

Post-Delisting Monitoring Plan
for
Snail Darter (*Percina tanasi*)



Plan Prepared by:

**U.S. Fish and Wildlife Service
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Cookeville, Tennessee**

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Final

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I. Introduction

Section 4(g) of the Endangered Species Act of 1973, as amended (Act; 16 U.S.C. 1531 et seq.) requires the U.S. Fish and Wildlife Service (Service) to implement a system in cooperation with the States to monitor, for not less than five years, the status of all species that have recovered and been removed from the Federal List of Endangered and Threatened Wildlife (List). Section 4(g)(2) of the Act directs the Service to make prompt use of its emergency listing authorities under section 4(b)(7) of the Act to prevent a significant risk to the well-being of any recovered species. While not specifically mentioned in section 4(g), authorities to list species following the process prescribed in sections 4(b)(5) and 4(b)(6) may also be used to reinstate species on the List, if warranted. Post-delisting monitoring (PDM) refers to activities undertaken to verify that a species delisted due to recovery remains secure from risk of extinction after the protections of the Act no longer apply. The primary goal of PDM is to monitor the delisted species to ensure the status does not deteriorate, and if a substantial decline in the species (numbers of individuals or populations) or an increase in threats is detected, to take measures to halt the decline so that re-proposing it as an endangered or threatened species is not necessary.

II. Review Summary

This plan was developed with help from members of the Tennessee Valley Authority's (TVA) stream monitoring and natural heritage programs and reviewed by managers in those areas at multiple times in the process, including a review of the completed draft. The review included suggestions updating our proposed sampling locations, but were supportive of the analytical framework. On May 27, 2022, we presented our proposed sampling locations and analytical framework to aquatic diversity coordinators for the state wildlife agencies within the range of the snail darter (Tennessee, Georgia, Alabama, and Mississippi). There were comments regarding our metrics and thresholds around sensitivity to detect decline, and with that input we were able to refine and strengthen this plan.

All comments provided by reviewers were incorporated where appropriate. We have coordinated with all cooperators identified in the plan and all agree that the methods provide adequate information to monitor the delisted species to ensure we can accurately assess the status of the species.

III. Brief summary of the roles of all cooperators in the PDM planning effort

The snail darter's (*Percina tanasi*) current range lies entirely within the Tennessee River Valley, including the mainstem and tributary streams in Alabama, Georgia, Mississippi, and Tennessee (Figure 1). In reaching our determination to remove the snail darter from the List in 2022, we drew heavily on data collected through the TVA Index of Biotic Integrity (IBI) stream monitoring and exploratory surveys for snail darters in reservoirs to

assess the resiliency of populations throughout the species range. Capitalizing on the availability of this existing aquatic survey framework spanning the snail darter's multistate range, the Service prepared this PDM plan in coordination with TVA to utilize results of IBI stream monitoring and reservoir-focused surveys as a basis for assessing resiliency of snail darter populations in the absence of protection under the Act. The Service designed this plan to detect substantial changes in snail darter occupied habitat and declines in snail darter occurrences with reasonable certainty.

Section 4(g) of the Act explicitly requires cooperation with the States in development and implementation of post-delisting monitoring programs. The Service remains responsible for compliance with section 4(g) and therefore, must remain actively engaged in all phases of the monitoring program. The Service seeks active participation of other entities that are expected to assume responsibilities for the species' conservation after delisting or that have natural resources management mandates.

In keeping with our mandate, the Service developed this monitoring plan in cooperation with TVA and the state wildlife agencies within the snail darter's range. Snail darters have been found in 13 tributaries that TVA monitors on a five-year cycle or more frequently for general watershed monitoring. Given the overlap between TVA's existing stream monitoring efforts and the snail darter's range, 13 IBI sites were selected to provide a basis for assessing resiliency of tributary populations across the species range. Additionally, TVA will continue conducting snail darter-focused trawling surveys at seven reservoirs that likely host populations, which will provide data for assessing resiliency of snail darter populations in deeper water habitats that are not sampled through the IBI program. We coordinated with the state agencies to ensure appropriate data sharing and survey coordination.

