

**RESULTS OF SURVEYS FOR DUSKYTAIL DARTERS,
ETHEOSTOMA PERCNURUM,
IN COPPER CREEK, SCOTT COUNTY, VIRGINIA 2008**
ADDENDUM

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Duskytail darter in Copper Creek October 14, 2008.

INTRODUCTION

The duskytail darter, *Etheostoma percnurum*, was described by Jenkins (Jenkins and Burkhead 1994) designating the type locality as Copper Creek just below Obeys Creek, Scott County, Virginia. The species is known from only five stream systems scattered throughout the upper Tennessee River drainage and one Cumberland River stream, the Big South Fork Cumberland River. Various recent status surveys have verified that populations persist in the Big South Fork (BSF) from Tennessee to Kentucky (Burr and Eisenhour 1996, CFI 2003, Scott 2007), as well as the Little River (Rakes and Shute 2007b) and Citico Creek, and have been restored to Abrams Creek (Shute et al 2005, Rakes and Shute 2007a). No recent status surveys have been conducted for the Copper Creek population.

Layman (1991, 1984a, 1984b) described life history and reproductive attributes of the species based on the Little River population. CFI personnel assisted in field and lab work for that study and later utilized the knowledge gained to initiate propagation efforts in 1993 that led to the Abrams Creek restoration (Shute et al 2005). More recently, propagation efforts have been employed to attempt expansion of the distribution of the Little River population above a dispersal barrier (Rakes and Shute 2007b). In all these efforts ongoing monitoring of source and stocked populations has been conducted on an annual basis. CFI has also indirectly observed Copper Creek duskytail darter populations in conjunction with yellowfin madtom surveys and collections since the mid-1990s.

Blanton and Jenkins (2008) recently diagnosed morphological variation between the above-described duskytail darter populations and described them as four species. The name *percnurum* is retained for the Copper Creek population since it is the type locality for the species. In 2002, CFI collected fin clip tissues from the BSF and Copper Creek and Citico Creek populations for a genetic comparison which may provide further support for taxonomic elevation (Dillman and Wood pers. comm./unpubl. ms.). Because *E. percnurum* now resides only in Copper Creek (Blanton & Jenkins 2008), this species is even more critically imperiled, emphasizing the importance of conservation of the population and its habitats. Knowledge of distribution and abundance is even more urgent to protection and management. A current survey of this population was conducted to evaluate the status of the species in Copper Creek and to determine the need to augment the population. A survey protocol is also proposed herein to monitor the species over time and evaluate any efforts that may assist the species toward recovery.

METHODS AND BACKGROUND

Duskytail darters can be extremely difficult fish to collect by standard fisheries techniques, as they generally remain hidden under cover rocks during daylight hours. Jenkins (Ibid) described “kick-hauling” collections with a seine as the most effective technique. We have participated in a modification of the technique that targets and encircles slab/cover rocks with a seine with Layman (Ibid) and Burr and Eisenhour (Ibid) and Etnier (Etnier and Starnes 1993), but prefer the less invasive/disruptive technique of snorkeling and carefully lifting rocks to locate and observe duskytail darters.

CFI personnel conducted snorkel surveys at select sites in Copper Creek during summer and fall 2008 to ascertain the current status and range of the population. Most of Jenkins's collection areas (p. 881, Jenkins and Burkhead 1994) throughout the then known range of duskytail darters in Copper Creek were first mapped using DeLorme XMap 5.2 Professional software. Discrepancies in his designated creek kilometers and currently mapped creek miles on the most recent USGS revised quadrangles were discovered and adjustments were made based on tributaries and other landmarks. Survey sites were confined to those where landowner permission could be secured. All sites were visually surveyed for duskytail darters and other fish species by either two or three experienced biologists using snorkel gear in either wetsuits or drysuits. Typical search protocol entailed entering the stream at a shallow riffle and walking upstream into water at least 6" in depth, then methodically snorkeling upstream and slowly lifting slab rocks, large cobble, and small boulders across the entire stream width. Searches were timed to calculate Catch Per Unit Effort (CPUE: # fish per person-hour) as a measure of relative abundance. Some individuals were briefly captured with a small hand net for closer examination. Only a few were digitally photographed *in situ* underwater—most individuals "bolted" at even the most cautious approach of a camera despite often remaining motionless for prolonged periods otherwise.

Notes were taken that identified signs of reproduction and successful recruitment (i.e., nests and/or young-of-the-year fish), as well as habitat condition. Statistically robust quantitative methods for sampling this population were not employed because: (1) it would be too cost prohibitive, (2) it could be destructive and result in harm and mortality to specimens, and (3) the data collected from quantitative methods were not necessary to adequately survey the population. Sites were plotted and mapped with a DeLorme Earthmate GPS unit and DeLorme XMap 5.2 Professional software and are described below in creek miles in keeping with USGS quadrangle maps; however, most other distances are metric.

