Blackside Dace
Phoxinus cumberlandensis

=Blackside Dace
Chrosomus cumberlandensis

5-Year Review:
Summary and Evaluation

Photo credit: J.R. Shute, Conservation Fisheries, Inc.

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5-YEAR REVIEW

Blackside dace, *Chrosomus cumberlandensis* (Starnes and Starnes 1978)*

*A taxonomic revision of the genus *Phoxinus* by Strange and Mayden (2009) resulted in a name change for all North American members of the genus *Phoxinus* (*Phoxinus* = *Chrosomus*). The revised classification for blackside dace is *Chrosomus cumberlandensis* (Starnes and Starnes 1978). Details of the name change are provided on page 13 (Section 2.3.1.3).

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Region: **Southeast** Region, Kelly Bibb, (404) 679-7132

Lead Field Office: Kentucky Ecological Services Field Office (KFO), Dr. Michael A. Floyd, (502) 695-0468, x102

Cooperating Field Office: Tennessee Ecological Services Field Office, Ken McDonald (931) 528-7075 and Peggy Shute (931) 528-6481

Peer Reviewers:
Dr. Hayden Mattingly, Tennessee Technological University
Dr. Chris Skelton, Georgia College & State University
Dr. Matthew Thomas, Kentucky Department of Fish and Wildlife Resources (KDFWR)
Mr. Michael Compton, Kentucky State Nature Preserves Commission (KSNPC)

1.2 Methods used to complete the review

We provided public notice of this five-year review in the *Federal Register* on July 29, 2008 (73 FR 43947), and opened a 60-day comment period. During this comment period, we obtained information on the status of this species from several experts; additional data were obtained from the recovery plan, peer-reviewed scientific literature, and our state partners. Once all known literature and information were collected for this species, Dr. Michael A. Floyd, lead Recovery Biologist with the KFO, completed the review. The draft document was peer-reviewed by Dr. Hayden Mattingly, Department of Biology, Tennessee Technological University, Cookeville, Tennessee; Dr. Chris Skelton, Department of Biological and Environmental Sciences, Georgia College & State University, Milledgeville, Georgia; Dr. Matthew Thomas, KDFWR, Frankfort, Kentucky; and Michael Compton, KSNPC, Frankfort, Kentucky. Comments received were evaluated and incorporated as appropriate (see Appendix A).

1.3 Background

1.3.1 Federal Register Notice citation announcing initiation of this review:

73 FR 43947 (July 29, 2008)

1.3.2 Species Status: Threats identified in the species' recovery plan (USFWS 1988) continue to impact the species, but based on repeated observations and surveys by consultants and agency biologists (KFO, KSNPC, KDFWR, and Tennessee Wildlife Resource Agency (TWRA)), the species' status appears to be stable. Range-wide surveys completed from 1982−1994 (Laudermilk and Cicerello 1998), 2003−2006 (Black et al. 2013a), and 2010−2012 (USFWS unpublished data) demonstrate that the species has been extirpated from 31 streams (Black et al. 2013a, USFWS unpublished data) but continues to persist in 125 streams across nine Kentucky counties (Bell, Harlan, Knox, Laurel, Letcher, McCreary, Perry, Pulaski, and Whitley), three Tennessee counties (Campbell, Claiborne, and Scott), and two Virginia counties (Lee and Scott) (USFWS 1988, Laudermilk and Cicerello 1998, Black et al. 2013a, Skelton 2013a, USFWS unpublished data). Most land ownership within watersheds occupied by blackside dace is private, but portions of 61 blackside dace watersheds are in public ownership. Most of these watersheds (85%) are located on the Daniel Boone National Forest (DBNF) in Laurel, McCreary, Pulaski, and Whitley Counties, Kentucky. Most blackside dace populations are considered to be small and remnant in nature (*i.e*., less than 10 individuals observed during surveys), an adequate understanding of population viability is lacking, and threats continue to impact the species (Black et al. 2013a). Three of the five listing factors pose threats to the species: the present or threatened destruction, modification, or curtailment of its habitat or range; the inadequacy of existing regulatory mechanisms; and other natural or manmade factors affecting its continued existence. The KFO continues to provide technical assistance related to the species to its state, Federal, and private partners, and we continue to look for opportunities to implement stream and riparian habitat restoration projects that may benefit the species within the upper Cumberland River drainage.

1.3.3 Recovery achieved: 1 (1= 0-25% species' recovery objectives achieved)

1.3.4 Listing history:

<u>Original Listing Rule</u>

FR notice:	52 FR 22580
Date listed:	June 12, 1987
Entity listed:	Species
Classification:	Threatened, Entire Range

1.3.5 Associated rulemakings: None

1.3.6 Review History:

Blackside Dace Recovery Plan (*Phoxinus cumberlandensis*). 1988.

Annual Recovery Data Call for the Blackside Dace (*Phoxinus cumberlandensis*), 2004-2014, U. S. Fish and Wildlife Service, Kentucky Ecological Services Field Office, Frankfort, Kentucky.

Five Year Review: November 6, 1991. In this review (56 FR 56882), different species were simultaneously evaluated with no species-specific, in-depth assessment of the five factors as they pertained to the different species' recovery. In particular, no changes were proposed for the status of this fish in the review.

1.3.7 Species' Recovery Priority Number at start of 5-year review:

11, indicating that the blackside dace is taxonomically categorized as a species, has a moderate degree of threat, and has a low recovery potential according to 48 FR 43098, September 31, 1983 and 48 FR 519845, November 15, 1983.

1.3.8 Recovery plan:

Name of plan: Blackside Dace Recovery Plan (*Phoxinus cumberlandensis*).

Date issued: August 17, 1988

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) Policy

2.1.1. Is the species under review listed as a DPS? No.

2.1.2. Is there relevant new information that would lead you to consider listing this species as a DPS in accordance with the 1996 policy? No.

2.2 Recovery Criteria

2.2.1. Does the species have a final, approved recovery plan containing objective, measurable criteria? Yes.

2.2.2. Adequacy of recovery criteria

2.2.2.1. Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat? No.

2.2.2.2. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria?

The recovery criteria do take into account any threats to this species in association with the 5 listing factors, since the assurance that populations are viable and are protected from any foreseeable threats is part of the criteria.

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information.

Delisting Criteria. The blackside dace will be considered for removal from the Federal list of Endangered and Threatened Wildlife and Plants upon completion of the following criteria:

1. Each of the <u>eight</u> (8) sub-basins identified in Figure 1 has a viable population* comprised of at least <u>three</u> (3), protected, inhabited stream reaches per sub-basin.

2. Each of the 24 stream reaches is protected in some manner, either through public agency or private conservation organization ownership or some form of permanent easement, and a management plan has been implemented for each stream that provides for the species' long-term protection.

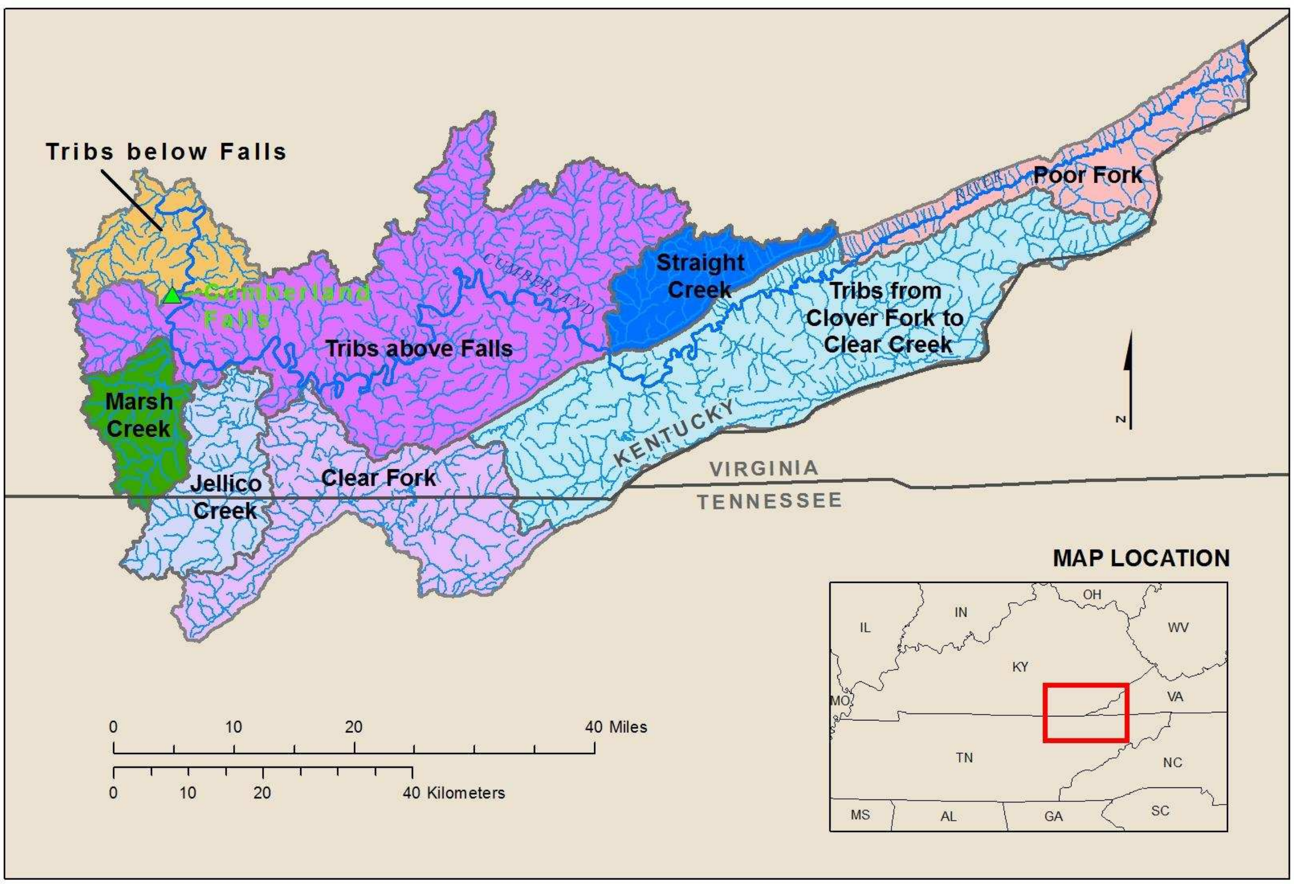

Figure 1. Blackside dace recovery units (sub-basins) identified in the species' recovery plan (USFWS 1988).

3. No foreseeable threats exist that would threaten survival of the species in any of the sub-basins.

4. Noticeable improvements in coal-related problems and substrate quality have occurred to the species' habitat throughout the upper Cumberland River basin, and the species has responded through natural means or with human assistance to successfully recolonize other streams and stream reaches within the upper Cumberland River basin.

*Viable population – A reproducing population that is large enough to maintain sufficient genetic variation to enable it to evolve and respond to natural habitat changes (as defined in the recovery plan). Movement of animals within some sub-basins may be required to maintain genetic viability. The number of individuals needed and the length of stream reaches required to meet this criterion will be determined for the species as one of the recovery tasks.

Status. *These criteria have not been met.* The species occupies numerous streams across its range (Table 1), but most populations are considered to be small and remnant in nature (*i.e*., less than 10 individuals observed during surveys), numerous populations have been extirpated, long-term protection is lacking for a sufficient number of streams in each sub-basin, and insufficient information is available on population viability (as defined above) (USFWS 1988, Laudermilk and Cicerello 1998, Black and Mattingly 2007, Black et al. 2013a, Compton et al. 2013). As shown in Table 1, we have gained more protected, occupied streams in these eight sub-basins (see the discussion of public ownership below); however, more information is needed to evaluate the viability of populations in these streams (see 4.0 Recommendations for Future Actions). Within Kentucky, significant portions of 47 dace watersheds are in public ownership. Most of these watersheds (85%) are located on the Daniel Boone National Forest (DBNF) in Laurel, McCreary, Pulaski, and Whitley Counties. Public ownership in these watersheds ranges from 50-100%, and DBNF streams are managed under the DBNF's Land and Resource Management Plan (USFS 2004; see Factor D under the Five Factor Analysis for more detail). Outside of the DBNF, public ownership in dace watersheds is limited to the Poor Fork headwaters in Letcher County (Jefferson National Forest), Bad Branch in Letcher County (Bad Branch State Nature Preserve), Watts Creek in Harlan County (Blanton Forest State Nature Preserve), Davis Branch, Little Yellow Creek, and Sugar Run in Bell County, Kentucky (Cumberland Gap National Historical Park (NHP)), and Wolf Creek (Big South Fork National River and Recreation Area) in McCreary County (see Appendix D). Within Tennessee, public ownership is limited to the headwaters of Little Yellow Creek in Claiborne County (Cumberland Gap NHP), two tributaries of Rock Creek (Massey Branch and an unnamed tributary) in Campbell County (Big South Fork National River and Recreation Area), and five stream systems located on the North Cumberland Wildlife Management Area in Campbell and Scott Counties - Elk Fork Creek, Hudson Branch, Jim Branch, Terry Creek, and Straight Fork (including Cross Branch and Jake Branch). New information has been gathered on the species' current distribution and biological requirements since the recovery plan was completed in 1988 (Mattingly et al. 2005; Black et al. 2013a, b; Detar and Mattingly 2013; Mattingly and Black 2013), but management strategies have not been developed. Threats identified in the recovery plan still remain and specifically we have not been able to make noticeable improvements regarding coal issues in the Cumberland River Basin to help this species.

Table 1. Distribution and number of occupied, protected stream reaches by sub-basin required for delisting and the corresponding number of currently occupied (and protected) stream reaches per sub-basin (modified/updated version of Table 3 from the recovery plan).

Metapopulation[1]	Recovery Unit (Sub-basin)	Number of Occupied, Protected Streams Required for Recovery	Number of Occupied (and Protected) Streams at Present[2]
Group A	Poor Fork	3	6 (1)
	Tributaries from Clover Fork to Clear Creek	3	11 (3)
	Straight Creek	3	3 (0)
	Clear Fork	3	17 (1)
Group B	Tributaries above Cumberland Falls	3	28 (8)
Group C	Jellico Creek	3	22 (7)
	Marsh Creek	3	4 (3)
Group D	Tributaries below Cumberland Falls	3	15 (15)
Group E[3]	South Fork	---	12 (9)
	TOTAL	24	118 (47)

[1]Strange and Burr (1995).
[2]Occupancy based on recent survey efforts and protected status based on public ownership (>50% of watershed); streams vary widely with respect to blackside dace abundance and viability.
[3]Group E streams not known when recovery plan published in 1988, so these streams not considered for recovery in Table 3 of recovery plan.

2.2.4 Recovery Efforts

Propagation. The first attempt at propagating the species was by Conservation Fisheries, Inc. at their facility in Knoxville, Tennessee (Rakes et al. 1999). More recently, Rakes et al. (2013) propagated blackside dace in captivity over a three-year period, 2011-2013. Details of both efforts are summarized below in Section 2.3.1.1 (Demographic Features). Initial observations by Rakes et al. (1999) suggested that eggs deposited in nature likely sink into gravel crevices (interstitial spaces) and remain there for up to two days. Rakes et al. (1999) concluded that this behavior could make the eggs, embryos, and larvae of the species susceptible to smothering by sediment, a vulnerability that may have led to the species' decline.

Kentucky Master Logger Program. From 2005-2008, The Kentucky Division of Forestry (KDOF); the University of Kentucky, Department of Forestry (UK Forestry); and the KFO developed new logging BMP recommendations and new outreach materials to assist loggers that operate near blackside dace streams in southeastern Kentucky. The KFO has participated in numerous Master Logger training courses in southeastern Kentucky, providing information on blackside dace biology, distribution, potential threats, and new BMP recommendations. Similar presentations have also been made to the KDOF's Southeastern District, the office that oversees logging activities within the vast majority of the species' range in Kentucky. An informational article (Floyd and Stringer 2005) on blackside dace was prepared through a joint effort of UK Forestry and the KFO and was included in the Fall 2005 issue of *LogJam*, a quarterly newsletter providing environmental, safety and professional information to Kentucky's loggers and foresters. The article covers species biology and new BMP recommendations for blackside dace streams. It is routinely provided to loggers during Master Logger training courses and is also available on the master logger website, *http://dept.ca.uky.edu/masterlogger/pdfs/LogJam/Fall_Winter_2005.pdf*. The Kentucky State Nature Preserves Commission, UK Forestry, and KFO developed a series of blackside dace distribution maps for Kentucky and Tennessee. These county maps display the locations of all known dace streams and other important county landmarks (cities, major state and county roads, larger streams) in Kentucky and Tennessee to assist loggers in planning their logging operations. The maps are available through Master Logger training courses and are also available on the master logger website, *http://www.masterlogger.org/logjam/*.

Mill Branch Stream Restoration. During 2006 and 2007, the Kentucky Ecological Services Field Office (KFO) worked cooperatively with a number of federal and state partners, as well as four private landowners, to complete an approximate 739-m reconfiguration of Mill Branch in Knox County, Kentucky (Floyd et al. 2013). Funding and in-kind support for the project was provided by Knox County Fiscal Court, Bluegrass Streams, LLC, Eastern Kentucky University, the KSNPC, Natural Resources Conservation Service (NRCS, Wildlife Habitat Incentive Program), the Service's Partners for Fish and Wildlife Program, KDFWR (Landowner Incentive Program), Cumberland Valley RC&D (Service Private Stewardship Grant), and Kentucky Division of Conservation (State Cost Share Program).

Mill Branch is a second order tributary of Stinking Creek and 1 of 15 tributaries in the Stinking Creek basin that supports a blackside dace population. The project involved habitat restoration activities along the Mill Branch mainstem, its riparian zones, and associated wetlands. Over the past few decades, instream and riparian habitats along Mill Branch were degraded through channelization of the mainstem, removal of riparian vegetation, over-grazing of adjacent pastures, and placement of culverts within the stream channel. Blackside dace had persisted within the stream, but population numbers were low compared to other streams within its range. The proposed project was designed to alleviate these problems by reconfiguring instream and riparian habitats for the species and removing a perched culvert that inhibited fish dispersal.

Project design and oversight was provided by the University of Louisville Stream Institute (Stream Institute), with the KFO serving as the lead federal agency. The project was constructed almost entirely "in the dry", meaning that the restored reach was constructed parallel to the existing channel and did not carry any water during construction. This allowed riparian vegetation to become established before the restored reach was connected to upstream reaches. About 90 percent of the existing channel was left undisturbed, and the existing channel carried the majority of the flow while construction continued. The stream was lengthened by building new channel sections that added curvature, established pool-riffle morphology, created specific instream habitats for blackside dace, and increased flood storage capacity. Small low-level floodplains were created to stabilize the stream and provide additional flood remediation. A fenced, 6- to 9-m wide riparian buffer was established along each bank in order to exclude livestock (horses), reduce animal waste inputs, reduce sedimentation, and reduce solar exposure. Most importantly, a large, perched culvert was replaced with a fish-friendly culvert that allowed for free movement by fishes.

Project goals included (1) creation, improvement, and protection of existing habitats in Mill Branch, (2) establishment of a more stable and abundant blackside dace population, and (3) demonstration that a complex restoration project could be completed for a stream supporting a federally listed species. The effectiveness of the physical restoration effort was demonstrated through repeated visual inspections of the restored channel. The response of the fish community was monitored through annual and biannual surveys (2006-2010) in three unrestored and two restored reaches using a Pulsed DC, backpack electrofisher. Visual inspections of restored habitats in 2009 and 2010 revealed that restoration design objectives had been met. Fish surveys produced a total of 14,580 individuals, representing 29 species. Restored reaches generally had higher catch per unit effort, species richness, and diversity values compared to unrestored reaches.

Post-restoration abundance of blackside dace was comparable to that observed during pre-restoration surveys, but no significant increase in blackside dace abundance was observed in reconfigured reaches. Overall, the restoration improved the habitat quality and permanence of flow within reconfigured reaches, as evidenced by increased species richness, diversity, evenness, and CPUE. These numbers suggest that the restoration benefited the fish community of Mill Branch, and they show that a complex restoration project can be designed and implemented successfully on a stream supporting a federally listed species. As habitat and flow conditions continue to improve within Mill Branch, we expect the blackside dace population to increase and utilize habitats within reconfigured reaches. Annual monitoring was re-initiated in 2014 and will continue in 2015.

McCreary County Fiscal Court Conservation Agreement. In 2008, the McCreary County (Kentucky) Fiscal Court (Fiscal Court) and the Service (KFO) entered into a conservation agreement to promote the survival, conservation, and recovery of blackside dace in McCreary County. Under this agreement, the Fiscal Court accomplished two major tasks that assisted in the species' conservation. In 2010, they purchased and made a charitable contribution of an 82-acre tract to the Kentucky Natural Lands Trust, a state-wide land trust with a mission to protect, restore, and connect remaining wild lands in Kentucky. This purchase provided long-term protection of a large forested tract adjacent to the Daniel Boone National Forest, and it established a permanent, forested buffer along an 853-m reach of Sid Anderson Branch, a Rock Creek tributary and blackside dace stream in McCreary County. In 2012, the Fiscal Court replaced a perched and partially-collapsed, 1.5-m culvert at the Rock Creek Road crossing near the downstream end of Sid Anderson Branch. The existing culvert was a partial barrier to fish movement, and it represented a danger to motorists using the county road above. The University of Louisville Stream Institute designed and implemented the project, which involved placement of the new culvert and reconfiguration of Sid Anderson Branch within an approximate 91-m reach of the stream. During post-construction fish surveys in November 2013, over 150 blackside were observed in the project area, including many age-0 individuals and a large school of about 100 individuals at the downstream end of the new culvert (USFWS unpublished data). Another survey is planned for late 2015, but preliminary results suggest a large increase in dace numbers and unrestricted movement through the new culvert.

Northern Cumberlands Forest Resources Plan (HCP). The blackside dace is 1 of 22 covered species in a Forest Resources Habitat Conservation Plan (HCP) under development by the Tennessee Wildlife Resources Agency (TWRA 2014). In the HCP, TWRA will implement scientifically based forest and timber harvest management practices that will protect the long-term viability of federally listed, threatened and endangered species, and rare species on TWRA's North Cumberland WMA (Royal Blue Unit) in Campbell and Scott Counties, Tennessee. Selection of the HCP's covered species was based on rarity status, location of documented occurrences, and possibility of impact from TWRA's activities. Biological goals and objectives (BGOs) have been developed to outline ecological functions the HCP is designed to sustain. Habitat conservation measures (e.g., maintain no-harvest buffers along streams) have been developed and are specific to each BGO. The draft Forest Resources HCP is being revised and submission to the Service is expected in 2015.

Decision Support Tool. In 2007 and 2008, a group of blackside dace experts, led by researchers at the University of Georgia, created a structured decision model describing the most up to date ecological knowledge about the species (McAbee et al. 2013). Decision analysis is a useful tool to support the recovery process because it provides users with a means to formalize relationships between variables, sources of uncertainty, and management outcomes in quantitative models (Peterson and Evans 2003). In addition, analysis of model outcomes can guide future management decisions and scientific research.

The blackside dace model was constructed in a Bayesian belief network, documenting the current ecological knowledge in a graphical influence diagram that focuses on human and environmental stressors (inputs), ecological system components, and management outcomes of interest (McAbee et al. 2013). The model was then evaluated via sensitivity analysis, determining the relative influence of various inputs, actions, and variables on forecasted outcomes (McAbee et al. 2013).

Sensitivity analysis and scenario building demonstrated that mining practices are predicted to be the most influential input, while other inputs seem to have less substantial impacts (McAbee et al. 2013). The smaller influence of other input nodes may serve as an indication that blackside dace are a robust species to certain stressors, even in combinations. The importance of mining is largely based on the influence of stream conductivity because mining is currently the primary input that affects conductivity. While the influence of stream conductivity on blackside dace presence has empirical support from habitat modeling (Black et al. 2013b), the underlying ecological cause is largely unknown. The combination of high influence on outcomes and little empirical data suggest that effects of conductivity warrant future investigation.

Upper Cumberland River Fishes Study. In 2012, the KSNPC and KFO initiated a distributional analysis and habitat modeling study in the upper Cumberland River drainage for blackside dace and two other fishes: the endangered Cumberland darter and the Cumberland arrow darter. Funding was provided through a Service flex fund award and the Kentucky Aquatic Resource Fund. The project involved field surveys at 83, 100-meter stream reaches and was designed to provide quantified data on the distribution (i.e., occupancy estimation and detection probability), status, population size, and environmental resource use (at the reach and microhabitat spatial scales) of these species. All field surveys were completed in 2012. Blackside dace were observed at only 7 of 83 reaches, including one new distributional record from Paint Gap Branch, a tributary of Stinking Creek in Knox County (USFWS unpublished data). Complete data analyses and the final report is expected in 2015.