A. U.S. Fish and Wildlife

The mission of the Service is working with others to conserve, protect, manage, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people. The Service implements the provisions of the Act. The Tennessee Ecological Services Field Office will retain the primary responsibilities for monitoring, coordinating with TVA and the states, and assessing species condition.

U.S. Fish and Wildlife Service Roles:

- Prepare, coordinate, and finalize the PDM plan.
- Determine restoration actions, coordinate monitoring, and estimate budget requirements for PDM implementation.
- Coordinate PDM actions with all cooperators and continue to provide input on military mission impacts, restoration actions, and conservation planning.
- Implement the PDM through monitoring, research activities, or restoration actions conducted by the Service or cooperators.

- Coordinate and convene an annual call or meeting, and other calls or meetings as necessary, to discuss monitoring results and management activities.

B. Tennessee Valley Authority

Tennessee Valley Authority has an overarching Environmental Policy “to produce increasingly clean, reliable and affordable power, support sustainable economic growth in the Tennessee Valley and promote proactive environmental sustainability in a balanced and ecologically sound manner.”

(<https://www.tva.com/environment/environmental-stewardship/>). As part of that policy, they have a commitment to natural resources and managing water quality and quantity impacts through permitting activities and the collection, maintenance, and distribution of water quality information.

Tennessee Valley Authority Roles:

- Support the preparation and implementation of the PDM.
- Continued implementation of Best Management Practices to protect aquatic life during management of dam operations in the range of the snail darter (e.g., implementation of the Reservoir Release Improvement Program (RRIP) for the maintenance of appropriate dissolved oxygen and temperature).
- Tributary Monitoring: Monitor 13 IBI sites according to the schedule defined below for water quality assessments and species assessments (threat and snail darter persistence monitoring).
- Reservoir Monitoring: Monitor 7 reservoir sites according to the schedule defined below.
- Provide annual reports to the Service.
- Participate in annual call or meeting to discuss PDM effectiveness and conditions at monitoring sites.

C. State Wildlife Agencies

Alabama Division of Wildlife and Freshwater Fisheries

Georgia Department of Natural Resources

Mississippi Department of Wildlife, Fisheries and Parks

Tennessee Wildlife Resources Agency

All of the state wildlife agencies have missions to conserve natural resources. Part of these missions include assessing the condition and distribution of at-risk and other species of interest in their states. Each state agency has a representative with expertise related to the monitoring, condition of snail darter, and threats in the watersheds where the species occurs. These experts will provide review and coordination throughout the PDM finalization and monitoring process.

State Roles:

- Support the preparation and implementation of the PDM.
- Provide annual monitoring summaries of any surveys or threats assessments in the range of snail darter in their corresponding states
- Perform/participate in monitoring at sites under the agency's jurisdiction.
- Participate in annual call or meeting to discuss PDM effectiveness and conditions at monitoring sites.

IV. Summary of Species' Status at time of Delisting

A. Habitat and Species Description

The snail darter is a small fish species that inhabits medium creeks to large rivers, reaching a maximum length of about 3.5 inches (90 mm) over a life span of up to 4 years (Etnier and Starnes 1993). Initially thought to require shallow shoals and riffles, the species has now been found in water up to 25 ft. (7.5 m) deep. As the name suggests, snail darters feed on snails and aquatic insects. These fish require clean gravel for feeding and spawning. This clean gravel habitat is maintained by consistent water flow preventing the accumulation of sediment. In the late winter and early spring, snail darters congregate on gravel shoals in the Tennessee River and its tributaries to spawn, likely burying eggs in the substrate. After hatching 15-20 days post-spawning, the snail darter larvae drift with the current, dispersing downstream before settling to the substrate. After three or four months, juvenile snail darters begin dispersing from these deeper habitats back into the shoals. Some snail darters are ready to spawn within the first year, but most mature in the second year. More detailed species and habitat data can be found in the delisting rule, Starnes (1977, entire), and Hickman and Fitz (1978, entire).

