

**Fish Species Distribution and Fish Movement Barriers in Four Streams
Considered for Southern Strain Brook Trout Reintroduction, Andrew
Pickens Ranger District, Sumter National Forest, South Carolina**



United States Department of Agriculture Forest Service
Center for Aquatic Technology Transfer
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June 2002

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Introduction

Brook trout (*Salvelinus fontinalis*) are the only native salmonid species of the southern Appalachians. Because of their popularity as a game fish and loss of habitat due to activities such as logging and stocking of non-native brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*) (Burrows 1935), brook trout have been stocked extensively throughout the southern Appalachians for decades. Most stocked brook trout were derived from northern populations and were introduced to streams from which native strains had been extirpated or never occurred, or were stocked on top of existing native brook trout populations. Genetic analysis has shown that northern and southern populations of brook trout are genetically distinct (Hayes et al. 1996, Stoneking et al. 1981) and southern Appalachian streams currently contain northern strain, southern strain, and hybrid populations (McCracken et al. 1993). Efforts are currently underway in several southern states to reestablish pure southern strain brook trout populations in streams within their native range (Dawn Kirk and Jeanie Riley, pers. comm.).

In March 2002 the USFS Center for Aquatic Technology Transfer (CATT) assisted the Sumter National Forest (SNF) in determining fish distribution and abundance using diver counts and identifying fish movement barriers in four South Carolina mountain streams. The purpose of the survey was to assess current stream conditions and identify areas best suited for reestablishing southern strain brook trout populations.

Study Area

All four streams surveyed were located within the Andrew Pickens Ranger District of the Sumter National Forest, South Carolina (Figure 1). Three of the streams (King Creek, Pigpen Creek, and Indian Camp Branch) are tributaries of the upper Chattooga River. Crane Creek is a tributary of the Flat Shoals River. Both the Chattooga River and Flat Shoals River are in the Savannah River watershed.

Indian Camp Branch

Indian Camp Branch originates within the Ellicott Rock Wilderness Area at an elevation of 853 m and flows approximately 2.4 km to its confluence with East Fork River near the Walhalla fish hatchery. The entire length of stream lies within the wilderness area except for a short section upstream of the confluence. On March 13, 2002 we performed a fish survey using diver counts on the mainstem Indian Camp Branch and an unnamed tributary (Figure 1).

Mainstem

We survey a 1542 m section of the mainstem starting just above the diversion dam for the hatchery. The surveyed section was characterized as having a relatively low gradient, large amounts of large woody debris in the lower reach, and sand imbedding larger substrate in pools and riffles.

Unnamed tributary

We surveyed a 324 m section of an unnamed tributary of Indian Camp Branch starting at its confluence with the mainstem. The tributary entered Indian Camp Branch from the west approximately 1 km upstream of the Ellicott Wilderness boundary. The surveyed section of the tributary had similar characteristics to the mainstem.

King Creek

King Creek originates at an elevation of 580 m and flows approximately 4.5 km to its confluence with the Chattooga River. On March 11 and 12, 2002 we performed fish surveys using diver counts on three separate sections of King Creek (all upstream of King Creek Falls) (Figure 1).

Section 1

Section 1 began approximately 500 m upstream of the King Creek Falls continuing 877 m upstream ending at a footbridge. This study section was characterized as having relatively low gradient and sand embedding larger substrate in pools and riffles.

Section 2

Section 2 began approximately 550 m upstream of the end of the section 1 and continued upstream 330 m ending at the culvert crossing of Forest Service road 708. This section of stream was characterized as having a relatively high gradient with several bedrock cascades with sand filling pools below.

Section 3

Section 3 began approximately 1 km upstream of the ending of the section 2 at an abandoned road (used as a landmark for the starting point) and continued upstream for 505 m. The abandoned road was used to access the site from highway 107 near the Burrell's Place wayside picnic area. This section of stream was characterized having short bedrock cascades and sand embedding larger substrate in pools and riffles.

Pigpen Branch

Pigpen Branch originates at an elevation of 658 m and flows approximately 3.2 km to its confluence with Lick Log Creek. On March 15, 2002 we performed a fish survey on the mainstem of Pigpen Branch and an unnamed tributary (Figure 1).

Mainstem

We surveyed a 440 m section of the mainstem of Pigpen Branch starting at the second crossing of an unnamed trail (accessed from Nicholson Ford Road/FS road 775) and ending at the confluence with a major tributary. Sand was the dominant substrate in both pools and riffles.

Unnamed Tributary

We surveyed a 446 m section of an unnamed tributary to Pigpen Branch starting at its' confluence with the mainstem. The tributary entered Pigpen Branch from the southeast and marked the end of the mainstem survey. This section of stream was characterized as having a higher gradient than the mainstem study section with relatively less sand in the stream channel and several bedrock cascades.

Crane Creek

Crane Creek originates at an elevation of 762 m and flows approximately 4.0 km to its confluence with Townes Creek. On March 14, 2002 we performed fish surveys using diver counts on 3 separate sections of Crane Creek (Figure 1).

West Branch

The west branch of Crane Creek was surveyed starting at the culvert crossing of Big Bend Road (FS road 709) and ending 511 m upstream. This section was characterized as having several small bedrock cascades and sand embedding larger substrate in pools and riffles.

East Branch

The east branch of Crane Creek was surveyed starting at the culvert crossing of Big Bend Road and ending 581 m upstream. This section of stream was characterized as having sand embedding larger substrate in pools and riffles.

Mainstem

The mainstem of Crane Creek was surveyed starting downstream of Big Bend Road and ending 285 m upstream at the confluence of the east and west forks of Crane Creek. This section

of stream was characterized as having a high gradient and several high bedrock cascades and falls with sand filling the plunge pools below.

Methods

Diver counts were used to determine distribution and relative abundance of fish species in the study area. Every 10th pool and 10th riffle encountered in each study section was sampled (with the exception of section 1 of King Creek in which every 5th pool and 5th riffle were sampled). The diver entered selected habitat units from the downstream end and proceeded upstream counting all fish species and determining the age class (either age 0 or adult) for each individual. In each sampled unit the habitat type (pool or riffle) was determined and the distance (m) from start of survey and average unit width (m) was measured and recorded. Occasionally the diver would sample a habitat unit not required within the normal protocol to determine the presence of fish. As we walked through the survey section we noted the location of potential fish movement barriers (waterfalls, culverts, dams, etc.) We also noted the general condition of the stream. When possible GPS points were recorded using a Garmin ColorTRAK handheld GPU at the start and end points of each study section, each habitat unit sampled, potential movement barriers, and other noteworthy locations (Appendix A). All points were recorded using the UTM coordinate system and NAD 27 CONUS map datum.

The SNF requested that we did not use electrofishing to sample fish because some streams were located in a wilderness area and there was concern of mortality in already small populations.

Results

Indian Camp Branch

Mainstem

Twelve pools (total surface area = 216 m²) and six riffles (total surface area = 174 m²) were sampled in a 1542 m section of the mainstem of Indian Camp Branch (Table 1). Six adult brook trout and seven adult brown trout were observed in the surveyed section (Figure 2). Four age 0 trout were observed but were not identified due to small size (25 to 30 mm) (Figure 3). The last brown trout observed was at survey meter 895. The last brook trout observed was at survey meter 1212. No fish movement barriers were identified in this study section, however the fish hatchery diversion dam at the start of the section probably acts as an effective barrier to upstream fish movement during base flows.

