U.S. Fish & Wildlife Service

Recovery Plan
for the
Black Warrior Waterdog (*Necturus alabamensis*)

Photo by: Joe Jenkins, Alabama Natural Heritage Program; Adult Black Warrior waterdog

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for
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PURPOSE AND DISCLAIMER

This document presents the U.S. Fish and Wildlife Service's (Service) plan for the conservation of the Black Warrior waterdog. The recovery plan is the second part of the Service's 3-part recovery planning framework including the statutorily required elements pursuant to section 4(f) of the Endangered Species Act (Act). This recovery plan is informed by the first part of the framework, a Species Status Assessment (SSA) that delivers foundational science for informing decisions related to the Act and includes an analysis of the best available scientific and commercial information regarding a species' life history, biology, and current and future conditions that characterizes the species' viability (i.e., ability to sustain populations in the wild over time) and extinction risk. Complimenting the recovery plan, we have also prepared a separate Recovery Implementation Strategy (RIS) the third part of the framework. The RIS is an easily updateable operational plan that describes the on-the-ground recovery activities needed to complete the recovery actions contained in the recovery plan.

Recovery plans describe the envisioned recovered state when a listed species should no longer meet the Act's definitions of a threatened species or endangered species) and include a recovery strategy, recovery criteria, recovery actions, and the estimates of time and cost needed to achieve it. Plans are published by the Service and are often prepared with the assistance of recovery teams, contractors, State agencies, and others. Recovery plans do not necessarily represent the views, official positions, or approval of any individuals or agencies involved in plan formulation, other than the Service. They represent the official position of the Service only after they have been approved and signed by the Regional Director. Recovery plans are guiding and planning documents only; identification of an action to be implemented by any public or private party does not create a legal obligation beyond existing legal requirements. Nothing in this plan should be construed as a commitment or requirement that any Federal agency obligate or pay funds in any one fiscal year in excess of appropriations made by Congress for that fiscal year in contravention of the Anti-Deficiency Act, 31 U.S.C. 1341, or any other law or regulation. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and completion of recovery actions.

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RECOMMENDED CITATION AND ELECTRONIC AVAILABILITY

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Recovery plans can be downloaded from: https://ecos.fws.gov/ecp/species/5426

1. INTRODUCTION

This recovery plan describes criteria for determining when the Black Warrior waterdog (*Necturus alabamensis*) should be considered for delisting, identifies site-specific actions that will be necessary to meet those criteria, and estimates the time required and costs for implementing actions necessary to achieve recovery. Additionally, cursory information on the species' biology and status are included, along with a brief discussion of factors limiting populations. The recovery plan was informed by the SSA (Service 2018), which provides a more detailed account of the species' status, distribution, biology, and threats.

Species status

The Black Warrior waterdog was federally listed as endangered and designated critical habitat on February 2, 2018 (83 FR 257–284) under the Endangered Species Act of 1973 (87 Stat. 884, as amended, 16 U.S.C. 1531 *et seq.*) (Act). The Black Warrior waterdog is assigned a recovery priority number of five, which indicates that the species faces a high degree of threat and a low recovery potential. Recovery potential is considered low because the species occurs in extremely low abundances. Further identifying and alleviating threats will require diligent and long-term efforts.

Habitat Requirements

Early descriptions of habitat requirements for the Black Warrior waterdog were identified as cold, clean flowing water, a stable rocky substrate with abundant submerged ledges, crevices, and other cover (Ashton and Peavy 1986). Later research indicated the species was associated with clay substrates lacking silt, and wide and shallow stream morphology (Guyer 1997). The species was also found dependent on leaf packs containing branches, rocks, and other stream obstructions used for shelter and forage habitat (Bailey 2000); these leaf packs are found at stream depths of 1 to 4 meters (m) (3.3 to 13.1 feet (ft)) (Durflinger Moreno et al 2006; Service 2018). Black Warrior waterdogs were also found to be negatively associated with the amount of impervious surface area in the watershed and positively associated with high-gradient headwater streams of smaller watersheds with low human impact (De Souza et al. 2016; Service 2018).

Unobstructed interstitial space is a critical habitat component for the Black Warrior waterdog, as it provides cover from predators and habitat for macroinvertebrate prey. When interstitial spaces become compacted or filled with fine sediment, the amount of available foraging habitat and protective cover for salamanders is reduced, resulting in population declines (Welsh and Ollivier 1998, O'Donnell et al., 2006).