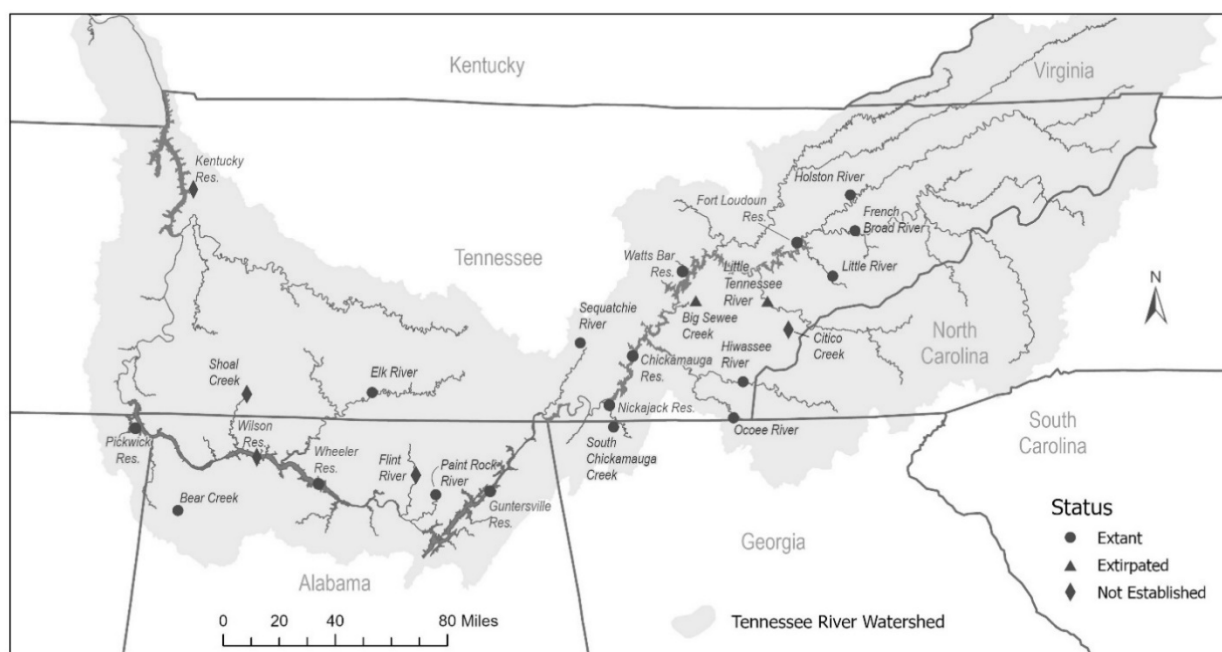


Figure 1: General location and status of snail darter populations at the time of delisting.

Map displays the general relationships of the reservoirs and tributary locations, but icons may not reflect sampling locations or locations of majority of snail darter captures.

B. Species Distribution

When the snail darter was listed in 1975, the species was only known from about 13 miles (21 km) of the lower Little Tennessee River in Loudoun County, Tennessee (40 FR 47506). Translocation efforts and additional surveys over the following 40 years resulted in snail darter populations in tributaries further down the Tennessee River Valley (Simmons 2019, p. 1). The addition of benthic trawl surveys provided evidence of populations in the mainstem Tennessee River (Simmons 2019, p. 2). At the time of delisting, snail darters were known to be extant in 13 tributaries, possibly extirpated in 1 additional tributary (e.g., Big Sewee; Figure 1; Table 1), present in at least 7 mainstem reservoirs of the Tennessee River, and potentially occurring in 2 additional reservoirs (e.g., Wilson and Kentucky; Table 2).

Table 1: Tributary population resiliency based on collection data and TVA IBI scores from 2009-2019. For explanation of metrics see Section C. Assessing Resiliency and Table 3.

Table reproduced from the proposed delisting rule (Service 2021) with additional notes added in the asterisks below.