Unnamed Tributary

Four pools (total surface area = 21 m²) and three riffles (total surface area = 28 m²) were sampled in a 324 m section of an unnamed tributary to Indian Camp Branch (Table 1). Four adult brook trout and four unidentified age 0 trout were observed in the tributary (Figures 4 and 5). No fish movement barriers were identified in the surveyed section.

King Creek

Section 1

Ten pools (total surface area = 225 m²) and eight riffles (total surface area = 211 m²) were sampled in the 877 m length of section 1 (Table 1). No fish were observed by the diver but one unidentified fish was observed prior to the diver entering the water at the beginning of this section. No fish barriers were identified in section 1.

Section 2

Three pools (total surface area = 84 m²) and two riffles (total surface area = 33 m²) were sampled in the 330 m length of the section 2 (Table 1). No fish were observed here. A bedrock cascade potentially acting as an upstream fish movement barrier was located 43 m upstream of the survey start point. The road culvert at the end of section 2 was identified as an impediment to upstream fish movement especially during low flows or for smaller size classes of fish, however it was not likely a complete barrier to movement.

Section 3

Four pools (total surface area = 27 m²) and four riffles (total surface area = 94 m²) were sampled in the 505-meter length of the section 3 (Table 1). No fish were observed and no fish barriers were identified in section 3.

Pigpen Branch

Mainstem

Three pools (total surface area = 113 m²) and two riffles (total surface area = 105 m²) were sampled in a 441 m section of the mainstem of Pigpen Branch (Table 1). One adult brook trout and one unidentified age 0 trout were observed by the diver (Figure 6). Seven unidentified age 0 trout were observed in a slack water area at meter 185. No fish barriers were identified in the mainstem study section.

Unnamed Tributary

Five pools (total surface area = 108 m²) and three riffles (total surface area = 40 m²) were sampled in a 446 m section of an unnamed tributary to Pigpen Branch (Table 1). Four creek chubs (*Semotilus atromaculatus*) were the only fish observed in this study section (Figure 7). An 8 m high waterfall potentially acting as a barrier to upstream fish movement marked the end of the surveyed section.

Crane Creek

West Branch

Six pools (total surface area = 26 m²) and six riffles (total surface area = 36 m²) were sampled in a 511 m section of the west branch of Crane Creek (Table 1). One adult brook trout and one unidentified age 0 trout were observed in this section (Figure 8). Both fish were located below a bedrock cascade potentially acting as a barrier to upstream fish movement near the end of the study section. No fish were observed above the cascade. The culvert road crossing at the start of the survey was identified as an impediment to upstream fish movement especially during low flows or for smaller size classes of fish, however it was not likely a complete barrier.

East Branch

Five pools (total surface area = 155 m²) and four riffles (total surface area = 89 m²) were sampled in a 581 m section of the east branch of Crane Creek (Table 1). Twelve adult brook trout and three unidentified age 0 trout were observed in this study section (Figure 9). The culvert road crossing marking the start of the survey was identified as an impediment to upstream fish movement but not an effective barrier.

Mainstem

Twelve pools (total surface area = 137 m²) were sampled in a 285 m section of the mainstem of Crane Creek (Table 1). No riffles were sampled in this study section. Three adult brook trout and one adult brown trout were observed in this section (Figure 10). The brown trout was observed at meter 273 upstream from a series of cascades/falls (likely barriers to upstream fish movement) and below the confluence of the east and west Branch of Crane Creek.

Conclusion

We observed very low fish densities during our diver surveys. A number of factors, including observation bias, habitat conditions, and water quality conditions could explain these results. However, the divers had hundreds of hours of diving experience in similar southern

Appalachian streams, visibility was good (generally 1.0 m or more), and dry suits provided adequate comfort in the cold conditions. Fish may have been using undercut banks, large woody debris, or other cover and avoided observation but we do not believe there were significantly more fish in the dive units than were observed.

Although we did not directly measure any habitat characteristics other than surface area, we did note that all of the stream sections surveyed had sand embedding larger substrate in pools and riffles to some degree. Sand has been shown to negatively affect brook trout reproduction (Jenkins and Burkhead 1993). In many of the study areas sand filled the pools and embedded riffle substrates. Indian Camp Branch and the upper reaches of Crane Creek had lower amounts of fine sediment but were still impacted. High amounts of large diameter large woody debris in Indian Camp Branch created several deep scour pools.

Water quality, particularly water temperature may also limit the ability of trout to survive in these streams. The study area is near the southern extent of brook trout range. Brook trout do not thrive in water temperatures over 16° C (Etnier and Starnes 1993).

The existence of natural and artificial fish barriers on several streams and low abundance of trout suggest that it may be relatively easy to eradicate northern strain/hybrid brook trout and other introduced salmonid species and reestablish southern strain brook populations. However, habitat and water quality conditions may limit the long-term viability of the populations. We recommend more intensive investigations of habitat conditions and year-round monitoring of water temperatures for locating streams with the greatest potential for success.

Literature Cited

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- Jenkins, R. E. and N. M. Burkhead. 1993. Freshwater Fishes of Virginia. American Fisheries Society, Bethesda, Maryland.
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Table 1: Summary of stream sections surveyed for fish using diver counts.

stream	total distance surveyed (m)	# sampled	Pools		# sampled	Riffles	
			total surface area (m ²)	avg. wetted width (m)		total surface area (m ²)	avg. wetted width (m)
Indian Camp Branch, mainstem	1542.2	12	216.45	3.44	6	173.87	3.63
Indian Camp Branch, tributary	323.8	4	20.88	1.80	3	27.96	2.10
King Creek, section 1	877.1	10	225.05	3.69	8	211.69	3.03
King Creek, section 2	330.1	3	83.83	3.77	2	33.12	2.05
King Creek, section 3	504.5	4	27.14	2.18	4	93.67	2.20
Pigpen Branch, mainstem	441.2	3	112.83	4.70	2	104.53	3.65
Pigpen Branch, south fork	445.7	5	108.35	3.54	3	40.33	2.73
Crane Creek, main stem	285	12	136.97	3.72	0	-	-
Crane Creek, east fork	581	5	155.21	1.94	4	89.25	2.25
Crane Creek, west fork	511.2	6	26.27	1.70	6	36.08	1.82