Southeastern Naturalist Special Issue. In 2013, a special issue of *Southeastern Naturalist* (Volume 12, Special Issue 4) was published, focusing on the ecology and conservation of blackside dace. The special issue contains 14 articles organized according to four themes: ecology, impacts and threats, restoration and recovery, and range extensions. These articles represent the single largest compilation of research on the species, and they are cited repeatedly in this five-year review.

2.3 Updated information and current species status

2.3.1 Biology and habitat:

2.3.1.1 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

Abundance and Population Trends. Extant populations of blackside dace are restricted to the upper Cumberland River drainage in Kentucky (eight counties) and Tennessee (three counties) (Burr and Warren 1986, Mattingly et al. 2005, Black et al. 2013a), the upper Kentucky River drainage in Kentucky (one watershed – Maces Creek, Perry County) (USFWS unpublished data), and the Powell and Clinch River drainages in Virginia (two counties) (Skelton 2007, 2013). The species occupies an estimated 125 streams across its range (see Appendix D for an evaluation of these extant streams); however, many of these populations are considered to be small and remnant in nature (*i.e*., less than 10 individuals observed during surveys), and the species appears to have been extirpated from 31 streams (Table 2) (USFWS 1988, Laudermilk and Cicerello 1998, Black and Mattingly 2007, Black et al. 2013a, Compton et al. 2013).

The most detailed information on abundance, population size, and density was provided by Black et al. (2013a), who used quantitative surveys throughout the upper Cumberland River drainage to make estimates of population size (#dace/200-m reach) and density (#dace/ m^2). Blackside dace were captured at 43 of 55 streams and 78 of 119 200-m reaches during June to August 2003, 2005, and 2006 using AC and pulsed-DC single-pass backpack electrofishing. As mentioned previously, two-thirds of all reaches (78 of 119, 66 %) produced no dace or had catch rates of 10 or fewer dace per 200-m reach. Fifty or more dace were captured in only 14 reaches (9 streams). Single-pass catch rates of occupied reaches ranged from 1 to 151 (mean $\pm$ SD = 27 $\pm$ 34) dace per 200-m reach. The highest catch rates were observed in Big Lick Branch, Breedens Creek, Mill Creek, Rock Creek, Ryans Creek, and Trace Branch (Table 3).

Black et al (2013a) estimated population size at 16 sites through Petersen mark-recapture techniques. These estimates averaged 192 $\pm$ 167 (range: 33–613) dace per 200-m reach, corresponding to density estimates of 31.9 $\pm$ 23.0 (range: 2.7–80.7) dace per 100 m^2. Based on these data, a regression model was constructed to obtain population estimates for the other 62 reaches in which dace were captured during single-pass electrofishing. Population estimates for these reaches averaged 64 $\pm$ 91 dace per 200 m (range: 3–396), corresponding to an average density estimate of 9.5 $\pm$ 15.5 (range: 0.3–91.3) dace per 100 m^2. Overall, population estimates for the 78 reaches in which dace were present averaged 90 $\pm$ 121 (range = 3–613) dace per 200 m, corresponding to an average density estimate of 14.1 $\pm$ 19.4 dace per 100 m^2. Average densities observed in 61 occupied Kentucky reaches (16.4 + 21.1 dace per 100 m^2) were significantly greater than the average densities observed in 17 occupied Tennessee reaches (6.0 + 7.5 dace per 100 m^2). For all reaches visited, 89 of 119 reaches (75%) had density estimates of <10 blackside dace per 100m^2.

Table 2. Historically occupied blackside dace streams where the species is now considered to be extirpated.

Stream	County / State	Last Observation[1]
Adams Branch	Whitley / KY	1993
Becks Creek	Whitley / KY	1984
Bens Fork	Bell / KY	2008
Billies Branch	Knox / KY	1993
Brices Creek	Knox / KY	1993
Brier Creek	Whitley / KY	1883
Brown Branch	Letcher / KY	1990
Cane Creek (Clear Fork)	Whitley / KY	1977
Cane Creek (nr Archers Crk)	Whitley / KY	1977
Coles Branch	Knox / KY	1993
Cloverlick Creek	Harlan / KY	1961
Clover Fork	Harlan / KY	1961
Craig Creek	Laurel / KY	1979
Crooked Creek	Campbell /TN	1994
Davis Branch	Bell / KY	2007
Honeycutt Branch	Knox / KY	1994
Left Fork Straight Creek	Bell / KY	1980
Little Clear Creek	Bell / KY	1981
Long Branch	Bell / KY	1984
Marsh Creek (headwaters)	McCreary / KY	1993
Murphy Creek	McCreary / KY	1993
Sanders Creek	Whitley / KY	1988
Sims Fork	Bell / KY	1984
Stevenson Branch	Bell / KY	1994
Stoney Fork	Bell / KY	1997
Straight Creek	Claiborne / TN	1989
Straight Creek	Bell/Harlan / KY	1984
Trammel Fork	McCreary / KY	1986
Turkey Creek	Knox / KY	1994
Whitman Branch	Whitley / KY	1996
Wolf Creek	Whitley / KY	1883

[1]Surveys have been completed in all these streams since 2003.

Density estimates (56.8–73.1 dace per 100 m^2) reported by Starnes and Starnes (1981) for three sites in Youngs Creek (Whitley County, Kentucky), one of the healthiest known populations at the time, were consistent with the ten highest average densities (range of 36.8–91.3 dace per 100 m^2) reported by Black et al. (2013a). Population estimates for Big Lick Branch by Leftwich et al. (1997) and Middle Fork Beaver Creek by Leftwich et al. (1995) were 10–350 dace per 100 m^2 and 130 dace per 100 m^2 (one pool), respectively. These results were considerably higher than those calculated by Black et al. (2013a), but both studies conducted by Leftwich et al. (1997) were based on habitat units (pools and riffles), rather than specific stream lengths. Consequently, they may have encountered elevated densities of blackside dace in certain pools.

Table 3. Summary of single-pass electrofishing catch rates and corresponding population estimates (≥ 100 dace/200 m) and densities (dace/m^2) reported by Black et al. (2013a).

Streams	County / State	Single-pass (dace/200 m)	Pop. Estimate (dace / 200 m)*	Density (dace/ m^2)
Big Lick Branch #3	Pulaski / KY	151	308	49.8
Big Lick Branch #1	Pulaski / KY	126	251	40.6
Trace Branch #3	Knox / KY	119	396	91.3
Mill Creek #3	Bell / KY	108	359	58.0
Ryans Creek #4	McCreary / KY	107	356	34.5
Breedens Creek #1	Harlan / KY	96	613	80.7
Rock Creek #2	McCreary / KY	94	429	55.3
Richland Creek #3	Knox / KY	76	252	51.4
Mill Creek #2	Bell / KY	72	238	26.8
Terry Creek #2	Campbell / TN	65	215	18.2
Mill Creek #1	Bell / KY	63	208	25.3
Rock Creek #4	McCreary / KY	62	190	44.4
Watts Creek #2	Harlan / KY	60	369	69.3
Richland Creek #4	Knox / KY	58	235	36.8
Blacksnake Branch #1	Bell / KY	46	152	20.3
Archers Creek #3	Whitley / KY	42	162	17.4
Trace Branch #1	Knox / KY	41	135	15.5
Watts Creek #3	Harlan / KY	36	118	29.6
Fall Branch	Campbell / TN	32	104	26.7

*Population estimate obtained from the combined regression model, $\mathrm{Log}_{10}y = 0.4998 + 1.0110 \log_{10}x$ (or $y = 3.16x^{1.0110}$), where y = blackside dace population estimate (dace per 200 m) and x = single-pass electrofishing catch.

Demographic Features. The spawning period for the species extends from April to July (Starnes and Starnes 1981; Mattingly and Black 2013), but most observations of spawning activity have taken place from May to June. Starnes (1981) reported the first observed spawning event in the wild (17 May 1981) at a temperature of 17.5^{o}C. Mattingly and Black (2013) observed 25 spawning events from 12 May to 12 June 2006 at water temperatures ranging from 11.9-18.2^{o}C. Eggs are typically deposited (broadcast) over fine gravel, primarily in nests constructed by other species such as creek chubs (*Semotilus atromaculatus*) (Cicerello and Laudermilk 1996) and central stonerollers (*Campostoma anomalum*) (Starnes and Starnes 1981). Creek chub nests appear to be used more often than stoneroller nests, as suggested by Cicerello and Laudermilk (1996) and demonstrated by Mattingly and Black (2013). Mattingly and Black (2013) observed 25 spawning events, with all events taking place over creek chub nests. They observed no evidence that blackside dace spawn independently. It is suspected that the species takes advantage of other minnow species' nests because these habitats provide the most abundant silt-free substrates in much of the species' current range (Mattingly and Black 2013). It remains unknown whether the species will spawn independently of other species if suitable substrates are available; however, Rakes et al. (2013) found that blackside will spawn independently in captivity without the presence of (or cues from) other fishes. In captivity, spawning periods extended from early April to mid-May, with water temperatures ranging from 16 to 21^{o}C (Rakes et al. 1999, 2013).

Spawning behavior was described by Starnes and Starnes (1981), Mattingly and Black (2013), and Rakes et al. (2013). Nuptial males are brightly colored, as characterized by a golden brown dorsum; an intense, wide, black lateral stripe; bright yellow fins; and scarlet on the lower head, nape, and belly. Females tend to be drab olivaceous dorsally and lack yellow fins, but they can exhibit bright red coloration on the belly and nape. Typically, schools of 3 to about 60 males hover above the nest, with groups of 2-3 frequently leaving and entering the nest. Spawning females quickly enter the nest and are immediately surrounded (corralled) by several males, which push her to the substrate while the remaining males swarm on top and vibrate violently.

Rakes et al. (1999) conducted the first study of blackside dace propagation in captivity. Using 24 adults collected in May 1993 from Buck Creek, Whitley County, Kentucky, Rakes et al. (1999) produced a total of 330 fertile eggs. The eggs were moved to incubation trays and selected life-history information was recorded, including egg diameter (1 mm), egg characteristics (demersal, non-adhesive), egg deposition (among gravel and pebbles of artificial minnow nests), hatchling size (5 mm total length), characteristics of embryos and larvae (benthic approximately 48 h), foods used by larvae (live copepods, brine shrimp nauplii (first larval stage of a crustacean)), and survival of fertile eggs to the juvenile stage (87%). More recently, Rakes et al. (2013) propagated blackside dace in captivity over a three-year period (2011-2013). They observed post-hatch yolk-sac larval production ranging from a low of 71 fry produced from 117 eggs in 2011 to a peak of 1,910 fry produced from 2,855 eggs in 2012. Survival rates (60-67%) were lower than those reported by Rakes et al. (1999), but the number of fry reared per breeding adult (38.2) was over twice that reported in the previous study (13.75; Rakes et al. 1999). Eggs hatched quickly (about 3 days), producing unpigmented immature yolk-sac larvae that remained benthic for about 5 days (compared to 2 days; Rakes et al. 1999).

Adults are capable of spawning at age 1 and have a lifespan of 3 to 4 years (Starnes and Starnes 1981; Black et al. 2013a); females appear to have greater survivorship (Starnes and Starnes 1981). Starnes and Starnes (1981) reported the sex ratio in September as 21 males: 29 females and in April as 11 males: 11 females. Based on length/frequency and scale data, growth rates were similar for males and females (age 0, 20 to 34 mm standard length [SL]; age I, 39 to 57 mm SL; and age II, 62 to 64 mm SL). The fastest growth occurs during the first year and then gradually declines during the second and third year (Starnes and Starnes 1981). The species has been shown to successfully hybridize with creek chubs in Kentucky (Eisenhour and Piller 1997) and Virginia (Skelton pers. comm. 2014).

2.3.1.2 Genetics, genetic variation, or trends in genetic variation:

Strange and Burr (1995) conducted the first genetic study on the blackside dace, examining both the genetic variation and metapopulation structure of the species. Their research identified nine composite mitochondrial haplotypes (collection of specific alleles (particular DNA sequences) in a cluster of tightly-linked genes on a single chromosome or DNA molecule of the mitochondria, a cellular organelle), with the number of haplotypes / population ranging from one (Poor Fork, Watts Creek, and Jellico Creek) to five (Straight Creek). Patterns of localized gene flow were identified through cluster analyses of net population divergence. These analyses revealed the presence of three or four metapopulation units: (a) one centered in the upper Poor Fork through Straight Creek stream systems (Group A – as summarized in Table 1), (b) another unit comprising the stream systems from Stinking Creek to Youngs Creek (Group B), (c) a third centered around Marsh and Jellico Creeks (Group C), and (d) a potential fourth comprised of streams below Cumberland Falls (Group D). A cladistic analysis of gene flow indicated that Group B was the center of dispersal for blackside dace mitochondrial DNA haplotypes.

To promote genetic diversity, Strange and Burr (1995) recommended that recovery plans treat the metapopulations as management units, employing carefully planned reintroductions and habitat protection. Translocation of the species between metapopulations was discouraged; rather, they recommended that translocations be made from sites geographically proximate to the site of the reintroduction and preferably within the same stream system. Their data further indicated considerable gene flow within metapopulations, suggesting that the protection of dispersal corridors may be as important as protecting actual habitats. If we combine the four metapopulation units proposed by Strange and Burr (1995) with the eight recovery units outlined in the recovery plan (USFWS 1988), we have the groupings shown below in Table 4.

Table 4. Summary of blackside dace metapopulations (Strange and Burr 1995) and recovery plan units (USFWS 1988).

Metapopulation[1]	**Recovery Plan Units (USFWS 1988)**
Group A	Poor Fork, Tributaries from Clover Fork to Clear Creek, Straight Creek
Group B	Tributaries above Cumberland Falls, Clear Fork
Group C	Jellico Creek, Marsh Creek
Group D	Tributaries below Cumberland Falls

[1]According to Strange and Burr (1995).

Genetic testing of specimens from the upper Tennessee River drainage of Virginia showed that these individuals align well with “haplotype 4” (Group A) of Strange and Burr (1995), reinforcing the suspicion that these populations entered the upper Tennessee river drainage via multiple bait bucket introductions (Strange and Skelton 2003, Skelton 2013). According to Strange and Burr (1995), haplotype 4 is widespread above Cumberland Falls but is most common in the upper reaches of the Cumberland River drainage in Bell, Harlan, and Letcher counties, Kentucky.

Preliminary genetic testing of individuals from three streams in the Big South Fork Cumberland River drainage, Kentucky, revealed that a portion of the population represented new haplotypes belonging to a previously unknown clade, while others had mitochondrial DNA haplotypes previously documented only from sites above Cumberland Falls (Strange 2005). This suggested that a portion of the dace population was native to the area (Metapopulation E – a potential fifth metapopulation – see Table 1), but a significant portion had been introduced and was comprised of individuals from the upper portions of the species’ range (Strange 2005). No genetic information is available for the upper Kentucky River population discovered in 2013, but genetic testing is planned for 2015.

The work by Strange (1995) and Strange and Burr (1995) provided preliminary genetic information on the species, but additional study is needed. Currently, the Service is working with Austin Peay State University to complete a more detailed and comprehensive study that uses new techniques to examine genetic structure, diversity, and gene flow across the species’ range. The new study will incorporate microsatellite markers which are bi-parentally inherited loci capable of detecting fine-scale genetic patterns. Unlike mitochondrial DNA restriction fragment data (Strange and Burr 1995), the current study will likely recover many alleles among stream systems and populations, allowing us to detect current gene flow patterns among blackside dace populations. Moreover, these data will allow us to determine effective genetic population size, which is a measure of genetic diversity and overall genetic health (viability) of populations. Finally, these data will allow us to identify unique populations,

populations which are currently experiencing little/no migration, and help identify source populations for those populations thought to be the product of anthropogenic activity.

2.3.1.3 Taxonomic classification or changes in nomenclature:

The blackside dace is a small member of the minnow family (Cyprinidae), reaching a maximum length of approximately 76-82 mm (Etnier and Starnes 1993; USFWS unpublished data). It is characterized by a wide black lateral stripe or two stripes converging on the caudal peduncle, an olive-colored dorsal surface with numerous dark spots/speckles, and some scarlet and yellow coloration on the head and belly (most pronounced in the spring). The scales are small and embedded, and the lateral scale counts average 75. The lateral line is incomplete, and the anal ray count is 8. During the breeding season, males of the species exhibit an intense black lateral stripe; scarlet coloration on the belly, ventral portion of the head, nape, and base of the dorsal fin; bright yellow fins with silvery metallic spots at insertions of paired fins; and a golden dorsum. The blackside dace is similar to and often occupies the same habitats as the southern redbelly dace, *Chrosomus erythrogaster*. The two species can be distinguished based on lateral pigmentation and the shape of the opercular bone. The blackside dace has a single lateral stripe (or two convergent stripes in subadults) and a subrectangular opercular bone. The southern redbelly dace has two parallel lateral stripes and a more triangular opercular bone (Starnes and Starnes 1978b; Etnier and Starnes 1993).

The blackside dace was probably first observed in 1883 by D. S. Jordan and J. Swain in Clear Fork tributaries, Whitley County, Kentucky (based on the color description), but they regarded it as a color variation of the southern redbelly dace. Nearly 100 years later, the species was formally recognized and described by Starnes and Starnes (1978a) as *Phoxinus cumberlandensis*.

In a recent phylogenetic analysis based on complete mitochondrial cytochrome *b* gene sequences for all North American *Phoxinus* species and the Eurasian species, *Phoxinus phoxinus*, Strange and Mayden (2009) determined that the genus *Phoxinus* was an unnatural group (it was not monophyletic – a taxonomic group that consists of an ancestral species and all its descendants). To have a classification that was consistent with the monophyletic groups recovered in their phylogeny, they proposed a revised taxonomy for *Phoxinus*, placing all North American *Phoxinus* (subgenus *Chrosomus*) in the genus *Chrosomus*. Consequently, the revised classification for blackside dace is *Chrosomus cumberlandensis* (Starnes and Starnes), which is supported by the Service.

2.3.1.4 Spatial distribution, trends in spatial distribution, or historical range:

The blackside dace is thought to have been widely distributed historically in small streams throughout the upper Cumberland River drainage in Kentucky and Tennessee (Figure 2). The first range-wide survey conducted by Starnes (1981) reported the species from only 27 of 168 surveyed streams (16.1 percent). Based on an evaluation of physical habitat compared to the species' preferences, Starnes (1981) speculated that the species had been eliminated from at least 52 streams before its existence was known, approximately 60 to 70 percent or more of its historical range. A later survey by O'Bara (1985, 1990) observed the species in only 30 of 193 surveyed streams (15.5 percent), despite the fact that at least 151 of the surveyed streams contained adequate habitat to sustain the species. Furthermore, O'Bara (1985, 1990) discovered that the species was absent from 10 streams in which Starnes (1981) had reported it.

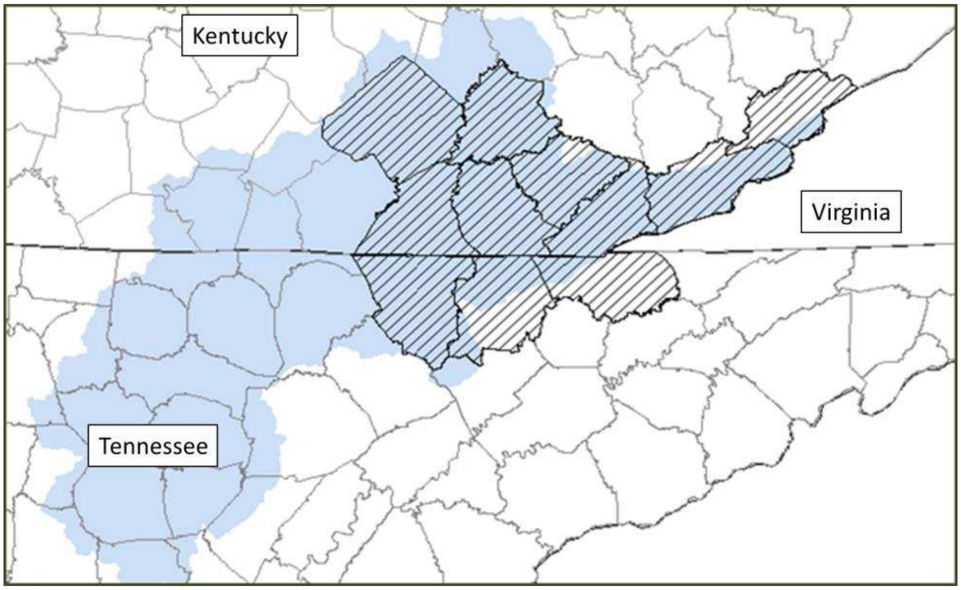

Figure 2. Historical distribution (striped counties) of blackside dace within the upper Cumberland River drainage of Kentucky and Tennessee. Blue shading indicates the Cumberland River drainage in eastern Kentucky and Tennessee (USFWS unpublished data).

From 1982 to 1994, the KSNPC completed an intensive fish survey of the Kentucky portion of the upper Cumberland River drainage (Laudermilk and Cicerello 1998). Their study reported blackside dace at 88 of 454 collection sites (72 streams). Fifty (50) of these streams contained previously unknown populations of the species, and approximately half of the newly discovered populations were located in two basins, Stinking Creek in Knox County (12 streams) and Jellico Creek in McCreary and Whitley Counties (12 streams).

Since 1998, blackside dace have been documented from approximately 40 additional streams as part of inventories or surveys by state/federal agencies, biological assessments for road and other construction projects, and baseline surveys for mining permits (Underwood 1999, Roghair et al. 2001; Roghair and Whalen 2001; Black et al. 2013a; USFWS unpublished data). The most comprehensive survey efforts within the upper Cumberland River drainage were completed in the summers of 2003, 2005, and 2006 by Black et al. (2013a) and in the summer of 2012 by the KSNPC and the Service. Black et al. (2013a) observed blackside dace at 43 of 55 streams and 78 of 119 200-m reaches using AC and pulsed-DC single-pass backpack electrofishing. Black et al. (2013a, b) documented the presence of several, seemingly robust populations across the species' range (Table 3), but they considered the majority of blackside dace populations to be small and remnant in nature (*i.e.*, less than 10 individuals observed during surveys).

KSNPC and the Service completed quantitative surveys at 83 100-m reaches throughout the Kentucky portion of the upper Cumberland River drainage in the summer of 2012 (USFWS unpublished data). These surveys were completed as part of a distributional analysis and habitat modeling study for the blackside dace, Cumberland darter (*Etheostoma susanae*), and Cumberland arrow darter (*Etheostoma sagitta*). The project was designed to provide quantified data on the distribution (i.e., occupancy estimation and detection probability), status, population size, and environmental resource use (at the reach and microhabitat spatial scales) of these species within the upper Cumberland River drainage. Based on the primary stream size occurrences of these species, sampling reaches (150 m in length) were chosen randomly using a stratified sampling design within third order and smaller stream segments. A total of 80 reaches were chosen, and blackside dace were encountered in only 7 of 83 reaches, with the discovery of one new occurrence (stream) – Paint Gap Branch (Knox County). This capture rate was low compared to that of Black et al, (2013a); however, this was understandable since Black et al. (2013a) focused on streams with known occurrences and the current study used a stratified sampling design that involved random selection of study reaches.

Currently, blackside dace populations are estimated to persist in 125 streams across nine Kentucky counties (Bell, Harlan, Knox, Laurel, Letcher, McCreary, Perry, Pulaski, and Whitley), three Tennessee counties (Campbell, Claiborne, and Scott), and two Virginia counties (Lee and Scott) (Black et al. 2013a; Skelton 2007, 2013a; USFWS unpublished data) (Figures 3-11, Appendix B) (Data sources for these figures include the KSNPC Natural Heritage Database, the Service's Endangered Species Database, the U.S. Geological Survey (USGS) National Hydrography Dataset, and Kentucky Transportation Cabinet road data). A summary of blackside dace stream occurrences is provided in Table 4 (Appendix C). Considering the distribution of these streams and the species' maximum recorded movement of 4 km, we believe the species is currently represented by 58 isolated groups (stream clusters or "populations") that are functionally separated from one another (Table 5, Appendix D). A synopsis of the species' current range is provided below and arranged by sub-drainage or major tributary, starting at the eastern or upstream end of the Cumberland River drainage and moving downstream. The number of streams currently believed to be occupied in each major tributary is listed parenthetically after the tributary name, followed by general comments on range, status, and habitat conditions.