Tributary	Multiple Detections	Multiple Age Classes	Population Score	IBI Score	IBI Trend	Habitat Score	Overall Resiliency
Holston River	Yes	Yes	High	Fair	Stable	Moderate	Moderate/ High
French Broad River	Yes	Yes	High	Fair/ Good	Stable or Improving	High	High
Little River	Yes	No	Low	Good/ Excellent	Stable	High	Low*
Citico Creek	No	No	Not Established	Good	Stable	High	Not Established
Big Sewee Creek	No	No	Extirpated**	Poor/ Fair	Stable	Low	Extirpated
Hiwassee River	Yes	Yes	High	Good/ Excellent	Stable	High	High
Ocoee River	Yes	Yes	High	Fair	Stable	Moderate	Moderate/ High
South Chickamauga Creek	Yes	Yes	High	Fair	Stable or Declining	Moderate	Moderate/ High
Sequatchie River	Yes	Yes	High	Fair	Stable or Declining	Moderate	Moderate/ High
Paint Rock River	Yes	Yes	High	Fair/ Good	Stable	High	High
Flint River	No	No	Not Established	Fair	Insufficient Data	Moderate	Not Established
Elk River	Yes	Yes	High	Fair/ Good	Stable or Improving	High	High

Tributary	Multiple Detections	Multiple Age Classes	Population Score	IBI Score	IBI Trend	Habitat Score	Overall Resiliency
Shoal Creek	No	No	Not Established	Good	Stable or Improving	High	Not Established
Bear Creek	Yes	Yes	High	Good	Stable or Improving	High	High

*While the habitat in Little River is very good, resiliency of this population is ranked low because of the low numbers of snail darters captured (≤ 3) and the lack of multiple age classes having been observed over time.

**Snail darters have not been collected in Big Sewee Creek since 2005; however, TVA has collected them in the Tennessee River approximately four miles downstream of the confluence of Big Sewee Creek and the Tennessee River (Simmons pers. comm. 2022).

Table 2: Reservoir population collections based on TVA benthic trawls, 2016-2020. For explanation of metrics see Section C. Assessing Resiliency and Table 4. Reservoirs are listed in upstream to downstream order. Table reproduced from the proposed delisting rule (Service 2021) with additional notes added in the asterisks below.

Reservoir	Population Score (Number Collected)	Age Classes	Direct Evidence of Reproduction	Reproduction Score	Overall Resilience
Fort Loudoun*	Low (2)	2	No	High	Moderate
Watts Bar	Low (3)	1	Yes	High	Moderate
Chickamauga	Low (4)	2	Yes	High	Moderate
Nickajack	High (11)	2	Yes	High	High
Guntersville	High (33)	2	No	High	High
Wheeler	High (18)	2	Yes	High	High
Pickwick	High (18)	3	Yes	High	High

* Captures listed as Ft. Loudoun trawl was indicated to be a trawl in the French Broad River, upstream of the reservoir (Simmons pers. comm. 2022).

C. Assessing Resilience

For the final delisting rule (i.e., in determining that the snail darter no longer meets the definition of a threatened or endangered species), we assessed the resilience of populations as described below to determine whether recovery criteria had been met (Service 1983). Details on the assessment of the snail darters' resiliency in tributaries and reservoirs are provided below.

Tributary Resiliency

In the proposed delisting rule for the snail darter, we characterized population resiliency in 14 tributaries (11 extant, one extirpated, and two apparently not established with only one collection each and no evidence of reproduction) using data related to three factors: collections in multiple years since 2009, presence of multiple year classes in these samples, and TVA IBI scores for the tributary (Table 3). We

used IBI scores from TVA monitoring stations to assess stream community health where possible for tributary populations. To determine potential IBI trends, we compared overall IBI scores for sites within the range of snail darters in each tributary from 2009 to 2019. Specifics of the IBI framework can be found below in the Monitoring Methods and Locations sections in the Field Methods subheading.