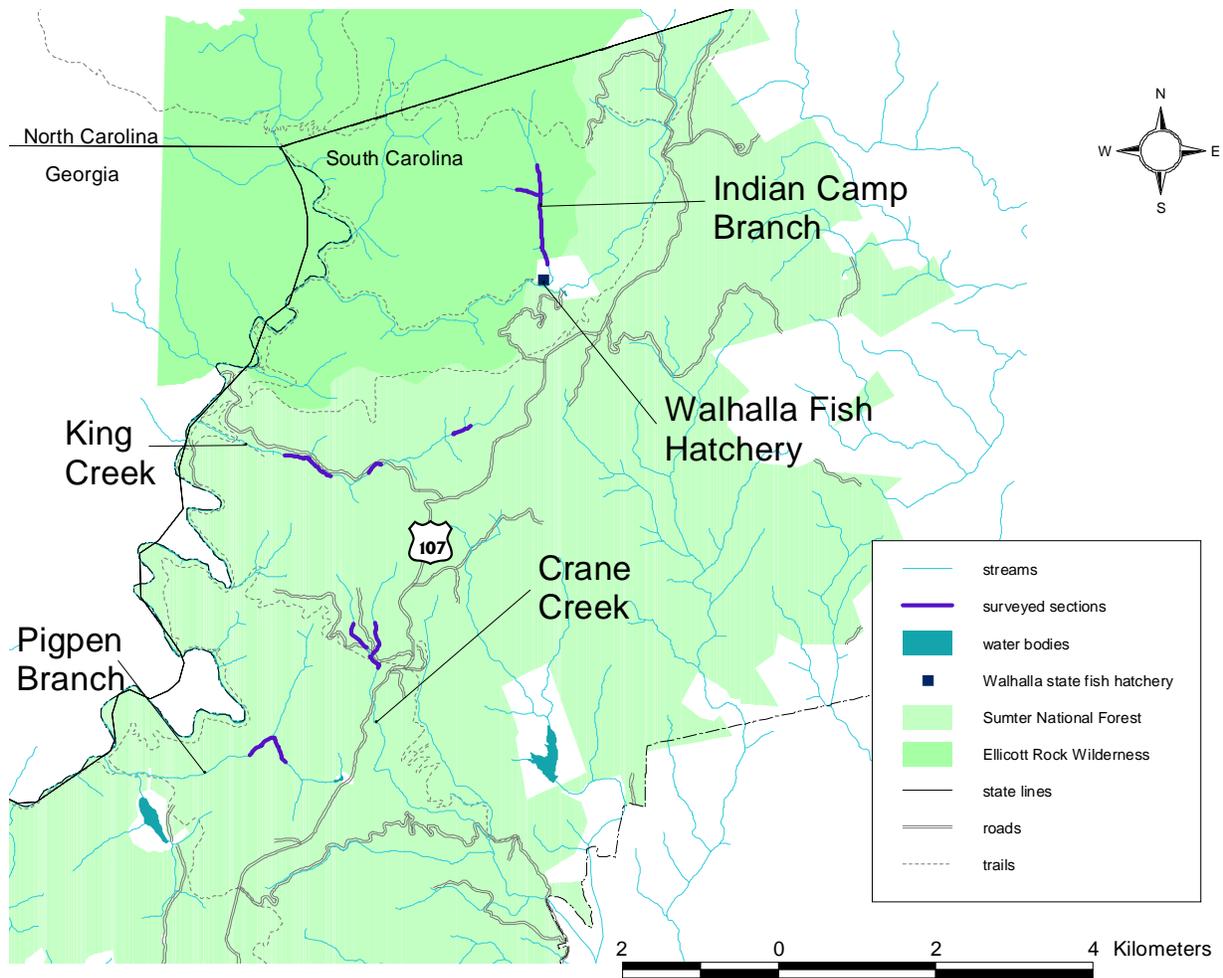


Figure 1: Location of stream sections surveyed in the Sumter NF in March 2002.

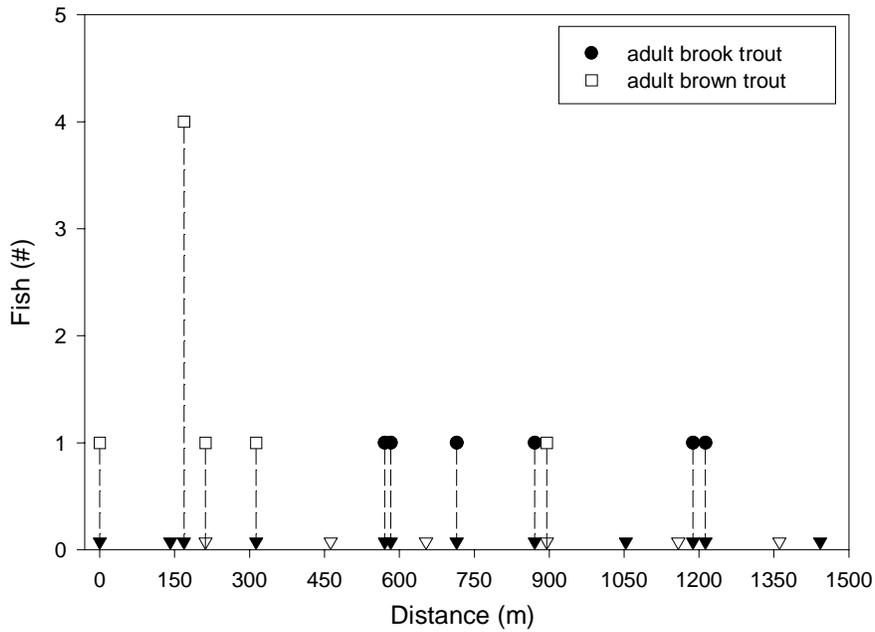


Figure 2: Fish species observed during diver counts in the mainstem of Indian Camp Creek (adult fish). Triangles indicate sample sites (closed triangles indicate pools, open indicate riffles). Closed circles indicate the presence of adult brook trout. Open squares indicate the presence of adult age brown trout. Distance is meters upstream from pool behind Walhalla state fish hatchery diversion dam.

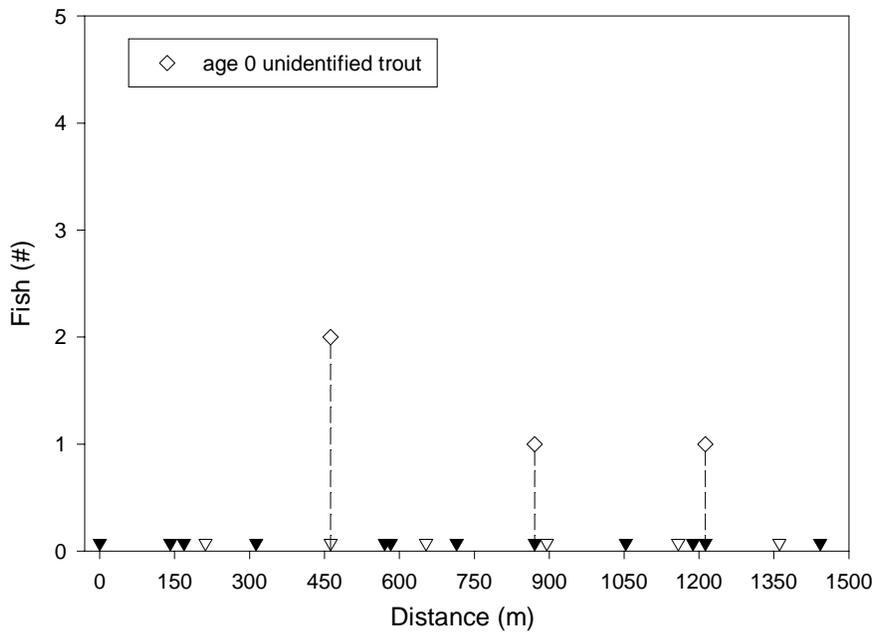


Figure 3: Fish species observed during diver counts in the mainstem of Indian Camp Creek (age 0 fish). Triangles indicate sample sites (closed triangles indicate pools, open indicate riffles). Open diamonds indicate the presence of age 0 unidentified trout. Distance is meters upstream from pool behind Walhalla state fish hatchery diversion dam.