Contaminants from various point and nonpoint source activities can impact water quality for the Black Warrior waterdog. Exposure to chemical fertilizers, pesticides, livestock waste, increased heavy metal concentrations, turbidity, altered pH levels and sedimentation, have observed malformations with amphibians and increased susceptibility to diseases that resulted in population declines, reproductive successes and overall biodiversity (Taylor et al., 2005, Schmutzer et al., 2008, Hayes et al., 2010, Ngole-Jeme and Ndava 2023). Waterways impacted by lowering of pH, increased heavy metal concentrations, electrical conductivity, total dissolved solids and turbidity documented damage to epithelial cells and gills of amphibian larvae,

inhibition of larval growth, and metamorphosis delays and chromosomal abnormalities from metal exposures (Ngole-Jeme and Ndava 2023). More specifically, evidence of negative impacts related to contaminants and pesticide exposure on various species of waterdogs has shown reproductive organ contamination, skeletal deformities, and limb developmental defects (Gendron et al. 1994).

While pollutants have been observed to cause negative effects among amphibians and other species of waterdogs, the best available knowledge regarding specific levels of these pollutants and how they impact the Black Warrior waterdog are still unknown due to a lack of toxicological studies on this species.

Overall, habitat can be described as a substrate consisting of clay or bedrock with little sand, and containing abundant rock crevices, rock slabs, and leaf packs. The following habitat features have been determined to be essential to the conservation of the Black Warrior waterdog, and were derived from the needs of waterdogs, other listed species in the same range, and waterdog prey species.

- Geomorphically stable, medium to large streams (typically 4 m (13 ft) wide or greater) with a substrate consisting of clay or bedrock with little sand, and abundant rock. The presence of crevices, rock slabs, and leaf packs. Moderate water velocity and a prey base of aquatic macroinvertebrates.

- Water quality (including, but not limited to, conductivity, hardness, turbidity, temperature, pH, ammonia, heavy metals, and chemical constituents) necessary to sustain natural physiological processes for normal behavior, growth, and viability of all life stages for the Black Warrior waterdog and primary prey base.

Populations

Known locations of the Black Warrior waterdog were consolidated into populations using the USGS Water Boundary Dataset, HUC10 (10-digit hydrologic unit code) as the base unit (Service 2018). Populations were further differentiated where an impoundment or dam was present and likely to prevent movement of animals within the same HUC10 watershed. A total of 11 populations were delineated following this approach. Of these 11, six populations are currently extant (Sipsey Creek, Brushy Creek, Blackwater Creek, Blackburn Fork, Locust Fork and Yellow Creek) and five populations are presumed extirpated (North River, Caroll Creek Lost Creek, Mulberry Fork, and Slab Creek; Fig. 1).

Based on the distribution of occurrences and the 11 delineated population, the historical range likely encompassed the entire Black Warrior River basin upstream of the fall line. Redundancy from the historic state has dramatically declined. Of the 11 delineated populations, redundancy has also declined by nearly half with the presumed loss of five populations: Carroll Creek, Lost Creek, Mulberry Fork, North River, and Slab Creek.

Only two of the six extant populations exhibit high quality habitat (Sipsey Creek and Brushy Creek; Fig. 1) as evidenced by consistent captures of waterdogs. These two populations are

adjacent to one another in the Bankhead National Forest, however they are separated by an impoundment and are likely not functionally connected demographically to each other or any of the other populations.