RESULTS AND DISCUSSION

All sites surveyed and fish observed in Copper Creek by CFI personnel in 2008 are presented in Table 1, arranged by Copper Creek Mile (CCM). These include sites well above the known range of duskytail darters (~CCM 17.5), but are presented here to confirm our observations of the presence of fantail darters, *Etheostoma flabellare*, and corresponding absence of duskytail darters. Although the target species in most of these latter surveys was yellowfin madtom, *Noturus flavipinnis*, survey protocols were essentially identical. Maps of all lower study sites with coordinates can be found in the Appendix. We surveyed 21 sites between 1 May and 15 October and tallied possibly 50 species [Note that several species have associated question marks, denoting uncertain identification, generally due to only brief glimpses and/or poor visibility].

Ninety-eight duskytail darters were observed at 7 sites, spanning approximately 12 of the lower 14 miles of Copper Creek. Table 2 presents additional survey data for duskytail and fantail darters including effort in person-hours, CPUE, and rough demographics for the duskytails (typically, fish <45 mm TL in the fall were considered YOYs). Note: of the pair of *Catonotus* darters, *E. percnurum* was observed only up to CCM 13.8, while *E. flabellare* was observed from CCM 52 down to CCM 11.5, with an area of overlap of approximately 2.3 creek miles observed in this study.

Copper Crk Mile / Date Field Note # ScientificName	~0.25 / 2-Jul CFI08-047	~0.75 / 5-Oct CFI08-124	1.8 / 17-Jun CFI08-040	1.9 / 26-Jun CFI08-045	~2.6 / 7-Oct CFI08-112	4.8 / 7-Oct CFI08-113	6.6 / 7-Oct CFI08-114	7.6 / 15-Oct CFI08-125	8.5 / 7-Oct CFI08-115	9.75 / 14-Oct CFI08-123	11.5 / 14-Oct CFI08-122	12.5 / 8-Oct CFI08-117	13.75 / 8-Oct CFI08-118	17.6 / 3-Jun CFI09-028	20.6 / 14-Oct CFI08-121	34.5 / 1-May CFI08-021	40.0 / 1-May CFI08-022	40.0 / 3-Jun CFI08-032	40.0 / 15-Oct CFI08-126	48.0 / 22-May CFI08-029	50.5 / 22-May CFI08-030	52.0 / 22-May CFI08-031
<i>Ambloplites rupestris</i>		F		F	F	S	F	2	S		F			1	S	1	F			S	S	
<i>Campostoma oligolepis</i>	A	A	C?	A	A	A	C	AA	A	C	C	A	C/A	C	A	A	A	C	C	A	A	C
<i>Cottus sp.</i>									4?													
<i>Cottus carolinae</i>				F	F	1	2	1		F		S	S/C	1	5-6	S	F	F	C	1	1	
<i>Cyprinella galactura</i>	F		S	C	S		F		C			S	C	C		S	C	S		F		
<i>Cyprinella spiloptera</i>							F															
<i>Erimystax dissimilis</i>	S	C			S	F	C	S	C	S		F	F									
<i>Erimystax insignis</i>								S							7-8	C		S		F		
<i>Etheostoma blennioides</i>	C	C/A	A	A	C/A	C	C	A	C	F	C	C	A	F	A	S	S/C	S	C	F	S	
<i>Etheostoma camurum</i>	F	2		F																		
<i>Etheostoma cinereum</i>			1																			
<i>Etheostoma flabellare</i>											2	2	2	A	2	A	S/C	S	C	C	C	1
<i>Etheostoma meadiae</i>							1		S				6									
<i>Etheostoma percnum</i>			50	14			1			12	8	6	7									
<i>Etheostoma rufilineatum</i>	S/C	C	S	F	S	C		S/C	C	F/S	C	C	A	S	C	S	C	C	C	C	C	
<i>Etheostoma tennesseensis</i>	C	C/A	S	C	C	C	C	S/C	A	S/C	C	F	C		A	AA	A	A		A	A	S
<i>Etheostoma vulneratum</i>		2	A	C	C	S	C	2	F		1	F	F	C	1							
<i>Etheostoma zonale</i>													1		1							
<i>Fundulus catenatus</i>	F	F	C	F				S/C	S	F											S-C	S
<i>Hybopsis amblops</i>		C		S	A	C	S/C	C	A	F	F	C	F		F	F	S	S	S	F		
<i>Hypentelium nigricans</i>	S	F/S	F	S	C	C	C	C	C	F	C	C	S	C	C	F	S	F	F	C	C	S
<i>Lepisosteus osseus</i>						1		3														
<i>Lepomis auritus</i>		F									1										1	
<i>Lepomis macrochirus</i>																					F	
<i>Lepomis sp.</i>				F	F		?															
<i>Luxilus chrysocephalus</i>	C/A	A	C/A	C	A	C	C	A	A	AA	A	A	C	C	A	C	A	A	C	AA	A	C
<i>Luxilus coccogenis</i>		A		S	S		C	A	C/A	A	A	A	C	F	A	C	C		C	F	C	
<i>Lythrurus lirus</i>								?									S				S	
<i>Micropterus dolomieu</i>	S	S	F	S	S	S	F	S	S	F	S	F	F	F			F			S	F	
<i>Moxostoma duquesnei</i>															A							
<i>Moxostoma sp.</i>		C	1dead	F	F	1	S	C/A	S				F	S		S	S			S-C	C	S
<i>Nocomis micropogon</i>	S/C	C/A	nest	F		S	S	A	S	F	S	S	F		S/C	C	C	C	S	F	S	
<i>Notropis leuciodus</i>		C	S/C	C	C	C	C	C/A	C	F	S	C	C	1	S	A	C	A		S	A	
<i>Notropis photogenis</i>							1	C														
<i>Notropis sp. "sawfin shiner"</i>	S		nest		F			C									S					
<i>Notropis telescopus</i>			1dead		S			C														
<i>Notropis volucellus</i>								?														
<i>Noturus eleutherus</i>											1											
<i>Noturus flavipinnis</i>			9(2)	11(2)	1	5			2		2	5	4	1						4*		
<i>Noturus flavus</i>				1	1							1										
<i>Percina aurantiaca</i>	S	F	C	C																		
<i>Percina burtoni</i>		7-8			6	3	1	4														
<i>Percina caprodes</i>					1							1										
<i>Percina evides</i>	S	S/C	F	S/C			1															
<i>Percina sciera</i>				1?																		
<i>Percina williamsi</i>				1?																		
<i>Phenacobius uranops</i>		S/C				3	S		1													
<i>Pimephales notatus</i>							C	AA					F		2-3							
<i>Rhinichthys obtusus</i>																					F	
<i>Semotilus atromaculatus</i>																					?	