Poor Fork Cumberland River (6). Blackside dace was first recorded from the Poor Fork drainage during a 1961 rotenone survey by KDFWR in the Poor Fork headwaters (specimens reported as *C. erythrogaster*) (Starnes 1981). Subsequent surveys by Harker et al. (1979, 1980), Starnes (1981), and O'Bara (1990) reported the species from the Poor Fork mainstem (6 individuals) and one of its tributaries, Colliers Creek (1 individual). Laudermilk and Cicerello (1998) reported the species from 5 streams in the drainage (Poor Fork, Bad Branch, Meadow Fork, Smith Creek, and Colliers Creek) during surveys of 11 streams (45 sites) between 1985 and 1995. Thomas (2007) reported the species (two individuals) from Franks Creek, just downstream of its confluence with Smith Creek; however, previous survey data and poor habitat conditions within Franks Creek (e.g., elevated conductivity) suggest that these individuals were likely transients from Smith Creek. Currently, we consider the species to be extant in six streams - Bad Branch, Colliers Creek, Meadow Branch, Meadow Fork, Poor Fork (from about the mouth of Slick Shoals Branch upstream), and Smith Creek (Figure 4). Two streams, Bad Branch and Poor Fork, have at least a portion of their watersheds in public ownership. Approximately 304 hectares (ha) in the Poor Fork headwaters is located within the Jefferson National Forest, while Bad Branch is located entirely within Bad Branch State Nature Preserve, a 1,068-ha preserve managed by KSNPC and The Nature Conservancy. Bad Branch is known for its exceptional habitat and water quality and has been designated as a Kentucky Wild River (401 Kentucky Administrative Regulation (KAR) 4:100).

Based on survey data collected over the past 35 years, blackside dace populations within the upper Poor Fork do not appear to be large or particularly robust. Both Starnes (1981) and O'Bara (1985, 1990) commented that the species' distribution may be somewhat limited within the upper Poor Fork due to the basin's steep gradients and fewer pool habitats. Smith Creek likely supports the largest population (Black et al. 2013a; Third Rock Consultants (TRC) 2011-2013, USFWS unpublished data), but collections from most of the remaining streams have produced fewer than 10 individuals per sampling effort. Meadow Fork, a tributary to Franks Creek, continues to have adequate water quality (low conductivity), but the species was not observed there during recent surveys (TRC 2013, USFWS unpublished data). TRC (2013) suggested that extensive beaver activity (pond development) may be affecting the persistence of blackside dace within Meadow Fork (TRC 2013). The Meadow Branch population is the most recent discovery (Potesta and Associates 2009), but this population is limited to an approximate 300-m headwater reach that is bordered / limited by a large beaver pond downstream and a road culvert upstream (TRC 2013). Remaining portions of the Meadow Branch watershed have been impacted by previous mining activities and conductivity is elevated (> 400 µS/cm). Colliers Creek continues to support a small population of blackside dace (Biological Systems Consultants, LLC (BSC) 2008a-2013a), but the species has declined significantly there since the early 2000s (Appalachian Technical Services (ATS) 2000; USFWS unpublished data), and extensive surface coal mining within the watershed has created unfavorable habitat conditions for the species (e.g., elevated conductivity, embedded substrates, siltation). Previously documented populations in Brown Branch (Letcher County) and Cloverlick Creek (Harlan County) are considered to be extirpated (see Table 1; Starnes 1981, O'Bara 1990, Laudermilk and Cicerello 1998, USFWS unpublished data). Both watersheds have been mined extensively for coal, and Starnes (1981) and O'Bara (1990) identified surface coal mining as the primary reason for the species' decline in Cloverlick Creek (Figure 4, Appendix B).

<u>Clover Fork Cumberland River</u> (2). The species was first recorded in the Clover Fork drainage in 1961, when a rotenone survey by KDFWR produced 33 adult individuals from the Clover Fork near the community of Highsplint (Starnes 1981) (Figure 5, Appendix B). The size of the Clover Fork at this site is too large for the species, so we suspect that these specimens were transient individuals that most likely originated from a nearby tributary such as Kelly Branch or Seagraves Creek. Subsequent surveys by Starnes (1981), O'Bara (1990), Laudermilk and Cicerello (1998), and the Service (USFWS unpublished data) have not observed the species within this area of the Clover Fork watershed. Based on our most recent records, the species currently occupies two streams within the drainage – Breedens Creek and Kelly Branch (BSC 2011b-2013b, USFWS unpublished data) (Figure 5). The Breedens Creek population was discovered in 1990 (USFWS unpublished data) and continues to be one of the species' most robust populations (Table 1). Black et al. (2013a) recorded their highest reach-scale population estimate (613 individuals / 200-m) on Breedens Creek (the next highest estimate was 429 inds / 200-m reach on Rock Creek, McCreary County), and surveys by BSC over the last several years indicate that the Breedens Creek population continues to be strong (BSC 2012b). The species was discovered in Kelly Branch in 2006 (USFWS unpublished data) and has been documented there consistently since that time (1-3 individuals/collection) (BSC 2012c). The Kelly Branch population may be limited in size due to the steep gradient and step-pool nature of the stream (not ideal conditions for the species), but other habitat conditions are favorable for the species (e.g., low conductivity, low siltation). It is unknown if reproduction is occurring in Kelly Branch, but we suspect that the majority of Kelly Branch individuals have been colonists from Breedens Creek. The mouths of these streams are separated by only 0.5 km, so colonists from Breedens Creek could easily migrate through the Clover Fork to Kelly Branch. KSNPC observed two dace individuals in the Clover Fork mainstem in July 2012, approximately 8 km upstream of its confluence with Breedens Creek. Based on previous survey data and poor habitat conditions (e.g., elevated conductivity) within this portion of the Clover Fork mainstem, we believe that these individuals were likely transients from Breedens Creek. The species was observed in the lower reaches of Fugitt Creek in 2008 (3 inds), but the species was not observed in subsequent surveys (USFWS unpublished data). Habitat conditions in Fugitt Creek are not

ideal for the species (e.g., high gradient, elevated conductivity), so we suspect that these individuals were simply transients or colonists, possibly from Breedens Creek. Extensive surface coal mining, logging, and residential development in the Clover Fork drainage have degraded the physical habitat and water quality of most streams within the system, rendering them unsuitable for blackside dace (Laudermilk and Cicerello 1998, USFWS unpublished data).

Watts Creek (1). Watts Creek is unique among Kentucky streams because its headwaters drain a large, intact block of old-growth forest that has been dedicated as a State Nature Preserve (Figure 5). Blanton Forest State Nature Preserve (SNP) was first dedicated in September 1995 and now protects 1,264 ha on the southern slope of Pine Mountain. The upper 2.8 km of Watts Creek are located within the preserve, and habitat conditions within this portion of the stream are excellent (e.g., extensive canopy cover, stable substrates, low sedimentation, and baseline water chemistry). Immediately downstream of the preserve, an approximate 200-m reach of Watts Creek is impounded within Camp Blanton, a privately-owned group camp. Downstream of Camp Blanton, Watts Creek flows through a narrow gorge with scattered residences. Habitat conditions within this reach are less than optimal for the species (e.g., narrow riparian zones, increased siltation, less canopy cover). The species was discovered in the upper reaches of Watts Creek in 1994 (Laudermilk and Cicerello 1998), and subsequent surveys by Black et al (2013a) suggest that this portion of the stream supports one of the species' strongest and most robust populations. The reach-scale population estimate of 369 individuals was the third highest estimate recorded by Black et al. (2013a) (out of 119 survey reaches). The species has not been observed in Watts Creek downstream of the Camp Blanton reservoir (Laudermilk and Cicerello 1998, Black et al. 2013a).

Brownies Creek (2). Blackside dace was first observed in Brownies Creek in 1975, and the species was later described by Starnes (1978) based on these specimens. Starnes (1981) and O'Bara (1990) described the blackside dace population in Brownies Creek as "moderate" and "healthy" upstream of the community of Cubage in Bell and Harlan Counties. Subsequent surveys by Laudermilk and Cicerello (1998), KSNPC (2010), Black et al. (2013a), and BSC (2010b, 2011c, 2011d, 2012d, 2013c, 2014a) demonstrate the species' continued presence within a 10-km (6.2-mi) reach of Brownies Creek and one of its tributaries – Blacksnake Branch (Figures 5-6). Based on surveys completed by BSC, the population appears to be at least moderately abundant throughout this reach but is most concentrated in the middle third of the reach near the Bell-Harlan County border. Nally and Hamilton Enterprises, Inc. has proposed a new surface coal mine operation within the Brownies Creek watershed. The proposed operation will include 106.7 ha of surface disturbance, including a 12.3-ha hollow-fill, and is located along the watershed divide between Brownies Creek to the south and Path Fork to the north at the Bell and Harlan County border. The proposed operation is in the final stages of review by state and federal agencies. The mining permit has been issued by the Kentucky Department of Natural Resources (DNR Permit #8480-0292), but the Kentucky Pollution Discharge Elimination System permit (KPDES #KY0108936) is still under review (see Factor A discussion). Blackside dace was first recorded from Blacksnake Branch in 1992 (Laudermilk and Cicerello 1998). Subsequent surveys by Black et al. (2013a) and BSC (2010b, 2010c, 2011b, 2012d) revealed the presence of a stable and robust population (Table 2) – despite the fact that stream conductivity was elevated and marginal for the species (conductivity > 300 μS/cm).

Yellow Creek (6). Blackside dace was first collected from the Yellow Creek drainage in 1875, but the exact locality of this collection is unknown (Starnes 1981). The single specimen was discovered in old material at the University of Michigan's Museum of Zoology and labeled simply as "Cumberland Gap." Currently, the species is thought to occur in seven isolated streams (watersheds) within the drainage – Bennetts Fork, Cannon Creek, Fourmile Run, Lick Fork, Little Yellow Creek, and Sugar Run (Figures 6 and 9). The Bennetts Fork record is based on a single specimen collected in 2000 by the Tennessee Wildlife Resources Agency about 0.4 km upstream (south) of the Kentucky border (TWRA 2001). Blackside dace was first reported from Cannon Creek in 1994 (Laudermilk and Cicerello 1998), but the stream has not been surveyed since that time. The approximate upstream half of Cannon Creek is separated from Yellow Creek by Cannon Creek lake, a 98-ha reservoir created in 1972. Little Yellow Creek and Sugar Run are located (at least partially) in Cumberland Gap National Historical Park (CUGA), a 8,299-ha national park established in 1940. Davis Branch, another CUGA stream, once supported a robust population of blackside dace (Starnes 1981, USFWS 1988, O'Bara 1990, Stephens 1990-2002, 2007), but the species is now absent from the stream due to extensive beaver colonization and subsequent habitat changes over a 15-year period (Compton et al. 2013). Little Yellow Creek appears to have a stable, moderately-sized population (USFWS unpublished data), but it is isolated from the remainder of the Yellow Creek watershed by Fern Lake, a 44-ha reservoir and water supply for the City of Middlesboro, Kentucky. A single specimen was reported from Sugar Run in 2010 (KSNPC 2010); the origin of this specimen and the status of the species in the Clear Fork (of Yellow Creek) watershed is unknown. Two Yellow Creek Bypass tributaries, Fourmile Run and Lick Fork, continue to support small populations (Laudermilk and Cicerello 1998, Eisenhour and Floyd 2013), but the species has disappeared from another Yellow Creek Bypass tributary - Stevenson Branch (Black et al. 2013a; USFWS unpublished data). Based on our observations of habitats in Stevenson Branch, we suspect that excessive sedimentation led to the extirpation.

<u>Clear Creek (0)</u>. Within the Clear Creek drainage (Bell County, Kentucky), blackside dace has been reported historically from Little Clear Creek and one of its tributaries, Bens Fork (Figure 6). Starnes (1981) described the Little Clear Creek blackside dace population as "one of the healthiest known populations…..with numbers perhaps exceeding 2,000 individuals." He considered Little Clear Creek to be "one of the most important refugia" for the species. Starnes and Starnes (1981) selected Little Clear Creek as one of two streams on which to conduct the initial ecological research on the species. Despite these early reports by Starnes (1981) and Starnes and Starnes (1981), the species now appears to be extirpated from the system or occurs in very low numbers. Multiple surveys since the mid-1980s have failed to collect a single individual from Little Clear Creek (Laudermilk and Cicerello 1998; Commonwealth Technology, Inc. (CTI) 2000-2001; TRC 2002a; USFWS unpublished data), and the species has not been observed in Bens Fork since 2008 (Eisenhour 2005-2012). The direct cause of the decline is unknown, but we suspect that increased coal mining activity just prior to listing (late 1980s) created unfavorable habitat conditions for the species (e.g., elevated conductivity and siltation). Our recent conductivity measurements in Little Clear Creek (>800 µS/cm) and Bens Fork (>500 µS/cm) exceed those typically tolerated by the species.

<u>Straight Creek</u> (3). Within the Straight Creek drainage, we have historical records of blackside dace from seven streams: Caney Creek (Left and Right Forks), Left Fork Straight Creek, Long Branch, Mill Creek, Sims Fork, Stoney Fork, and Straight Creek (Starnes 1981, O'Bara 1985) (Figures 5-6). O'Bara (1985, 1990) described the Left Fork Caney Creek population as the most robust in the drainage and believed that its high numbers of individuals had allowed expansion of the species into adjacent streams. Currently, the species continues to occupy the Caney Creek system and also occurs in two other streams - Howard Branch (one individual observed in 2009) and Mill Creek (BSC 2009b, USFWS unpublished data). The Left Fork Caney Creek population has remained fairly strong (BSC 2009b), but Mill Creek appears to support the largest population in the drainage (Black et al. 2013a, USFWS unpublished data). Black et al. (2013a) recorded their fifth highest reach-scale population estimate (369 inds / 200-m) at one Mill Creek station. The species appears to be extirpated from Left

Fork Straight Creek, Long Branch, Sims Fork, Stoney Fork, and Straight Creek; habitat conditions in each of these streams is poor (e.g., elevated conductivity, embedded substrates) (KSNPC 2010; USFWS unpublished data).

Fourmile Creek (1). Blackside dace was first observed in Fourmile Creek in 1993 (Laudermilk and Cicerello 1998). More recent surveys by BSC (2008b, 2010c, 2011e, 2012e) demonstrate that the species continues to occupy the stream, ranging in abundance from 53-198 individuals per year in six sampling reaches (Figure 6).

Stinking Creek (9). When the recovery plan was completed in 1988, blackside dace was not known from the Stinking Creek drainage (USFWS 1988). Surveys within the drainage had been limited to Middle Fork (at mouth), Road Fork (near Barnyard and Dewitt), and Stinking Creek (near Mills) (Starnes 1981, O'Bara 1985). Laudermilk and Cicerello (1998) sampled extensively throughout the drainage in the mid-1990s, discovering new populations of the species in 11 of 19 streams surveyed – Brices Creek, Coles Branch, Hale Fork, Hinkle Branch, Honeycut Branch (of Turkey Creek), Mill Branch, Moore Creek, Mud Lick, Roaring Fork, Trace Branch, and Turkey Creek (Figure 7). The species now appears to be extirpated from Brices Creek, Coles Branch, Honeycutt Branch, and Turkey Creek (KSNPC 2010, USFWS unpublished data). In varying degrees, these streams suffer from poor habitat quality (e.g., embedded substrates, eroded banks, unstable channels, reduced canopy cover). New populations have been discovered in two streams – Acorn Fork and Paint Gap Branch (USFWS unpublished data). Based on surveys by KSNPC (2010) and Black et al. (2013a), Trace Branch appears to have the largest dace population within the drainage. Trace Branch Site #3 yielded the third highest catch rate (396 inds / 200-m reach) and the highest density value (91.3 dace / m^2) of any site visited by Black et al. (2013a) (Table 3). The first, large-scale habitat restoration effort for the species was completed on Mill Branch in 2008 (Floyd et al. 2013) (see *Conservation Efforts* section, pp. 27-28. The restoration was made possible through voluntary conservation agreements with four Mill Branch landowners. Funding and in-kind support for the project was provided by Knox County Fiscal Court, Bluegrass Streams, LLC, Natural Resources Conservation Service (NRCS, Wildlife Habitat Incentive Program), the Service's Partners for Fish and Wildlife Program, KDFWR (Landowner Incentive Program), Cumberland Valley RC&D (Service Private Stewardship Grant), and Kentucky Division of Conservation (State Cost Share Program).

Richland Creek (2). Laudermilk and Cicerello (1998) reported blackside dace from three streams within the drainage – Billies Branch (tributary to Sasser Branch), Hunting Shirt Branch, and Richland Creek (headwaters) (Figure 7). KSNPC (2010) reported that Billies Branch was inundated by beaver ponds and no longer contained habitat suitable for the species. The last, naturally meandering section of Hunting Shirt Branch (an approximate 564-m reach) was channelized (straightened) in 2009. Exhaustive surveys of Hunting Shirt Branch after the incident demonstrated that the species occurred in very low numbers throughout the stream (only one individual was observed). The current status of the species in Hunting Shirt Branch is unknown. Surveys of Richland Creek in 2005 (Black et al. 2013a) and 2012 (USFWS unpublished data) suggest that it supports a robust dace population – possibly one of the best within the species' range (Table 3). Black et al. (2013a) completed surveys at four, 200-m reaches, producing catch rates of 11-58 dace/reach, population estimates ranging from 36-252 dace/reach, and density estimates ranging from 6.5-51.4 dace/m^2.

Little Poplar Creek (3). Blackside dace was first reported from the drainage by Starnes and Starnes (1978a), based on a 1976 collection of one individual from Little Poplar Creek, 13.7 km south of Barbourville. Subsequent surveys by Laudermilk and Cicerello (1998), TRC (2002b), and KSNPC

(2010) confirmed the species' continued presence in Little Poplar Creek, where it appears to inhabit an approximate 6.1-km reach (including East Ridge Branch), extending upstream from the Little Poplar Creek-Hubbs Creek confluence (Figure 7). In 2012, we discovered a new population in Bain Branch, a tributary of Hubbs Creek (USFWS unpublished data). Flows within Bain Branch were intermittent, but five dace individuals were located in several isolated pools. Habitat conditions in Bain Branch were marginal, with elevated conductivity (317 µS/cm) and silted substrates.

Poplar Creek (1). Starnes (1981), O'Bara (1985), and Laudermilk and Cicerello (1998) surveyed numerous streams within the drainage but did not observe blackside dace. The species was not recorded from the Poplar Creek drainage until 2007, when one individual was collected from Seng Branch, a Poplar Creek tributary, by biologists with Apogee Environmental and Archaeological, Inc. (USFWS unpublished data) (Figure 8, Appendix B). The species was not observed in Seng Branch during recent surveys in 2012 (USFWS unpublished data).

Patterson Creek (2). The species was first reported from the Patterson Creek drainage in 1993, when Laudermilk and Cicerello (1998) observed four individuals in Patterson Creek, just upstream of its confluence with Rose Creek, Whitley County, Kentucky (Figure 8). Subsequent surveys by Copperhead Environmental Consulting, Inc. (2010), Black et al. (2013a), and BSC (2011f, 2012f, 2013d) demonstrate that Patterson Creek continues to support a moderately-sized, stable population of blackside dace upstream of its confluence with Rose Creek. In 2001, TRC discovered a new blackside dace population (nine individuals) in Tyes Fork, a tributary to Bennetts Branch, at the KY 904 bridge crossing of Tyes Fork, Whitley County (TRC 2001, USFWS unpublished data). No surveys have been completed in Tyes Fork since that time.

Clear Fork (17). As mentioned previously, blackside dace was first recorded from the Clear Fork drainage by Jordan and Swain (1883), who recognized it as a color variant of *C. erythrogaster*. They described the species as "very abundant in the smaller streams" of the Clear Fork (e.g., Wolf Creek). Starnes (1981) and O'Bara (1985, 1990) completed surveys at 41 streams within the drainage (including Wolf Creek) but only observed the species in Buck Creek, Buffalo Creek, Davis Creek, Elk Creek, and Louse Creek (Figures 8-9). In general, these populations were described as "small" or "sparse", and they concluded that the species' distribution within the drainage was limited by (coal) mining and logging activities. One exception was Buffalo Creek, which Starnes (1981) described as "a relatively dense population" and identified as one of Tennessee's healthiest populations. O'Bara (1990) resurveyed Buffalo Creek but described the population as "limited" and estimated the suitable habitat at 0.5 km, about half the amount estimated by Starnes (1981). Currently, a small population persists within Buffalo Creek (BSC 2012g), and we have extant records of blackside dace from 15 other streams scattered across the drainage (Figures 6, 8-9, Appendix B). We now consider the species to be extirpated from Adams Branch (KY), Cane Creek (KY), Crooked Creek (TN), Straight Creek (TN), and Wolf Creek (KY) (Table 1). Based on survey data collected over the past 35 years, most populations within the Clear Fork drainage do not appear to be large or particularly robust. The best remaining populations occur in Buck Creek (KY), Mud Creek (KY), Rose Creek (TN), and Terry Creek (TN) (KSNPC 2010, Black et al. 2013a, USFWS unpublished data). Black et al (2013a) reported reasonably high catch rates and population estimates for Fall Branch (Campbell County, TN) (Table 2); however, conductivity values were high (> 400 µS/cm), raising some doubt as to the species' ability to persist within Fall Branch. Within Tennessee, portions of the Louse Creek (Jim Branch) and Elk Fork Creek (Terry Creek) watersheds are located within the North Cumberland Wildlife Management Area in Campbell and Scott Counties (Figure 9, Appendix B). A 6.3-km reach of Wolf Creek (KY) has been designated as critical habitat for the federally listed, endangered

Cumberland darter, *Etheostoma susanae* (77 FR 63603). In July 2015, TWRA biologists discovered the species (three individuals) in the headwaters of Tackett Creek, Claiborne County. The current status and size of this population is unknown, but additional surveys are planned by TWRA and the Service. Due to the recent nature of this discovery, there was not sufficient time to add Tackett Creek to Figures 3 and 9 (Appendix B).

Brier Creek (0). Blackside dace was first reported from Brier Creek by Jordan and Swain (1883), who described it as "very abundant." Multiple attempts to find the species in Brier Creek since that time have been unsuccessful (Starnes 1981; Laudermilk and Cicerello 1998, Thomas 2007, USFWS unpublished data), and we now consider the species to be extirpated from the stream (Table 2; Figure 8, Appendix B). A variety of land use activities (e.g., surface coal mining, relocation of Kentucky Highway 92, construction of Kentucky Splash Water Park, and other commercial development) within the Brier Creek watershed have likely contributed to this loss. Current habitat conditions in Brier Creek are poor, as evidenced by elevated conductivity (>800 µS/cm), a lack of shade, and embedded substrates.

Youngs Creek (1). Blackside dace was first reported from Youngs Creek (Figure 8) by Starnes and Starnes (1978b), and the population was later described by Starnes (1981) and O'Bara (1985) as "large" and "healthy." The majority of biological information known for the species came from studies of this population (Starnes and Starnes 1981). The species continued to be common during KSNPC surveys in the mid-1990s (Laudermilk and Cicerello 1998), but recent surveys by Thomas (2007) and KSNPC (2010) at two historical sites suggest that the population has declined (only one individual observed). Habitat conditions continue to be good, with low conductivity and minimal siltation, so the cause of the perceived decline is unknown. Coal reserves (Lee Formation) are limited in the watershed (Starnes 1981), so mining does not appear to be an imminent threat. A 7.4-km reach of Youngs Creek has been designated as critical habitat for the Cumberland darter (77 FR 63603).

Sanders Creek (0). Blackside dace was first reported from Sanders Creek (Figure 8) by Starnes and Starnes (1978a), and Starnes (1981) described the population as "minor but perhaps stable." O'Bara (1985, 1990) did not observe the species in Sanders Creek during the mid-1980s and commented that the stream had been severely impacted by coal mining. The species' recovery plan (USFWS 1988) identified the Sanders Creek population as extirpated due to impacts from construction and mining (Table 2). This assertion was reinforced by Laudermilk and Cicerello (1998) and Thomas (2007), who were unsuccessful in locating the species during subsequent surveys. Currently, we consider the blackside dace population in Sanders Creek to be extirpated.

Jellico Creek (22). Blackside dace was first reported from the Jellico Creek drainage by Starnes and Starnes (1978), who collected the species in Lawson Branch and Trammel Branch (both in TN). Within the Tennessee portion of the drainage, the species continues to be extant in the Jellico Creek headwaters and several streams within the Capuchin Creek sub-drainage (Figure 9). Within the headwaters of Jellico Creek, we have recent records of the species from Chitwood Branch (of Jellico Creek), Gum Fork (near Raven Hollow), and Jellico Creek (upstream of Chitwood Branch) (USFWS unpublished data). Both Starnes (1981) and O'Bara (1985) described the Gum Fork population as strong and healthy but warned of potential mining impacts. Recent surveys suggest that this population has declined (Black et al. 2013a, USFWS unpublished data). Within the Capuchin Creek system, we have recent records of the species from Capuchin Creek (upstream of Incline Hollow including Dan Branch, Bear Branch, and Incline Hollow), Lawson Branch, Hatfield Creek, Baird Creek, and Trammel Branch (tributary of Hatfield Creek) (USFWS unpublished data). Trammel

Branch (of Hatfield Creek) appears to have the strongest population (USFWS unpublished data) within the Capuchin Creek system and could be the sole source of individuals observed in other tributaries.