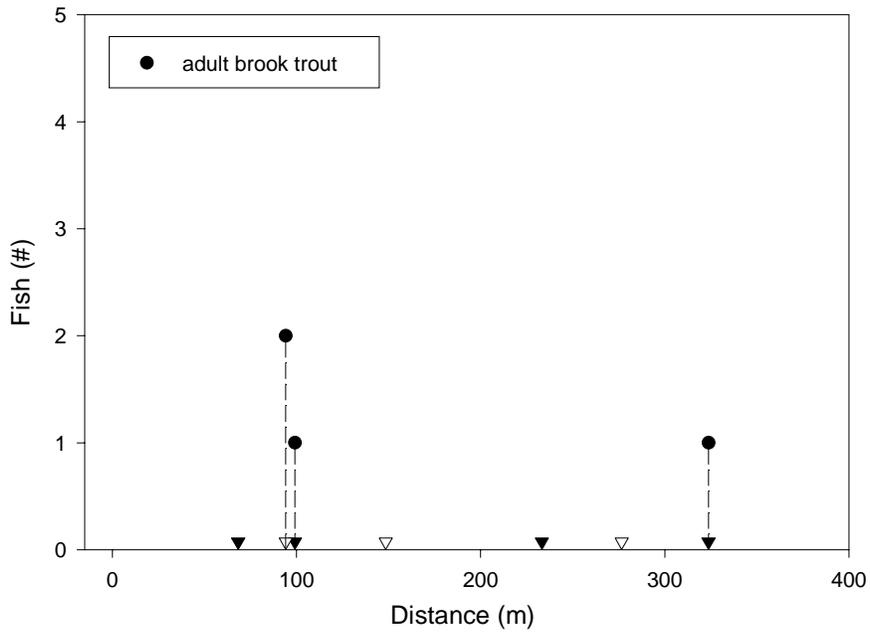


Figure 4: Fish species observed during diver counts in an unnamed tributary of Indian Camp Creek (adult fish). Triangles indicate sample sites (closed triangles indicate pools, open indicate riffles). Closed circles indicate the presence of adult brook trout. Distance is meters upstream from the confluence with Indian Camp Creek.

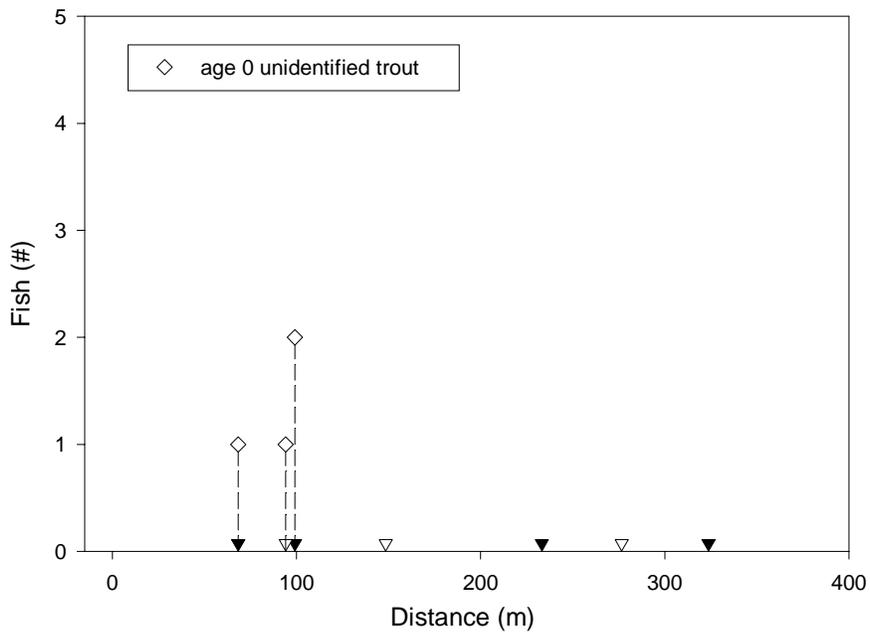


Figure 5: Fish species observed during diving counts in an unnamed tributary of Indian Camp Creek (age 0 fish). Triangles indicate sample sites (closed triangles indicate pools, open indicate riffles). Open diamonds indicate the presence of age 0 unidentified trout. Distance is meters upstream from the confluence with Indian Camp Creek.

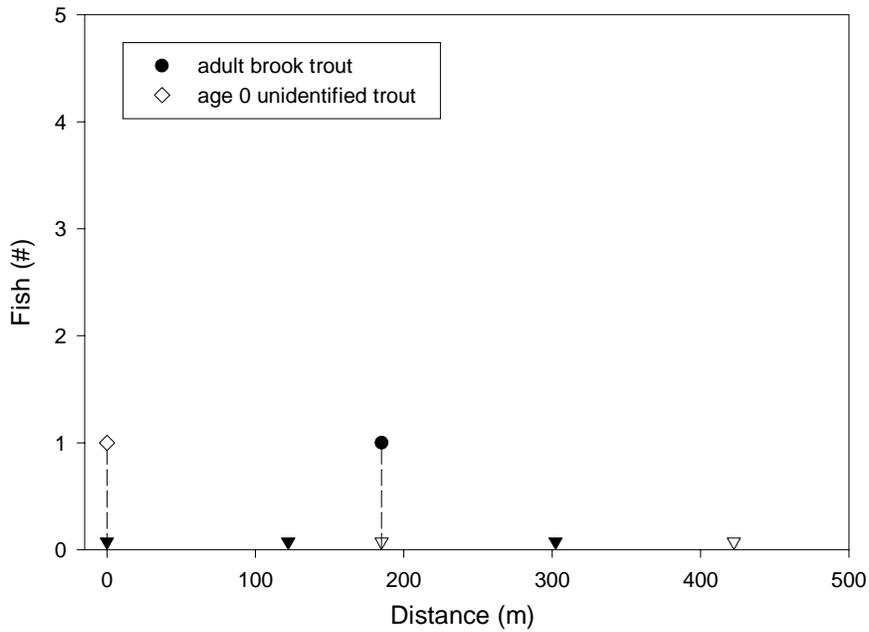


Figure 6: Fish species observed during diving counts in the mainstem of Pigpen Creek. Triangles indicate sample sites (closed triangles indicate pools, open indicate riffles). Closed circles indicate the presence of adult brook trout. Open diamonds indicate the presence of age 0 unidentified trout. Distance is meters upstream from trail crossing (UTM point: 307183 E, 3867203 N).

