

**Recovery Outline for  
Barrens Topminnow (*Fundulus julisia*)  
November 2019**



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## **I. INTRODUCTION**

This document outlines a preliminary course of action for recovery of the Barrens topminnow until a comprehensive recovery plan for the species is approved. The final rule listing of the Barrens topminnow as an endangered species was published on October 21, 2019 (84 FR 56131). This freshwater species is a small fish that is restricted to springhead pools and slow-flowing areas of spring runs on the Barrens Plateau in middle Tennessee. Due primarily to predation by the western mosquitofish, and secondarily to habitat alteration exacerbated by climate change, overall viability of the Barrens topminnow is low. Population resiliency and range-wide representation and redundancy of the species all reflect overall low condition of the species, and several of its populations are small. The Barrens topminnow currently occupies only six sites, a 66% decrease from 18 historically occupied sites (i.e., sites occupied since recurring surveys for the species were initiated in the 1970's). Note that this figure incorporates a sixth population that was documented as being viable since publication of the final listing rule.

### **Listing and Contact Information:**

Listing Classification:	Endangered range-wide
Effective Listing Date:	November 20, 2019
Lead Agency, Region:	U.S. Fish & Wildlife Service, Region 4
Lead Field Office:	Tennessee Ecological Services Field Office
Contact Biologist:	Warren Stiles, 931-525-4977, warren_stiles@fws.gov

## II. RECOVERY STATUS ASSESSMENT

### A. BIOLOGY/THREATS ASSESSMENT

Members of the subgenus *Xenisma*, like the Barrens topminnow (*Fundulus julisia*) tend to be residents of backwaters and edges of streams. This small, colorful killifish grows to 98 millimeters (3.9 inches) and has an upturned mouth, flattened head and back, and rounded fins set far back on the body (Etnier and Starnes 1993).

The Barrens topminnow is a fractional, protracted spawner (i.e., depositing a few eggs at a time over a long period) that spawns during the warmer months (April to August), peaking in May or June. Over the course of one breeding season, a female may lay more than 300 eggs during multiple spawning events. Adults typically live only two years due to high spawning mortality, though some survive to four years. Most fish mature and are ready to spawn within the first year, though some of the fish spawned later in the season do not reproduce until reaching year two (Rakes 1989).

The most recent range-wide status survey for this species was conducted during the period of 2013 to 2015 (Kuhajda 2017). During a survey of 35 sites, Barrens topminnows were found at 18 sites. Evidence of successful reproduction (i.e., presence of juvenile fish) was documented at 12 of these sites during the three-year survey period. The species was present at 17 sites in the final year of the survey, but evidence of successful reproduction was observed at only six of the sites. The Barrens topminnow is currently found in Cannon, Coffee, DeKalb, Franklin, and Warren Counties in Tennessee, and three major watersheds, the Duck, Elk, and Caney Fork Rivers; but the fish in the Duck have been introduced from the other two watersheds since the original strain was lost.

According to the recently conducted Species Status Assessment (SSA) (USFWS 2019), long-term viability of the Barrens topminnow is affected by predation and habitat alteration. Specifically, the species is threatened primarily by western mosquitofish (*Gambusia affinis*) and habitat impacts associated with livestock, riparian vegetation removal, impoundment, and drought. The small size of Barrens topminnow populations at some sites and the overall restricted range of the species (USFWS 2018) compound these threats.

#### Western mosquitofish

The western mosquitofish poses the largest and most direct threat to the continued existence of the Barrens topminnow. This small, live-bearing fish is native to parts of Tennessee, but not the Barrens Plateau. These fish were likely first introduced to the plateau in the 1960s as an effort to control mosquitos. With human help and natural expansion, western mosquitofish are now found in most streams on the Barrens Plateau and are adapted to expand rapidly into unoccupied habitat. The mosquitofish are highly adapted to rapidly expand upon invasion of a new area, greatly increasing competition. Adult mosquitofish prey on terrestrial and aquatic arthropods as well as larval fishes (Etnier and Starnes 1993). Where the two species co-occur, mosquitofish prey upon and harass larval (i.e., less than 16 millimeters; 0.6 inch) and juvenile Barrens topminnows, leading to higher mortality and little to no recruitment (Laha and Mattingly 2006). Large mosquitofish also aggressively harass adult topminnows.

