



Figure 5. The Appalachian Landscape Conservation Cooperative (outlined in purple) and the UTRB (outlined in red), illustrating the importance of the UTRB as the core of the south-central portion of the Appalachian Landscape Conservation Cooperative.

## Species and Threat Information

### Distribution

There are 13 imperiled fish species extant in the UTRB, which represent 8% of the total fish fauna in the basin (Hampson 2003, Jelks et al. 2008), including 8 federally listed as endangered, 4 federally listed as threatened, and 1 Federal candidate (Appendix 1). One species is considered to be non-native to the UTRB, having been introduced, while a 14th species is extirpated from the basin (Appendix 1). Therefore, 12 imperiled fish species are included in this Strategy (Table 1, Appendix 1). Nine of these 12 imperiled fish species are endemic only to the UTRB (Table 1) and 7 species have critical habitat designated within the basin (Appendix 1).

Basic life history information, predominant threats, and likelihood of extinction of UTRB imperiled fishes is from Etnier and Starnes (1993) and Jenkins and Burkhead (1994) (Appendix 2). Information on threats to imperiled UTRB fishes is summarized from final rules in the Federal Register, species recovery plans, and 5-year reviews accessible at:

<http://www.fws.gov/endangered>. Additionally, some information on threats was taken from the

draft 5-year review for the spotfin chub (USFWS 2014). Imperiled fish species occurrence by 8-digit hydrologic unit code (HUC) is provided in Table 2.

There are 24 imperiled mussel species extant in the UTRB, which represents 29% of the total historic mussel fauna in the basin (Parmalee and Bogan 1998, Hampson 2003) (Appendix 1). All 24 species are federally listed as endangered and 6 of these have critical habitat designated within the UTRB. Therefore, 24 imperiled mussel species are included in this Strategy (Appendix 1, Table 1). Four of these extant imperiled mussel species are endemic only to the UTRB, and 3 others are now globally restricted to the UTRB. Two imperiled mussel species are considered extinct and 6 imperiled mussel species are extirpated from the UTRB (Appendix 1).

Basic life history information, distribution, abundance, and likelihood of extinction of UTRB imperiled mussels is from Parmalee and Bogan (1998), Williams et al. (2008), and the mussel population restoration and conservation plan developed by the Cumberlandian Region Mollusk Restoration Committee (2010) (Appendix 3). Imperiled mussel species occurrence by 8-digit HUC is in Table 2.

## **Threats**

Threats are sources of stressors that can interfere with the life history requirements of biota. Their effects are essentially magnified due to the status of imperiled species. Stressors can degrade or destroy imperiled species habitat and adversely affect population viability. The most ubiquitous stressor associated with threats to aquatic species in the UTRB, and globally, may be sedimentation. In addition, chemicals (e.g., ammonia, heavy metals, inorganic compounds, and pesticides) that alter water and sediment quality and disrupt species' life history processes are important stressors. Sources of sedimentation and other contaminants originate from fossil fuel extraction, agricultural and developmental activities, and insufficient sewage treatment in rural residential areas lacking modern infrastructure. Impoundments have had major impacts, altering natural flow and temperature regimes, eliminating habitat, interfering with migration, and prohibiting dispersal and genetic exchange. The stresses of population fragmentation and small population size include reduced fitness of subsequent generations through inbreeding depression and loss of genetic diversity, and increased risk of extirpation due to habitat alteration or stochastic events such as floods, droughts, and episodic chemical spills.

Since the early 1900s, numerous land use activities now common in the UTRB have been contributing sediments and contaminants, causing instream temperature changes, and otherwise acting as sources of stress to fish and mussel populations. Common land uses include urban, industrial, commercial, and residential development; livestock production; agricultural cropping (e.g., tobacco and corn); road and railroad networks; timber harvest/silviculture; and fossil fuel extraction. Both reclaimed coal mined lands and abandoned lands mined for coal prior to current Federal laws contribute to water quality problems in the UTRB. Other sources of stress within the UTRB include point source discharges from wastewater treatment and industrial facilities and atmospheric deposition of pollutants such as nitrates and mercury. Collectively, these and other stressors have contributed to the decline of the fish and mussel fauna in UTRB streams.

