

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.

For the purposes of strategy development, we used expert elicitation to evaluate the consequences of alternative strategies. Expert elicitation can provide important information for decision making when sufficient data from research or monitoring is not complete or available (U.S. Environmental Protection Agency 2011, Drescher et al. 2013). We followed published best practices for expert elicitation to obtain experts' judgments on likely outcomes for conservation benefits and costs along with uncertainty in those judgments if alternative strategies were implemented (Gregory et al. 2012, Drescher et al. 2013). The general modified-Delphi process was to (1) carefully and systematically achieve a common understanding among experts of the questions being asked, (2) elicit a first round of judgments, (3) discuss the rationale for those judgments, and (4) repeat the steps as necessary until experts finalized their judgments.

The decision problem was to identify the management approach that would best achieve the conservation objectives. The alternative management approaches were defined by the effort allocated to a set of specific management actions. Further, the team aimed to identify which species and locations would be most likely to benefit from the implementation of the best management approach.

The alternative management approaches do not emphasize any one set of management actions to the exclusion of another. For example, habitat management will continue if population management is emphasized, and stressors will continue to be identified, studied, and ameliorated. Rather than selecting one type of management action to the exclusion of another, the purpose of strategy development is to optimize allocation among a large array of management actions through a selected approach.

Strategy development included the following steps:

1. Determine conservation objectives and specify performance measures for each objective.
2. Identify a comprehensive set of management actions (Appendix 4) and formulate broad actions and approaches that address threats and factors limiting species recovery.
3. Predict the consequences on species and habitat and estimate the costs of implementing each management approach within management units of the UTRB.
4. Identify the management approach that best achieves the conservation objectives of maximizing conservation benefit while minimizing costs.
5. Prioritize species for focused management based on level of imperilment¹, likely conservation benefit (as predicted from step 3), and species-specific management cost.
6. Prioritize locations for general habitat management based on diversity (richness) of imperiled species and feasibility of habitat improvement at each location.

Goals and Objectives

The goal of the Strategy is to maximize conservation and recovery of imperiled aquatic species and the UTRB ecosystem upon which they depend. Ecosystem conservation is implicit because to recover imperiled species ecosystems must be included. Objectives were outlined and used to guide the strategic planning process (Figure 6). A distinction is made between objectives that are

¹ The degree of imperilment is relative amongst species considered in the Strategy and a lower degree of imperilment should not be construed to suggest any specific determination regarding any pending listing/delisting action.