### Livestock Influence

Many of the springs occupied historically by Barrens topminnows are used as water sources for cattle. Access of livestock to surface waters tends to result in sediment transport, with associated deposition on substrate and vegetation. Increased nutrient levels and reduced visibility are typical of these areas, with impacts to topminnow spawning displays.

### Riparian Vegetation Removal

An activity often associated with livestock operations is the clearing of vegetation up to the edge of the springs and runs that topminnows rely on. Trees and shrubs are cleared to allow for easier access by cattle, increase available pasture, or to provide views of the stream. Riparian vegetation acts to stabilize banks and reduce overland runoff. Sedimentation increases with vegetation removal (Barling and Moore 1994; Beeson and Doyle 1995), and water temperature increases with subsequent loss of shade (Brazier and Brown 1973; Barton et al. 1985; Pusey and Arthington 2003). However, a fully-shaded stream will reduce the amount of filamentous algae and other submerged vegetation, which is needed as habitat for the Barrens topminnow.

### Drought

Springhead discharges decrease during drought, and reduced discharge leads to a reduction of available habitat. Fish can be stranded if springs dry up completely, becoming easier targets for predators. In conjunction with livestock access, drought-reduced spring discharge can result in a high concentration of animal waste in topminnow habitats. Benedict Spring, the Barrens topminnow type locality, has dried completely during droughts on multiple occasions, necessitating the capture and housing of topminnows until conditions allow them to be returned to the spring pool. When fish at Benedict Spring and Pedigo Farm were captured and returned in October 2016, the drought index for the Barrens area was classified as only a moderate level by the United States Drought Monitor. Since 2006, type locality fish have been captured and returned at least six times due to drought, including one event in 2019. Prior to human alteration of habitat in the Barrens area, topminnows were able to move out of drying springs during drought to more permanent water and then re-colonize the springs once conditions improved. Manmade barriers and invasive mosquitofish in the lower reaches of streams inhabited by topminnows now prevent successful re-colonization in these situations.

### Impoundment

A few of the springs occupied by Barrens topminnows have been dammed for use as water sources, as well as for fishing opportunities and aesthetics. These impoundments tend to exhibit higher temperatures than observed in typical spring-fed streams. The deeper water of these impoundments can also result in reduced growth of aquatic vegetation that the Barrens topminnow uses for cover and as a spawning substrate. A population at Lewis Farm was lost when the spring at this site was impounded.

### Small Population Sizes and Restricted Range

The Barrens topminnow range has become more restricted due to losses of natural populations in the Duck River and Elk River watersheds and multiple populations in the Caney Fork River watershed. The species is now restricted to a single self-sustaining, natural population and two stocked populations in the Caney Fork River watershed; two stocked populations in the Duck River watershed; and a single introduced population in the Elk River watershed. Habitat

fragmentation has subjected the small populations to genetic isolation, reduced space for reproduction, and reduced adaptive capabilities, thereby increasing the likelihood of extinction. Small, isolated populations are also vulnerable to the Allee effect (a positive relationship between individual fitness and either numbers or density of conspecifics) (Stephens et al. 1999).

### Low Genetic Diversity

Species that are restricted in range and population size are more likely to suffer loss of genetic diversity due to genetic drift, potentially increasing their susceptibility to inbreeding depression, decreasing their ability to adapt to environmental changes and reducing the fitness of individuals (Soule 1980; Hunter 2002; Allendorf and Luikart 2007). It has been estimated that effective population sizes may range from 500 individuals (Franklin and Frankham 1998) to avoid deleterious effects of genetic drift over several generations, up to 5,000 individuals (Lande 1995) for long-term survival. The long-term viability of a species is founded on the conservation of numerous local populations throughout its geographic range (Harris 1984). These separate populations are essential for the species to recover and adapt to environmental change (Harris 1984; Noss and Cooperrider 1994). Hurt et al. (2017) found very low genetic diversity in populations of Barrens topminnows. They also found low effective population sizes for several sites where a number could be generated; however, due to small sample sizes and low number of alleles, the confidence intervals were very wide for the estimates (Hurt and Kuhajda 2017).