To assess the repeated detections and age-class metrics, we used multiple data sources in the delisting rule. Because the IBI framework is designed to sample the overall fish community rather than targeting collections of snail darter specifically, it can result in an underestimate of snail darter presence. For this reason, we used other collection records available from Conservation Fisheries, Inc. (CFI) and the Tennessee Aquarium Conservation Institute (TNACI) for the period 2009 through 2020, in conjunction with TVA's IBI data, to assess persistence over time and evidence of reproduction. Detection of the species in multiple years provides evidence of persistence within a tributary. Consistent collections also indicate population numbers that are high enough to be detected even for a hard to capture fish like the snail darter. The presence of multiple age classes is evidence of successful reproduction in the population. Results are summarized in Table 1.

Table 3: Tributary resilience metrics and an explanation of scoring. Overall resilience based on a combination of the four metrics.

Resilience Category	Population Score*	IBI Score**	IBI Trend	Habitat Score
High	Combination of Detections and Age Class metrics: Both Yes is High	Excellent (58-60) or Good (48-52)	Improving: IBI scores increasing over past 10 years	Stable or Improving Good or Excellent IBI; Or Fair with Improving trend
Moderate	One Yes one No	Fair (40-44) or Poor (28-34)	Stable: No clear trend	Fair with Stable or Improving trend
Low	Both No: considered Extirpated or Not Established	Very Poor (12-22)	Declining: IBI score decreasing over past 10 years	Poor/Fair or lower IBI score

* Population Score based on Multiple Detections in past 10 years (Yes or No) and the Collection of Multiple age classes based on size as determined in Hickman and Fitz (1978).

**IBI scores between these ranges receive intermediate rankings (e.g., 46 would be Good/Fair).

Reservoir Resiliency

Survey data for the reservoir populations of snail darters are limited because effective methods for conducting benthic trawls for the species were not developed until 2016. Using the data available from the TVA snail darter trawl surveys (Simmons 2019, p. 3), we analyzed resiliency of the reservoir populations based on the number of individuals captured and whether available data provided evidence of reproduction (Table 4). Evidence of reproduction was established either indirectly by the presence

of multiple age classes, or directly by adults in spawning condition (i.e., gravid females and/or flowing males) or presence of juveniles. Similar to the stream populations, overall resilience was calculated by combining the scores of the number collected and reproduction metrics (Table 4). Results are summarized in Table 2.

Table 4: Reservoir resilience metrics and an explanation of their scoring.

Resilience Category	Population Score (Number Collected)	Reproduction Score
High	≥10 individuals	Evidence of reproduction based on multiple age classes and direct evidence of spawning.*
Moderate	5-9 individuals	Multiple age classes, but no direct evidence of spawning
Low	<5 individuals	No more than one age class, no direct evidence of reproduction

* Direct evidence of spawning based on based on adults in spawning condition (gravid females, males flowing milt) or juveniles.

Our analysis of the snail darter populations determined there were 10 established tributary populations, nine of which had better than Moderate resilience, and seven reservoir populations with high reproduction scores. The TVA reservoir trawl data support the conclusion that snail darters are persisting and reproducing in the mainstem of the Tennessee River.

D. Residual Threats

One of the biggest factors still affecting the snail darter is the impoundment of large portions of the Tennessee River Valley. The TVA operates nine dams on the mainstem Tennessee River and 38 dams on tributaries to the Tennessee River. These impoundments create large areas of deep, still water that do not meet the habitat needs of the snail darter. However, beginning in 1981, TVA began studies to improve conditions in the tailwaters of their dams. Through the Reservoir Release Improvement Program (RRIP), TVA began implementing strategies to increase minimum flow, dissolved oxygen, and, in some cases, temperature, in the tailwaters of their dams beginning in 1991 (Bednarek and Hart 2005, p. 997). These changes have improved conditions for the snail darter and may have contributed to improvements to the species' status since the 1990s within flowing tailwaters below dams, across more than 400 miles (640 km) of the mainstem of the Tennessee River basin. Additionally, because the RRIP manipulates ecologically meaningful parameters in tailwaters, such as dissolved oxygen and temperature, this program could provide some resiliency to a warming climate and future precipitation variability, especially if TVA adjusts the program to maintain the needed conditions in the tailwaters.

