

presence of the following habitat elements: connectivity and suitable substrate, temperature, water quality, and water quantity. The performance measures for operational efficiency were based on management cost as measured by staffing levels and operational costs.

Alternative Management Approaches

Formulation of alternative management approaches was guided by identifying primary threats and ecological factors that currently limit imperiled species population growth, distribution, and viability. The limiting factors considered were predation, invasive species, physical habitat, host fishes (mussels only), flows, water quality (dissolved oxygen, temperature, contaminants), lack of dispersal/fragmentation, disease, and depensation due to low density (Allee effect). Experts² ranked the top three limiting factors for imperiled fishes and mussels. A rank of 1, 2, and 3 received 30, 20, and 10 points, respectively, and then the points were summed for each factor separately for fishes and mussels. The summed scores were standardized between 0 and 100 for least to most important, respectively (Table 3). Depensation, contaminants, and lack of dispersal/fragmentation were among the top three limiting factors for both fishes and mussels.

Table 3. Ranking of factors that could limit the persistence of imperiled fishes and mussels in the UTRB.

Potential Limiting Factors	Standardized Score for Fishes	Standardized Score for Mussels
Depensation (Allee effect)	88	100
Water quality – contaminants	100	89
Lack of dispersal/fragmentation	88	78
Physical habitat	50	33
Host fish	0	22
Flows	13	11
Predation	0	0
Invasive species	0	0
Water quality – dissolved oxygen	0	0
Water quality – temperature	0	0
Disease	0	0

Two broad approaches were considered to address the limiting factors: population management emphasis and habitat management emphasis. Population management emphasis addresses low population size (depensation) and lack of dispersal/fragmentation by increasing extant populations (augmentations) and establishing additional populations (reintroductions/introductions) through propagation and release of cultured individuals and translocated adults into suitable habitat. Habitat management emphasis addresses water quality, physical habitat, and flows by protecting or restoring occupied and unoccupied habitat within the historical range of imperiled species. These two approaches—population management emphasis and habitat management emphasis—were compared to a status quo management approach, which is a continuation of the management actions currently being implemented by USFWS.

An inventory of management actions (Appendix 4) was taken along with associated costs (Appendix 5). Management approaches were defined by the relative level of effort or agency resources committed to implementing management actions (Table 4). The three alternative approaches considered did not indicate exclusive reliance on either habitat or population management emphasis actions. Instead the alternatives represented different shifts in the types of management actions that would be emphasized (Table 4). For example, a high level of effort

² Brian Evans, Catherine Gatenby, Roberta Hylton, Cindy Schulz, and Peggy Shute.

Table 4. Relative level of effort to implement management actions under alternative management approaches. The management emphasis approaches were status quo, habitat, and population. Level of effort ranges from no implementation (0) to maximum implementation (1).

Management Actions		Basis for Level of Implementation	Alternative Approaches		
Type	Task ¹		Status Quo Management	Habitat Management Emphasis	Population Management Emphasis
Population Management	Implement ESA Section 7 and 10 regulations/influence agencies (A1a, A1b, B2a, B2b, B2c)	Level and consistency of enforcement	0.7	0.7	0.8
	Use available means to protect or establish populations (A1e1, A1e2, A1e3)	Number of species and populations	0.5	0.5	0.9
	Conduct status assessment/list candidate species (A1c, A1d)	Number of species	0.3	0.3	0.3
	Increase extant populations (A2a, A2b1, A2b2, A2b3, A2c)	Number of species and populations	0.7	0.6	0.9
	Establish new populations (A3a, A3b, A3c, A3d)	Number of species and populations	0.5	0.2	0.9
	Manage captive populations (C1a, C1b, C1c, C2a, C2b)	Number of species	0.0	0.0	0.5
	Habitat Management	Develop best management practices (BMPs) for managing stream and riparian habitat (B1)	Number of sites	0.6	0.8
Land acquisition and easements (B3a, B3b)		Number of sites	0.2	0.3	0.1
Restoration of instream and riparian habitat (B4a, B4b, B4c)		Number of sites	0.3	0.4	0.1
Monitoring/ Research	Life history (D1)	Number of species	0.4	0.6	0.6
	Population and habitat monitoring (D2a, D2b, D3a, D3b, D3c, D3d)	Number of populations and sites	0.5	0.5	0.5
	Evaluate and monitor threats (D4a, D4b, D4c, D4d)	Number of species	0.6	0.7	0.7
	Genetics monitoring and research (D5a, D5b, D5c)	Number of species	0.3	0.2	0.5
	Population viability analyses (D6a, D6b, D6c)	Number of species	0.2	0.0	0.7
	Evaluate habitat for reintroductions (D7a, D7b, D7c)	Number of species	0.1	0.1	0.8
	Propagation and captive management research (D8a, D8b)	Number of species	0.1	0.1	0.4
	Evaluate ecosystem services (D9, D10a, D10b, D10c)	Categorical effort	0.1	0.3	0.2
Communication and Partnerships	Outreach (E1a, E1b, E1c, E1d, E1e)	Categorical level of effort	0.3	0.8	0.5
	Work with partners and industry (E2a, E2b, E2c, E2d, E2e, E3a, E3b, E4)	Potential partnerships established	0.5	0.9	0.7
Agency Operations	Intra-agency (F1)	Categorical level of effort	0.5	0.5	0.5

¹Items in parentheses correspond to management actions listed in Appendix 4 and relate to other parts of the Strategy as explained in Appendix 6.

would be committed to increasing extant populations through propagation under the population management emphasis approach, whereas reduced effort would be committed to that action under the habitat management emphasis or status quo management approaches. Management flexibility was incorporated in all alternatives.