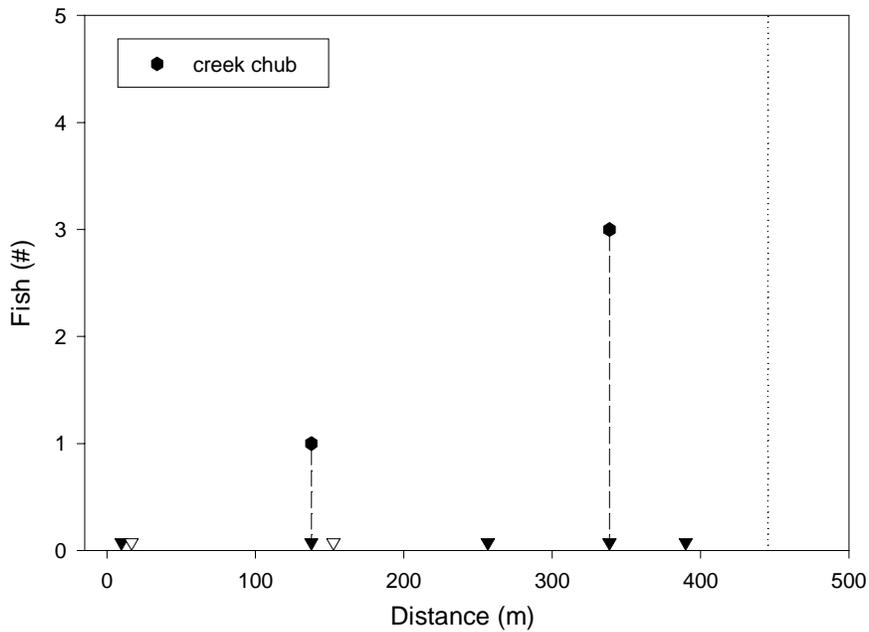


Figure 7: Fish species observed during diving counts in an unnamed tributary of Pigpen Creek. Triangles indicate sample sites (closed triangles indicate pools, open indicate riffles). Closed hexagons indicate the presence of creek chub. Dotted lines indicate location of potential fish movement barriers. Distance is meters upstream from confluence with the mainstem.

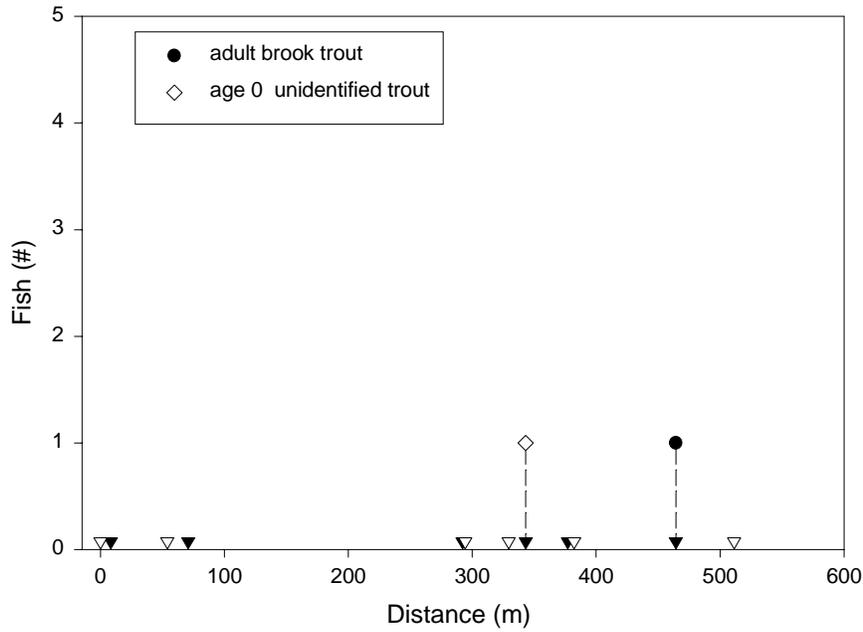


Figure 8: Fish species observed during diver counts in the west fork of Crane Creek. Triangles indicate sample sites (closed triangles indicate pools, open indicate riffles). Closed circles indicate the presence of adult brook trout. Open diamonds indicate the presence of age 0 unidentified trout. Distance is meters upstream of Forest Service road 709 culvert crossing.

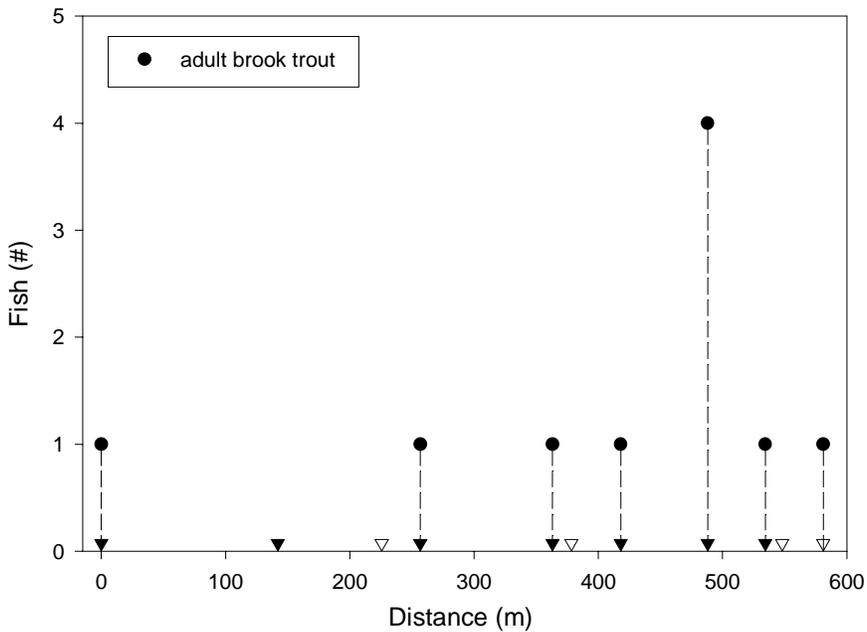


Figure 9: Fish species observed during diver counts in the east fork of Crane Creek. Triangles indicate sample sites (closed triangles indicate pools, open indicate riffles). Closed circles indicate the presence of adult brook trout. Distance is meters upstream of Forest Service road 709 culvert crossing.

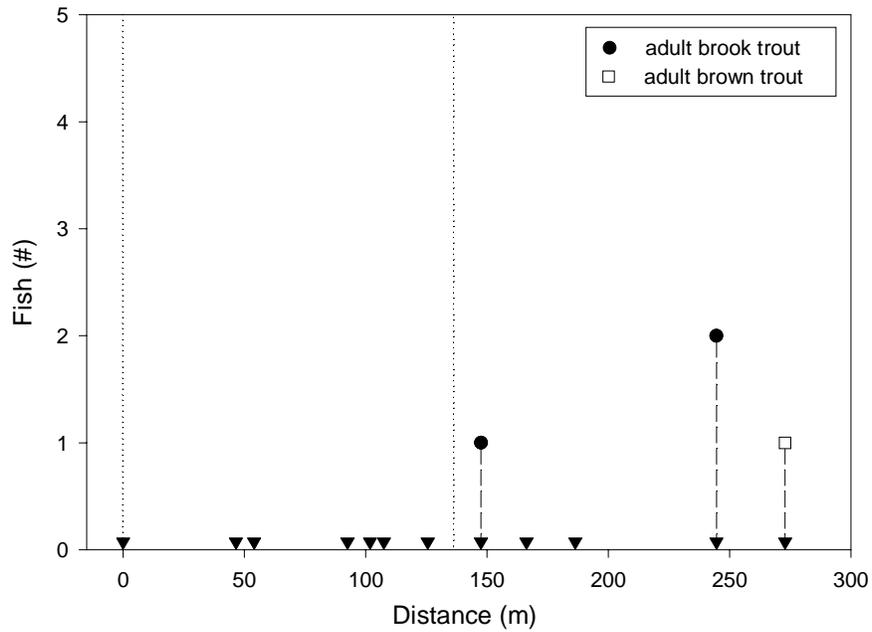


Figure 10: Fish species observed during diver counts in the mainstem of Crane Creek. Closed triangles indicate pool sample sites. Closed circles indicate the presence of adult brook trout. Open squares indicate the presence of adult brown trout. Dotted lines indicate location of potential fish movement barriers. Distance is meters upstream from survey start (UTM point: 308728 E, 3868368 N).

