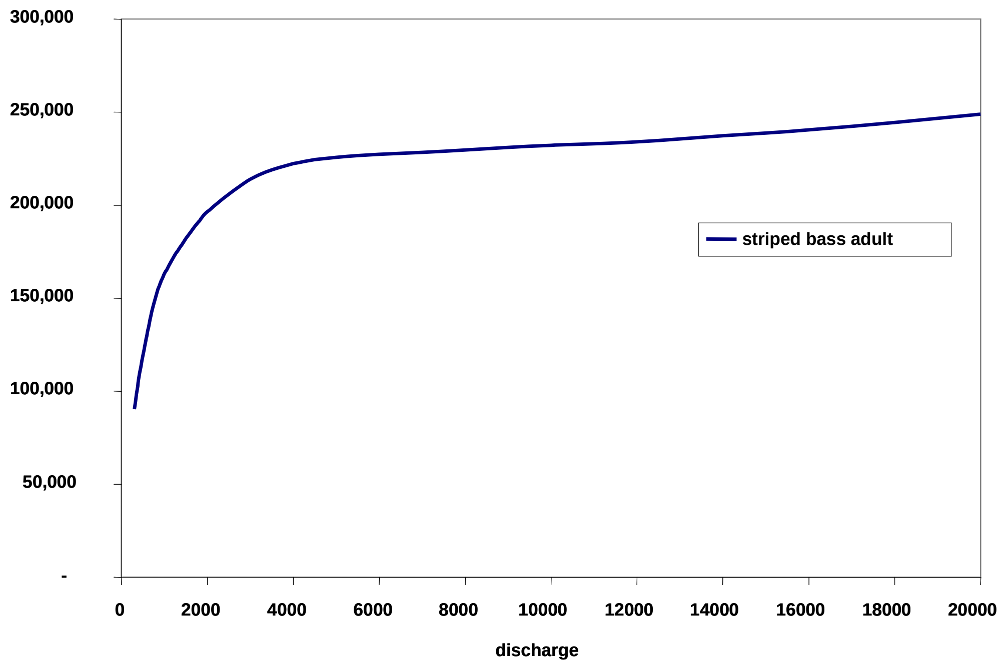

Figure H-10: Saluda River Instream Flow Study – Reach 2 Run, Adult Striped Bass Adult Habitat Suitability

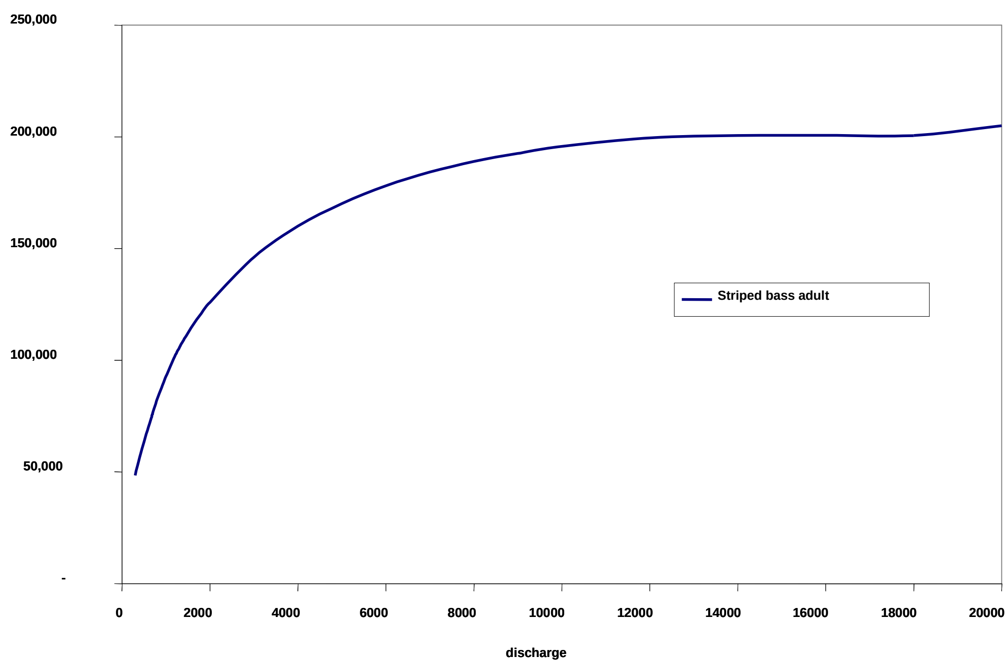

Figure H-11: Saluda River Instream Flow Study – Reach 4 Run, Adult Striped Bass Adult Habitat Suitability

Table H-10: Saluda River Instream Flow Study – Reach 2 Run, Adult Striped Bass Habitat Suitability

DISCHARGE CFS)	striped bass adult WUA	
300	90,305	36%
400	106,371	43%
500	119,555	48%
583	129,470	52%
600	131,429	53%
700	142,260	57%
800	151,181	61%
900	157,989	64%
1,000	163,241	66%
1,211	172,030	69%
1,400	178,810	72%
1,600	185,260	74%
1,800	191,117	77%
2,000	196,542	79%
3,000	213,988	86%
4,000	222,210	89%
5,000	225,657	91%
6,000	227,323	91%
7,000	228,311	92%
8,000	229,702	92%
9,000	230,971	93%
10,000	232,177	93%
12,000	233,882	94%
14,000	237,271	95%
16,000	240,425	97%
18,000	244,420	98%
20,000	248,781	100%

Table H-11: Saluda River Instream Flow Study – Reach 4 Run, Adult Striped Bass Habitat Suitability

DISCHARGE (CFS)	Striped bass adult WUA	
300	48,508	24%
400	56,658	28%
500	63,597	31%
600	70,138	34%
688	75,695	37%
700	76,443	37%
800	82,489	40%
900	87,893	43%
1,000	92,810	45%
1,200	101,619	50%
1,316	106,013	52%
1,400	108,932	53%
1,600	115,318	56%
1,800	120,907	59%
2,000	125,966	61%
3,000	146,098	71%
4,000	160,061	78%
5,000	170,169	83%
6,000	178,072	87%
7,000	184,218	90%
8,000	188,985	92%
9,000	192,662	94%
10,000	195,670	95%
12,000	199,502	97%
14,000	200,567	98%
16,000	200,709	98%
18,000	200,566	98%
20,000	205,051	100%