## **B. CONSERVATION ACTIONS**

Since 1980, considerable amounts of time and funding were expended in an effort to preclude the need to list the Barrens topminnow. In 2001, the Barrens Topminnow Working Group, consisting of the Tennessee Wildlife Resources Agency (TWRA), U.S. Fish and Wildlife Service (USFWS), universities, and nonprofit organizations, was created to coordinate actions such as habitat improvement, propagation and stocking. However, the topminnow has failed to demonstrate the desired response in terms of viability, and the USFWS determined in 2018 (USFWS 2018) that listing the species was warranted.

Most conservation efforts for the Barrens topminnow have been directed at stocking the species into unoccupied springs. Since initiation of the stocking program, more than 44,000 individuals have been released at twenty-seven sites. Beginning in the mid-1980s, brood fish were taken from the McMahan Creek watershed, Hickory Creek watershed, and Elk River watershed. The brood fish were then propagated by Conservation Fisheries, Inc. (CFI) and the Tennessee Aquarium Conservation Institute (TNACI), and young Barrens topminnows were grown out at Dale Hollow and Wolf Creek National Fish Hatcheries, CFI, and TNACI.

One site stocked with topminnows, located near Verville, Tennessee, is situated in the Hickory Creek watershed on land acquired by USFWS. When the tract came under management of the Tennessee National Wildlife Refuge, mosquitofish occupied the spring on the property, and topminnows were absent. Spring pools were deepened to improve habitat for topminnows at the site, a concrete barrier was installed, and mosquitofish were removed. Topminnows from the type locality were then stocked above the barrier in 2001. This population maintained viability until 2010 when mosquitofish re-invaded the site during a flood.

Stocking has proven unsuccessful at most sites either because of insufficient habitat or invasion of western mosquitofish (Goldsworth and Bettoli 2005). A decision was made during the 2016 working

group meeting to discontinue the stocking program because it was no longer needed to maintain populations at suitable sites without mosquitofish and because continued stocking was unlikely to establish self-sustaining populations at other sites.

In addition to stocking, several other types of actions have been attempted to benefit the Barrens topminnow. A monitoring program was implemented at all of the known sites until 2015. Surveys were conducted by several partners (including Tennessee Technological University, TNACI, CFI, and TWRA) using standardized techniques. Data acquired through these survey efforts provided a foundation for assessment of the stocking program's success (Kuhajda et al. 2014; updated by Kuhajda 2017). Partners for Fish and Wildlife biologists have also worked with landowners at several sites to exclude livestock from springs and spring runs in an effort to curb sedimentation. Some waterways have been enlarged to improve habitat conditions, but with minimal success. None of the agreements associated with these projects are still active, but vegetated buffers remain in place at some of the sites. As discussed in the previous section on drought, capture and return of topminnows during drought conditions has been utilized as a tool to benefit the species. This action will likely continue to be important in the future.

### **III. PRELIMINARY RECOVERY STRATEGY**

#### **A. RECOVERY PRIORITY NUMBER WITH RATIONALE**

The Barrens topminnow is assigned a recovery priority of 5, which indicates the species faces a significant level of threat and has low recovery potential. The degree of threat is considered high because the stressors to this fish and its habitat are numerous and ongoing, thus contributing to continual decline. The Barrens topminnow's decline is due primarily to predation and habitat alteration/degradation resulting in reduced connectivity among occupied watersheds. Recovery potential is considered low because several biological and ecological limiting factors exist (i.e., predation by mosquitofish and habitat limitations, exacerbated by drought conditions). Threats to the habitat and the species' success have been identified, but conservation actions taken in attempt to address them have not proven successful.