Key: F (few) <5; S (several) ~5-10; C (common) ~10-25; A (abundant) >25; AA (very abundant) >50
*stocked yellowfins

Table 1. Fish species and numbers observed during 2008 at each survey site, sorted by Copper Creek mile.

Scientific Name	Field Note #	Date	Locality	R Mi	#	Effort (p-hrs)	Fish / p-hr	Year class
<i>E. percnum</i>	CFI08-047	02-Jul	From mouth upstream ~350m	0-0.25		3	0.0	
<i>E. percnum</i>	CFI08-124	15-Oct	From ford below tribs at Horton Cemetery to CCM 1.0	0.75-1.0		3	0.0	
<i>E. percnum</i>	CFI08-040	17-Jun	@ the lowest bridge crossing (VA 627) ~50 m up & ~300m down	1.8	50	10	5.0	45AD 5YOY
<i>E. percnum</i>	CFI08-045	26-Jun	@ the lowest bridge crossing (VA 627) & ~150m up	1.9	14	6	2.3	poor vis.- most=AD
<i>E. percnum</i>	CFI08-112	07-Oct	Northern bend above Jennings Ford, above northern trib	2.6-3.0		3	0.0	
<i>E. percnum</i>	CFI08-113	07-Oct	100m above unnamed trib ~1 mi above Spivey Ford	4.8		3	0.0	
<i>E. percnum</i>	CFI08-114	07-Oct	Lawson Memorial Church up to unnamed ford	6.6	1	3	0.3	AD
<i>E. percnum</i>	CFI08-125	15-Oct	Below Spivey Mill Dam to 250m below VA CR 665	7.6		2.5	0.0	
<i>E. percnum</i>	CFI08-115	07-Oct	@ mouth of Blackoak Branch	8.5		2.25	0.0	
<i>E. percnum</i>	CFI08-123	14-Oct	Mouth of Lark Creek	9.75	12	1.5	8.0	8AD 12YOY
<i>E. flabellare</i>	CFI08-122	14-Oct	~500 m above Flower Branch	11.5	2	3	0.7	
<i>E. percnum</i>	CFI08-122	14-Oct	~500 m above Flower Branch	11.5	8	3	2.7	5AD 3YOY
<i>E. flabellare</i>	CFI08-117	08-Oct	Mouth of Plank Camp Creek	12.5	2	2.5	0.8	
<i>E. percnum</i>	CFI08-117	08-Oct	Mouth of Plank Camp Creek	12.5	6	2.5	2.4	YOYs
<i>E. flabellare</i>	CFI08-118	08-Oct	Below VA 72 Bridge and Obeyes Branch (~75m)	13.8	2	2	1.0	
<i>E. percnum</i>	CFI08-118	08-Oct	Below VA 72 Bridge and Obeyes Branch (~75m)	13.8	7	2	3.5	YOYs
<i>E. flabellare</i>	CFI09-028	3-Jun-09	Mills farm, above upper island	17.6	A	3	N/A	~15AD ~13YOY
<i>E. flabellare</i>	CFI08-121	14-Oct-08	@ and ~100m above mouth of Hale Spring run	20.6	2	3	0.7	1AD 1YOY
<i>E. flabellare</i>	CFI08-021	01-May	@ Dorton Fort	34.5	A	4	N/A	
<i>E. flabellare</i>	CFI08-022	01-May	@ VA 682 bridge	40	C	2.5	N/A	
<i>E. flabellare</i>	CFI08-032	03-Jun	@ VA 682 bridge	40	S	1	N/A	
<i>E. flabellare</i>	CFI08-126	15-Oct	@ VA 682 bridge	40	C	2	N/A	
<i>E. flabellare</i>	CFI08-029	22-May	500-750m below Jessee Cemetery, beside VA 678	48	C	2	N/A	
<i>E. flabellare</i>	CFI08-030	22-May	Bend above Dorton Cemetery between VA 679 & L. Copper Creek	50.5	C	1	N/A	
<i>E. flabellare</i>	CFI08-031	22-May	~CCM 52 along VA 678 W of Meade Cemetery	52	1	0.25	4.0	