Threats to snail darter habitat associated with continued urbanization and agriculture are certain to persist into the foreseeable future, but efforts are being made to reduce

the impact to many of the tributaries inhabited by snail darters. Snail darters appear to be resilient to urbanization and agriculture in certain tributaries such as South Chickamauga Creek and Sequatchie River; however, in a more severely impacted tributary, Big Sewee Creek, snail darters have likely been extirpated. In the past, industrial and mine runoff has had major negative impacts on the water quality in some of the snail darter watersheds. Efforts related to the Clean Water Act have improved water quality in many of these places, but some risk persists.

E. Legal and/or Management Commitments for Post-delisting Conservation

The TVA will continue to carry out the RRIP in the tailwaters of their large hydropower dams. The presence of many other listed species in the tailwaters require the continuation of the program to maintain water and habitat quality, and TVA will continue to consult on actions that would affect that habitat under section 7 of the Act. The snail darter is listed by state wildlife agencies within its range as a threatened species or a species of greatest conservation need and will likely garner continued protection from the states, either directly or through regulatory activities related to the Clean Water Act.

V. Monitoring Methods and Locations

A. Monitoring Framework

Systematic, species-focused surveys encompassing the range of snail darter are lacking. Many of the known snail darter collections have been recorded through TVA's stream Index of Biotic Integrity (IBI) monitoring, conducted since 1986 at sites throughout the Tennessee River Valley spanning the entire range of the species (Table 5). In addition to conducting IBI monitoring in tributary streams to the Tennessee River, TVA began reservoir surveys in 2016 using a mini-Missouri trawl¹ to sample water too deep for traditional collection methods for small-bodied benthic fishes (Simmons 2019, p.2).

Monitoring locations will be sites that have been previously assessed in the past to compare detections of snail darters and habitat conditions. These sites span the range of the species and occur in the upper, middle, and lower Tennessee River basin including tributary and mainstem (reservoir) sites where snail darters are known to occur or near occurrence locations. These sites represent locations that have been monitored by TVA in the past as part of their IBI assessments as either fixed sites (surveyed every 2 years), HUC monitoring (Hydrologic Unit Code, i.e.,

¹ A mini-Missouri trawl is a smaller version of Missouri trawl, i.e., a balloon trawl that uses two different mesh sizes, a larger mesh on the outside to exclude larger materials, which funnels down to a smaller mesh section to allow capture of smaller species. The trawl commonly attached to a small boat and is used to skim the bottom substrates and areas immediately above it and has shown success in the capture of smaller fish species in larger, deeper water bodies and rivers (Herzog et al. 2005, 2009).

subwatershed; surveyed every 5 or more years), or reservoir operations compliance and release improvement monitoring (surveyed annually).

Tributary sampling sites (fixed sites; n=7) will continue to be sampled every two years (Table 5). These will be sampled two or three times during post delisting monitoring depending on their rotation in the schedule. Other IBI sites (n=6) where snail darters occur or near known occurrence locations will be sampled at least once within the monitoring period and are identified as those with five-year rotation in Table 5. All surveys will focus on following past methods but may be increased in scope to survey suitable habitat to determine species presence and condition at the IBI stations. At those sites where snail darters captures have been limited (e.g., South Chickamauga Creek, Sequatchie River, Flint River, Elk River), additional, targeted surveys will be made in known habitat areas if snail darters are not detected at the established IBI station or an alternate site (either predefined in Table 5 or agreed upon with the Service) may be also sampled.

In the thresholds (see Section V), we divide the established, resilient tributary populations into two categories: large (French Broad and Hiwassee rivers) and midsized (Holston River, Ocoee River, South Chickamauga Creek, Sequatchie River, Elk River and Bear Creek) populations based on population size. The large populations have occupied stream lengths over 15 miles and the midsized populations have occupied stream lengths between 1 and 15 miles.