Within the Kentucky portion of the drainage, we consider the species to be extant in Bailey Branch, Bucks Branch, Campbell Branch, Criscillis Branch, the Rock Creek system (John Anderson Branch, Lot Hollow, Litton Branch, Sid Anderson Branch, Shut-In Branch, and Rock Creek headwaters), and Ryans Creek, (Figures 8, 10). O'Bara (1985) described the Bucks Branch population as one of the species' "best", and this was confirmed later by Laudermilk and Cicerello (1998). The species was rare (one individual observed) in Bucks Branch during recent surveys in 2012, suggesting that the population has declined (USFWS unpublished data). O'Bara (1985, 1990) reported blackside dace from Becks Creek but described the habitat as "poor" and commented on active mining within the watershed. We now consider this population to be extirpated (Table 2). About one-half of the watersheds of Bucks Branch, Rock Creek, and Ryans Creek are in public ownership (DBNF), as well as an approximate 7-km reach of the Jellico Creek mainstem and an approximate 1.8-km reach of the Capuchin Creek mainstem near the Kentucky and Tennessee border. A 11.5-km reach of Jellico Creek, a 4.2-km reach of Capuchin Creek, and a 6.1-km reach of Rock Creek has been designated as critical habitat for the Cumberland darter (77 FR 63603).

Archers Creek (1). Blackside dace was first reported from Archers Creek by Starnes and Starnes (1978a) (Figure 8). Subsequent surveys in 1993 (Laudermilk and Cicerello 1998) and 2005 (Black et al. 2013a) indicate the continued presence of a moderate to robust population. Black et al. (2013a) reported a catch rate of 42 dace / 200-m reach, a population estimate of 162 dace / 200-m reach, and a density value of 17.4 dace / m^2 from Archers Creek Site #3 (Table 3). A portion of the Archers Creek headwaters is in federal ownership (DBNF).

Cane Creek (0). Starnes and Starnes (1978a) first reported blackside dace from Cane Creek (three, small age-1 individuals), but the species was not observed by Laudermilk and Cicerello (1998) (Figure 8, Appendix B). The entire watershed is only about 2 km in length, and the amount of suitable habitat for blackside dace is limited by siltation (e.g., runoff from access road and campsites) and a 5-m waterfall located 300 m from the mouth (Starnes 1981). Therefore, we agree with Starnes (1981) and O'Bara (1990), who regarded the population as "marginal" and "extremely sparse." We expect that Cane Creek may be colonized occasionally by transient individuals from Archers Creek or some other population, but we do not consider the Cane Creek population to be permanent or viable. Over one-half of the watershed is in federal ownership (DBNF).

Marsh Creek (4). Harker et al. (1980), Starnes (1981), and O'Bara (1990) reported blackside dace from the Marsh Creek headwaters, specifically Marsh Creek, Murphy Creek, and Trammel Fork (Figure 10, Appendix B). Populations within Marsh Creek and Murphy Creek were considered small and tenuous, but O'Bara described the Trammel Fork populations as "healthy, with both adults and juveniles." Surveys by Laudermilk and Cicerello (1998), Thomas (2007), and KSNPC (2010) demonstrate that the species is now extirpated from this part of the drainage (Table 2; Figure 8, Appendix B). KSNPC (2010) described the habitat conditions in these streams as degraded (e.g., elevated conductivity, excessive siltation, straightened channels, narrow riparian zones). These watersheds are located within the DBNF proclamation boundary, but all remain in private ownership. Farther downstream within the drainage, the species occupies Big Branch and the Laurel Creek system (Elisha Branch, Jenneys Branch, and Laurel Creek) (Laudermilk and Cicerello 1998, Thomas 2007, Black et al. 2013a, USFWS unpublished data) (Figure 8, Appendix B). Public ownership (DBNF) in these watersheds is high (generally over 50 percent), and habitat and water quality conditions in these streams tend to be good - low conductivity, low siltation, undisturbed channels, and wide riparian zones.

Indian Creek (5). Within this drainage, the species occupies portions of five streams – Barren Fork, Indian Creek, Kilburn Fork, Laurel Fork, and Pigeon Roost Branch (Laudermilk and Cicerello 1998, Thomas 2007, USFWS unpublished data) (Table 10). Barren Fork appears to have the most robust population within the drainage (Stephens 2009). Approximately 75 percent of the drainage is in public ownership (DBNF), and habitat conditions are generally good in all streams. A 6.3-km reach of Barren Fork, a 4.0-km reach of Indian Creek, a 4.6-km reach of Kilburn Fork, and a 3.5-km reach of Laurel Fork have been designated as critical habitat for the Cumberland darter (77 FR 63604-63668).

Slick Shoals Branch (1). The species was first recorded from Slick Shoals Branch by Laudermilk and Cicerello (1998), who observed one individual within the stream's first 400 m (Figure 8). No surveys have been conducted since that time. The entire watershed of Slick Shoals Branch is in public ownership (DBNF).

Bunches Creek (2). Harker et al. (1980) first reported the species from Bunches Creek (Figure 8), and a moderate population has been documented repeatedly in Bunches Creek and Calf Pen Fork by a number of researchers (Starnes 1981, O'Bara 1990, Laudermilk and Cicerello 1998, Thomas 2007). Habitat quality within Bunches Creek was described as excellent by Starnes (1981) and O'Bara (1985), and these conditions have been maintained. Black et al. (2013a) did not observe the species in Bunches Creek, but their surveys took place in the downstream half of the stream, where densities are lower. With the exception of the Calf Pen Fork headwaters, the entire Bunches Creek watershed is located within the DBNF. A 5.8-km reach of Bunches Creek and a 2.9-km reach of Calf Pen Fork have been designated as critical habitat for the Cumberland darter (77 FR 63603).

Cumberland River Tributaries – Downstream of Cumberland Falls (15). Blackside dace was first reported downstream of Cumberland Falls by Starnes and Starnes (1978a), who observed the species in Eagle Creek, Hughs Fork (of Beaver Creek), and South Fork Dogslaughter Creek (Figures 8, 10). Surveys by Harker et al. (1979), Starnes (1981), Warren (1981), and the Kentucky Division of Water (USFWS unpublished data) reported the species from four additional streams - Big Lick Branch (Cumberland River tributary); Craig Creek and Whitman Branch (Laurel River drainage); and Ned Branch (Rockcastle River drainage). Multiple attempts to locate the species in Craigs Creek and a single, but exhaustive attempt, to find the species in Whitman Branch were unsuccessful (Starnes 1981, O'Bara 1990, Laudermilk and Cicerello 1998, Thomas pers. comm. 2014). Currently, we consider blackside dace to be extant in eight watersheds below Cumberland Falls - Eagle Creek, Dog Slaughter Creek (Dogslaughter Creek, Little Dogslaughter Creek, North and South Forks of Dogslaughter Creek), Mill Creek, Fish Trap Branch, Ned Branch, Big Lick Branch, unnamed tributary to Big Lick Branch, and Beaver Creek (Beaver Creek, Middle Fork Beaver Creek, Drury Branch, Freeman Fork, and Hurricane Fork). Public ownership (DBNF) is high in each of these systems, approaching at least 80 to 90 percent in all but Mill Creek. Habitat and water quality conditions within these systems are excellent, and some populations (e.g., Big Lick Branch, Middle Fork Beaver Creek, Mill Creek) are robust (Starnes 1981, O'Bara 1985, Laudermilk and Cicerello 1998, Black et al. 2013a). Black et al. (2013a) reported some of its highest catch rates, population estimates, and density estimates at Big Lick Branch (2 reaches) (Table 3).

Big South Fork Cumberland River (12). Blackside dace was first observed in the Big South Fork drainage in 1999 in White Oak Creek (Figure 10, Appendix B), a tributary of Rock Creek in McCreary

County, Kentucky (Bivens et al. 2013). Since that time, populations have been discovered in five other Rock Creek tributaries (Dolen Branch, Massey Branch, Puncheon Camp Branch, Watts Branch, and an unnamed tributary to Rock Creek) and two Big South Fork tributaries, Alum Creek and Wolf Creek (Figures 9-10, Appendix B) (Scott 2007, Brandt 2009, Bivens et al. 2013). The species also occupies several streams within the Straight Fork (of New River) drainage in Scott County, Tennessee - Jake Branch, Cross Branch, Straight Fork, and an unnamed tributary to Straight Fork (Figure 7, Appendix B) (USFWS unpublished data). Public ownership is high in each of these watersheds, approaching 100% for Dolen Branch (DBNF), Massey Branch (Big South Fork), Watts Branch (DBNF), White Oak Creek (DBNF) and the unnamed tributary of Rock Creek (Big South Fork and DBNF), and about 50-90% for Alum Creek (DBNF) and Wolf Creek (Big South Fork and DBNF). Approximately 50% of the upper Straight Fork system (e.g., Cross Branch, Jake Branch) is located within TWRA's North Cumberland Wildlife Management Area. The species is moderately abundant in most of these streams and appears to be well established (Bivens et al. 2013). The origin of these populations is in question, but bait bucket introduction (by anglers) is suspected as a potential mechanism by which the species entered these systems (Bivens et al. 2013). Initial genetic testing by Strange (2005) revealed that a portion of the population represented new haplotypes belonging to a previously unknown clade, while others had mitochondrial DNA haplotypes previously documented only from sites above Cumberland Falls. This suggested that a portion of the dace population was native to the area, but a significant portion had been introduced and was comprised of individuals from the upper portions of the species' range (Strange 2005).

<u>Maces Creek, Kentucky River Drainage</u> (1). Blackside dace was discovered in Right Fork Maces Creek, Perry County, Kentucky, in October 2013 (USFWS unpublished data) (Figure 3, Appendix B). Biologists with Third Rock Consultants, LLC (Lexington, KY) observed about 40 individuals during baseline biological surveys associated with a bridge replacement project. A return visit in November 2013 by Third Rock, KDFWR, and the Service confirmed the species' identity and documented another occurrence on Right Fork Maces Creek approximately 2.4 km upstream. Additional surveys on Left Fork and Middle Fork Maces Creek did not produce specimens, so it appears that the species is confined to the Right Fork. Fin clips were taken from 15 individuals from Right Fork Maces Creek; these tissue samples will be analyzed genetically by Austin Peay State University to determine the population's origin (see section 2.3.1.2 on pp. 13-14).

<u>Clinch and Powell River Drainages, Virginia (6)</u>. Blackside dace was first discovered in Virginia in 1999 (Skelton 2013). Biologists from TVA collected a series of *Chrosomus* individuals from Cox Creek, a North Fork Powell River tributary in Lee County. Since that time, surveys at over 90 sites in the upper Powell and Clinch River systems of Tennessee and Virginia have produced additional records of the species from two creek systems in the North Fork Powell River drainage in Lee County and a single creek system in the Upper Clinch River drainage in Scott County (Skelton 2013) (Figure 3, Appendix B). Within the North Fork Powell River drainage, the species occupies Cox Creek and three Jones Creek tributaries - Mud Creek, Right Fork Mud Creek, and Reeds Creek. Within the Upper Clinch River drainage, the species occupies portions of Staunton Creek and one of its tributaries, McGhee Creek (Skelton 2013).

2.3.1.5 Habitat:

Habitat for the blackside dace consists of small (generally 1.2 to 4.6 m [4 to 15 ft] wide), cool (rarely exceeding 26.7°C [80°F]), upland streams with moderate flows and generally silt-free substrates (Starnes and Starnes 1978a, b; Starnes 1981; O'Bara 1985; USFWS 1988; O'Bara 1990; Mattingly et al. 2005; Black et al. 2013a, b; Mattingly and Black 2013). Streams inhabited by the species are generally those with good riparian vegetation that provide at least 70 percent canopy cover and numerous submerged root wads, undercut banks, and large rocks (USFWS 1988). Blackside dace rarely have been found in low-gradient streams or high-gradient tributaries (O'Bara 1985, USFWS 1988). A riffle to pool ratio of less than 60:40 and elevations ranging from 300 to 500 m above sea level appear to be preferred by the species (Starnes and Starnes 1981, O'Bara 1990). Streams with higher riffle to pool ratios (above 60:40) harbor fewer populations of blackside dace and tend to be dominated by western blacknose dace (*Rhinichthys obtusus*) and creek chubs (*Semotilus atromaculatus*). Juveniles and females seem to prefer shallower areas with less cover than males (O'Bara 1990; USFWS unpublished data).

Research by Black et al. (2013b) attempted to identify those environmental attributes which affect the distribution of blackside dace. Map-produced and field-collected habitat variables (*e.g.*, turbidity, stream temperature, conductivity) were gathered for 91 streams within the species' range at a headwaters-to-mouth stream scale and at 72 stream sites at a 200-meter long reach scale. Logistic regression analyses at the stream spatial scale showed that dace presence was significantly predictable from only one environmental variable, the crude stream gradient. The model predicted that dace were about four times more likely to occur in a stream with a crude gradient between 1 and 6 percent than in a stream with a lower or steeper gradient. At the 200-m reach spatial scale, they determined that blackside dace were likely to be present in stream reaches with low turbidity (at or below 10 NTU), high dissolved oxygen (greater than 8.5 mg/L), low summer temperatures (between 14.6 and 18.5^{o}C), low to moderate stream conductivity (at or below 240µS/cm), percent riffle habitat between 35 and 50 percent, and a link magnitude (measure of stream size) between 3 and 6. Blackside dace presence was also positively associated with southern redbelly dace and Cumberland arrow darter (*Etheostoma sagitta*) but negatively associated with two potential predators, largemouth bass (*Micropterus salmoides*) and redbreast sunfish (*Lepomis auritus*).

Black et al. (2013b) validated their logistic regression habitat models through collections at 27 new streams and 47 stream reaches that historically harbored blackside dace. Models were generated with crude gradient at the stream scale and turbidity, water temperature, conductivity, percent riffle, and link magnitude at the reach scale to predict the probability of dace presence/absence. Model performance was assessed quantitatively with the Cohen's kappa statistic (Cohen's kappa is a statistic that calculates the proportion of all presence/absence cases that are correctly predicted by a model after taking random chance into consideration [Manel et al. 2001]). Kappa values range from -1 to 1, with higher values representing stronger model performance and values below zero indicating poor performance. The stream scale model (crude gradient) and several reach scale models (utilizing turbidity, percent riffle, and link magnitude) performed poorly when tested with independent data. All of the strongest models included conductivity as a predictor variable, with the combination of conductivity and temperature producing the strongest performance (kappa = 0.41). These findings suggest that conductivity, water temperature, and link magnitude are three important reach-scale variables for predicting blackside dace presence and persistence at a site.

Mattingly and Black (2013) observed that differences between blackside dace spawning and non-spawning microhabitats were related to channel width, silt depth, and substrate embeddedness. Spawning areas had mean channel widths of 3 to 4 m, with silt depths and substrate embeddedness always at zero. Non-spawning areas averaged about 2 m in depth, with silt depths ranging from 1 mm (sites with no known timber harvest upstream in watershed) to 2 mm (moderate logging) and stream embeddedness ranging from negligible/low (no logging) to moderate (moderate logging).

2.3.1.6 Other:

<u>Biology</u>
The biology of blackside dace is only partially understood. Feeding habits and reproductive characteristics were investigated by Starnes and Starnes (1981), who reported schools of 5 to 20 fish grazing on rocks and sandy substrates. Gut analyses revealed that sand comprised the largest portion of the species' gut (36 percent). The remaining portions of the gut were composed of unidentified organisms (32 percent), algae and diatoms (12 percent), and macroinvertebrates (4.5 percent). Macroinvertebrates composed the entire diet during the winter (Starnes and Starnes 1981).

Fish species commonly found in association with blackside dace include the creek chub, central stoneroller, white sucker (*Catostomus commersoni*), northern hog sucker (*Hypentelium nigricans*), green sunfish (*Lepomis cyanellus*), stripetail darter (*Etheostoma kennicotti*), Cumberland arrow darter, and rainbow darter (*E. caeruleum*) (Starnes and Starnes 1978b, O'Bara 1990, Black et al. 2013a). Additional species that may occur along with blackside dace include the bluntnose minnow (*Pimephales notatus*), silverjaw minnow (*Notropis buccata*), striped shiner (*Luxilus chrysocephalus*), southern redbelly dace, longear sunfish (*Lepomis megalotis*), redbreast sunfish, and Cumberland darter (*Etheostoma susanae*) (USFWS unpublished data). Jones (2005) reported that blackside dace was negatively correlated with redbreast sunfish presence, a potential predator and introduced species that was stocked historically by state resource agencies due to its popularity as a sport fish and its tolerance of low stream pH.

The southern redbelly dace is a potential competitor of the blackside dace that appears to be invading portions of the species' range, despite the fact that in a geological timeframe, it is a relative newcomer to the upper Cumberland River basin (Starnes and Starnes 1978b). The blackside dace appears to compete well, even hold its own, in clear, relatively undisturbed streams, but the southern redbelly dace is thought to displace the blackside dace from disturbed streams or streams with lower gradients, heavier silt loads, and warmer stream temperatures (Starnes and Starnes 1978a, USFWS 1988). Mattingly and Black (2007, 2013) used measures of constancy and fidelity to express co-occurrence patterns of blackside dace and selected minnow species. For any given minnow species, constancy was the number of occurrences with blackside dace as a percentage of total blackside dace occurrences. Fidelity was the number of occurrences with blackside dace as a percentage of total occurrences of the given species. Mattingly and Black (2013) reported that species constancy with blackside dace was highest with creek chub, while fidelity values with blackside dace were highest for southern redbelly dace (Mattingly and Black 2013). These findings suggested that blackside dace depend heavily on creek chubs as a nest-building or spawning associate. The high fidelity for southern redbelly dace indicated a common preference for similar habitats but also highlighted the potential for competition between the two species.

<u>Dispersal Patterns</u>
Detar (2004), Mattingly et al. (2005), and Detar and Mattingly (2013) studied the frequency, spatial extent, directionality, and environmental correlates of blackside dace movements by tagging 653 dace from Big Lick Branch (Pulaski County, Kentucky) and Rock Creek (Jellico Creek drainage, McCreary County, Kentucky) with visible implant elastomer injections. Movement was monitored in Big Lick Branch from November 2002 to August 2005 (data reported below are for an approximate one-year cycle, November 2002 to March 2004) and in Rock Creek from March 2003 to March 2004 using baited minnow traps. The majority of tagged dace (81 percent in Big Lick Branch and 58 percent in

Rock Creek) were recaptured within their original tagging site. Other individuals moved considerable distances from their original tagging site, including the first documented intertributary movement for the species (the tagged individual moved from an unnamed tributary of Big Lick Branch downstream through impounded backwaters of Lake Cumberland and into Big Lick Branch). Distances moved upstream in Big Lick Branch (148 $\pm$ 138 m) and Rock Creek (733 $\pm$ 1,259 m) were not statistically different from distances moved downstream (77 $\pm$ 29 m and 314 $\pm$ 617 m, respectively). However, the mean overall distance moved was statistically greater in Rock Creek than in Big Lick Branch; maximum distances moved in Big Lick Branch and Rock Creek were 1.0 km and 4.0 km, respectively (Detar and Mattingly 2013). These results were similar to other movement studies that showed that stream fish populations are comprised of a relatively large sedentary group and a small mobile group (Freeman 1995, Smithson and Johnston 1999, Rodriguez 2002). The exceptional dispersal ability of blackside dace observed in this study suggests that the species can successfully colonize other streams if suitable stream corridors are present. Conversely, the sedentary tendency of many individuals and the low densities observed in most streams (Black et al. 2013) may render many populations susceptible to local extirpation due to drought, a poor year-class, or some type of habitat disturbance (Detar and Mattingly 2013).

2.3.2 Five-factor analysis:

2.3.2.1 Factor A: Present or threatened destruction, modification or curtailment of its habitat or range

The recovery plan attributed the loss of many blackside dace populations to impacts associated with the extraction of coal and timber resources in Kentucky and Tennessee (USFWS 1988). Coal mining-related problems were identified as the primary threat to the species, followed in order of importance by logging, road construction, agriculture, human development, and naturally low stream flows (USFWS 1988). All of these threats remain, but the overall decline of blackside dace can be attributed to a variety of human-related activities in the upper Cumberland River drainage. Resource extraction (e.g., surface coal mining, logging, oil/gas well exploration), land development, rural residential land use, road construction, and agricultural practices have all contributed to the degradation of streams within the species' range (Mattingly et al. 2005; Thomas 2007; Kentucky Division of Water (KDOW) 2010, 2013; Tennessee Department of Environment and Conservation (TDEC) 2014).

These land use activities have led to chemical and physical changes to stream habitats that have adversely affected the blackside dace and other fishes. Specific stressors have included inputs of dissolved solids and elevation of instream conductivity, inputs of nutrients and organic enrichment, sedimentation/siltation of stream substrates (excess sediments suspended or deposited in a stream), the removal of riparian vegetation, and the relocation or straightening of stream channels (KDOW 2011, 2013). A summary of specific threats in the upper Cumberland River drainage was provided by KDOW (2013) and TDEC (2014), who identified portions of 27 (KY) and 7 (TN) blackside dace streams as impaired, placing them on either Kentucky's or Tennessee's 303(d) list (Tables 5 and 6).

Table 5. Summary of Kentucky's 303(d) listed streams in the upper Cumberland River system (KDOW 2013) historically supporting the blackside dace. Streams marked with an asterisk (*) no longer support populations of blackside dace (see Table 2).

Stream	County	Impacted Stream Reach (mi)	Pollutant Source	Pollutants
Acorn Fork	Knox	0-1.9	Highway/road/bridge runoff; loss of riparian habitat; petroleum/natural gas activities	Chloride; sedimentation/ siltation, specific conductance
Bens Fork*	Bell	0-2.2	Coal mining	Specific conductance; total dissolved solids
Cane Creek*	Whitley	0-4.4	Highway/road/bridge runoff; impacts from hydrostructure flow regulation; loss of riparian habitat; residential districts	Low dissolved oxygen, sedimentation/ siltation
Cannon Creek	Bell	0-1.8	Dredging; loss of riparian habitat	Sedimentation/ siltation
Clover Fork*	Harlan	9.2-33.8	Surface coal mining; sewage discharges in unsewered areas; silviculture activities; channelization; loss of riparian habitat; municipal point source discharges; urban runoff/storm sewers	Sedimentation/ siltation; total suspended solids; nutrient/eutrophi-cation; organic enrichment; specific conductance
Cloverlick Creek*	Harlan	0-5.0	Channelization; loss of riparian habitat; municipal point source discharges; urban runoff/storm sewers	Total suspended solids
Colliers Creek	Letcher	0-4.1	Coal mining; surface mining	Specific conductance; total dissolved solids
Craig Creek*	Laurel	5.8-6.8	Channel erosion/incision from upstream hydromodifications; stream bank modification	Sedimentation/ siltation
Jenneys Branch	McCreary	0-6.0	Silviculture; land development or redevelopment; urban runoff/storm sewers	Sedimentation/ siltation
Kilburn Fork	McCreary	0.9-6.2	Source unknown	Sedimentation/ siltation
Laurel Creek	McCreary	3.6-5.1	Package plant or other permitted discharges	Unknown
Laurel Fork of Clear Fork	Whitley	4.2-13.8	Silviculture; non-irrigated crop production; woodlot site clearance	Sedimentation/ siltation
Left Fork Straight Creek*	Bell	0-13.1	Coal mining; crop production; surface mining	Sedimentation/ siltation; total

				suspended solids; turbidity
Little Clear Creek*	Bell	0-10.9	Legacy coal extraction	Sedimentation/ siltation; specific conductance; total dissolved solids
Little Poplar Creek	Knox	0-2.8, 3.1-4.4	Crop production; non-irrigated crop production; site clearance (land development or redevelopment; legacy coal extraction; loss of riparian habitat	Sedimentation/ siltation
Marsh Creek	McCreary	13.5-16.5, 19.0-24.1	Silviculture; agriculture; coal mining	Sedimentation/ siltation
Middle Fork Beaver Creek	McCreary	0-2.3	Impacts from abandoned mine lands (inactive)	pH; sedimentation/ siltation
Mud Creek	Whitley	0-5.2	Highways, roads, bridges; non-irrigated crop production; site clearance (land development or redevelopment)	Sedimentation/ siltation
Poor Fork Cumberland River*	Harlan	14.9-16.3	Rural residential areas; site clearance (land development or redevelopment)	Sedimentation/ siltation
Richland Creek	Knox	0-6.3	Coal mining; legacy coal extraction; urban runoff/ storm sewers	Iron; nutrient/ eutrophication; sedimentation/ siltation
Ryans Creek	McCreary	0-5.3	Surface mining	Total suspended solids
Sims Fork*	Bell	0-5.2	Source unknown; surface mining	Sedimentation/ siltation, TDS
Stevenson Branch*	Bell	0-1.9	Logging; surface mining	Sedimentation/ siltation
Straight Creek*	Bell	1.7-23.3	Channel erosion/incision from upstream modifications; loss of riparian habitat; rural residential areas; surface mining	Sedimentation/ siltation; specific conductance
White Oak Creek	McCreary	0-4.2	Coal mining	Iron
Wolf Creek*	Whitley	0-1.8	Non-irrigated crop production; surface mining	Sedimentation/ siltation
Yellow Creek	Bell	0-6.7	Surface mining; unspecified domestic waste; urban runoff/ storm sewers	Nutrient/ eutrophication; organic enrichment; sedimentation/ siltation; specific conductance; total dissolved solids

Table 6. Summary of Tennessee's 303(d) listed streams in the upper Cumberland River system (TDEC 2014) historically supporting the blackside dace. Streams marked with an asterisk (*) no longer support populations of blackside dace (see Table 2).