Table 2. Duskytail and fantail darter survey results, sorted by Copper Creek mile.

Duskytail darter abundance, as measured by CPUE, ranged from 0 to 8 fish/p-hr. None were observed in the lower 0.75 mile of the creek or at 4 of the 11 sites above CCM 1.8, indicating a fairly “patchy” distribution within the overall range. Jenkins (p. 881, Jenkins and Burkhead 1994) summarized 98 collection records in numbered areas of Copper Creek from approximately 1967 through 1985. Duskytail darters were collected or observed during that time span from near the mouth of the creek up to around CCM 17.4 mostly by seining and/or shocking (therefore little of the CPUE/abundance data are directly comparable to ours). Examination of the original field notes from all these collections reveals that the majority of the efforts captured only one or a few duskytail darters with the exception of a few areas where much greater numbers were sometimes taken. Comparisons of data provided by Jenkins and TVA for each area/reach are discussed below, with Copper Creek mileages (CCM) produced from USGS topos (see maps in Appendix) by using descriptions or coordinates from original field notes.

Area 1, [CCM 0-0.99] mouth to just above suspension bridge, along VA 627: a total of 36 duskytail darters were collected prior to 1972, including 30 in a single 1971 effort, but none since. We snorkeled the entire lower and upper thirds of this reach without finding any duskytails. Though appropriate small slab rocks and cobble cover were relatively common, underlying substrates were generally coarser than what we conceive to be ideal for *E. percunurum* (i.e., lacking depositional sand and coarse inorganic silt). We wonder if this is responsible for the species absence and whether this might be the result of hydrologic alterations of this part of Copper Creek or some other chronic negative impact is occurring.

Area 2, [CCM 2.6-3.0 & 1.8-1.85] Jennings Ford area & VA 627 bridge: the “lowest Rt. 627 ford” was sampled at least 20 times between 1967 and 1992. Only 24 duskytail darters were collected, half of those taken in a lone 1967 effort. We snorkel surveyed just above the ford (in 2007) as well as the reach in the northern bend above the ford, but found no duskytail darters. As described above, habitat is marginal around the ford but begins to improve upstream near CCM 3.0. In contrast, we have consistently observed numerous duskytails below the VA 627 bridge (1997: 9, 2002: 50, 2007: 12), as did Jenkins and Burkhead in a snorkel survey in 1973 (9) and TVA workers in 1981 (24), 2002 (6) and 2007 (8). This year we discovered that the long shallow pool above the bridge also contains ideal habitat for duskytail darters—64 individuals were observed in two snorkel efforts extending above and below the bridge while searching for yellowfin madtoms in June. We have observed more duskytail darters in this small area than anywhere else in Copper Creek and consider it to be “model” habitat for the species in this stream: broad, shallow, gently flowing pools and glides, with cobble and slab rocks resting on a matrix of depositional sand and coarse silt. Moderate siltation doesn’t seem to be problematic so long as cavities under rocks remain fairly clean.

Area 3, [CCM 4.3-4.9, 5.5] along VA 627 above and below VA 644: only one duskytail darter has been collected in this reach (1970) in 7 past efforts. Large areas of this reach are dominated by bedrock. The reach we surveyed ~400m above VA 644 had suitable habitat (& 5 yellowfin madtoms), but no duskytails.

Area 4, [CCM 6.3-6.5] Bellamy area, off VA 627, below and above ford above Sorrel Creek: only a few duskytails have been collected in the past around the ford above Bellamy (~6 in 11 collections). We surveyed from 500 to 1500 m above the ford and only found one.

Area 5, [CCM 7.4-7.75] Spivey Mill area, below dam by VA 627-665: another reach of Copper Creek dominated by bedrock; only 3 duskytails have been observed here (12 collections 1968-92). We found none this year or in a 2001 effort.

Area 6, [CCM 7.8-8.5] Spivey Mill Pond, along VA 627 and 665: only 6 historic collections of this reach with 5 duskytails observed, all in 2 efforts (1969, 1970) near the mouth of Blackoak Branch. We were unable to find much suitable habitat (i.e., very few cover rocks).