Table 1. Imperiled fish and mussel species extant in the UTRB included in the Strategy.

Species <sup>1</sup>	Number of 8-digit HUCs of Occurrence <sup>2</sup>	Geographic Distribution
<b>Fishes</b>		
Chucky madtom	1	UTRB endemic
Citico darter	1	UTRB endemic
Duskytail darter	1	UTRB endemic
Laurel dace	2	UTRB endemic
Marbled darter	1	UTRB endemic
Pygmy madtom	1	Tennessee River Basin endemic
Sicklefin redhorse	3	UTRB endemic
Slender chub	2	UTRB endemic
Smoky madtom	1	UTRB endemic
Snail darter	8	Tennessee River Basin endemic
Spotfin chub	7	Tennessee River Basin endemic
Yellowfin madtom	3	UTRB endemic
<b>Mussels</b>		
Alabama lampmussel	2	Tennessee River Basin endemic
Appalachian elktoe	5	UTRB endemic
Appalachian monkeyface	2	UTRB endemic
Birdwing pearl mussel	4	Tennessee River Basin endemic
Cracking pearl mussel	2	Ohio River Basin endemic
Cumberland bean	1	Cumberlandian Region endemic <sup>3</sup>
Cumberland monkeyface	1	Tennessee River Basin endemic
Cumberlandian combshell	3	Cumberlandian Region endemic <sup>3</sup>
Dromedary pearl mussel	3	Cumberlandian Region endemic <sup>3</sup> , currently restricted to UTRB
Fanshell	2	Ohio River Basin endemic
Finerayed pigtoe	4	Tennessee River Basin endemic, currently restricted to UTRB
Fluted kidneyshell	6	Cumberlandian Region endemic <sup>3</sup>
Golden riffleshell	3	Tennessee River Basin endemic, currently restricted to UTRB
Littlewing pearl mussel	3	Cumberlandian Region endemic <sup>3</sup>
Oyster mussel	6	Cumberlandian Region endemic <sup>3</sup> , currently restricted to UTRB
Pink mucket	6	Mississippi River Basin endemic
Purple bean	3	UTRB endemic
Rough pigtoe	2	Ohio River Basin endemic
Rough rabbitsfoot	2	UTRB endemic
Sheepnose	3	Mississippi River Basin endemic
Shiny pigtoe	3	Tennessee River Basin endemic
Slabside pearl mussel	5	Cumberlandian Region endemic <sup>3</sup>
Snuffbox	2	Mississippi River and Great Lakes Basins endemic
Spectaclecase	3	Mississippi River Basin endemic

<sup>1</sup>See Assumptions and Terminology section.

<sup>2</sup>Species occurrence in the UTRB by 8-digit HUC is in Table 2.

<sup>3</sup>Essentially, the Cumberland and Tennessee River Basins.

Table 2. UTRB imperiled fish and mussel occurrence by 8-digit HUC. Occurrences are based on post-1980 records. "O" indicates reintroduced population. Although in some streams where reintroductions have been attempted it may be too early to assess success, reintroductions were counted towards total species occurring in each 8-digit HUC.