Appendix A: Field Data From Surveyed Stream Sections

Table A1: Mainstem Indian Camp Branch field data.

LOCATION: SUMTER NF		DIVER: J. MORAN						UTM coordinates		
STREAM: INDIAN CAMP BRANCH		RECORDER: JOHN								
DATE: 3/13/2002		NOTES: ALL GPS ZONE 17, NAD 27 UTM								
unit type	unit number	distance	species	count	age	unit length	unit width	east	north	comments
P	1	0.0	BRN	0	A	6	3.1	310962	3873455	START ABOVE DIVERSION IN POOL NOT INFLUENCED BY DAMN. WATER TEMP 9.
DAM								310855	3873288	BELOW START POINT. Concrete diversion dam for hatchery. Approx 1.2 m high. STREAM VERY SANDY.
P	10	141.1	NONE			9.3	4.8	311142	3873627	TREE TAG 691.
P	11	168.7	BRN	4	A					
R	10	212.0	BRN	1	A	6.4	6.6	310897	3873664	
TRIB		227.0								IN ON LEFT.
SPRG		274.3								.5 M WIDE
P	20	313.2	BRN	1	A	7.4	3.4	310926	3873751	BRN FEEDING.
TRIB		373.3								IN ON LEFT. LOTS OF LWD FORMING POOLS. LESS SAND BUT STILL ALOT.
LWD		405.5								LARGE HEMLOCK 1 M WIDE IN STREAM.
R	20	462.5	TRT	2	Y	11.4	2.6	310874	3873877	VERY SMALL, NOT ABLE TO ID.
P	29	570.7	BKT	1	A					4 IN.
TRIB		576.4								IN ON LEFT IN BEND OF MAINSTEM. SPRING. .5 M WIDE.
P	30	582.9	BKT	1	A	4	2.3	310865	3873977	5 IN.
R	30	653.5	NONE			3	4	310893	3874032	3 BRN ADULTS IN POOL BELOW THIS UNIT.
TRIB		667.1								IN ON RIGHT.
SCH		673.5								IN RT.
P	40	714.5	BKT	1	A	8.7	4.1	310846	3874080	SCH OUT ON RT.
TRIB		748.1					0.5			IN LEFT.
TRIB		780.9					0.75			IN LEFT.
TRIB		829.5					0.5			IN RIGHT.
P	50	871.0	BKT	1	A	4.5	3.7	310852	3874224	
			TRT	1	Y					PROBABLY BRN.
R	40	895.3	BRN	1	A	17.3	3.5	310852	3874254	
TRIB		1008.0								IN ON LEFT. 2.5 M.
TRIB		1014.0								IN RIGHT. 1 M.
P	60	1053.5	NONE			3.8	3.1	310886	3874371	3 BKT IN RIFFLE BEFORE DIVE UNIT.
TRIB		1095.1					1			IN RT.
R	50	1158.3	NONE			4.6	2.8	310818	3874474	GPS UPPER END OF UNIT.
P	67	1187.9	BKT	1	A					
P	70	1212.7	BKT	1	A	11.5	4.5	310818	3874518	
			TRT	1	Y					NOT ID'ED.
TRIB		1338.2					1			IN RIGHT.
R	60	1361.0	NONE			7.2	2.3	310822	3874663	FORM I CAMBARUS.
TRIB		1414.0								IN RIGHT.
P	80	1442.7	NONE			1.5	2	310823	3874714	
TRIB		1542.2					1.5			IN RIGT.
END SURVEY.										QUIT 1600.;NOT RETURNING TOMORROW.

Table A2: Unnamed tributary of Indian Camp Branch field data.

LOCATION: SUMTER NF		DIVER: CR						UTM Coordinates		
STREAM: INDIAN CAMP BRANCH TRIB		RECORDER: JOHN								
DATE: 3/13/2002		TRIB AT 1008 M OF MAINSTEM.								
unit type	unit number	distance	species	count	age	unit length	unit width	east	north	comments
P	8	68.4	TRT							WATER TEMP 9 C. NOT IDED.
R	7	94.2	BKT	2	A					
			TRT	1	Y					KEPT FOR ID.
P	10	99.2	BKT	1	A	5.7	2.4	310781	3874412	
			TRT	2	Y					NOT ID'ED. 5-10 MM.
R	10	148.5	NONE			7.6	2	310747	3874393	
TRIB		179.8								IN ON RIGHT. LARGE, PROBABLY HOLDS FISH, NOT CHECKED.
P	20	233.3	NONE			3	1.5	310648	3874437	
TRIB		200.0								IN ON RT, BEFORE POOL 20 AND AFTER LAST TRIB.
R	20	276.6	NONE			5.8	2.2	310613	3874458	
P	30	323.8	BKT	1	A	1.8	1.5	310578	3874419	4 IN. FISH. STOP TRIB SURVEY HERE.

Table A3: King Creek, section 1 field data.

LOCATION: SUMTER NF
 STREAM: KING CREEK, section 1
 DATE: 3/11/2002

DIVER: J. MORAN, C. ROGHAIR
 RECORDER: J. RILEY, MARK ?