Area 7, [CCM 8.5-8.9] ~1/2 mile reach above Blackoak Branch, just above Spivey Mill Pond, along VA 627: 8 collections (1969-92) produced 18-20 duskytail darters. We surveyed only the bottom of the reach (above) following pre-plotted creek kilometers, but noted possible suitable habitat upstream (from road). Our survey upstream at/above the mouth of Lark Creek (~CCM 9.75) yielded 12 duskytails in only 1.5 p-hrs effort, the highest CPUE we have ever recorded in Copper Creek (8.0 duskytails/p-hr). Apparently high quality habitat was visible in the mile upstream.

Area 8, [CCM ~10.6-11.6], Flower Branch mouth area, along VA 627: only 3 historic collections here with 16 duskytails collected from a 65m reach one night in 1970. TVA collected a lone fantail (but no duskytails) just above this reach at CCM 11.8 in 1996. Our survey in the upper part of this area (CCM 11.5) yielded 8 duskytail darters as well as 2 fantail darters with only 3 person-hours effort.

Area 9, [CCM 12.5-12.7], Camp Creek mouth and along VA 627 up to VA 619 bridge: again only 3 older historic collections yielding only 2 duskytails. TVA surveys collected one duskytail here (CCM 12.6) in 1996 but only one fantail in 1997. Our survey of this reach produced 6 duskytail and 2 fantail darters in only 2.5 p-hrs effort.

Area 10, [~CCM 13.4-14.5], Obeys Creek mouth area, along VA 627, bisected by (new) VA 72 bridge: 9 collections between 1967 and 1992 have produced more than 120 duskytail darters here, by far the most productive historical area in Copper Creek. More recently (1996), a TVA survey at the foot of the reach (CCM 13.4) yielded no *Catnotus* darters. CFI has also worked here for many years primarily monitoring and collecting yellowfin madtoms--typically looking under only larger slab rocks, therefore potentially 'missing' many *Catnotus*-- with far fewer duskytail darter observations: 1997 (1), 1998 (0, 1, 2), 2001 (0, 0, 10). This year we surveyed the 75 m reach below Obeys Creek, finding 7 duskytail and 2 fantail darters.

Area 11, [CCM 17.3-17.4], 3.1 air km NE mouth Obeys Creek, below tail of island above CCM 17: one collection here in 1970 captured 46 duskytail darters. **This is an extremely inaccessible area, for which we were only able to secure landowner permission to visit after the end of the 2008 field season. A snorkel survey at the most accessible part of this reach at CCM 17.6 on June 3rd, 2009 found abundant fantail darters**

as well as a yellowfin madtom, but no duskytail darters. Abundant slab rocks and cobble situated in slow, shallow glides and transition zones provided excellent habitat for both *Catnotus* species. Although we can not absolutely rule out the presence of *E. percnum* only a couple hundred meters downstream, it seems extremely unlikely and therefore appears that fantail darters have replaced a formerly robust duskytail darter population here.

Area 12, [CCM 20.5-20.6], [CCM 21.3-21.4], Hale Spring mouth and north end of next upstream bend, off Rt. 670: 4 collections here between 1964 and 1970 found only fantail darters. Our snorkel survey also detected only fantail darters—no duskytails. Nearly the entire stream bottom here is bedrock, with only isolated patches of any depositional substrates.

CONCLUSIONS AND RECOMMENDATIONS

With some notable exceptions, the results of our surveys for duskytail darters in Copper Creek do not differ greatly from data collected prior to 1993. We found the range to still be at least as far upstream as near Obeyes Creek (CCM 13.8), **but in the most recent survey around CCM 17 we were unable to find (formerly common) duskytail darters, suggesting a possible range contraction and/or exclusion by fantail darters.** As noted by Jenkins and Burkhead (1994), duskytail darter abundance in Copper Creek apparently remains “generally rare or uncommon” within much of its range, but our efforts found that there are still localized populations with good numbers. The absence of duskytail darters from the lowest mile of the creek, where they were taken in significant numbers prior to 1972, and the possible decline in abundance around **and possibly upstream of** Obeyes Creek may be real causes for concern and merit careful future monitoring. Given that this is an extremely microhabitat-specific fish (like many rare darters) the patchiness of its distribution can be considered normal. Only portions of the creek with appropriate depth, flow regimes, and substrates—cobble and slab rocks on a finer matrix—can support *E. percnum*. Because natural events can cause particular reaches to change over time, areas once suitable for a species with such narrow microhabitat requirements may not be suitable a decade later. Microhabitat changes over time could account for not seeing duskytail darters in the lowest mile of Copper Creek, and the decline noted in other areas. Future monitoring efforts should be (flexibly) designed with this in mind.