At least seven mainstem **reservoir sampling sites** (e.g., Pickwick, Wheeler, Guntersville, Nickajack, Chickamauga, Watts Bar, and Fort Loudoun) will each be surveyed with a mini-Missouri trawl at least three times within the five-year monitoring period. This method uses a weighed net with fine mesh that is pulled along the bottom of the river and funnels captured fish into the net bag. These efforts will target appropriate gravel habitat in less than 25 feet (7.5m) of water (typical locations where snail darters have been captured in the past). When possible, trawls will be timed in the pre-spawn period to enable detection of adult fish coming into reproductive condition while limiting potential for disrupting reproductive activity that would result from sampling during the height of the spawning period.

Table 5: Tributary IBI sites to be sampled during the post delisting monitoring. Location is based on miles from mouth of the stream. Rotation indicates whether site is a fixed IBI sampling sites (2 years) or uses a different monitoring cycle. If alternate sites (those not indicated in the table) are chosen based on habitat or access issues, TVA will coordinate any new locations with the Service.

Stream	Population Size	Site Location (River mile)	Sampling Rotation	Snail Darter Occurrence
Holston River*	Midsize	6	2 years	Nearby, occasionally at station
French Broad River*	Large	8.1	2 years	Expected
Little River**	Small	10.4	Annually**	Nearby, uncommon
Big Sewee Creek	Extirpated***	6	5 years	Likely extirpated
Hiwassee River*	Large	38	2 years	Expected
Ocoee River*	Midsize	2.5	2 years	Expected
South Chickamauga Creek	Midsize	5 or 19.3	5 years	Nearby, once at station
Sequatchie River*	Midsize	7.1 or 16.9	2 years	Nearby, occasionally at station
Paint Rock River	Small	24.6	5 years	Expected
Flint River	N/A	12.1 or alternate site	5 years	Only once
Elk River*	Midsize	41.5	2 years	Nearby, occasionally at station
Shoal Creek	N/A	13.9	5 years	Only one detection
Bear Creek*	Midsize	25	2 years	Expected

* Seven primary tributary populations that undergo fixed and biannual sampling, which will be sampled for the PDM

**Little River is surveyed annually in coordination with TWRA

***This population was considered Midsize on recovery plan but is currently considered extirpated (Service 1983). Sampling location will provide information relative to habitat conditions in the river and contributions to downstream habitats.

B. Field Methods

Tributary Monitoring

Stream community monitoring is conducted by TVA throughout the Tennessee River basin using an IBI approach and will sample the seven established tributary populations as well as six additional tributaries where snail darters occur or may expand (Table 5). These surveys are performed to assess stream health by targeting representative sample of the overall fish assemblage rather than individual species, so are not designed to provide population size information on rare species. In addition to providing insights on stream health, the data from IBI surveys are useful for determining species persistence at a site. The IBI incorporates 12 metrics to measure

fish community health based on the number of species or proportion of individuals in different guilds (groups of species with similar life history) compared to what is expected in a reference condition stream. These metrics are adjusted based on stream size and physiographic region in order to be relevant to the differences in natural conditions across the Tennessee River Basin. Each metric is assigned a value matching a ranking of good (5), fair (3), or poor (1). The 12 metrics are then summed for each, yielding an overall rating of the stream community health. An IBI score of 12 to 22 equates to a very poor rating, 28 to 34 to a poor rating, 40 to 44 to a fair rating, 48 to 52 to a good rating, and 58 to 60 to an excellent rating. Scores between these ranges received intermediate ratings (TVA 2005, entire). This overall score will be used to track habitat trends (e.g., habitat conditions and the threats related to water quality) for the PDM.

The IBI sampling protocol disperses individual subsamples or efforts (e.g., one seine set or shoreline sample) within the sample reach of the stream to survey available habitat in roughly representative proportions, while still attempting to capture a representation of the fish diversity at the site based on stream size and location. During the post delisting monitoring, at sites where snail darters are expected or likely nearby (See Table 3), extra effort will be made in areas of appropriate habitat if snail darters are not detected during the normal IBI protocol to assess species presence. Data from additional sampling efforts will not be included in calculating the IBI metrics but are only to target snail darters to determine persistence at the sites. Past IBI surveys have shown snail darters can be tied to very specific habitat patches at some sites (e.g., Bear Creek).