Stream	County	Miles Impaired	Pollutant Source	Pollutant
Straight Creek*	Claiborne	1.4	Coal mining discharges; highway, road, bridge runoff	Siltation
Clear Fork	Claiborne, Campbell	9.6	Coal mining discharges; highway, road, bridge runoff; septic tanks	Siltation, bacteria
White Oak Creek	Campbell	6.7	Coal mining discharges, abandoned mining, septic tanks	Siltation, bacteria
Davis Creek	Campbell	24.0	Septic tanks	Bacteria
Hickory Creek	Campbell	9.5	Septic tanks	Bacteria
Little Elk Creek	Campbell	9.9	Septic tanks	Bacteria
Elk Fork Creek	Campbell	3.9	Abandoned mining, septic tanks	Siltation, bacteria

Water Quality Degradation

A significant threat to the blackside dace is water quality degradation of streams caused by a variety of non-point source pollutants. Surface coal mining represents a major source of these pollutants because it has the potential to contribute high concentrations of dissolved metals and other solids that may elevate stream conductivity, increase sulfate levels, and can cause wide fluctuations in stream pH (Curtis 1973; Pond 2004; Hartman et al. 2005; Mattingly et al. 2005; Pond et al. 2008; Palmer et al. 2010; USEPA 2011a; Black et al. 2013a, b). The upper Cumberland River system of Kentucky and Tennessee has been mined extensively, and these activities continue to occur throughout the system.

As of June 2014, 169 mining permits were associated with active coal removal and production in the upper Cumberland River system of Kentucky (Wahrer pers. comm. 2014). These permits consisted of four primary types (other, prep plant, surface, and underground) and 22 secondary types (e.g., haul road, refuse disposal, surface area, surface contour, surface auger, surface mountaintop, and underground). The greatest number of permits were located in Harlan County (67), followed by Bell (60), Knox (15), Whitley (14), Letcher (11), and Laurel (2) Counties. The permits covered a combined area of 820 km^2. No permits with active coal removal were located in McCreary or Pulaski Counties. Another 215 permits were still considered as "active" but did not involve active mining or coal production. These permits were classified as (1) active permits in forfeiture, (2) active temporary cessation, (3) coal removal complete – reclamation activities only, (4) no disturbances, (5) phase I release, and (6) phase II release. These permits covered an area of 1311 km^2. As mentioned previously, Nally and Hamilton Enterprises, Inc. has proposed a new surface coal mine operation within the Brownies Creek watershed (1 km^2 of surface disturbance, including a 0.1-km^2 valley fill). The mining permit has been issued by the Kentucky Department of Natural Resources (DNR Permit #8480-0292), but the Kentucky Pollution Discharge Elimination System permit (KPDES #KY0108936) is still under review.

As of October 2014, 77 mining permits were associated with active coal removal and production in the upper Cumberland River system of Tennessee (Middleton pers. comm. 2014). These permits encompassed a total area of 85 km^2 and consisted of six primary types - surface, underground, preparation plant, ancillary (haul road, conveyor, and rails), refuse or impoundment, and loading facility or tipple. Another 40 permits were considered as "active" but did not involve active mining, coal production, or reclamation activities. Four active permits, #3211, #3218, #3249 and #3264, were located within dace watersheds – Crooked Creek (#3211), Davis Creek (#3218), Lick Fork of Elk Fork Creek and Capuchin Creek (#3249) and Bennetts Fork and Spruce Lick Branch (#3264).

Numerous studies have documented the fact that streams receiving discharges from mined watersheds exhibit water quality characteristics not observed in unmined watersheds (Curtis 1973, Dyer and Curtis 1977, Bryan and Hewlett 1981, Dyer 1982, Hren et al. 1984, US EPA 2005, Pond et al. 2008, Palmer et al. 2010). As rock strata and overburden (excess material) are removed, placed in fills, and exposed to the atmosphere, precipitation leaches metals and other solids (e.g., calcium, magnesium, sulfates, iron, manganese, selenium) from these materials and carries them in solution to receiving streams (Pond 2004, Pond et al. 2008). Dissolved ions can enter streams through surface runoff or as groundwater flowing through fractured geologic layers. If valley fills are used as part of the mining activity, precipitation and groundwater percolate through the fill and dissolve minerals until they discharge at the toe of the fill as surface water (Pond et al. 2008). All of these scenarios can result in elevated conductivity, sulfates, and hardness in the receiving stream. Stream conductivity in mined watersheds can be significantly higher compared to unmined watersheds, and conductivity values can be high for decades (Merricks et al. 2007, Johnson et al. 2010).

Elevated levels of metals and other dissolved solids (i.e., elevated conductivity) in Appalachian streams have been shown to negatively impact biological communities, including losses of mayfly and caddisfly taxa (Chambers and Messinger 2001, Pond 2004, Hartman et al. 2005, Pond et al. 2008, Pond 2010) and decreases in fish diversity (Kuehne 1962; Branson and Batch 1972; Branson and Batch 1974; Stauffer and Ferreri 2002; Fulk et al. 2003; Black et al. 2013a, b; Hitt 2014; Hitt and Chambers 2014). Stauffer and Ferreri (2002) investigated fish assemblages in eastern Kentucky and West Virginia streams and determined that fish assemblages downstream of valley fills supported about half the number of species found at reference sites. Fulk et al. (2003) used the Stauffer and Ferreri (2002) data set to calculate bioassessment scores and reported decreased richness of cyprinids (minnows), decreased richness of invertivores (species that feed on invertebrates), and increased proportions of tolerant individuals in small watersheds (2-10 km^2) below valley fills. Hitt and Chambers (2014) observed lower fish taxonomic and functional diversity in streams downstream of valley fills in West Virginia. Exposure assemblages (those downstream of valley fills) had fewer species, lower abundances, and less biomass than reference assemblages across years and seasons. Taxonomic differences between reference and exposure (mined) assemblages were associated with conductivity and aqueous selenium concentrations (Hitt and Chambers 2014).

Listed and at-risk fishes in Kentucky and Tennessee such as blackside dace, Cumberland arrow darter, and Kentucky arrow darter tend to be less abundant in streams with elevated conductivity levels (USFWS 2013a, b; Black et al. 2013b), and declines in blackside dace abundance have been observed in streams where conductivity increased following mining disturbance (Weaver 1997, Hartowicz pers. comm. 2008). Black et al. (2013b) developed and validated habitat models for blackside dace by examining a number of habitat variables at 91 streams within the species' known range. They determined that blackside dace have an affinity for stream reaches with low temperatures (<18.5^{o}C), a link magnitude between 3 and 6, and summer conductivities less than 240 µS/cm – a conductivity value very close to the 300 µS/cm benchmark developed recently for Central Appalachian ecoregion streams by USEPA (2011b). Hitt (2014) used a large presence-absence data set (511 sites) from the Service, KDFWR, KSNPC, and KDOW to evaluate the relationship between blackside dace and Kentucky arrow darter abundance and stream conductivity. Hitt (2014) reported that conductivity was a strong predictor of blackside dace and Kentucky arrow darter abundance, and sharp declines in abundance were observed at 343 µS/cm (95% confidence intervals of 123-632 µS/cm) for blackside dace and 258 µS/cm (95% confidence intervals of 155-590 µS/cm) for Kentucky arrow darter. Conductivity was the most important variable for both species and was more than twice as important as the two next-most important variables (upstream % forest and % agricultural land uses).

The direct effect of elevated stream conductivity on blackside dace is poorly understood, and the exact conductivity threshold for the species is unknown. The overall conductivity level is important in determining vulnerability, but blackside dace presence is more likely influenced by what individual metals or dissolved solids (e.g., sulfate) are present. Determination of discrete conductivity thresholds will require additional study (KSNPC 2010).

Mine drainage also causes chemical (and some physical) impacts to streams as a result of the precipitation of entrained metals and sulfate, which become unstable in solution (USEPA 2003, Pond 2004). Hydroxide precipitants are formed from iron and aluminum, creating orange or white sludge ("yellow boy") that forms a thick coating on stream substrates (Pond 2004). Most affected streams also have elevated levels of calcium in solution, and if pH is elevated, calcium sulfate ($CaSO_4$) or calcium carbonate ($CaCO_3$) will precipitate (Pond 2004, USEPA 2005). These precipitants accumulate on substrates, encrusting and cementing stream sediments, making them unsuitable for colonization by invertebrates and rendering them unsuitable as foraging or spawning habitat for the blackside dace. Acid mine drainage (AMD) tends to be more of a legacy problem, as enforcement, newer technology, and mining methods have mostly eliminated it in the coal fields of Kentucky and Tennessee (Pond 2004). In the few streams where the problem persists, AMD can be highly detrimental to fish and aquatic insect populations (Henry et al. 1999, Pond 2004). Streams affected by AMD tend to have low pH, high conductivity, and high metal and sulfate concentrations (Herlihy et al. 1990, Pond 2004).

Oil and gas exploration and drilling activities represent another significant source of harmful pollutants (KDOW 2013). Alternative methods (i.e., hydraulic fracturing ("fracking") and horizontal drilling) have allowed for the expansion of oil and gas drilling into deposits that were previously inaccessible (Papoulias and Velasco 2013, KGS 2015). This has led to increased activity within eastern Kentucky and Tennessee, including the upper Cumberland River drainage. A variety of chemicals (e.g., hydrochloric acid, surfactants, potassium chloride) are used during the drilling process and can be harmful to aquatic organisms if the chemicals leave the drill site and enter nearby waterways. Acorn Fork, a known blackside dace stream and tributary to Stinking Creek in Knox County, Kentucky, was impacted by such a release in June 2007 (Papoulias and Velasco 2013). The Service investigated the spill and found that the release had produced an approximate 2.4- to 3.2-km, visibly affected stream zone, as evidenced by a reddish-orange flocculent and sheening on the water's surface. Blackside dace were still present in one unimpacted tributary, but downstream of the spill, the fish community had been severely decimated and two dead blackside dace were discovered. In subsequent investigations, we found conductivity measurements in Acorn Fork and its tributaries to be extremely elevated downstream of the new wells, with readings peaking at about 30,000 µS/cm. Readings upstream of the wells (in all forks and tributaries) displayed normal to slightly elevated conductivity readings (200 to 500 µS/cm). Fish and invertebrates were conspicuously absent from an approximate 2.4-km reach downstream from the site of the spill, but both groups were present just downstream of the confluence with Stinking Creek. Conductivity readings were abnormally elevated for the remaining distance of the stream prior to its confluence with Stinking Creek. The Service has a reached a tentative agreement with the gas company for a financial settlement that would fund restoration activities for blackside dace in the Upper Cumberland River basin. Because oil and gas exploration activities are increasing within eastern Kentucky and Tennessee, events similar to the Acorn Fork spill have the potential to occur again. It is also likely that these types of incidents would go unreported given the lack of Federal oversight and the number and distribution of oil and gas wells that are being developed within the range of the species.

Other nonpoint-source pollutants that affect the blackside dace include domestic sewage (through septic tank leakage or straight pipe discharges) and agricultural pollutants such as animal waste, fertilizers, pesticides, and herbicides. Nonpoint-source pollutants can cause excessive nutrification (increased levels of nitrogen and phosphorus), excessive algal growth, instream oxygen deficiencies, and other changes in water chemistry that can seriously impact aquatic species (KDOW 2006, 2011). Non-point source pollution from land surface runoff can originate from virtually any land use activity and may be correlated with impervious surfaces and storm water runoff (Allan 2004). Pollutants may include sediments, fertilizers, herbicides, pesticides, animal wastes, septic tank and gray water leakage, pharmaceuticals, and petroleum products. These pollutants tend to increase concentrations of nutrients and toxins in the water and alter the chemistry of affected streams such that the habitat and food sources for species like the blackside dace are negatively impacted.

Sedimentation / Siltation

Sediment (siltation) has been listed repeatedly by the KDOW as the most common stressor of aquatic communities in the upper Cumberland River system (KDOW 2006, 2011, 2013). Sedimentation comes from a variety of sources, but KDOW identified the primary sources of sediment as loss of riparian habitat, surface coal mining, legacy coal extraction, logging, and land development (KDOW 2008, 2011, 2013). All of these activities can result in canopy removal, channel disturbance, and increased siltation, thereby degrading habitats used by fishes for both feeding and reproduction. The reduction or loss of riparian vegetation results in the elevation of stream temperatures, destabilization of stream banks, and removal of submerged root systems that provide habitat for fish and macroinvertebrates (Johnson and Jones 2000, Sutherland et al. 2002). Channelization of streams associated with residential development and agriculture has been widespread within the upper Cumberland River drainage. Generally, streams are relocated to one side of the stream valley to provide space for home sites, livestock, hay production, or row crops. Channelization dramatically alters channel dimensions, gradient, stream flow, and instream habitats, and these modified channels are often managed through vegetation removal and dredging to improve flood conveyance (Allan and Castillo 2007) and through placement of quarried stone or gabion baskets to protect against bank erosion. Numerous streams within the blackside dace's current range have been identified as impaired (primarily due to siltation from mining, logging, agricultural activities, and land development) and have been included on Kentucky's 303(d) list of impaired waters (Table 5).

Resource extraction activities (e.g., surface coal mining, legacy coal extraction, logging, oil and gas exploration and drilling) are major sources of sedimentation in Appalachian streams (Paybins et al. 2000, Wiley et al. 2001, KDOW 2013). Activities associated with surface coal mining (e.g., land clearing, road construction, excavation) produce large areas of bare soil that, if not protected or controlled through various erosion control practices, can contribute substantial amounts of sediment into streams during storm events. Mining companies are required to implement erosion control measures during mining activities, but sedimentation continues to be a significant stressor in some mined watersheds. Land use practices such as the placement of valley fills can affect sediment and water discharges into downstream stream reaches, leading to increased erosion or sedimentation patterns, destruction or modification of in-stream habitat and riparian vegetation, stream bank collapse, and increased water turbidity and temperature (Wiley et al. 2001, Messinger 2003). Logging activities can adversely affect blackside dace through removal of streamside (riparian) vegetation (increased stream temperatures), direct channel disturbance, and sedimentation of instream habitats (Mattingly and Black 2013). Sedimentation occurs as soils are disturbed, the overlying leaf or litter layer is removed, and sediment is carried overland from logging roads, stream crossings, skid trails, and riparian zones during storm events. Excess sediment can bury instream habitats used by the species for foraging, reproduction, and sheltering, and disrupt the dynamic equilibrium of channel width, depth, flow velocity, discharge, channel slope, roughness, sediment load, and sediment size that maintains stable channel morphology (Allan 2004). This can lead to channel instability and further degradation of instream habitats. Reductions in riparian vegetation can adversely affect the species through increased solar radiation, elevated stream temperatures, loss of allochthonous (organic material originating from outside the channel) food material, and bank instability or erosion (Allan 2004, Hauer and Lamberti 2006). Any rise in stream temperature is significant as blackside dace appear to prefer average stream temperatures lower than 19.0^{o}C (Black et al. 2013b). Direct channel disturbance occurs primarily at stream crossings during culvert, log, or rock placement. Severe impacts can occur when loggers use stream channels illegally as skid trails (Floyd pers. obs. 2009).

Land use practices that affect sediment and water discharges into a stream can also increase the erosion or sedimentation pattern of the stream, which can lead to destruction or modification of in-stream habitat and riparian vegetation, stream bank collapse, and increased water turbidity and temperature. Historical land use within the upper Cumberland River drainage is partially responsible for these impacts. As the region was settled and cleared of timber in the late 19th and early 20th centuries, stream channels were choked with eroded soils from adjacent floodplains and hillsides (Davis 1924, Trimble 1974, Costa 1975, Jacobson and Coleman 1986, Knox 1987). To improve flood conveyance and increase the amount of available agricultural land, many streams were relocated to the side of their valley, straightened, enlarged, and cleared of debris. This resulted in a network of modified streams with unstable substrates, sparse instream cover, eroding stream banks, and reduced canopy cover. Since that time, some of these habitats have stabilized, but current land use practices (e.g., agriculture, residential development, logging, and surface coal mining) continue to influence sediment and water discharges into streams. Stormwater runoff from unpaved roads, all-terrain vehicle (ATV) trails, and driveways represents another significant, but difficult to quantify, source of sediment that impacts streams within the drainage. Our observations during field collections suggest that this is a common and widespread problem during storm events.

Sediment has been shown to damage and suffocate fish gills and eggs, larval fishes, bottom dwelling algae, and other organisms; reduce aquatic insect diversity and abundance; and, ultimately, negatively impact fish growth, survival, and reproduction (Waters 1995, Meyer and Sutherland 2005). Wood and Armitage (1997) identified at least five impacts of sedimentation on fish, including (1) reduction of growth rate, disease tolerance, and gill function; (2) reduction of spawning habitat and egg, larvae, and juvenile development; (3) modification of migration patterns; (4) reduction of food availability through the blockage of primary production; and (5) reduction of foraging efficiency. With respect to blackside dace, Mattingly and Black (2013) noted that spawning occurred in areas with lower siltation and less embedded substrates.

Other

Another threat to the species is physical alteration of instream habitats by beaver (*Castor canadensis*), a species that has been increasing in number in eastern Kentucky over the past 10 to 15 years (Compton et al. 2013). Signs of beaver activity, including flooded stream channels, girdled trees, thinned riparian zones, and small ponds, are evident in some portions of the species' range. Some of the affected Kentucky streams include Buck Creek (Whitley County), Hale Branch (Knox County), Moore Creek (Knox County), Patterson Creek (Whitley County), Rock Creek (McCreary County), and Ryans Creek (McCreary County). It has been suspected by some biologists that these physical habitat changes could be detrimental to rare fishes such as the blackside dace. Evidence for this hypothesis has now been gathered from a long-term monitoring study at Davis Branch, a known blackside dace and Cumberland arrow darter stream in Cumberland Gap NHP, Bell County, Kentucky (Compton et al. 2013). Blackside dace and Cumberland arrow darters were first documented at Davis Branch in the late 1970s, and successive surveys revealed that the populations were robust and stable (Stephens 2000-2012, Compton et al. 2013). Monitoring data gathered at eight stations on Davis Branch from 1990 to 2010 initially indicated robust, stable populations, but dace and arrow darter numbers began to show declines by the late 1990s as beaver activity increased along the stream. As of 2008, a total of 16 beaver dams were located along an approximate 1-km reach of Davis Branch, with two of the resulting ponds each encompassing over 0.4 ha. The last blackside dace was observed in 2008, and no Cumberland arrow darters have been observed since 2007. The physical character of Davis Branch has changed dramatically since beaver invaded the stream in 1994. The dams have impeded instream flows, producing long, canal-like reaches with no riffles; the dams have disrupted natural dispersal patterns of fishes and have created conditions favorable for lentic, potential predatory species such as redbreast sunfish (*Lepomis auritus*) and warmouth (*L. gulosus*) that are now dominant; riparian vegetation has been diminished while solar exposure has increased; instream siltation has increased as sediment collects behind the dams; and stream temperatures have increased during summer months. An effort to restore the blackside dace population at Davis Branch has begun and will involve a cooperative effort between the National Park Service, the Service, and other State and Federal partners.

In summary, the blackside dace's habitat and range have been modified and limited by both water quality degradation and physical habitat disturbance. Contaminants associated with surface coal mining (metals, other dissolved solids), domestic sewage (bacteria, nutrients), and agriculture (fertilizers, pesticides, herbicides, and animal waste) cause degradation of water quality and habitats through increased conductivity and sulfates, instream oxygen deficiencies, excess nutrification, and excessive algal growths. Annual coal production in eastern Kentucky (including counties in the upper Cumberland River basin) has declined over the past two decades, but annual production in eastern Kentucky continues to be relatively high (over 39 million tons produced in 2013) (KEEC 2014), recoverable reserves for the eastern Kentucky portion of the Appalachian Basin are estimated at 5.8 billion tons (Milici and Dennen 2009), and the species' distribution continues to be limited as a result of previous mining activities within the basin. Consequently, the potential remains for blackside dace to be adversely affected by water quality degradation associated with surface coal mining activities. Demand for natural gas production in Kentucky is expected to increase in future years (Kentucky Geological Survey (KGS) 2012), so threats from these activities will likely increase. Sedimentation from coal mining, logging, agriculture, development sites, and beaver activity within the upper Cumberland River drainage negatively affect the species by burying or covering instream habitats used by the species for foraging, reproduction, and sheltering. These impacts can cause reductions in growth rates, disease tolerance, and gill function; reductions in spawning habitat, reproductive success, and egg, larvae, and juvenile development; modifications of migration patterns; decreased food availability through reductions in prey; and reduction of foraging efficiency. Furthermore, threats faced by the blackside dace from sedimentation and contaminants are imminent due to ongoing projects that are expected to continue indefinitely. As a result of the imminence of these threats, combined with the vulnerability of the remaining small populations to extirpation from natural and manmade threats, we have determined that the present or threatened destruction, modification, or curtailment of the blackside dace habitat and range represents a threat of moderate magnitude. We have no information indicating that the magnitude or imminence of this threat is likely to be appreciably reduced or increased in the foreseeable future.

2.3.2.2 Factor B: Overutilization for commercial, recreational, scientific, or educational purposes

The blackside dace is not believed to be utilized for commercial, recreational, scientific, or educational purposes. When the species was described and listed in the early 1990s, it was suggested that the species' rareness would make it desirable to private and institutional collectors; however, over-collecting does not appear to have been a significant threat since that time. Individuals may be collected occasionally by recreational anglers in minnow traps and used as live bait, but this activity does not appear to be a substantial threat. However, the inadvertent transplantation of blackside dace by recreational anglers into other watersheds, some outside the species' historical range, confounds management and conservation efforts.

2.3.2.3 Factor C: Disease or predation

Disease is not considered to be a factor in the decline of blackside dace. We do not believe that predation currently poses a significant threat to the species as most of this predation is naturally occurring or a normal aspect of the species' population dynamics. However, the widespread occurrence and abundance of introduced predators in the upper Cumberland River drainage (e.g., redbreast sunfish) and the species' low population numbers in some portions of its range may make it more susceptible to the effects of predation. Our current information does not indicate that disease or predation is likely to become a threat to the blackside dace in the foreseeable future, but the threat from predation may become more significant in portions of the range where population declines are most severe.

2.3.2.4 Factor D: Inadequacy of existing regulatory mechanisms

The blackside dace and its habitats are afforded some protection from water quality and habitat degradation under the Clean Water Act of 1977 (33 U.S.C. 1251 et seq.), Surface Mining Control and Reclamation Act of 1977 (30 U.S.C. 1234 – 1328), Kentucky's Forest Conservation Act of 1998 (KRS 149.330-355), Kentucky's Agriculture Water Quality Act of 1994 (KRS 224.71-140), Kentucky Wild Rivers Act (KRS 146.200), additional Kentucky laws and regulations regarding natural resources and environmental protection (KRS 146.200-360; KRS 224; 401 KAR 5:026, 5:031) and Tennessee's Water Quality Control Act of 1977 (T.C.A. 69-3-101). It is difficult to determine whether these statutes and regulations are adequately addressing the habitat and water quality threats to the blackside dace; however, as demonstrated under Factor A, some population declines and degradation of habitat for this species are ongoing despite the protection afforded by these statutes and associated regulations. While these laws have undoubtedly resulted in some improvements in water quality and stream habitat for aquatic life, including the blackside dace, we must conclude that they alone have been inadequate in fully protecting this species in all portions of its range. The species is also afforded protection by the Endangered Species Act (Act) of 1973, as amended (87 Stat. 884, as amended: 16 U.S.C. 1531 *et*

seq), which requires federal agencies to consult with the Service when activities they fund, authorize, or carry out may affect a listed species. The Act requires that federal permits must be obtained for any activity that may result in "take" of a listed species.
Significant portions of at least 47 streams with extant blackside dace populations are located on the DBNF (watersheds with >50% ownership) and receive management and protection through the National Forest Management Act of 1976 (16 U.S.C. 1600 *et seq*.) and DBNF's land and resource management plan (LRMP) (USFS 2004). Public ownership in these watersheds ranges from about 25 to 100 percent. The LRMP is implemented through a series of project-level decisions based on appropriate site-specific analysis and disclosure. It does not contain a commitment to select any specific project; rather, it sets up a framework of desired future conditions with goals, objectives, and standards to guide project proposals. Projects are proposed to solve resource management problems, move the forest environment toward desired future conditions, and supply goods and services to the public (USFS 2004). The LRMP contains a number of protective standards that in general are designed to avoid and minimize potential adverse effects to the blackside dace and other sensitive species; however, the DBNF continues to consult with the Service when their activities may adversely affect streams supporting the species. The DBNF's management under the LRMP contributes substantially to the conservation of the species, and we expect the DBNF to continue to implement management actions that benefit the species. A significant portion (about 39 percent) of the species' remaining populations occurs within the DBNF, and these populations have benefited from management goals, objectives, and protective standards included in the LRMP. Collectively, these streams contain some of the species' best remaining habitats and support some of the species' most robust populations.