As mentioned above, historical data resulting from collections by seine and electrofishing are not directly comparable to those we have recorded via snorkel observations. In general, we believe that snorkeling is the most efficient of these methods for detecting rare benthic species that hide under rocks (visibility permitting). If correct, it is likely our results produce higher CPUEs than simultaneous efforts by the other methods. This suggests that current duskytail darter abundances in many areas of the creek are similar to, or even reduced relative to those in the past from the collection records described above. Future snorkel monitoring should consider all past data but can only be directly compared to the base line data initiated herein.

We recommend establishment of three or four permanent quantitative snorkel monitoring sites for duskytail darters in Copper Creek. These sites should be monitored on a regular basis at least every two or three years. In addition, less frequent surveys of

other sites should be performed, particularly at the extremes of the range. Due to ease of access and duskytail darter abundance, two sites we highly recommend are the lowest VA 627 bridge (CCM 1.8) and Obeys Creek/VA 72 bridge (CCM 13.8). Another site we recommend is the mouth of Lark Creek (CCM 9.75) where we observed our highest CPUE. This site also has the advantage of falling midway between our lowest fantail darter site (CCM 11.5) and Jenkins's (CCM 8.9). It can serve to monitor potential future shifts in range and abundance of these similar and likely competing species. One additional site might be near/above Flower Branch (~CCM 11.5), approximately midway between the latter site and Obeys Creek, or, alternatively, above the mouth of Plank Camp Creek (CCM 12.5).

Sampling protocol should be as described above in Methods, utilizing no less than two and no more than four biologists experienced at visually identifying and distinguishing *E. percnurum* and *E. flabellare* underwater. Searching should always begin above a defining riffle below the primary site landmark and then work upstream through slow run/glide/pool habitat for at least 60 minutes. Sampling should be conducted in the late summer or fall, outside breeding season to avoid disturbance of spawning and nests and when juveniles and adults can both be located. Snorkeling is an effective, efficient, and feasible means to monitor this rare fish with minimal impacts. Such monitoring is an activity that will be essential to the long term conservation and management of the species.

One final conservation recommendation would be to conduct a population genetics analysis of the duskytail darter population throughout its range in Copper Creek to determine whether any structure exists and any potential implications for management. Spivey Mill Dam is likely a barrier to upstream genetic exchange, but whether this is problematic would require such a study.

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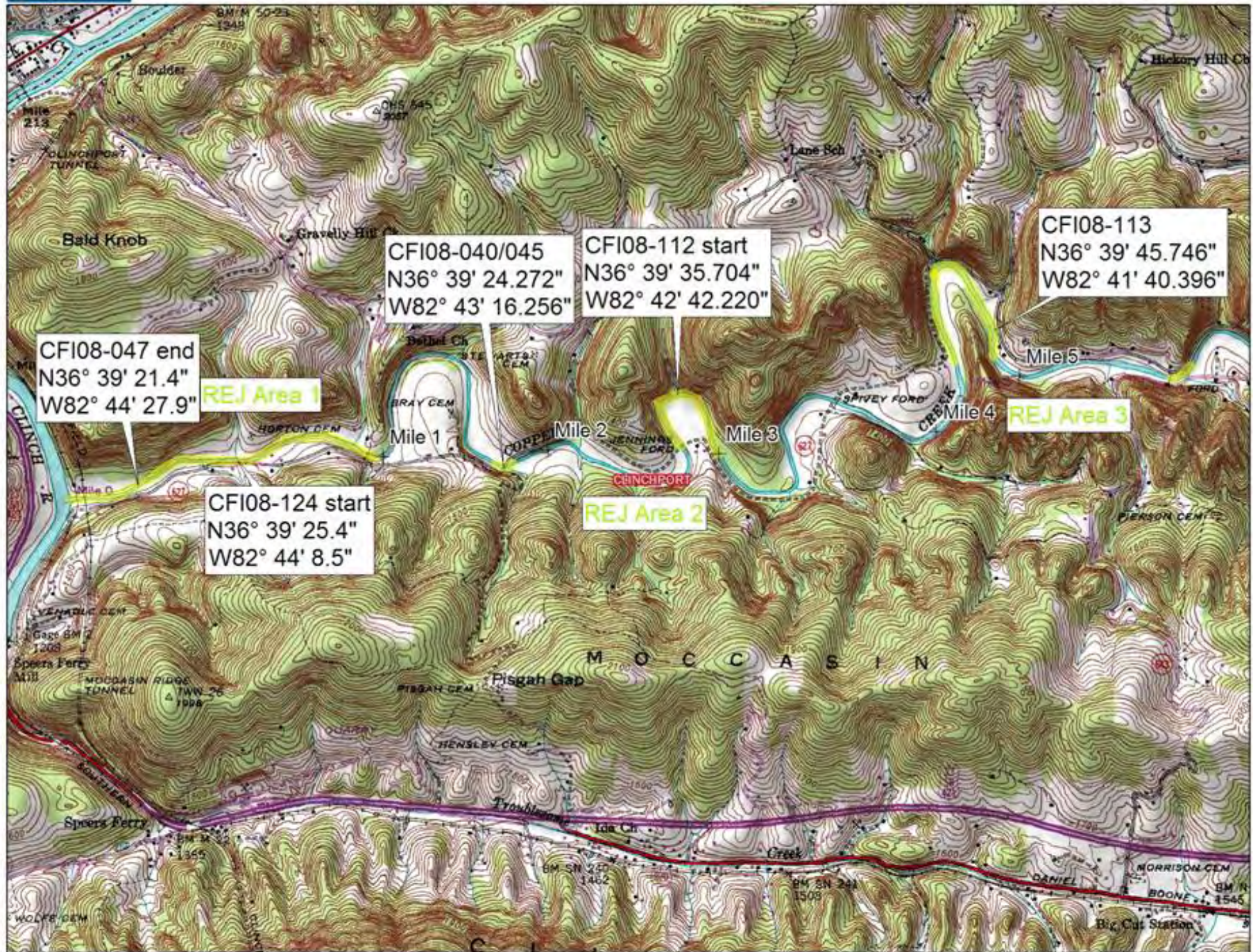
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Appendix