Species	Powell	Upper Clinch	Lower Clinch	North Fork Holston	South Fork Holston	Holston	Nolichucky	Upper French Broad	Lower French Broad	Emory	Pigeon	Tuckasegee	Upper Little Tennessee	Lower Little Tennessee	Middle Tennessee-Chickamauga	Watts Bar Lake	Hiwassee	Sequatchie	Ocoee	Number of 8-digit HUC Occurrences
<b>Fishes</b>																				
Chucky madtom							X													1
Citico darter														X						1
Duskytail darter		X																		1
Laurel dace															X	X				2
Marbled darter																X				1
Pygmy madtom		X																		1
Sicklefin redhorse												X	X				X			3
Slender chub	X	X																		2
Smoky madtom														X						1
Snail darter						X			X					X	X	X	X	X	X	8
Spotfin chub				X	X	X				X			X	O		X				7
Yellowfin madtom	X	X												X						3
<b>Mussels</b>																				
Alabama lampmussel										X									O	2
Appalachian elktoe							X	X			X	X	X							5
Appalachian monkeyface	X	X																		2
Birdwing pearl mussel	X	X					O		O											4
Cracking pearl mussel	X	X																		2
Cumberland bean																	X			1
Cumberland monkeyface	X																			1
Cumberlandian combshell	X	X					O													3
Dromedary pearl mussel	X	X													X					3
Fanshell		X													X					2
Finerayed pigtoe	X	X		X												X				4
Fluted kidneyshell	X	X		X	X		O							O						6
Golden riffleshell		X			X												X			3
Littlewing pearl mussel		X		X									X							3
Oyster mussel	O	X					X		O								O	X		6
Pink mucket		X				X	O		X						X	X				6
Purple bean		X				X				X										3
Rough pigtoe		X													X					2
Rough rabbitsfoot	X	X																		2
Sheepnose	X	X				X														3
Shiny pigtoe	X	X		X																3
Slabside pearl mussel	X	X		X	X												X			5
Snuffbox	X	X																		2
Spectaclecase		X	X				X													3
No. of species extant in 8-digit HUC	1 6	2 4	1	6	4	5	8	1	4	3	1	2	4	6	6	6	6	6	3	1

The significance of various threats to UTRB imperiled aquatic species vary depending upon level of imperilment and where the species are distributed across the basin's three major physiographic provinces (Figure 1). Species inhabiting the Appalachian Plateau, which contains all of the coal fields and most of the oil and natural gas deposits in the UTRB, and those inhabiting receiving streams in the Ridge and Valley, are experiencing threats from energy extraction activities. Most residential development, transportation corridor construction, and other urbanization effects occur in the flatter, valley portions of the Ridge and Valley. Timbering, stream impoundment, and agriculture are dispersed more broadly across all three provinces.

## Assumptions and Terminology

Definitions specific to this Strategy are found in Appendix 4. During development of the Strategy, the following assumptions and terminology were used:

- Species federally listed as endangered or threatened, species proposed for Federal listing as endangered or threatened, and candidate species are considered imperiled species to the exclusion of other rare species in the UTRB.
- Common and/or scientific names currently accepted in scientific literature are used, but are not necessarily the common and/or scientific names under which the species were listed pursuant to the ESA. For example, the duskytail darter, *Etheostoma percnurum*, is the federally listed taxon. However, since its Federal designation, a taxonomic study was published splitting the species into four taxa (Blanton and Jenkins 2008). Three of these (duskytail, marbled, and Citico darters; Tables 1 and 2, Appendices 1 and 2) are endemic to the UTRB. Similarly, the golden riffleshell, *Epioblasma florentina aureola*, was recently determined to be a subspecies taxonomically distinct from the federally listed tan riffleshell, *Epioblasma florentina walkeri* (Jones and Neves 2010). Currently, *E. f. aureola* is globally restricted to the UTRB. No formal Federal actions have been undertaken to recognize these taxonomic revisions.
- Populations of fishes and mussels are generally considered extant (currently existing) if living individuals or fresh dead specimens (for mussels) have been collected since 1980.

## Strategy Development

Through a series of meetings, workshops, conference calls, webinars, and emails that took place from August 2011 through March 2014, SDM was used to develop and evaluate conservation strategies intended to increase persistence of imperiled aquatic species in the UTRB. The application of SDM to natural resource management is increasing, as its utility for assisting decision making in the face of competing objectives and uncertainty is being documented (Gregory and Long 2009, Martin et al. 2011, Gregory et al. 2012, Gregory et al. 2013, Conroy and Peterson 2013). SDM is values-focused and deconstructs the decision problem into universally recognizable components that can be deliberated by stakeholders, resource experts, and analysts. Transparency and explicitness are hallmarks of SDM. Identification of fundamental objectives is the first component considered after the problem is defined and framed. Development of alternatives follows identification of objectives. Optimal solutions can be found by evaluating the alternative management actions or strategies that best meet the objectives.