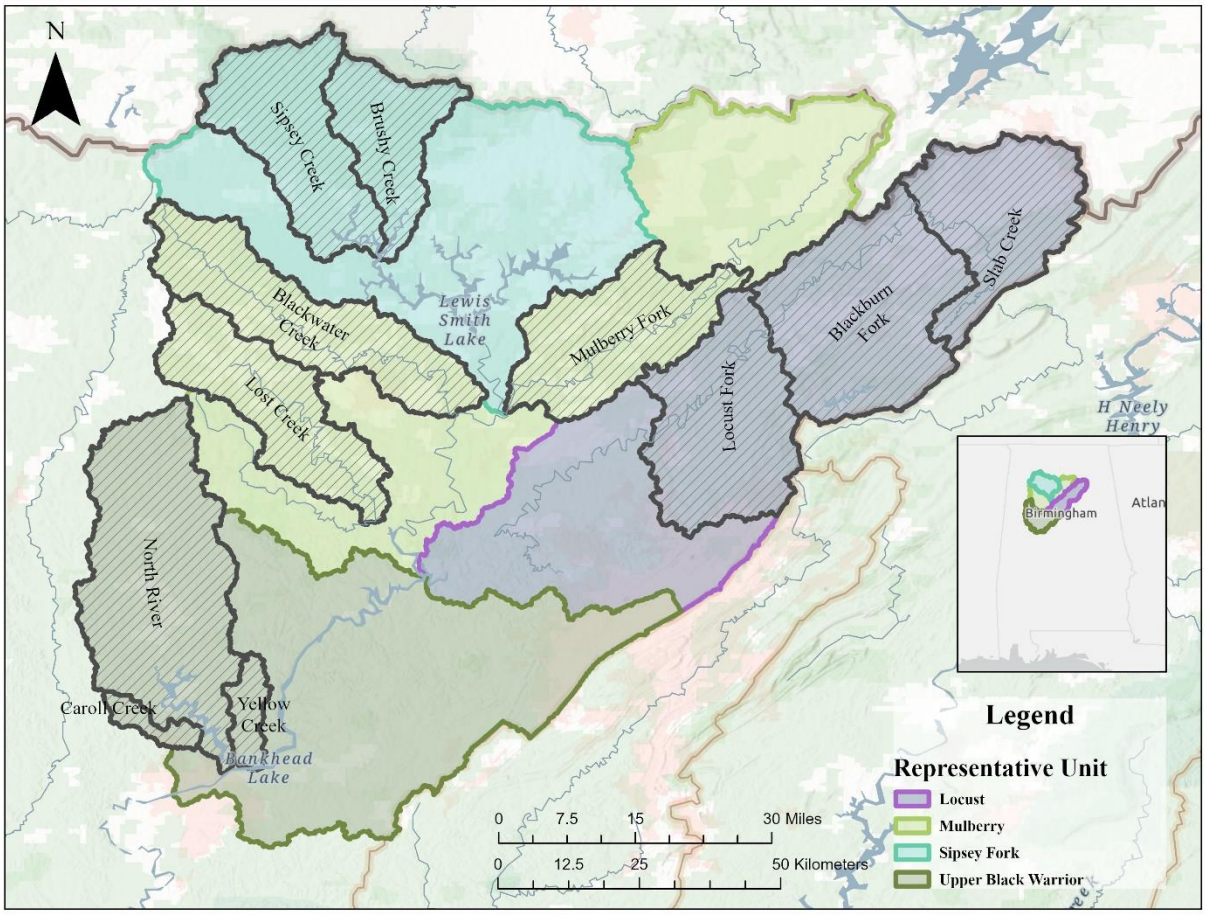

Figure 1. Entire range of the Black Warrior waterdog in the Black Warrior River basin. Black Warrior waterdog populations are delineated by HUC10 hydrologic units, and in several cases further separated by dams or impoundments. Representative Units with 11 historic Black Warrior waterdog populations displayed.

Limiting Factors

The Black Warrior waterdog faces several limiting factors including low population density, restricted range, vulnerability to stochastic events (e.g., extreme droughts, toxic spills), and inadequate funding to address recovery actions. Genetic bottlenecking and inbreeding depression could limit the ability for natural recovery, as evidenced by documented small effective population sizes (Apodaca 2021). Recovery actions identified in this plan are focused on addressing these factors. While eDNA evidence has been used to identify occupied streams, additional survey effort throughout the species' range is needed to remove uncertainty about location and status of populations.

2. RECOVERY STRATEGY

The recovery strategy provides a concise overview of the envisioned recovered state for the Black Warrior waterdog, describes the Service's chosen approach to achieve it, and includes the rationale for why the approach was chosen. Specifically, the recovery strategy articulates how the plan's statutory elements (e.g., recovery criteria, recovery actions, and estimates of time and cost) will work together to achieve Black Warrior waterdog's recovery.