Maps of Lower Copper Creek, Scott County, Virginia

Areas from Jenkins and Burkhead (p. 881, 1994) are highlighted in yellow, labeled chartreuse

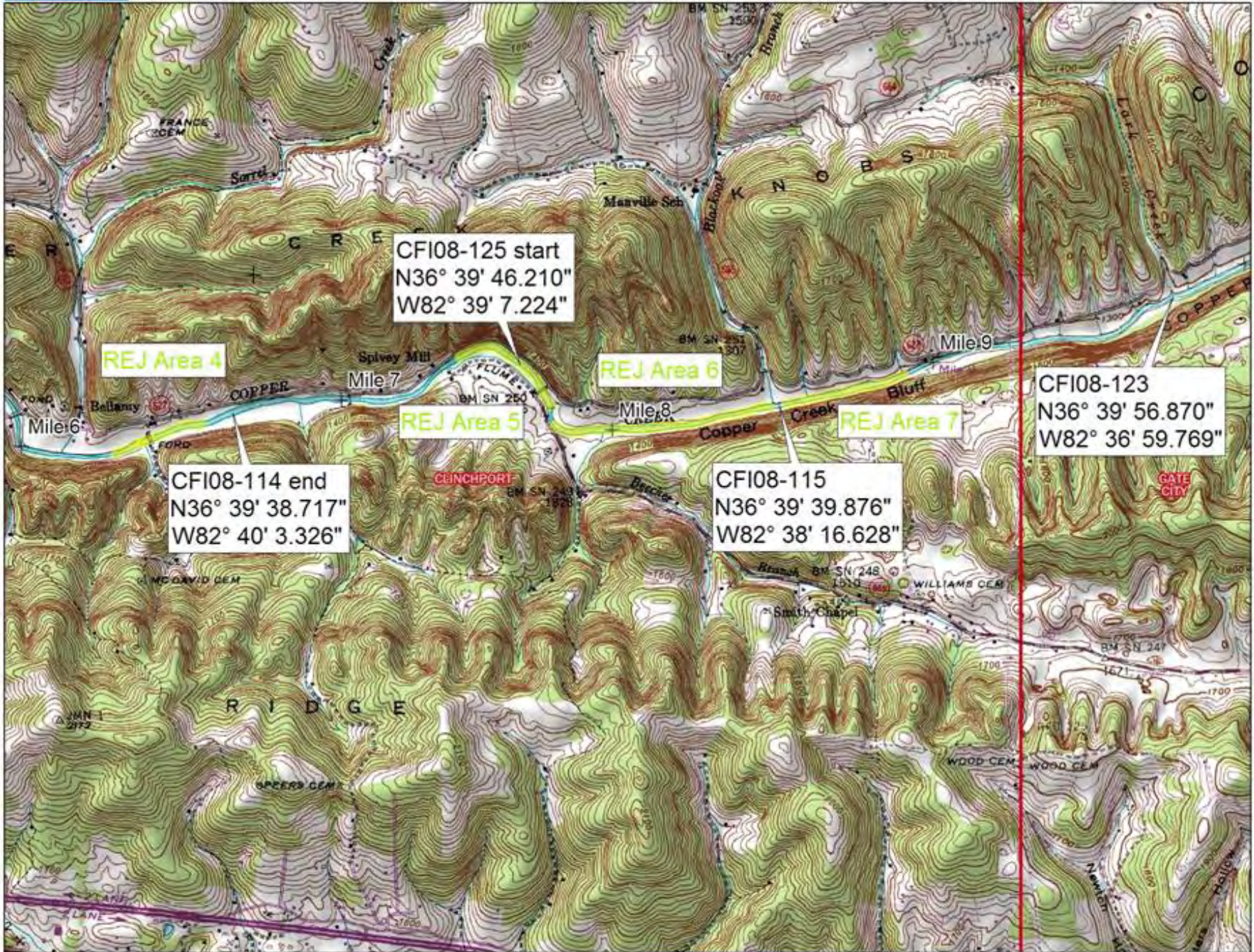


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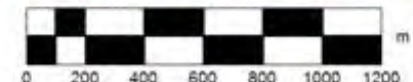