#### **B. RECOVERY STRATEGY/INITIAL ACTION PLAN**

The goal of the recovery effort is to ensure long-term survival of the Barrens topminnow by controlling and/or reducing threats to the extent that populations are self-sustaining and protections afforded by the Endangered Species Act are no longer required. The initial plan is to work with partners to reduce and alleviate threats to the Barrens topminnow. Specifically, we will improve habitat conditions at extant locations and at sites that are currently unoccupied, and we will investigate and implement methods to reduce the threat of western mosquitofish. USFWS will cooperate with County officials and planners, State agencies, Federal agencies, and private entities (especially landowners) to maintain and improve long-term habitat conditions for the topminnow. Cooperation to accomplish conservation goals on privately-owned properties is expected to be central to this effort, and acquisition of properties for long-term protection by non-governmental conservation entities and/or governmental organizations may also become important. We will work with local, state, and federal regulatory partners to promote use of regulations for conservation of the species. Ongoing assessment of threats and their influence upon the topminnow is expected to continue as a multi-partnership effort.

Recovery actions for the Barrens topminnow will focus on monitoring of existing populations, improving habitat quality, addressing predator influences, and bolstering topminnow populations that exhibit declines.

At this time, the following recovery actions have been identified as top priorities:

- Identify practical methods for addressing threats posed by western mosquitofish (e.g., mosquitofish exclusion and/or removal) at sites occupied by Barrens topminnows that currently contain suitable habitat and are most likely to maintain suitable conditions during drought events.
- Develop methods for sustainably addressing impacts due to drought, including protection of watersheds that supply groundwater sources (i.e., through reduction in water withdrawals, improved water storage, use of wells, and other potential methods).
- Maintain ark populations of each genetic lineage for the purpose of re-introduction as needed.
- Use captive-reared or trans-located Barrens topminnows to establish or augment populations where habitat conditions are suitable.
- Conduct surveys, using standardized methods, in the Barren topminnow's historical range, to assess the status of existing populations.
- Assess suitability of sites that are not currently occupied by the species.
- Conserve Barrens topminnow sites through acquisition or easements.
- Develop and maintain connectivity between sites occupied by Barrens topminnows through removal of threats from mosquitofish and adverse habitat conditions.

Other important conservation actions include:

- Control the input of nutrients, sediment, and other forms of pollution from point- and non-point sources through cooperation with landowners, regulatory agencies, and non-governmental organizations.
- Conduct outreach and education through internet resources and additional contact with local entities.

#### **IV. PREPLANNING PROCESS**

##### **A. PLANNING APPROACH**

A Species Status Assessment has been conducted for the Barrens topminnow. We will prepare a recovery plan for the species, using the science-based methodology described in the SSA. Overall, the SSA process and its conservation biology principles of resilience, redundancy, and representation (collectively known as the "3Rs") are used as a lens to evaluate the current and future predicted condition of the species. An SSA characterizes a species' ability to sustain populations in the wild over time based on the best scientific understanding of historical, current, and future abundance and distribution within the species' ecological settings. An SSA is, in essence, a biological risk assessment tool applied by decision makers in using the best available scientific information to make policy decisions. Using scientifically-derived information provided in the SSA report, the recovery plan will include objective and measurable criteria which, when met, will maximize potential for conservation of the species.

Recovery criteria will address all significant threats to the species and provide a basis for estimation of the time and cost for achieving recovery. The Tennessee Ecological Services Field Office will lead the recovery planning effort, providing the draft and final recovery plans to the Regional Office for review prior to July 2020 and July 2021, respectively. These timelines may change as affected by available resources and regional priorities.

**B. STAKEHOLDER INVOLVEMENT**

Many stakeholders are currently involved in ongoing efforts associated with conservation of spring- and stream-related resources of the Barrens Plateau, including the Barrens topminnow. These stakeholders include State and Federal agencies, industrial and agricultural groups, university researchers, and conservation organizations. USFWS will continue to seek input and cooperation from multiple stakeholders during the recovery planning process.

Approve: Franklin J. Arnold III

Date: 11/19/2019

Acting Assistant Regional Director, Region 4