Regulatory mechanisms associated with other Federal and State lands in Kentucky, Tennessee, and Virginia provide additional protections for the species. These lands and corresponding statutes/ regulations include Cumberland Gap NHP in Bell and Harlan Counties, Kentucky, Claiborne County, Tennessee, and Lee County, Virginia and Big South Fork NRRA in McCreary County, Kentucky and Scott County, Tennessee (National Park Service Organic Act of 1916 (16 U.S.C. 1 *et seq*.)); Jefferson National Forest in Letcher County, Kentucky and Lee and Scott Counties, Virginia (National Forest Management Act of 1976); Bad Branch SNP in Letcher County, Kentucky and Blanton Forest SNP in Harlan County, Kentucky (400 KAR 2:090); and North Cumberland Wildlife Management Area in Campbell and Scott Counties, Tennessee (Tennessee Code Annotated §§ 70-5-101-113). In general, streams occupied by blackside dace in these areas are protected from general disturbance and receive some level of management and protection under a formal land management or natural resource plan.

The blackside dace has been designated as a Threatened species in Kentucky (KSNPC 2005) but this state designation conveys no legal protection. Kentucky law prohibits the collection of the fish species for scientific purposes without a valid state-issued collecting permit (KRS 150.183). Enforcement of this permit is difficult, but we do not believe that these activities represent a significant threat to the species. Within Kentucky, persons who hold a valid fishing license (obtained from the Kentucky Department of Fish and Wildlife Resources (KDFWR)) are prohibited from using listed fish species such as the blackside dace as bait (KDFWR 2008, 301 KAR 1:130). The Tennessee Wildlife Resources Agency (TWRA) lists the blackside dace as Threatened in Tennessee (Tennessee Code Annotated §§ 70-8-101-112) and scrutinizes collection permit applications to prevent over-collection of imperiled species for scientific purposes (TWRA 2009). We do not currently believe this is a significant threat (see Factor B) or is likely to become a threat in the foreseeable future.

The blackside dace has been designated as a Threatened species in Tennessee (Withers 2009). Under the Tennessee Nongame and Endangered or Threatened Wildlife Species Conservation Act of 1974 (Tennessee Code Annotated §§ 70-8-101-112), "[I]t is unlawful for any person to take, attempt to take, possess, transport, export, process, sell or offer for sale or ship nongame wildlife, or for any common or contract carrier knowingly to transport or receive for shipment nongame wildlife." Further, regulations included in the Tennessee Wildlife Resources Commission Proclamation 00-15 Endangered Or Threatened Species state the following: except as provided for in Tennessee Code Annotated, Section 70-8-106 (d) and (e), it shall be unlawful for any person to take, harass, or destroy wildlife listed as threatened or endangered or otherwise to violate terms of Section 70-8-105 (c) or to destroy knowingly the habitat of such species without due consideration of alternatives for the welfare of the species listed in (1) of this proclamation, or (2) the United States list of Endangered fauna. This regulation is inadequate for the protection of the blackside dace, as it only requires parties to consider alternatives before knowingly altering the habitat of it or other species listed by the State of Tennessee as threatened or endangered.

In summary, existing regulatory mechanisms (e.g., Clean Water Act) have provided for some improvements in water quality and habitat conditions but they have been inadequate in fully protecting the species and its habitats. Sedimentation and non-point source pollutants continue to be a significant problem across the species' range. Due to the vulnerability of blackside dace to water quality and habitat degradation, we find the inadequacy of regulatory mechanisms that address water quality and physical habitat disturbance to be an imminent threat of low to moderate magnitude. Further, the information available to us at this time does not indicate that the magnitude or imminence of this threat is likely to be appreciably reduced in the foreseeable future.

2.3.2.5 Factor E: Other natural or manmade factors affecting its continued existence

The disjunct nature of some blackside dace populations restricts the natural exchange of genetic material between populations. The localized nature and small size of many populations also makes them vulnerable to extirpation from intentional or accidental toxic chemical spills, habitat modification, progressive degradation from runoff (non-point source pollutants), natural catastrophic changes to their habitat (e.g., flood scour, drought), and other stochastic disturbances, such as loss of genetic variation and inbreeding. For example, inbreeding and loss of neutral genetic variation associated with small population size can further reduce the fitness of the population (Reed and Frankham 2003), subsequently accelerating population decline (Fagan and Holmes 2006).

The Intergovernmental Panel on Climate Change (IPCC) concluded that warming of the climate system is unequivocal (IPCC 2014). Numerous long-term climate changes have been observed including changes in arctic temperatures and ice, widespread changes in precipitation amounts, ocean salinity, wind patterns and aspects of extreme weather including droughts, heavy precipitation, heat waves, and the intensity of tropical cyclones (IPCC 2014). Species that are dependent on specialized habitat types, limited in distribution, or at the extreme periphery of their range may be most susceptible to the impacts of climate change (75 FR 48896, August 12, 2010); however, while continued change is certain, the magnitude and rate of change is unknown in many cases.

Climate change has the potential to increase the vulnerability of the blackside dace to random catastrophic events (e.g., McLaughlin et al. 2002; Thomas et al. 2004). An increase in both severity and variation in climate patterns is expected, with extreme floods, strong storms, and droughts becoming more common (Cook et al. 2004, Ford et al. 2011, IPCC 2014). During 2007, a severe drought affected the upper Cumberland River drainage in Kentucky and Tennessee. Streamflow values (cubic feet per second) for the Cumberland River at Williamsburg, Kentucky, (USGS Station Number 03404000) in September and October were among the lowest recorded monthly values (99th percentile for low-flow periods) during the last 67 years (Cinotto pers. comm. 2008). Climate change could intensify drought events such as the one that occurred in 2007. Thomas et al. (2004) report that frequency, duration, and intensity of droughts are likely to increase in the Southeast as a result of global climate change. Predicted impacts of climate change on fishes include disruption to their physiology (such as temperature tolerance, dissolved oxygen needs, and metabolic rates), life history (such as timing of reproduction, growth rate), and distribution (range shifts, migration of new predators) (Jackson and Mandrak 2002, Heino et al. 2009, Strayer and Dudgeon 2010, Comte et al. 2013). According to Kaushal et al. (2010), stream temperatures in the Southeast have increased roughly 0.2-0.4 ^{o}C per decade over the past 30 years, and as air temperature is a strong predictor of water temperature, stream temperatures are expected to continue to rise.

Estimates of the effects of climate change using available climate models typically lack the geographic precision needed to predict the magnitude of effects at a scale small enough to discretely apply to the range of a given species. However, data on recent trends and predicted changes for Kentucky and Tennessee (Girvetz *et al.* 2009), and, more specifically, the upper Cumberland River drainage (Alder and Hostetler 2013) provide some insight for evaluating the potential threat of climate change to the blackside dace. These models provide estimates of average annual increases in maximum and minimum temperature, precipitation, snowfall, and other variables. Depending on the chosen model, average annual temperatures for the upper Cumberland River drainage are predicted to increase by 2.5 to 5^{o}C (4.5 to 9^{o}F) by the 2080s (Girvetz *et al.* 2009, Alder and Hostetler 2013), while precipitation models predict that the region will experience a slight increase in average annual precipitation (2 cm/day (0.8 in/day) (x 100)) through 2074 (Girvetz *et al.* 2009, Alder and Hostetler 2013).

Although climate change is almost certain to affect aquatic habitats in the upper Cumberland River drainage in eastern Kentucky (Alder and Hostetler 2013), there is great uncertainty about the specific effects of climate change on the blackside dace. Currently, we have no evidence that climate changes observed to date have had any adverse impact on the blackside dace or its habitats, and we have no evidence that climate change represents an imminent threat now or in the foreseeable future.

The hemlock woolly adelgid (HWA) (*Adeleges tsugae*), an aphid-like insect native to Asia, represents a new threat to the blackside dace because it has the potential to severely damage stands of eastern hemlocks (*Tsuga canadensis*) that occur throughout the species' range. In many areas where dace occur, hemlocks are the dominant riparian tree and provide the majority of shade to stream corridors. The HWA was introduced in the Pacific Northwest during the 1920s and has since spread throughout the eastern United States, reaching eastern Tennessee by 2002 and Kentucky by 2006. The species creates an extreme amount of damage to natural stands of hemlock, specifically eastern hemlock and Carolina hemlock (*Tsuga caroliniana*). Loss of hemlocks along dace streams has the potential to adversely affect the species through increased solar exposure and subsequent elevated stream temperatures, bank erosion, and excessive inputs of woody debris that will clog streams and cause channel instability and erosion (Townsend and Rieske-Kinney 2009). We expect these impacts to occur in some blackside dace watersheds; however, we do not believe these impacts will be widespread or severe. Eastern hemlocks are not abundant in all portions of the blackside dace's range, and we expect hemlocks to be replaced by other tree species in areas where hemlocks are more common. Based on all these factors, we do not believe the invasion of HWA and the subsequent loss of eastern hemlock in eastern Kentucky and Tennessee poses a significant threat to the blackside dace.

Our current information also does not indicate that the loss of eastern hemlock is likely to become a threat to the blackside dace in the foreseeable future.

2.4 Synthesis

When the recovery plan was completed in 1988, the species was known from a total of 35 streams in Kentucky and Tennessee. Currently, blackside dace populations are estimated to persist in 125 streams across nine Kentucky counties (Bell, Harlan, Knox, Laurel, Letcher, McCreary, Perry, Pulaski, and Whitley), three Tennessee counties (Campbell, Claiborne, and Scott), and two Virginia counties (Lee and Scott) (Black et al. 2013a; Skelton 2007, 2013; USFWS unpublished data) (Figure 3; Table 7, Appendix C). Considering the distribution of these streams and the species' maximum recorded movement of 4 km, it is estimated the species is currently represented by 57 isolated groups (or populations) that are functionally separated from one another (Table 8, Appendix D). Over the past 27 years, we have gained more protected, occupied streams in the eight sub-basins (recovery units) summarized in the species' recovery plan (Table 1); however, more information is needed to evaluate the genetic diversity and viability of populations in these streams (see 4.0 Recommendations for Future Actions). Based on survey results and our observations regarding abundance, age-class structure, and recruitment, we estimate that 76 streams contain stable populations, with the remaining 49 streams rated as vulnerable (See Table 7, Appendix C). The species appears to have been extirpated from at least 31 streams in which it was previously documented.

Land ownership in the majority of blackside dace watersheds is private, but significant portions of 47 blackside dace watersheds (watersheds with >50% ownership) are in public ownership. Most of these watersheds (85%) are located on the Daniel Boone National Forest (DBNF) in Laurel, McCreary, Pulaski, and Whitley Counties, Kentucky. Public ownership on the DBNF varies between 25-100 percent, and DBNF streams are managed under the DBNF's Land and Resource Management Plan (USFS 2004). Outside of the DBNF in Kentucky, public ownership in dace watersheds is limited to the Poor Fork headwaters in Letcher County (Jefferson National Forest), Bad Branch in Letcher County (Bad Branch State Nature Preserve), Watts Creek in Harlan County (Blanton Forest State Nature Preserve), Davis Branch, Little Yellow Creek, and Sugar Run in Bell County, Kentucky (Cumberland Gap National Historical Park (NHP)), and Wolf Creek (Big South Fork National River and Recreation Area (NRRA)) in McCreary County. Within Tennessee, public ownership is limited to the headwaters of Little Yellow Creek in Claiborne County (Cumberland Gap NHP), two tributaries of Rock Creek (Massey Branch and an unnamed tributary) in Campbell County (Big South Fork NRRA), and four stream systems located on the North Cumberland Wildlife Management Area in Campbell and Scott Counties - Elk Fork Creek, Hudson Branch, Terry Creek, and Straight Fork (including Cross Branch and Jake Branch). New information has been gathered on the species' current distribution and biological requirements since the recovery plan was completed in 1988, but management strategies have not been developed.

Three of the five listing factors pose threats to the blackside dace: the present or threatened destruction, modification, or curtailment of its habitat or range; the inadequacy of existing regulatory mechanisms; and other natural or manmade factors affecting its continued existence. The species' habitat and range have been modified and limited by both water quality degradation and physical habitat disturbance. Water quality impacts (e.g., elevated conductivity, high sulfates) associated with surface coal mining, oil and gas exploration, and other land use practices vary from low to high magnitude across the species' range, but they are most severe in the eastern half of the range, where intensive land disturbances, such as surface coal mining, are most prevalent. Activities associated with surface coal mining are a major source of pollutants because they have the potential to contribute high concentrations of dissolved metals and other solids that elevate stream conductivity, increase sulfate and hardness levels, and cause wide fluctuations in stream pH. These water quality changes can be permanent and render these habitats unsuitable for blackside dace. Black et al. (2013b) and Hitt (2014) demonstrated that blackside dace do not persist in areas with elevated stream conductivity, and declines or extirpations have been observed when conductivity levels exceed 240 µS/cm. Based on all of these factors, we consider water quality degradation to be severe and of high magnitude in the eastern half of the range. In the western half of the species' range, water quality threats are diminished (low magnitude) because surface coal mining is less prevalent, average water quality conditions are better (e.g., low conductivity), and large portions of the upper Cumberland River drainage are in public ownership (e.g., DBNF and North Cumberland Wildlife Management Area). For this particular threat, we consider the variation in magnitude from west to east and arrive at an overall threat magnitude of "moderate."

Physical habitat degradation associated with sedimentation and other physical habitat disturbance (e.g., loss of riparian vegetation, channelization) is widespread across the blackside dace's range (the geographic scope is widespread and not localized). Sedimentation/siltation is the most significant threat to physical habitat quality across the species' range, and sedimentation continues to be ranked by the KDOW as the most common stressor of aquatic communities in the upper Cumberland River system. We consider physical habitat threats to be of moderate magnitude due to their widespread occurrence and the fact that several blackside dace populations have disappeared from systems impacted solely by these threats.

Current regulatory mechanisms, such as the Federal Clean Water Act, have contributed to some water quality and habitat improvements across the species' range, especially on public lands (e.g., DBNF); however, they alone have been inadequate to prevent water quality degradation and habitat disturbance. The disjunct nature of some blackside dace populations restricts the natural interchange of genetic material between populations and makes natural repopulation following localized extirpations arduous without human intervention. The small size of many blackside dace populations may make them vulnerable to extirpation from intentional or accidental toxic chemical spills, habitat modification, progressive degradation from runoff (non-point source pollutants), natural catastrophic changes to their habitat (e.g., flood scour, drought), and other stochastic disturbances, such as loss of genetic variation and inbreeding.

Based on the best available scientific and commercial information available to the Service regarding the species' current status and past, present, and future threats, the species continues to be impacted by poor water quality and habitat deterioration resulting from resource extraction activities, siltation caused by poor land use practices, reductions in riparian cover, and by other nonpoint-source pollutants. The species' patchy distribution limits the natural genetic exchange between and within its populations. Because of its restricted distribution and continued vulnerability to these threats, and our uncertainty with regard to the viability of individual populations across the range, we believe that the species continues to meet the definition of threatened (likely to become endangered within the foreseeable future throughout all or a significant portion of its range) and should remain classified as such.

3.0 RESULTS

3.1 **Recommended classification:** Threatened; no change is needed.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

The following recovery and conservation recommendations are based on actions identified in the species' recovery plan (USFWS 1988), other activities summarized by Mattingly and Floyd (2013), and new ideas generated during the preparation of this five-year review. The recommended actions are listed in no particular order of priority.

- Continue to utilize existing legislation and regulations to protect the species and its habitats (e.g., ESA, federal and state surface mining laws, US Clean Water Act and other state water quality regulations, Federal Energy Regulatory Commission licensing).

- Continue cooperative efforts such as habitat conservation plans, Farm Bill programs, Partners for Fish and Wildlife program projects, state stream mitigation programs, and other resources to address threats and to protect, enhance, and restore dace populations and habitats.

- Conduct research to address information needs with regard to the species' biology, ecology, behavioral patterns, and early life history:

    - The species' genetic diversity, level of genetic exchange, and viability of populations
    - The species' response and vulnerability to elevated conductivity
    - The species' swimming performance as it relates to culvert/bridge design
    - Development of a sound, cost-effective, range-wide monitoring strategy
    - The species' response to the potential loss of eastern hemlocks
    - The species' response to climate change
    - Interactions with other species (e.g., redbreast sunfish)
    - Impacts of beaver colonization across the range
    - The species' habitat characteristics as it relates to stream restoration efforts
    - The species' early life history stages – biological and habitat needs

- Work cooperatively with federal, state, and private partners to develop a range-wide conservation strategy for blackside dace that (1) builds on recovery actions identified in the species' recovery plan and (2) incorporates the best available scientific information on the species' biology, status, and threats as outlined in this five-year review;

- Continue to monitor extant populations and search for new populations using a standardized monitoring protocol to help us determine and evaluate viability across its range. Survey activities should be prioritized to include those streams for which recent survey data is lacking or streams in which the species appears to be vulnerable. A preliminary list of these streams is provided below:

    - Acorn Fork, Knox County, KY
    - Bailey Branch, Whitley County, KY
    - Bain Branch (Hubbs Creek), Knox County, KY
    - Bennetts Fork, Claiborne County, TN

- Bucks Branch, Whitley County, KY
- Capuchin Creek headwaters, Campbell/Scott Counties, TN
- Cannon Creek, Bell County, KY
- Colliers Creek, Letcher County, KY
- Drury Branch, McCreary County, KY
- Fall Branch, Campbell County, TN
- Fourmile Run, Bell County, KY
- Hatfield Creek system, Campbell County, TN
- Hinkle Branch, Knox County, KY
- Hunting Shirt Branch, Knox County, KY
- Jellico Creek headwaters, Scott County, TN
- Lick Fork, Campbell County, TN
- Louse Creek and Jim Branch, Campbell County, TN
- Meadow Branch, Letcher County, KY
- Meadow Fork, Letcher County, KY
- Ned Branch, Laurel County, KY
- Rock Creek system, McCreary County, KY & Scott County, TN
- Seng Branch, Whitley County, KY
- Slick Shoals Branch, Whitley County, KY
- Sugar Run, Bell County, KY
- Tackett Creek (headwaters), Claiborne County, TN
- Turkey Creek, Knox County, KY
- Tyes Fork, Whitley County, KY
- Youngs Creek, Whitley County, KY

- Initiate other recovery actions as specified in the range-wide conservation strategy and revised recovery plan.

- Revise the current listing to reflect the taxonomic change and the species' extended range into Virginia.

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U.S. FISH AND WILDLIFE SERVICE

5-YEAR REVIEW of Blackside dace (*Phoxinus cumberlandensis*)

Current classification: Threatened

Recommendation resulting from the 5-Year review: No change is needed.

Review conducted by: Dr. Michael A. Floyd, Kentucky Field Office, Frankfort, Kentucky

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve Virgil Lee Andrews Date 9/11/15

REGIONAL OFFICE APPROVAL

For

Lead Regional Director, Fish and Wildlife Service

Approve Aaron L Valenta Date 9-16-15

APPENDIX A: Summary of peer review for the 5-year review of the blackside dace (*Chrosomus cumberlandensis*).

A. Peer Review Method: The draft document was peer-reviewed by Dr. Hayden Mattingly, Tennessee Technological University, Cookeville, Tennessee; Dr. Chris Skelton, Georgia College and State University, Milledgeville, Georgia; Dr. Matthew Thomas, Kentucky Department of Fish and Wildlife Resources (KDFWR), Frankfort, Kentucky; and Mr. Michael Compton, Kentucky State Nature Preserves Commission (KSNPC), Frankfort, Kentucky; and comments received were incorporated as appropriate.

B. Peer Review Charge: Peer reviewers were asked to read the 5-year review and provide any comments, both editorial and content related. They were not asked to comment on the recommendation regarding listing status.

C. Summary of Peer Review Comments/Report: Each of the reviewers made minor editorial comments or changes and provided their general approval of the draft as written. Dr. Mattingly provided several substantive comments and new text regarding the distribution and genetics of the recently discovered Virginia populations, the population estimates and densities reported by Black and Mattingly (2013a), and the conservation benefits of the Northern Cumberlands Habitat Conservation Plan process in Tennessee. Dr. Skelton provided new details regarding the species' distribution in Virginia. Dr. Thomas provided comments and new information regarding distributional records for the Rock Creek drainage, McCreary County, Kentucky; he provided new information regarding land use and threats in the Brier Creek drainage, Whitley County; and he provided a written summary of the new taxonomic change for the genus *Phoxinus*. Mike Compton recommended the addition of new text regarding the phenotypic similarity of blackside dace and southern redbelly dace; he provided new distributional information for the Laurel River drainage (Whitman Branch), Laurel County; he provided substantive comments and new text regarding Factor C - potential predation threats from introduced sunfishes; and he recommended the addition of new text on the significance of legacy stream impacts (i.e., channelization, channel relocation).

D. Response to Peer Review: Peer review comments were incorporated into the 5-year review as suggested by the reviewers (refer to C above).

APPENDIX B. Blackside dace distributional maps.

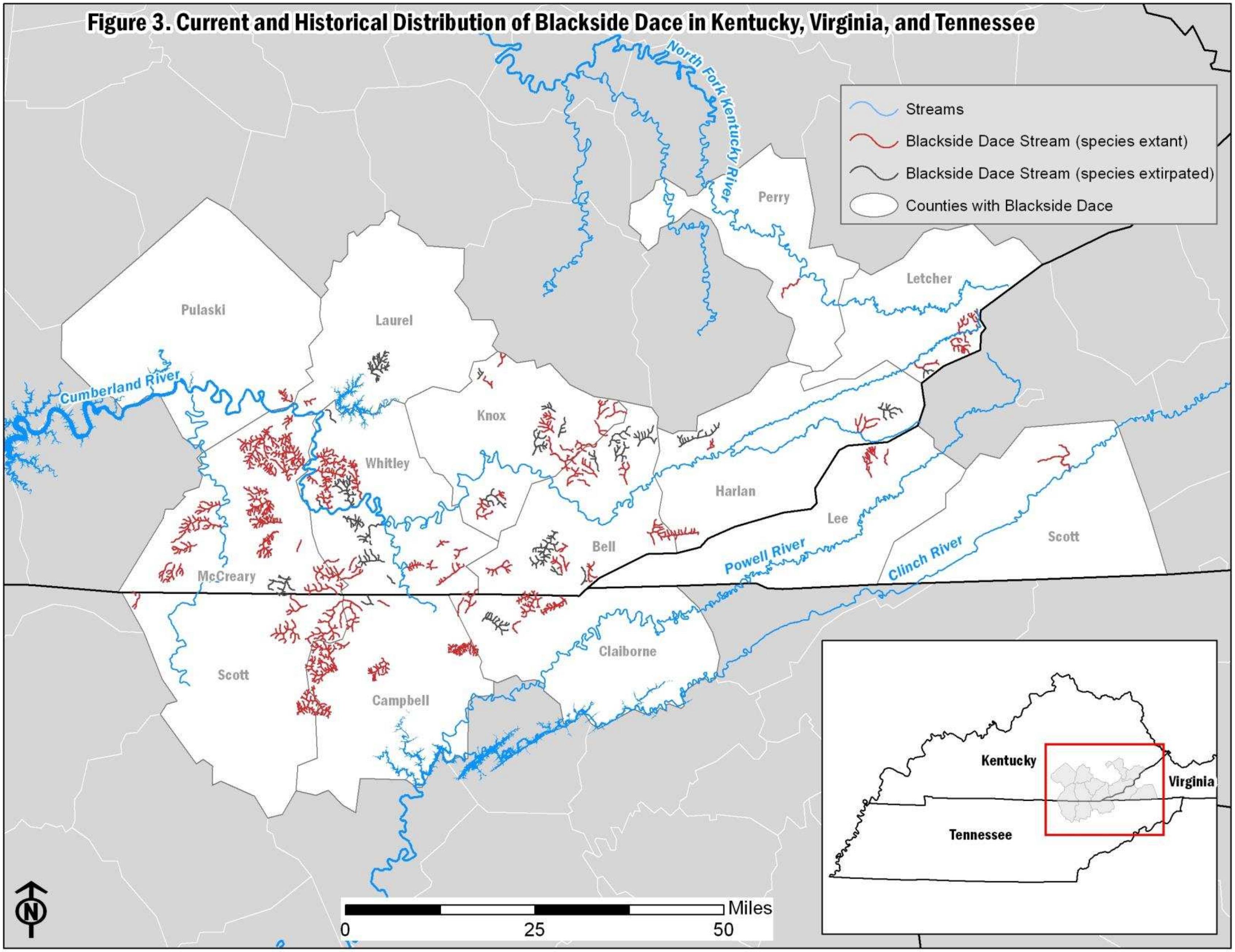
Figure 3. Current and Historical Distribution of Blackside Dace in Kentucky, Virginia, and Tennessee
Streams
Blackside Dace Stream (species extant)
Blackside Dace Stream (species extirpated)
Counties with Blackside Dace
North Fork Kentucky River
Cumberland River
Powell River
Clinch River
Perry
Letcher
Pulaski
Laurel
Knox
Whitley
Harlan
Lee
Bell
Scott
McCreary
Claiborne
Scott
Campbell
Miles
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Kentucky
Virginia
Tennessee

Figure 4. Current Distribution of Blackside Dace (*Chrosomus cumberlandensis*) in Letcher County, Kentucky.