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New VA 72

Mile 14

REJ Area 10

CFI08-118 end
N36° 40' 50.094"
W82° 33' 12.206"

TVA 5/21/96

TVA 5/20/96 & 6/18/97

Mile 13

REJ Area 9

TVA 5/21/96

REJ Area 8

Mile 11

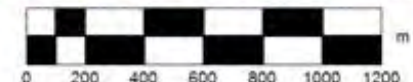
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W82° 34' 7.972"

CFI08-122
N36° 40' 8.650"
W82° 35' 16.144"

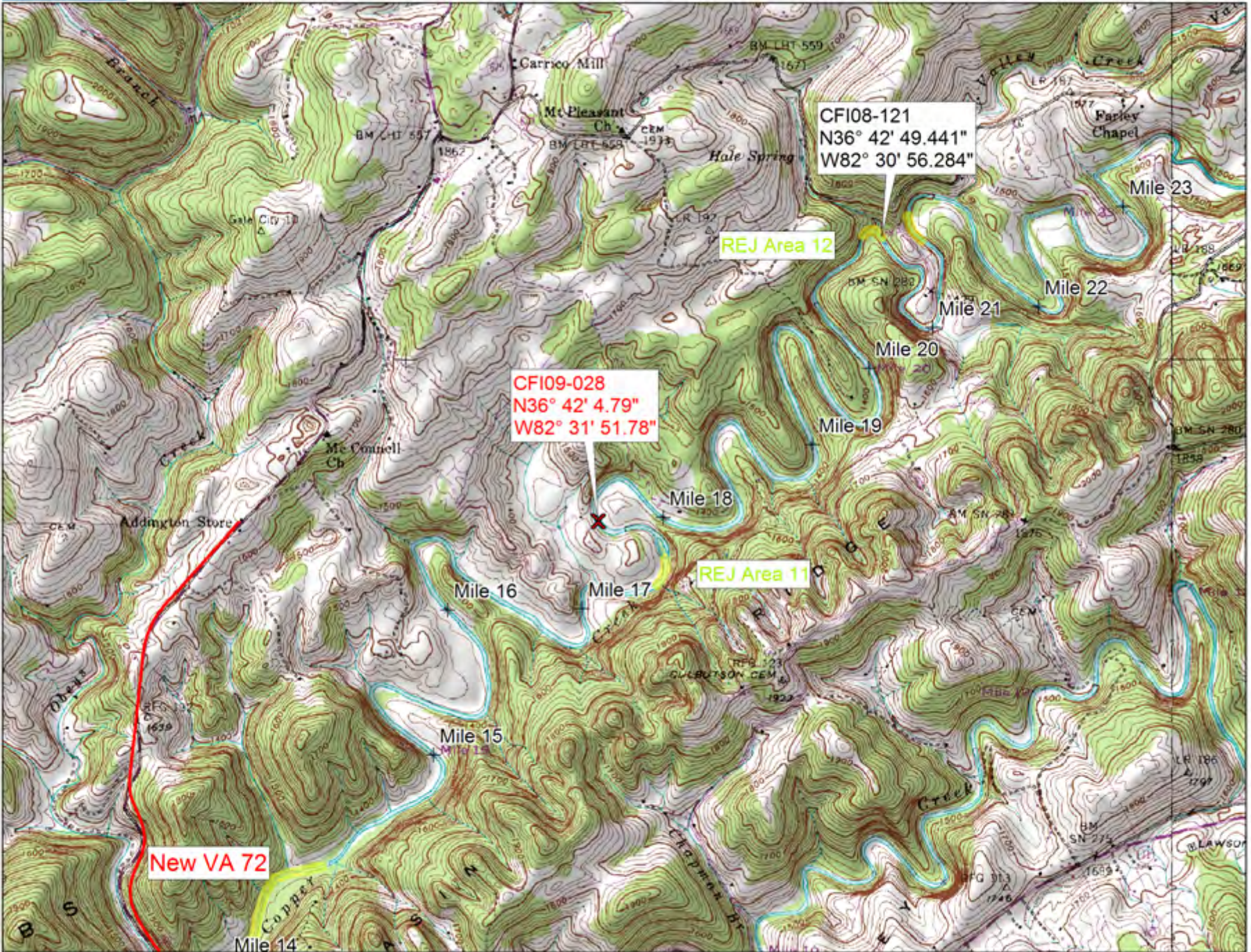
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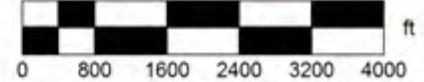
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