The Black Warrior waterdog is one of several species protected under the Act found in the upper Black Warrior River system. Habitat alteration and impoundments have converted many miles of flowing river reaches into more lake-like environments. This habitat alteration has fragmented occupied streams into less resilient isolated populations and prevents recolonization and genetic exchange, leaving each population more susceptible to stochastic events and extirpation. Additionally, harmful effects associated with various point source and nonpoint source discharge into streams, as well as physical alterations have degraded or continue to degrade environmental conditions on which the species depends through point source and non-point source discharge into streams and physical alteration.

The overall recovery strategy will focus on securing enough resilient Black Warrior waterdog populations throughout the Black Warrior River system to maintain species representation and establish redundancy such that the protections afforded by the Act are no longer required. The initial recovery strategy for the Black Warrior waterdog is to prevent further species declines, and provide a path toward recovery by restoring healthy, self-sustaining populations throughout the historical range while also restoring and maintaining suitable stream habitats. Periodic evaluations of the status of recovery efforts and extant populations will be used to measure success.

Recovery efforts will focus on further investigating and addressing potential causes of population declines while continuing to stabilize populations using captive propagation and a head-starting program. To investigate and address potential causes for decline, recovery efforts will focus on reducing sediment input, improving water quality, conducting outreach, and research to identify unknown factors contributing to declines. Recovery efforts will aim to increase reproduction or recruitment of young into populations, decrease stress on individuals in the wild, and improve habitat affecting survival. Particularly important toward recovery, is the protection of sites where the species occurs at high enough numbers that it can be reliably observed.

3. RECOVERY CRITERIA FOR DELISTING

The Service may consider delisting the Black Warrior waterdog when the following conditions are met:

Recovery Criterion 1:

All six currently extant populations (Blackburn Fork, Blackwater Creek/Browns Creek, Brushy Creek/Capsey Creek, Locust Fork, Sipsey Fork, and Yellow Creek; Fig. 1) demonstrate a stable or increasing population trend, documented through standardized survey methods for a period of 20 years. Results of trapping surveys should indicate minimum catch rates equivalent to those of Sipsey Fork and Brushy Creek (0.017-0.029 per trap night). There is evidence of successful

recruitment to support a sustaining population, with recruitment defined as attainment of sexual maturity by young, within all currently occupied populations. Pathogen prevalence and disease incidence should remain at sufficiently low levels such that effects on population growth and demography are insignificant.

Rational for Criterion 1:

Populations must exhibit a stable or increasing trend, natural recruitment, and multiple age classes across a 20-year monitoring period to be resilient to stochastic events. In twenty years, approximately eight cohorts could be recruited into the reproduction population since reproductive maturity is reached at approximately 2.5 years of age (Bailey 2005; Service 2018). While total lifespan is unknown for the Black Warrior waterdog, other species in the genus *Necturus* can live to 34 years (Niemiller and Reynolds 2011). Therefore, a period of twenty years provide time to observe and document population trends. When met, all recovery criteria will indicate high resilience of currently occupied population and maintain representation.

For the Black Warrior waterdog to adapt to changing conditions, the distribution of resilient populations needs to be representative of geographic, genetic, and ecological variation that exists across the species' historical range. Studies on population genetics of the Black Warrior waterdog indicate small effective population size and low genetic diversity (Apodaca 2021). The estimated effective population size indicates that the species does not have enough individuals contributing to subsequent generations to support long-term viability and may not be able to support even short-term viability. Therefore, maintaining extant populations into the future may be insufficient to preserve an already limited adaptive capacity and ensure localized adaptations or novel mutations are not lost.

The final listing rule found that disease and predation do not currently pose a significant threat for the species. However, the increasing prevalence of novel diseases in other waterdog species (Glorioso et al. 2017) and amphibian taxa across North America (Rothmerel et al. 2008) and the catastrophic consequences resulting from outbreaks of such diseases (Lips et al. 2006) indicate that this threat needs to be closely monitored.

Recovery Criterion 2:

Threats have been addressed and managed to the extent that water quality, water quantity, instream habitat, and habitat connectivity will be maintained at levels that meet the life-history requirements of the Black Warrior waterdog and stressors causing detrimental effects occur at levels that have a minimal effect on subpopulation resilience.