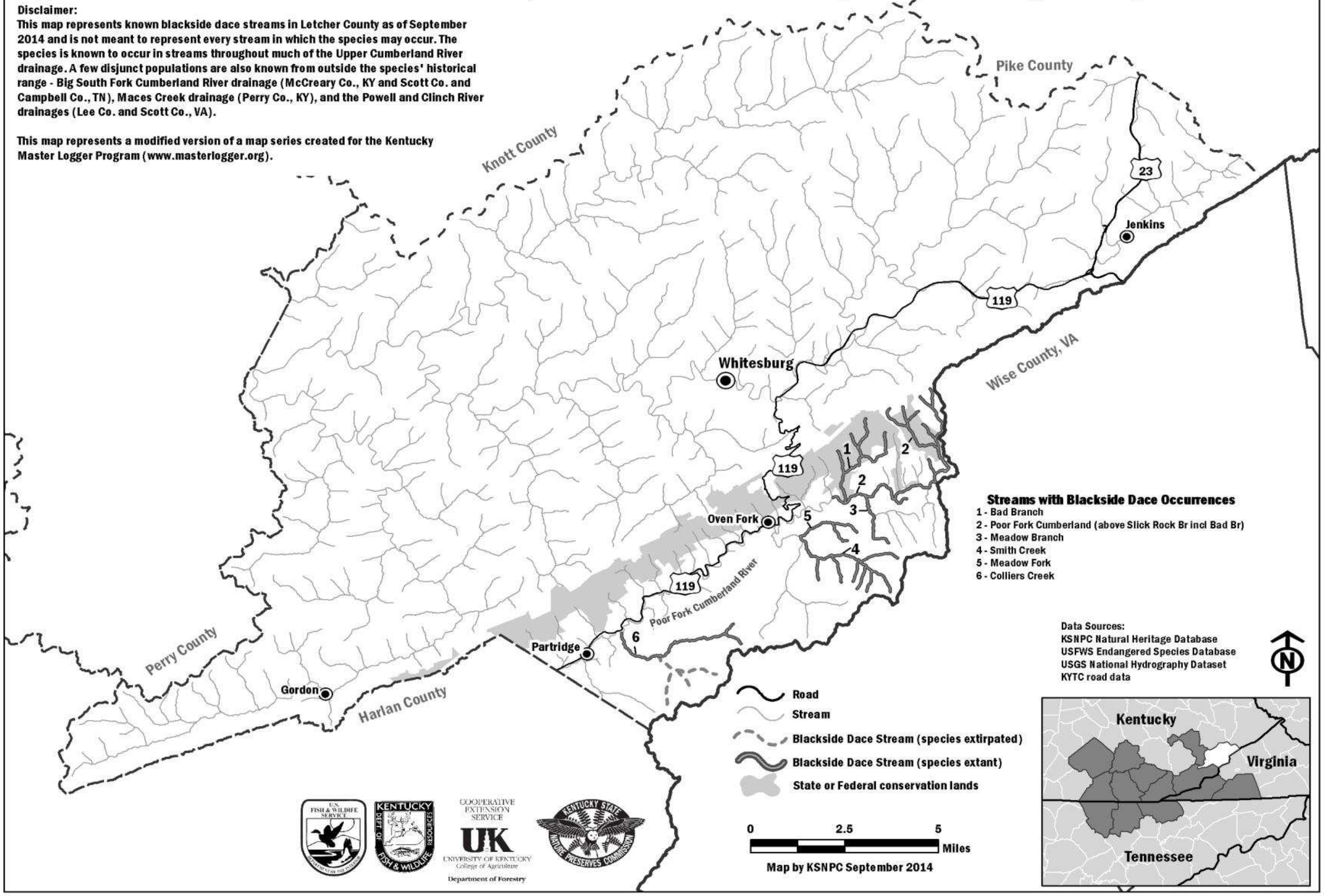
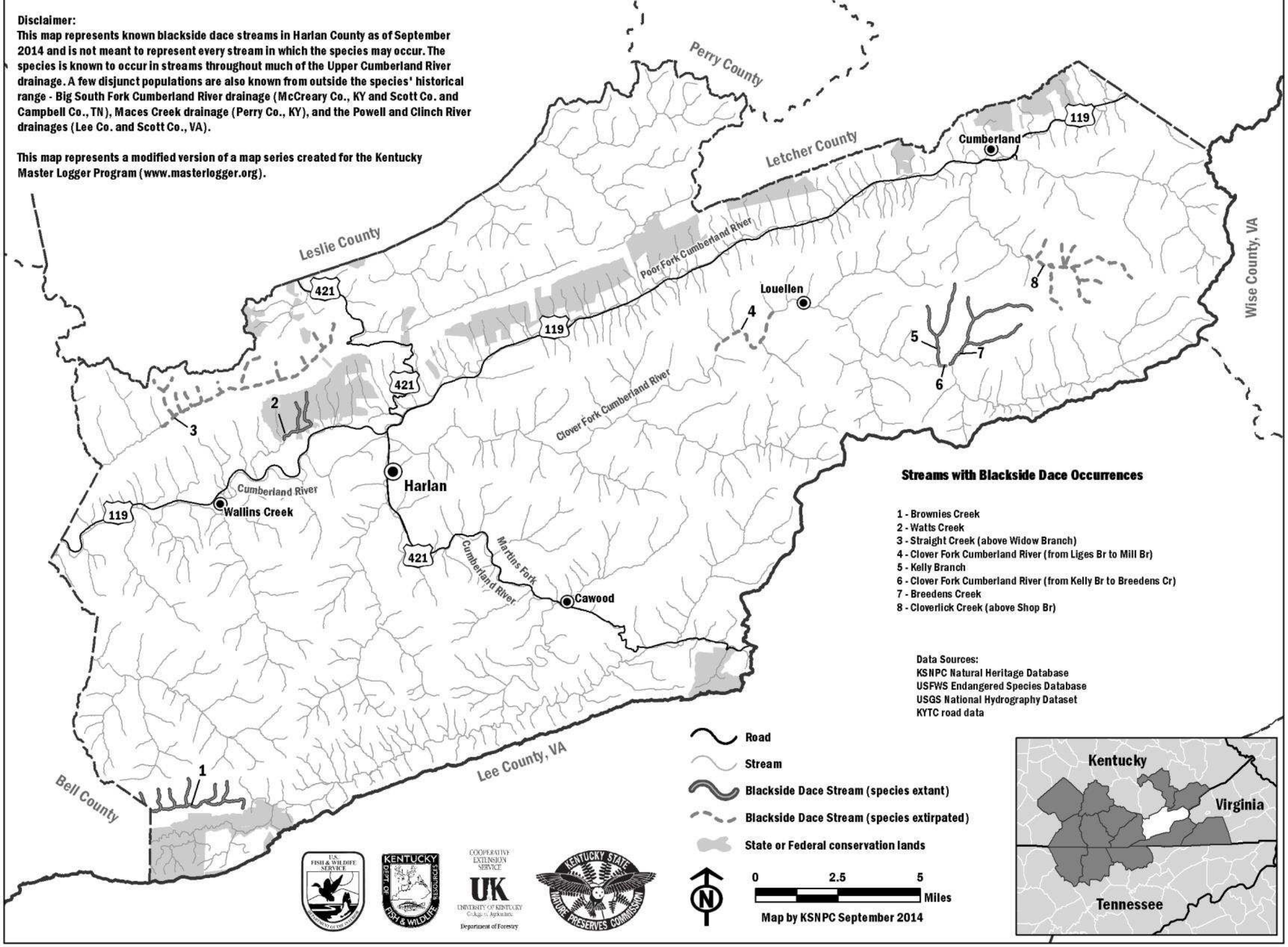


Figure 5. Current Distribution of Blackside Dace (*Chrosomus cumberlandensis*) in Harlan County, Kentucky.



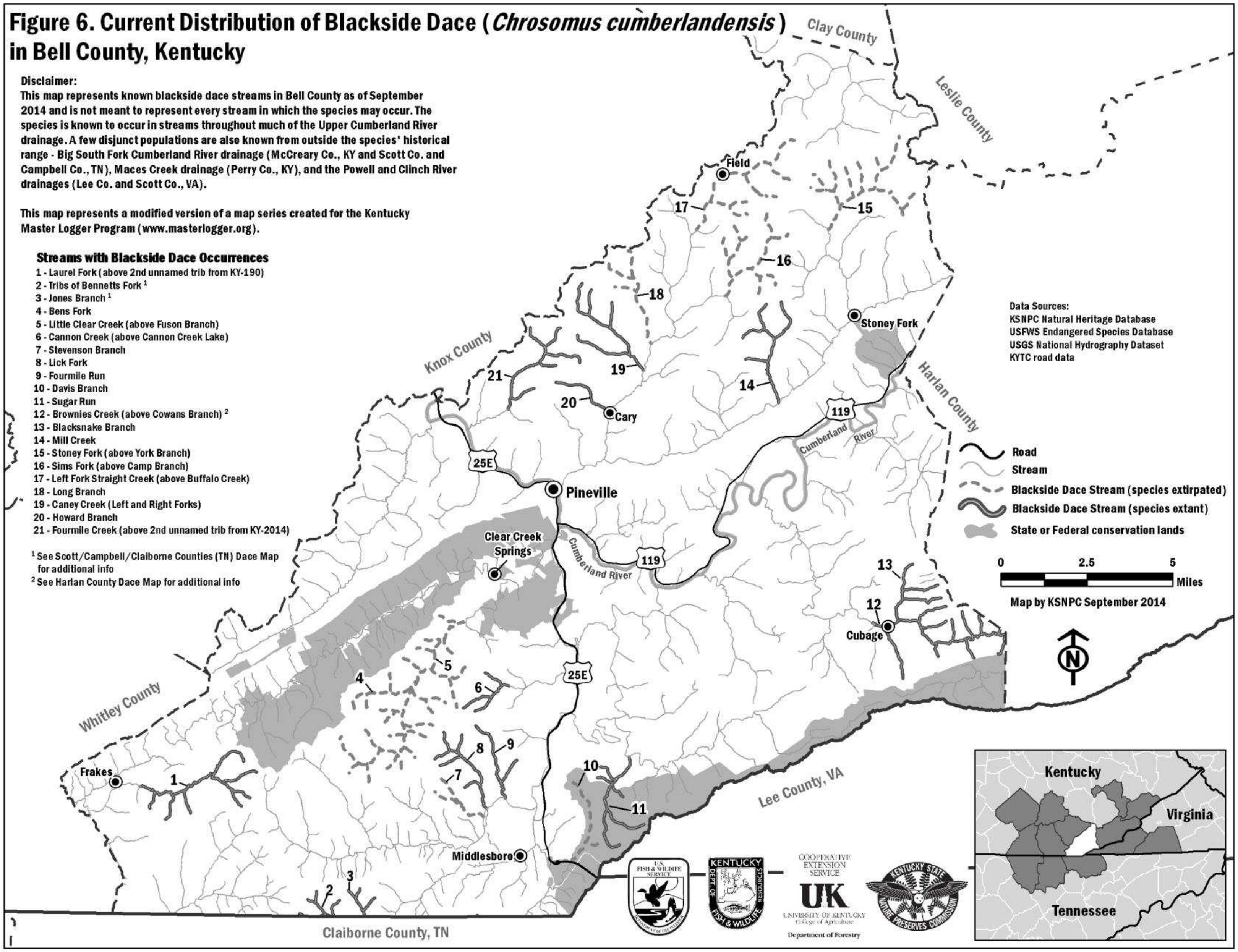
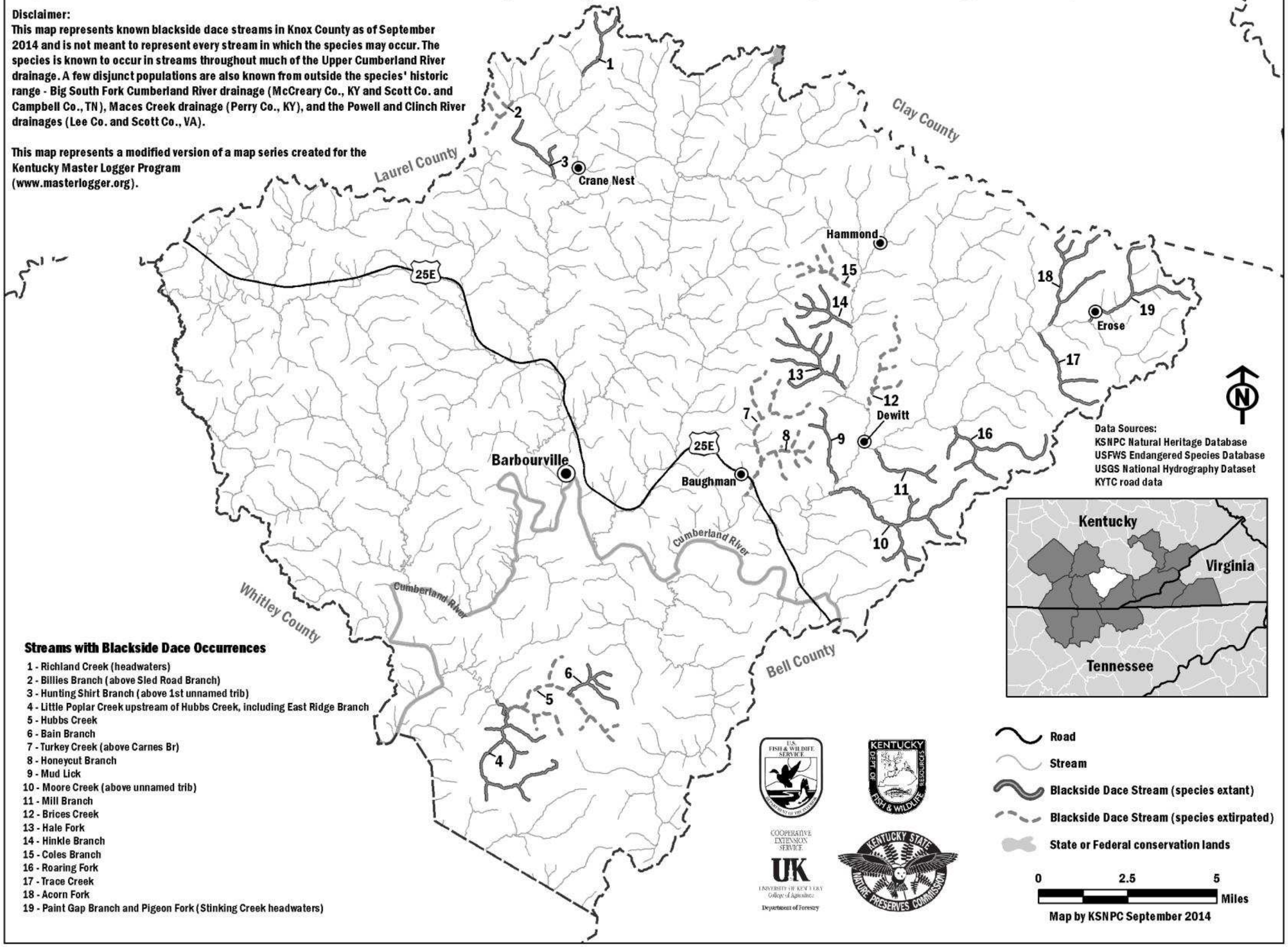


Figure 6. Current Distribution of Blackside Dace (*Chrosomus cumberlandensis*) in Bell County, Kentucky

Figure 7. Current Distribution of Blackside Dace (*Chrosomus cumberlandensis*) in Knox County, Kentucky.



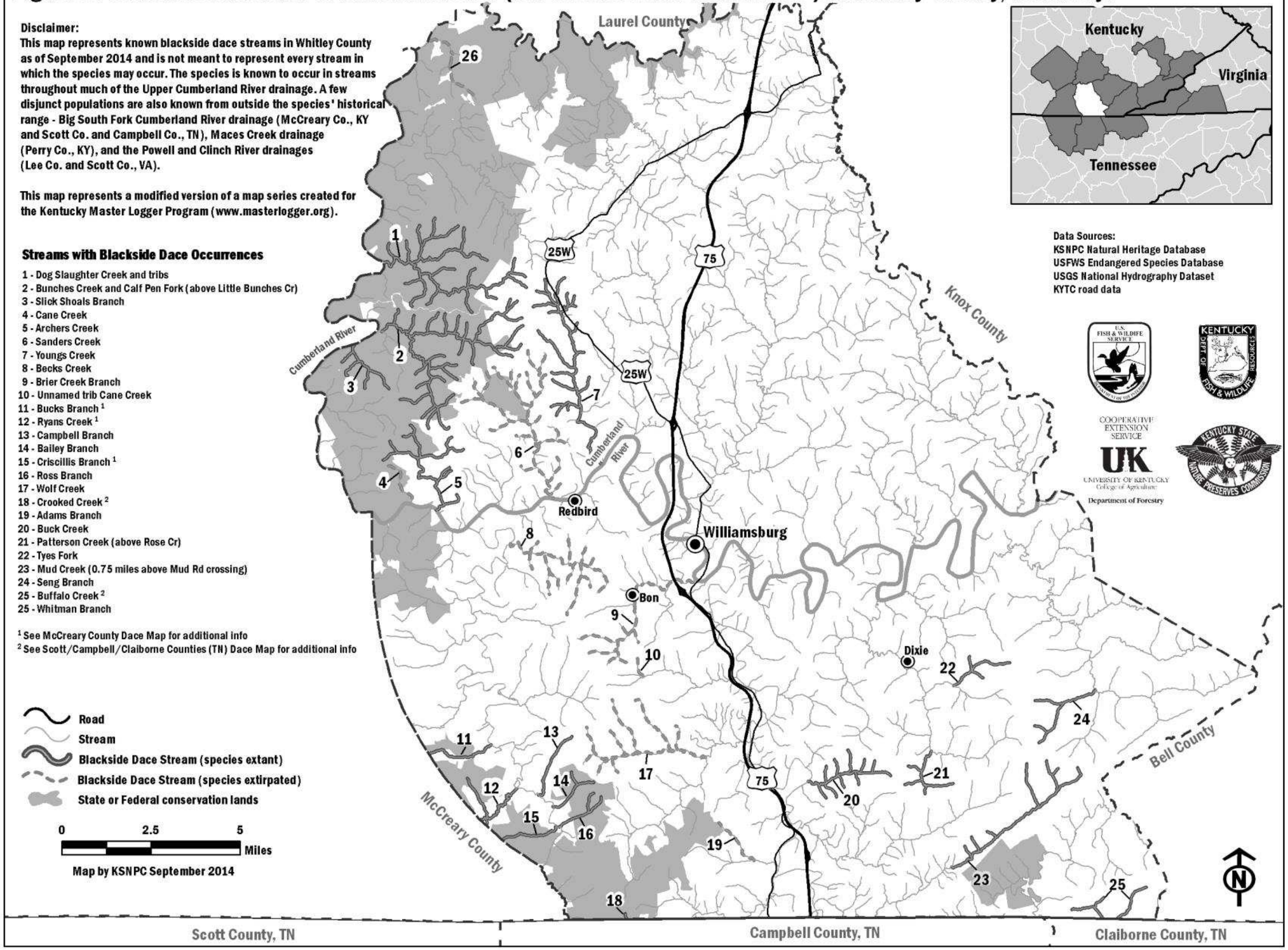


Figure 8. Current Distribution of Blackside Dace (*Chrosomus cumberlandensis*) in Whitley County, Kentucky.

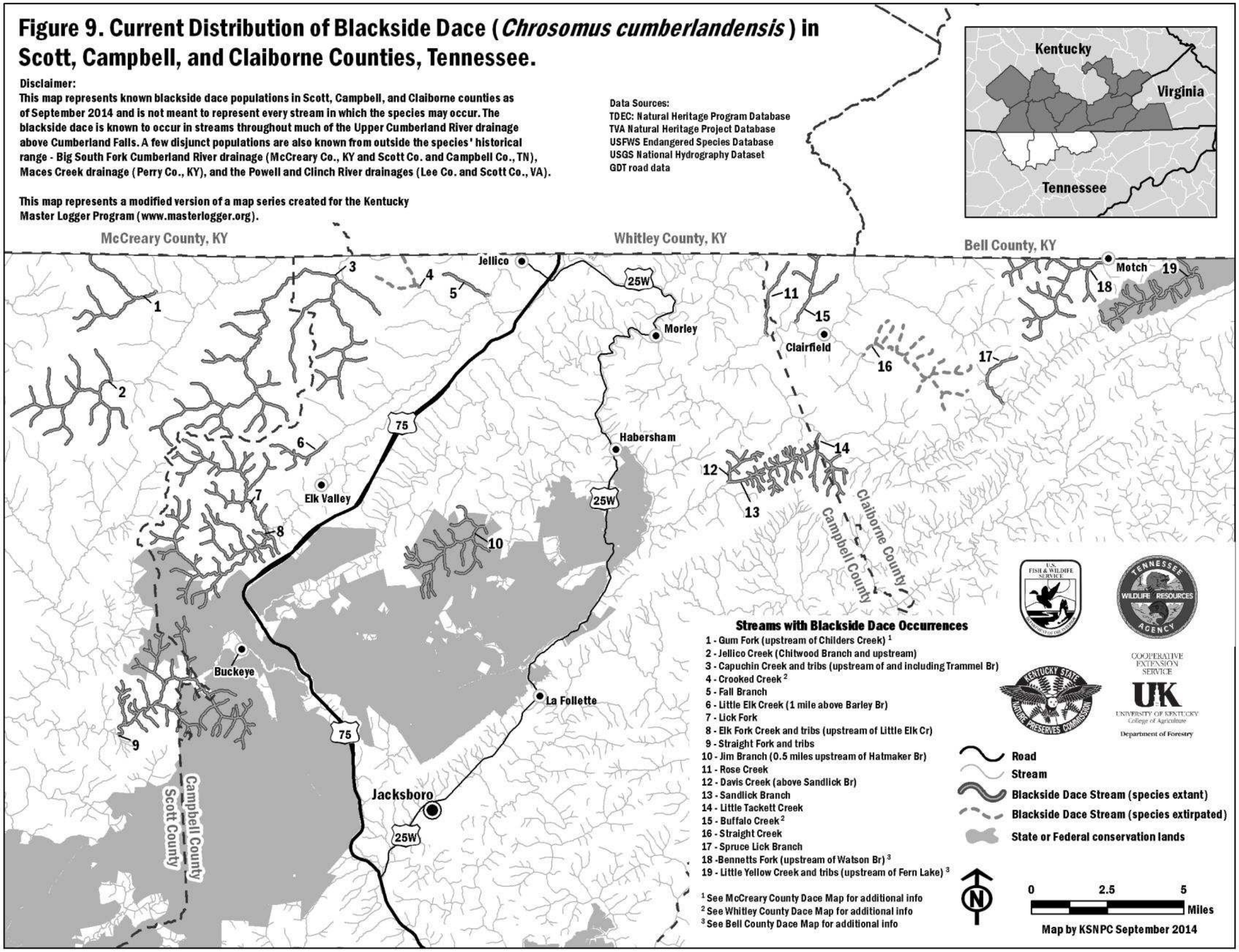
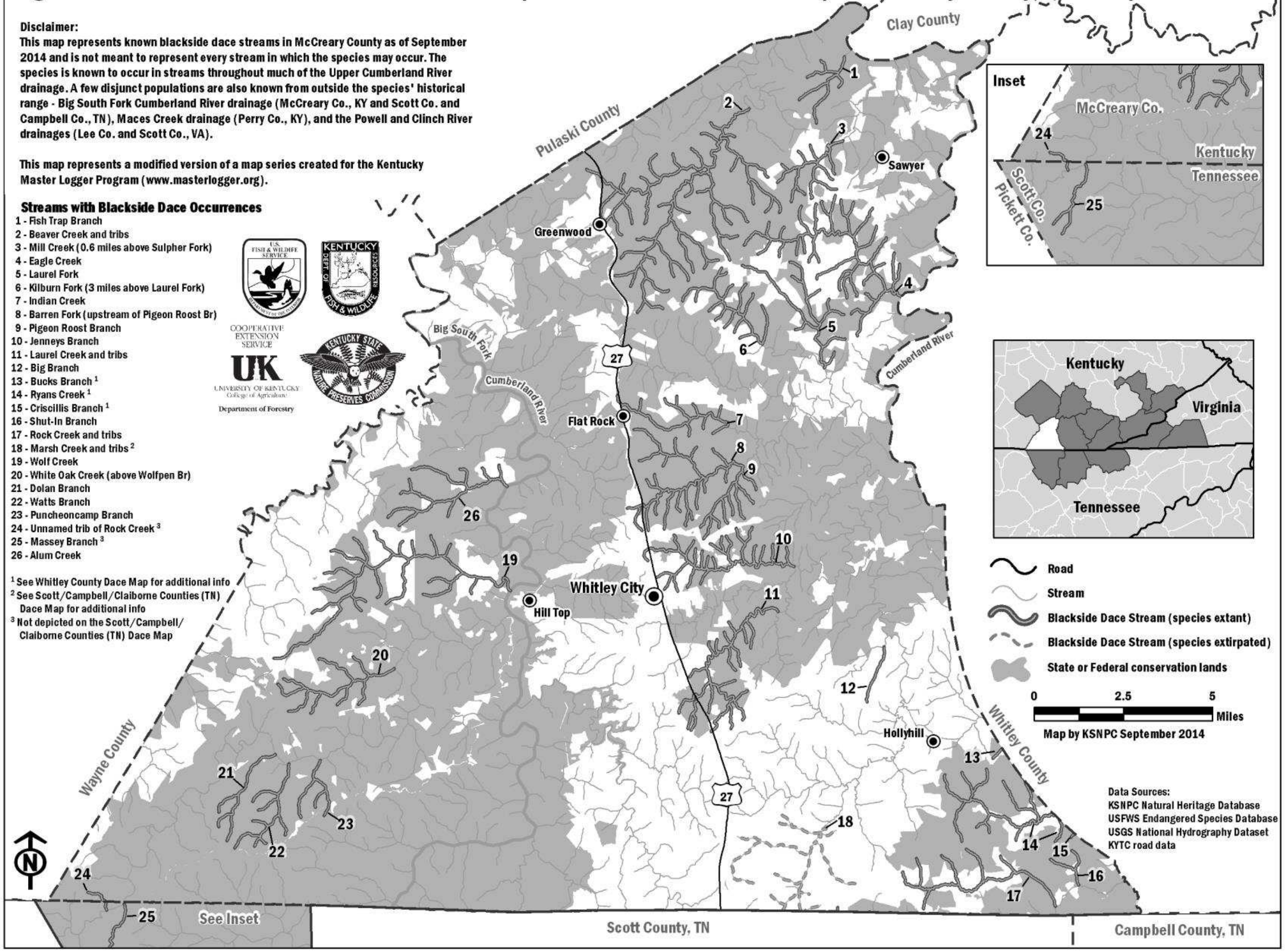


Figure 9. Current Distribution of Blackside Dace (*Chrosomus cumberlandensis*) in Scott, Campbell, and Claiborne Counties, Tennessee.