unit type	unit number	distance	species	count	age	unit length	unit width	UTM Coordinates		comments
								East	North	
P	1	0.0	NONE	0		2.8	1.2	307020	3870670	1 FISH <50MM SEEN; START AT FLAT SECTION OF CREEK;10:30; SEE GPS COORDINATES; NO LANDMARKS; GPS NAD27; UTM; ZONE 17
R	1		NONE	0		2.7	3.8			NEXT UNIT US OF P1; ALL DISTANCES ARE TO THE DS END OF HABITAT UNITS
RN	5		NONE	0		10	3	307632	3871056	GPS TAKEN 2.5M RIGHT OF STREAM; SAW TIPULID AND WORM IN OPEN ON STREAM BED
P	5		NONE	0		3	4.5			NEXT UNIT US OF RN5
TRIB		89.0								IN LEFT;0.5M WIDE
R	10		NONE	0		17.1	4	308075	3869282	WATER TEMP: 8C
P	10					15	3.5			NO DATA TAKEN-OOPS
P	15		NONE	0		5.5	3.3	308173	3871031	GPS TAKEN 5M RIGHT OF STREAM
TRIB		325.3								IN LEFT;0.3M WIDE
R	15		NONE	0		12.8	2.6	307953	3871018	CADDIS; OPEN CANOPY;MACROPHYTES
TRIB		384.3								IN LEFT; 0.3M WIDE
P	20	406.8	NONE	0		10	2.7	307963	3870973	LOTS OF SAND;LWD;MACROPHYTES
R	20	469.1	NONE	0		2	3.5	307962	3870940	
P	25	493.3	NONE	0		7.9	5.6	307990	3870912	LOADED WITH SAND
FLAG		525.3								BLUE FLAGS MAKING TRANSECT ACROSS STREAM
R	25	562.2	NONE	0		11	2.8	307994	3870884	
P	30	603.3	NONE	0		4.3	5.2	308049	3870860	
TRIB		623.5								IN RIGHT 0.5M WIDE
R	30	698.2	NONE	0		3.5	1.5	308085	3870811	
P	35	702.6	NONE	0		3.8	5.2			NEXT UNIT US OF R30
TRIB		722.5								IN RIGHT
P	45	794.8	NONE	0		2.6	2.1	308167	3870783	GPS TAKEN 1M LEFT OF STREAM; SMALL PLUNGE POOL
R	45	821.1	NONE	0		8.9	3	308197	3870776	ONE METER US HAB BEGAN
P	50	864.1	NONE	0		5.2	3.6	308210	3870788	
BRIDGE		877.1								SMALL FOOTBRIDGE;JUST US OF P50;STOPPING THIS REACH HERE;GOING US TO ROAD CROSSING;14:00

Table A4: King Creek, section 2 field data.

unit type	unit number	distance	species	count	age	unit length	unit width	UTM Coordinates		comments
								east	north	
P	1	0.0	NONE	0		10	5	308682	3870821	BEDROCK FALL 6M HIGH AT US END OF UNIT, UNIT BEDROCK FILLED WITH SAND; WATER TEMP: 9C
C								308721	3870825	BEDROCK CASCADE;ENDS 43M US FROM START OF THIS SECTION;THIS IS THE BARRIER
P	10	128.9	NONE	0		6.6	3.8	308747	3870900	POOL LOADED WITH STICKBAIT CADDIS
R	10	152.8	NONE	0		3.2	2.1	308764	3870927	SAND COVERED WITH FINE SEDIMENTS BETWEEN HERE AND CULVERT IN LEFT;STEEP BEDROCK 0.5M WIDE
TRIB		151.1								
POOL	20	253.3	NONE	0		3.5	2.5	308851	3870919	
R	20	261.7	NONE	0		13.2	2	308855	3870926	
CULVERT		330.1						308920	3870997	ROAD 708 CULVERT;CONCRETE BOX CULVERT 2.5X2.5M;ENDS AT 357.4; END REACH 17:00
P	1	0.0	NONE	0		10	5	308682	3870821	BEDROCK FALL 6M HIGH AT US END OF UNIT, UNIT BEDROCK FILLED WITH SAND; WATER TEMP: 9C
C								308721	3870825	BEDROCK CASCADE;ENDS 43M US FROM START OF THIS SECTION;THIS IS THE BARRIER

Table A5: King Creek, section 3 field data.

LOCATION: SUMTER NF		DIVER: Craig Roghair								
STREAM: KING CREEK, section 3		RECORDER:								
DATE: 3/12/2002										
		UTM Coordinates								
unit type	unit number	distance	species	count	age	unit length	unit width	East	north	comments
P	1		NONE	0		2	2.2	309756	3871312	10 DEGREE C
RUN	1	2.0	NONE	0		4.5	2.2			SWIMMING SALAMANDER OBSERVED; NEXT UNIT US OF P1
CASCADE		85.3								1 M HEIGHT
RIFFLE	10	118.4	NONE	0		14.2	3.1			NO SATELITE SIGNAL
POOL	10	133.0	NONE	0		3.2	1.2			STILL SANDY; SINK TO YOUR ANKLES SANDY
TRIB		169.8								IN FROM LEFT; STRING FROM HAB SURVEY 2001 TO RITE IN KING CR
UNGR		204.2								UNGR FOR 3 M
RIFFLE	20	273.0	NONE	0		14.7	1.7	309992	3871394	
POOL	20	295.0	NONE	0		4.4	2.7	309999	3871391	CAMBARRUS SP MALE FORM 2 CAPTURED;CASCADE AT END OF POOL 1 M HEIGHT
CASCADE		392.6								2 M LENGTH FOLLOWED BY 2 ROCK SHELVES W/IN 15 M US 1/4 M HEIGHT
TRIB		436.8								IN FROM RIGHT
POOL	30	484.3	NONE	0		2.7	2.6			
RIFFLE	30	486.6	NONE	0		8.2				NO SATELITE READ
TRIB		504.5						310188	3871379	IN FROM RITE SPRINGHEAD; STOP HERE DAY 2 12:00; STILL RAINING; NO MORE WORK TODAY
NOTES										SALAMANDERS CAPTURED;POOLS SAMPLED BEYTWEEN UNITS NO FISH
								309235	3870841	king creek blue line trib - not surveyed but Jeanne gps it anyway
								307388	3871459	king creek falls - 900m upstream from confluence with Chattooga - gps by mark on the 15th

Table A6: Mainstem of Pigpen Branch field data.

LOCATION:		SUMTER NF		DIVER:		J. MORAN				
STREAM:		PIGPEN BRANCH		RECORDER:		C ROGHAIR				
DATE:		3/15/2002		NOTES:		ALL GPS ZONE 17 NAD 27 UTM; STARTING AT TRAIL CROSSING ON MAP 10:30				
UTM Coordinates										
unit type	unit number	distance	species	count	age	unit length	unit width	east	north	comments
P	1	0.0	TRT	1	Y	13.2	4	307183	3867203	DIST IS METERS TO DS END OF UNIT; LOTS OF SAND HERE; WATER TEMP 11C; POOLDS OF CROSSING
P	11	122.1	NONE			4.5	4.7	307247	3867295	OOPS-MISSED P10; SAW 3IN ADULT BKT IN NEXT UNIT US (RUN)
R	10	185.1	BKT	1	A	26.1	3	307295	3867342	LONG BEDROCK SLIDE, MOSTLY TOO SHALLOW TO DIVE; BKT 3IN; SAW 7 YOY TRT IN NEXT POOL
P	20	302.3	NONE			7.2	5.4			POOL BETWEEN BEDROCK SLIDES FILLED W SAND; NICE BIG POOL; NO GPS COVERAGE
TRIB		365.1								IN RIGHT 1M WIDE; COMES IN UNGR BUT CAN SEE IT ON RIGHT
R	20	422.5	NONE			6.1	4.3	307472	3867415	ACTUALLY SOME COBBLE/PEBBLE HERE
TRIB		441.2								IN RIGHT 3M WIDE; THIS IS THE FORK THAT GOES UP TO BURLES PLACE GOING UP TRIB; START NEW SURVEY; THEY ALREADY HAVE EFISH DATA UPSTREAM ON MAINSTEM

Table A7: Unnamed tributary of Pigpen Branch field data.