Rational for Criterion 2:

Reduced water quality, excessive sedimentation, impoundments, urbanization, and effects from severe weather events such as droughts are considered threats the Black Warrior waterdog (83 FR 262-265, Service 2018). Management and abatement of these threats throughout the Black Warrior River basin must be achieved to meet life history requirement, achieve recovery, and delist the species. Watersheds that meet this criterion will match the habitat descriptions provided above

Recovery Criterion 3:

Eight populations matching the description of Criterion 1 are documented and distributed throughout the four representative units (Fig. 1) within the Black Warrior waterdog River basin. Each representative unit must contain a minimum of two highly resilient populations.

Rational for Criterion 3:

This criterion will enhance representation across the species' range and assist the species' ability to adapt to changing environmental conditions over time by maintaining a degree of environmental diversity among the populations. This criterion will also enhance redundancy, bolstering the species ability to withstand larger scale stochastic or catastrophic events.

Recovery Criterion 4:

The eight populations are distributed in such a manner that 1) connectivity is sufficient to maintain genetic diversity and 2) the population is resilient to stochastic event (e.g., occupied patches occur in longer reaches and within multiple tributaries).

Rational for Criterion 4:

Habitat characteristics are crucial for Black Warrior waterdog resilience, and habitat degradation was the primary reason for the species being listed as endangered. Impoundments influence habitat quality by changing the physical and biological properties of the habitat and directly influence species redundancy by forming barriers to dispersal and reducing connectivity of populations.

Recovery criteria also correspond with resiliency, representation, and redundancy metrics identified in the SSA. The population's resiliency analyses in the SSA describes characteristics that would indicate whether a population is capable of withstanding stochastic events and resistance to localized extirpation. Resiliency conditions in the SSA considers physical habitat, water quality, and population characteristics. Water quality was further broken out into two contributing factors: point source pollution and nonpoint source pollution. The conditions for these factors were ultimately combined to generate a single resilience score for each population.

4. RECOVERY ACTIONS

Recovery actions are the statutorily required, site-specific management actions needed to achieve recovery criteria, as described in section 4(f)(1)(B)(i) of the Act. The Service assigns recovery action priority numbers (1-3) to rank recovery actions. The assignment of priorities does not imply that some recovery actions are of low importance, instead implies that lower priority items may be deferred while higher priority items are being implemented. Recovery action priority numbers are based on the following:

Priority 1: An action that must be taken to prevent extinction or to prevent the species from declining irreversibly.

Priority 2: An action that must be taken to prevent a significant decline in species population/habitat quality, or some other significant negative impact short of extinction.

Priority 3: All other actions necessary to provide for full recovery of the species

Table 1: Recovery Action Summary Table.

Recovery Action ID Number	Recovery Action	Est. Cost ($1000s)	Recovery Action Priority Number	Related Recovery Criterion
1	Increase knowledge of the biology of the species, particularly its response to threats	$700	1	1, 2, 3, 4
2	Propagate the Black Warrior waterdog in captivity to augment declining, wild populations, and restore extirpated populations.	$4,000	1	1, 3, 4
3	Institute a surveying and monitoring program for existing populations and locate additional populations	$1,960	2	1, 3, 4
4	Protect and improve habitat and water quality, which may include land acquisition	$3,200	1	1, 2, 3, 4
5	Coordinate with and empower local, state, and federal partners to reduce sources of pollutants, to promote watershed stewardship, and to conduct outreach in local communities	$100	2	1, 2, 3, 4
Total Cost		**$9,960,000**		

5. Estimated Time and Cost to Achieve Recovery

Estimates of time and cost, as defined in section 4(f)(1)(B)(iii) of the Act, must reflect, to the maximum extent practicable, the total amount of time and costs it will take to achieve the recovery (delisting) of Black Warrior waterdog. The cost estimates provided do not account for possible future inflation.

We estimate that the full implementation of the recovery actions would improve the status of Black Warrior waterdog so that it could be delisted within 50 years following the adoption of this recovery plan. We also estimate the total cost of recovery at $9,960,000 dollars (Table 1). We note that the recovery program may change over time, or the timeframe estimated to implement the recovery actions to achieve recovery of the species may take longer than expected. The recovery of Black Warrior waterdog will depend largely on the commitment and the ability of the Service and our partners to implement the recovery actions necessary to achieve the recovery criteria.

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