Disclaimer:
This map represents known blackside dace populations in Scott, Campbell, and Claiborne counties as of September 2014 and is not meant to represent every stream in which the species may occur. The blackside dace is known to occur in streams throughout much of the Upper Cumberland River drainage above Cumberland Falls. A few disjunct populations are also known from outside the species' historical range - Big South Fork Cumberland River drainage (McCreary Co., KY and Scott Co. and Campbell Co., TN), Maces Creek drainage (Perry Co., KY), and the Powell and Clinch River drainages (Lee Co. and Scott Co., VA).

This map represents a modified version of a map series created for the Kentucky Master Logger Program (www.masterlogger.org).

Figure 10. Current Distribution of Blackside Dace (*Chrosomus cumberlandensis*) in McCreary County, Kentucky.



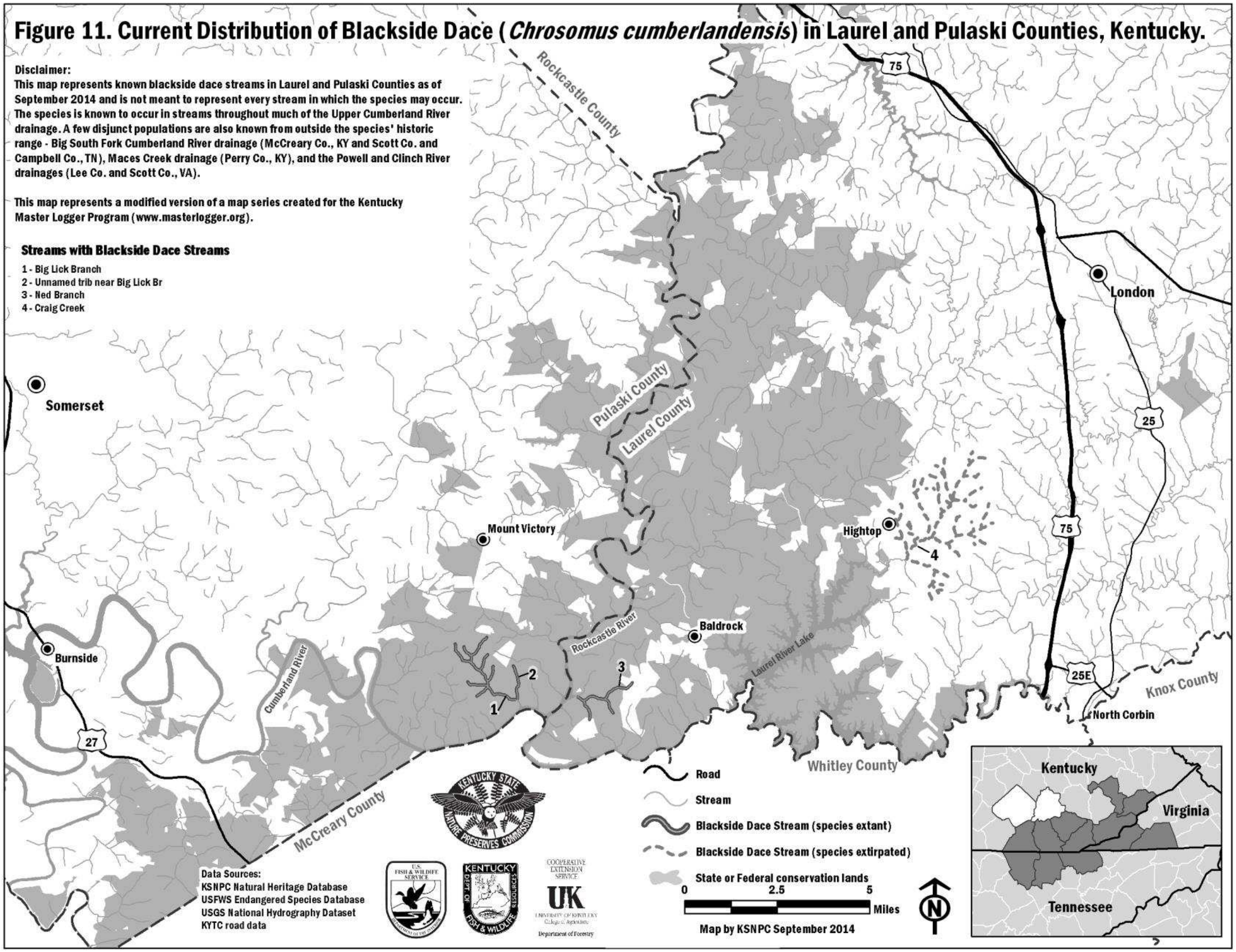


Figure 11. Current Distribution of Blackside Dace (*Chrosomus cumberlandensis*) in Laurel and Pulaski Counties, Kentucky.

APPENDIX C.

Table 7 – Summary of Blackside Dace Stream Occurrences.

Sub-drainage	Stream[1]	State	Current Status[2]	Date of Last Observation
	Cumberland River – upstream of Cumberland Falls			
Poor Fork	Poor Fork	KY	Stable	2012
	Bad Branch	KY	Stable	1995
	Meadow Branch	KY	Vulnerable	2012
	Smith Creek	KY	Stable	2012
	Meadow Fork	KY	Vulnerable	1995
	Brown Branch	KY	Extirpated	1990
	Colliers Creek	KY	Vulnerable	2013
	Cloverlick Creek	KY	Extirpated	1961
Clover Fork	Breedens Creek	KY	**Stable**	2012
	Kelly Branch	KY	Stable	2012
	Clover Fork	KY	Extirpated	1961
Watts Creek	Watts Creek	KY	**Stable**	2005
Brownies Creek	Brownies Creek	KY	**Stable**	2013
	Blacksnake Branch	KY	Stable	2013
Yellow Creek	Little Yellow Creek	TN	**Stable**	2014
	Davis Branch	KY	Extirpated	2007
	Bennetts Fork	TN	Vulnerable	2000
	Stevenson Branch	KY	Extirpated	1994
	Lick Fork	KY	Vulnerable	2013
	Fourmile Run	KY	Vulnerable	1994
	Sugar Run	KY	Vulnerable	2010
	Cannon Creek	KY	Vulnerable	1994
Clear Creek	Little Clear Creek	KY	Extirpated	1984
	Bens Fork	KY	Extirpated	2008
Straight Creek	Straight Creek	KY	Extirpated	1984
	Stoney Fork	KY	Extirpated	1997
	Mill Creek	KY	**Stable**	2012
	Sims Fork	KY	Extirpated	1993
	L Frk Straight Creek	KY	Extirpated	1980
	Long Branch	KY	Extirpated	1984
	Caney Creek	KY	Stable	2010
	Howard Branch	KY	Vulnerable	2009
Fourmile Creek	Fourmile Creek	KY	Stable	2012
Stinking Creek	Paint Gap Branch	KY	**Stable**	2012
	Acorn Fork	KY	Vulnerable	2007
	Trace Branch	KY	**Stable**	2010
	Roaring Fork	KY	Stable	2010
	Mill Branch	KY	Stable	2014
	Coles Branch	KY	Extirpated	1993
	Hinkle Branch	KY	Vulnerable	1993
	Hale Fork	KY	Stable	2012
	Brices Creek	KY	Extirpated	1993
	Mud Lick	KY	Stable	2000
	Moore Creek	KY	**Stable**	2012

Table 4 - Continued

Stinking Creek	Turkey Creek	KY	Extirpated	1994
	Honeycutt Branch	KY	Extirpated	1994
Richland Creek	Richland Creek	KY	**Stable**	2012
	Billies Branch	KY	Extirpated	1993
	Hunting Shirt Br	KY	Vulnerable	2009
Little Poplar Creek	Little Poplar Creek	KY	Stable	2010
	East Ridge Branch	KY	Stable	2010
	Bain Branch	KY	Vulnerable	2012
Poplar Creek	Seng Branch	KY	Vulnerable	2007
Patterson Creek	Patterson Creek	KY	Stable	2010
	Tyes Fork	KY	Vulnerable	2001
Clear Fork	Straight Creek	TN	Extirpated	1989
	Buffalo Creek	KY, TN	Vulnerable	2012
	Rose Creek	TN	**Stable**	2012
	Tackett Creek	TN	Vulnerable	2015
	Spruce Lick Branch	TN	Vulnerable	2013
	Little Tackett Creek	TN	Stable	1995
	Davis Creek	TN	Vulnerable	2012
	Sandlick Branch	TN	**Stable**	2012
	Louse Creek	TN	Vulnerable	2002
	Laurel Fork	KY	Stable	2010
	Mud Creek	KY	**Stable**	2010
	Terry Creek	TN	**Stable**	2013
	Hudson Branch	TN	Stable	2013
	Coontail Branch	TN	Stable	2011
	Lick Fork	TN	Vulnerable	2012
	Little Elk Creek	TN	Vulnerable	2011
	Crooked Creek	TN	Extirpated	1994
	Fall Branch	TN	Vulnerable	2005
	Adams Branch	KY	Extirpated	1993
	Buck Creek	KY	Stable	2012
	Wolf Creek	KY	Extirpated	1883
	Cane Creek	KY	Extirpated	1993
Brier Creek	Brier Creek	KY	Extirpated	1883
Youngs Creek	Youngs Creek	KY	Vulnerable	2010
Sanders Creek	Sanders Creek	KY	Extirpated	1988
Jellico Creek	Jellico Creek	TN	Stable	2006
	Chitwood Branch	TN	Vulnerable	2005
	Gum Fork	TN	Vulnerable	2005
	Capuchin Creek	TN	Vulnerable	2014
	Dan Branch	TN	Vulnerable	2014
	Bear Branch	TN	Vulnerable	2014
	Incline Hollow	TN	Vulnerable	2014
	Lawson Branch	TN	Vulnerable	1989
	Hatfield Creek	TN	Vulnerable	2012
	Baird Creek	TN	Vulnerable	2012
	Trammel Branch	TN	Stable	2012
	Rock Creek	KY	**Stable**	2013
	Lot Hollow	KY	Vulnerable	2003
	Sid Anderson Br	KY	**Stable**	2013
	John Anderson Br	KY	Stable	2003

Table 4 - Continued

Jellico Creek	Litton Branch	KY	Vulnerable	1993
	Shut-in Branch	KY	Vulnerable	2003
	Criscillis Branch	KY	Vulnerable	2012
	Bailey Branch	KY	Vulnerable	1993
	Campbell Branch	KY	Stable	2011
	Ryans Creek	KY	**Stable**	2012
	Bucks Branch	KY	Vulnerable	2012
	Becks Creek	KY	Extirpated	1984
Archers Creek	Archers Creek	KY	Stable	2010
Cane Creek	Cane Creek	KY	Extirpated	1977
Marsh Creek	Murphy Creek	KY	Extirpated	1993
	Trammel Fork	KY	Extirpated	1986
	Marsh Creek	KY	Extirpated	1993
	Big Branch	KY	Vulnerable	2012
	Elisha Branch	KY	Vulnerable	2012
	Laurel Creek	KY	Vulnerable	1993
	Jenneys Branch	KY	Vulnerable	2007
Indian Creek	Indian Creek	KY	Stable	2009
	Barren Fork	KY	**Stable**	2009
	Pigeon Roost Br	KY	Vulnerable	2008
	Kilburn Fork	KY	Vulnerable	2012
	Laurel Fork	KY	Stable	2012
Slick Shoals Br	Slick Shoals Br	KY	Vulnerable	1993
Bunches Creek	Bunches Creek	KY	Stable	2006
	Calf Pen fork	KY	Stable	2006
Cumberland River - downstream of Cumberland Falls				
Eagle Creek	Eagle Creek	KY	Stable	2010
Dog Slaughter	Dog Slaughter Cr	KY	Stable	2010
	Little Dogslaughter	KY	Stable	2003
	North Fork	KY	Stable	2003
	South Fork	KY	Stable	2003
Laurel River	Craig Creek	KY	Extirpated	1979
	Whitman Branch	KY	Extirpated	1993
Mill Creek	Mill Creek	KY	Stable	2010
Fish Trap	Fish Trap Branch	KY	Stable	1996
Rockcastle	Ned Branch	KY	Stable	2003
Big Lick Branch	Big Lick Branch	KY	**Stable**	2010
	Unnamed Tributary	KY	Stable	2003
Beaver Creek	Beaver Creek	KY	Stable	2010
	Middle Frk Beaver	KY	**Stable**	2010
	Drury Branch	KY	Stable	1993
	Hurricane Frk	KY	Stable	2010
	Freeman Fork	KY	Stable	2010
Big South Fork Cumberland River				
New River	Jake Branch	TN	**Stable**	2012
	Cross Branch	TN	**Stable**	2002
	Unnamed Tributary	TN	**Stable**	2002
	Straight Fork	TN	**Stable**	2012
Rock Creek	Unnamed Tributary	TN	Vulnerable	2005
	Massey Branch	TN	Vulnerable	2005
	Dolen Branch	KY	Stable	2009
	Watts Branch	KY	Stable	2009

Table 4 - Continued

Rock Creek	Puncheon Camp Cr	KY	Stable	2009
	White Oak Creek	KY	**Stable**	2008
Wolf Creek	Wolf Creek	KY	Stable	2006
Alum Creek	Alum Creek	KY	Vulnerable	2014
	North Fork Kentucky River			
Maces Creek	R Fork Maces Creek	KY	**Stable**	2013
	Powell River			
N Frk Powell River	Cox Creek	VA	Stable	2009
	Mud Creek	VA	**Stable**	2009
	R Frk Mud Creek	VA	**Stable**	2009
	Reeds Creek	VA	**Stable**	2009
	Clinch River			
Staunton Creek	McGhee Creek	VA	Stable	2007
	Staunton Creek	VA	**Stable**	2007

[1]Streams: Recent Kentucky occurrence records for Franks Creek (Letcher County), Clover Fork (Harlan County), and Fugitt Creek (Harlan County) have been excluded from the table. In each case, observed individuals were considered to be transitory in nature. Each of these records is discussed in Section 2.3.1.4. (Spatial distribution, trends in spatial distribution, or historical range).

[2]Current Status: For any given stream, the species is considered to be Stable if (1) there is little evidence of significant habitat loss or degradation (conductivity near baseline levels, siltation low, etc.), (2) the species' abundance has remained relatively constant (species has persisted at site) or increased during recent surveys, and (3) evidence of relatively recent recruitment has been documented since 2000. Robust populations (in **bold**) have all the aforementioned characteristics, plus ≥25 individuals have been observed during multiple surveys, with multiple age classes present.

For any given stream, the species is considered to be Vulnerable if (1) there is ample evidence of significant habitat loss or degradation since the species' original capture (elevated conductivity, embedded substrates, bank erosion, etc.), (2) there is an obvious decreasing trend in abundance since the historical collection, (3) less than 5 individuals have been observed during recent surveys (low numbers, typically 1-2 individuals observed), or (4) no evidence of relatively recent recruitment (since 2000) has been documented.

For any given stream, the species is considered to be Extirpated if (1) there is ample evidence of significant habitat loss or degradation since the species' original capture (elevated conductivity, embedded substrates, bank erosion, etc.), and (2) the species has not been observed during multiple survey attempts.

Status Category	# Streams
Stable	29
Stable	47
Vulnerable	49
Extirpated	31

APPENDIX D.

Table 8. Summary of dace populations (stream clusters) by sub-basin (recovery unit).

Sub-basin (Recovery Unit)	Population (Cluster)	County	# streams	#/rec unit	Stream(s)[1]	Public Land[2]
Poor Fork	Upper Poor Fork	Letcher	5	6	Poor Fork, Bad Branch, *Meadow Branch, Meadow Fork*, Smith Creek	Jefferson National Forest (Poor Fork), Bad Branch SNP (Bad Branch)
	Colliers Creek	Letcher	1		*Colliers Creek*	None
Clover Fork to Clear Creek	Clover Fork	Harlan	2	11	**Breedens Creek**, Kelly Branch	None
	Brownies Creek	Bell, Harlan	2		**Brownies Creek,** Blacksnake Branch	None
	Watts Creek	Harlan	1		**Watts Creek**	Blanton Forest SNP
	Yellow Creek Bypass	Bell	3		*Fourmile Run, Lick Fork, Cannon Creek*	None
	Bennetts Fork	Bell, Claiborne	1		*Bennetts Fork*	None
	Little Yellow Creek	Claiborne	1		**Little Yellow Creek** (upstream of Fern Lake)	CUGA
	Clear Fork (Yellow Creek)	Bell	1		*Sugar Run*	CUGA
Straight Creek	Straight Creek	Bell	1	3	**Mill Creek**	None
	Left Fork Straight Creek	Bell	2		Caney Creek, *Howard Branch*	None
Tribs Above Falls	Fourmile Creek	Bell	1	28	Fourmile Creek	None
	Lower Stinking Creek	Knox	6		Mill Branch, **Moore Creek**, Mudlick Creek, Hale Fork, *Hinkle Branch*, Roaring Fork	None
	Upper Stinking Creek	Knox	3		*Acorn Fork*, **Paint Gap Branch**, **Trace Branch**	None
	Richland Creek 1	Knox	1		**Richland Creek** (headwaters)	None
	Richland Creek 2	Knox	1		*Hunting Shirt Branch*	None
	Little Poplar Creek	Knox	3		Little Poplar Creek, East Ridge Branch, *Bain Branch*	None
	Poplar Creek	Whitley	1		*Seng Branch*	None
	Patterson Creek	Whitley	2		Patterson Creek, *Tyes Fork*	None
	Youngs Creek	Whitley	1		*Youngs Creek*	None
	Archers Creek	Whitley	1		Archers Creek	DBNF
	Indian Creek 1	McCreary	3		**Barren Fork**, *Pigeonroost*	DBNF

					Branch, Indian Creek	
	Indian Creek 2	McCreary	2		*Kilburn Fork*, Laurel Fork	DBNF
	Slick Shoals Branch	Whitley	1		Slick Shoals Branch	DBNF
	Bunches Creek	Whitley	2		Bunches Creek, Calf Pen Fork	DBNF
Clear Fork	Upper Clear Fork	Claiborne	2	16	*Buffalo Creek*, **Rose Creek**	None
	Tackett Creek	Campbell, Claiborne	2		Little Tackett Creek, *Tackett Creek*, *Spruce Lick Branch*	None
	White Oak Creek	Campbell	2		*Davis Creek*, **Sandlick Branch**	None
	Louse Creek	Campbell	1		*Louse Creek* (*Jim Branch*)	North Cumberland WMA
	Laurel Fork	Bell/Whitley	1		Laurel Fork	None
	Mud Creek	Whitley	1		**Mud Creek**	None
	Elk Creek	Campbell	1		*Fall Branch*	None
	Little Elk Creek	Campbell	1		*Little Elk Creek*	None
	Elk Fork Creek	Campbell	4		*Lick Fork*, Coontail Branch, **Terry Creek**, Hudson Branch	North Cumberland WMA
	Buck Creek	Whitley	1		Buck Creek	None
Jellico Creek	Jellico Creek 1	Scott	2	22	Jellico Creek, *Chitwood Branch*	None
	Jellico Creek 2	Scott	1		*Gum Fork*	None
	Jellico Creek 3	Scott	5		*Capuchin Creek* (*headwaters*), *Dan Branch*, *Bear Branch*, *Incline Hollow, Lawson Branch*	None
	Jellico Creek 4	Campbell, Scott	3		*Baird Creek*, *Hatfield Creek*, Trammel Branch	None
	Jellico Creek 5	McCreary	6		**Rock Creek**, *Shut-in Branch*, *Lot Hollow*, **Sid Anderson Branch**, John Anderson Branch, *Litton Branch*	DBNF
	Jellico Creek 6	Whitley	5		*Criscillis Branch*, *Bailey Branch*, Campbell Branch, **Ryans Creek**, *Bucks Branch*	DBNF
Marsh Creek	Marsh Creek 1	McCreary	1	4	*Big Branch*	DBNF
	Marsh Creek 2	McCreary	3		*Laurel Creek*, *Elisha Branch*, *Jenneys Branch*	DBNF
Tribs Below Falls	Tribs Below Falls 1	Whitley	4	15	Dog Slaughter Creek (mainstem, N. Fork, S. Fork, Little Dogslaughter)	DBNF
	Tribs Below Falls 2	McCreary	1		Eagle Creek	DBNF
	Tribs Below Falls 3	McCreary	2		Mill Creek, Fish Trap Branch	DBNF

	Tribs Below Falls 4	Pulaski	3		**Big Lick Branch,** Dace Branch, Ned Branch	DBNF
	Tribs Below Falls 5	McCreary	5		Beaver Creek (mainstem, **Middle Fork**, Hurricane Fork, Freeman Fork, Drury Branch)	DBNF
N/A	KY River drainage	Perry	1	1	**Right Fork Maces Creek**	None
N/A	Big South Fork 1	Cambpell	2	12	*Massey Branch, Unnamed trib to Rock Creek*	BISO
	Big South Fork 2	McCreary	3		Dolen Branch, Punchencamp Branch, Watts Branch	DBNF
	Big South Fork 3	McCreary	1		**White Oak Creek**	DBNF
	Big South Fork 4	McCreary	1		Wolf Creek	BISO, DBNF
	Big South Fork 5	McCreary	1		Alum Creek	DBNF
	Big South Fork 6	Campbell, Scott	4		**Straight Fork, Cross Branch, Jake Branch, Unnamed tributary to Straight Fork**	North Cumberland WMA
N/A	Virginia 1	Lee	3	6	**Mud Creek, Right Fork Mud Creek, Reeds Creek**	None
	Virginia 2	Lee	1		Cox Creek	None
	Virginia 3	Scott	2		**Staunton Creek**, McGhee Creek	None
			125	125	**# extant streams**	
				58	**# extant "populations" or stream clusters**	

[1]Vulnerable populations in italics, robust populations in bold (See Table 4).
[2]Public Land: Daniel Boone National Forest (DBNF), Cumberland Gap National Historical Park (CUGA), Big South Fork National River and Recreation Area (BISO), State Nature Preserve (SNP), Wildlife Management Area (WMA).