LOCATION: SUMTER NF DIVER: J. MORAN
 STREAM: PIGPEN BRANCH TRIB ON RIGHT GOES TO BURLES PLACE RECORDER: C ROGHAIR
 DATE: 3/15/2002 NOTES: ALL GPS ZONE 17 NAD 27 UTM; START11:30, CONFLUENCE 307435 3867444

unit type	unit number	distance	species	count	age	unit length	unit width	UTM Coordinates		comments
								east	north	
P	1	9.8	NONE			6	3.1	307464	3867454	
R	1	16.6	NONE			4.4	2.9			FIRST RIFF ENTIRE IN TRIB
TRIB		35.4								IN LEFT 1M WIDE NICE CASCADE ON IT
P	10	137.7	CHUB	1	A	3.5	2.7	307516	3867329	TRIB LOW GRADIENT 2-3% LIKE MAINSTEM; JUST CAUGHT GLIMPSE OF FISH
R	10	152.6	NONE			6.5	3.7			2 UNITS US OF P10;WATER TEMP 11C;JOHN SAW CRAYFISH;STILL SANDY BUT NOT BAD AS MAINSTEM
P	20	256.7	NONE			3.4	3.7			NO GPS COVERAGE;GETTIG A LITTLE STEEPER HERE
TRIB		301.0								IN LEFT STEEP 1M WIDE; BEDROCK AREA - 1M HIGH FALL/CASCADE JUST US
R	20	328.9	NONE			2.2	1.6			NO GPS SIGNAL
P	36	338.7	CCHUB	3		7.1	3.2			ON RECON DIVE JOHN SAW 3, 1.5 IN CREEK CHUB-DARK SPOT AT BASE OF DORSAL
P	40	390.0	NONE			9	5	307591	3867140	
FALL		445.7						307626	3867104	BEDROCK FALL/CASCADE 45DEGREE SLOPE 5M HIGH, ANOTHER JUST US
										ENDING HERE 12:35-LAST SITE THIS TRIP;BACK TO B'BURG
										JOHN RECON DIVE ABOVE FALLS=NO FISH BUT A THIRD CASCADE 8M HIGH UP ABOVE THESE TWO

Table A9: East Branch of Crane Creek field data.

LOCATION: SUMTER NF		DIVER: C. ROGHAIR								
STREAM: CRANE CREEK EAST BRANCH		RECORDER: J. RILEY								
DATE: 3/14/2002		NOTES: START US OF CULVERT;ALL GPS ZONE 17 NAD27 UTM								
		UTM Coordinates								
unit type	unit number	distance	species	count	age	unit length	unit width	east	north	comments
								308734	3868481	START 09:30 AT US END OF CULVERT;4 INCH BKT POOL BELOW CULVERT; NOT BARRIER
POOL	1	0.0	BKT	1	ADULT	42.9	1.9			US CULVERT; 6 IN FISH; SANDY SUBSTRATE
RIFFLE	1			0		4	1.5			NEXT UNIT US POOL 1
POOL	10	142.0		0		10.4	1.8	308817	3868589	FULL OF SAND; FORMED BY LWD DEBRIS DAM
		180.4								TRAIL XING
RIFFLE	10	225.7		0		3.5	2	308800	3868656	
GLIDE	20	256.6	BKT	1	ADULT	13	1.6	308787	3868693	3 INCH FISH
POOL	30	363.1	BKT	1	ADULT	14.7	1.9	308774	3868752	3 INCH FISH
RIFFLE	20	378.3		0		15.5	3.5	308773	3868754	7 FOOT ERODING BANK ON LEFT IN STREAM CURVE FOR 8 FT
		418.0	BKT	1	ADULT					POOL OBSERVATION
		443.1	TRT	3	YOY					APPROX 10 ML LENGTH; OBSERVED SIDE POOLOFF RIFFLE;BKT?
		488.0	BKT	4	ADULT					OBSERVED IN POOL; APPROX 3 INCH FISH
		449.5								FOOT TRAIL XING
POOL	40	534.4	BKT	1	ADULT	2.5	2.5	308801	3868851	8 INCH FISH;BIGGEST BY FAR I'VE SEEN; NEW STATE RECORD?!
RIFFLE	30	547.9		0		11	2	308790	3868870	REAL SHALLOW
CASCADE	1	581.0						308760	3868882	END. Not a fish barrier but good impediment.
		581.0	BKT	1	ADULT					4 IN FISH; IN POOL BELOW CASCADE
			BKT	2	ADULT					5 IN FISH; IN POOL US CASCADE; 1 FEMALE CAMBARUS NON GRAVID
										DONE AND HIKING BACK TO TRUCK 11:30;OLD ROAD BED AND TRAIL ON LEFT OF STREAM

Table A10: Mainstem of Crane Creek field data.

LOCATION:		SUMTER NF		DIVER:		C. ROGHAIR, J MORAN				
STREAM:		CRANE CREEK MAIN STEM		RECORDER:		J. RILEY, M GARNER				
DATE:		3/14/2002								
								UTM Coordinates		
unit type	unit number	distance	species	count	age	unit length	unit width	east	north	comments
POOL	1	0.0				14.3	4	308728	3868368	DOING RECON; DIVING NICE POOLS LOOKING FOR BROWN TROUT;ADULT BNT? OBSERVED GPS AT BOTTOM OF CASCADE; POSSIBLE BARRIER
POOL	3	46.5		0		4	3.2			
POOL	4	54.0		0		3.3	3.2	308800	3868323	
POOL	5	92.5		0						
POOL	6	101.8		0			3.5			
POOL	7	107.5		0						
POOL	8	125.6		0						
CASCADE		136.1		0		9.4	8.9	30821	3868384	40 PER CENT SLOPE
POOL	9	147.5	BKT	1	ADULT	5.1	6.1			BETWEEN CASCADES; 3 IN FISH
CASCADE		152.6		0						
POOL	10	166.3		0						
CASCADE		177.3		0						
POOL	11	186.4								
POOL	12	244.6	BKT	2	ADULT					4 IN FISH; KNEE DEEP SEDIMENT FOOT BRIDGE XING
POOL		260.1								
POOL	13	272.9	BNT	1	ADULT	11	2.3			5 IN FISH
POOL ENDS		285.0								AT CONFLUENCE EAST AND WEST FORKS CRANE CREEK DONE AT 15:00;1 MINUTE HIKE BACK TO ROAD; GOING TO GPS UPPER AND LOWER BOUDARY OF FISH BARRIERS ON LOWER MAINSTEM NOW

Table A11: Description of a lower reach of the mainstem of Crane Creek.

Date: 3/14/2002
 Crew: J.Moran, C. Roghair
 Comments: Start at FS road 107 crossing. Note: no diver survey performed. Just locating fish barriers.

Distance (m)	Description	UTM Coordinates		comments
		east	north	
0	Bridge on FS 107	310043	3866339	
144	s_ch in right			Camp site and trail crossing just below this point.
221	s_ch out right			
285	s_ch in left			
306	s_ch out left			
410	cascade/waterfall	309764	3866493	Approx 9 m high. Fish could possibly get around left side. Pool below fall is shallow and full of sand.
450	bedrock slide			
508	bedrock slide	309673	3866496	7 m high, 8 m long. Definite fish barrier. Deep pool below. Several northern dusky salamanders observed on left bank in wet, rocky area adjacent to slide.
735	bedrock cascade			Potential fish barrier. Did not observe any fish while walking upstream.

End survey here. Time: 1635