Reservoir Monitoring

The reservoirs indicated in Table 2 will be surveyed using a mini-Missouri trawl (Herzog et al. 2005, 2009) targeting appropriate clean gravel habitat in water 25ft (7.5m) deep or less. Appropriate habitat will be determined with sonar, dredge, or underwater camera. Exact sampling locations will be selected based on known appropriate habitat as well as likely areas based on pre-impoundment maps of shoals and islands. Habitat patches will be trawled in time-constrained transects 5-15 minutes long, depending on size of habitat. Each reservoir will be surveyed a minimum of one hour of active trawling time (trawl deployed on the bottom) per year, in at least three years of the PDM period.

Ad-Hoc Monitoring

Although not a formal part of the PDM monitoring, many of the state agencies may also sample streams in the course of their normal operations within the range of the snail darter. The information will be requested from the state agencies in an annual data call and assessed along with the TVA data to determine conditions, threats in those watersheds. If information is presented to the Service that calls for additional or formalized monitoring, the PDM plan will be adjusted, with coordination with partners to incorporate the new information.

Data Collection

Snail darters collected during the PDM will be measured for total length and assigned to an age class based on life history studies (Starnes 1977, pp. 47-63; Hickman and Fitz 1978, pp. 10-19). When possible, individuals will be sexed and assessed for reproductive status (i.e., gravid females, flowing males). Scores and metrics from the IBI surveys will be collected for habitat analysis to inform resiliency assessments of tributary populations within the PDM. Trawl location, depth and other relevant information from the reservoir surveys will be collected to improve understanding of mainstem habitat use. Trawl data (e.g., individual capture data and catch per hour of trawl) will be compared to past efforts to assess potential changes in population structure and numbers. Data from these surveys will be shared with the Service annually.

VI. Thresholds

Effective PDM requires timely evaluation of data and responsiveness to observed trends. In order to assure timely response to observed trends, it is necessary to identify possible outcomes from monitoring that could be anticipated and general approaches for responding to these scenarios. To identify thresholds that would trigger alternative responses in the case of the snail darter, it will be necessary to analyze data from the recovery monitoring period to identify how species viability has changed compared to that at the time of delisting, using the framework laid out in the delisting (see section III above). We will use snail darter capture data and age class structure from TVA IBI surveys to assess the persistence and reproductive success of the species in the tributaries. We will use the overall IBI scores and comparison to past scores as a measure of long term habitat quality for the tributary populations. In tributaries where snail darters are not captured at the predetermined IBI sites, additional surveys of appropriate habitat will be made to determine species persistence (Table 5). We will use capture data from TVA reservoir trawl surveys to assess the mainstem snail darter populations, based on continued persistence and evidence of reproductive success. Data from the PDM program will be used to assign the species to one of the status categories that follow and, if needed, to trigger additional conservation efforts if the species' status is uncertain or declining after a five-year period. This five-year period would include at least 3 generations of reproduction for the species and should provide the ability to assess population shifts and certainty in habitat management and assessment of residual threats.

A. Category I: Stable

Snail darter remains secure without protections of being listed under the Act.

This would be true if **all** of the following conditions are met:

1. Both large populations (e.g., French Broad and Hiwassee rivers) have High population scores and Moderate or better habitat scores, and

2. There are six or more tributary populations with Moderate or better overall resilience scores, and
3. At least four reservoir populations from Pickwick Reservoir upstream to and including Watts Bar Reservoir (e.g., Pickwick, Wilson, Wheeler, Guntersville, Nickajack, Chickamauga, and Watts Bar) have an overall resilience of Moderate or better and show evidence of recruitment.

In this case, PDM would be concluded at the end of the 5-year timeframe specified in this plan.

B. Category II: Uncertain

Snail darter may be less demographically stable than anticipated at time of delisting, but information does not indicate that the species meets the definition of threatened or endangered.

This would be true if **any** of the following occurs:

1. The population score at either of the large populations (e.g., French Broad and Hiwassee rivers) declines to Moderate, or if both overall resiliency scores drop below High.
2. If overall resiliency declines at 50% (3 or more) of the mid-sized populations (Ocoee River, South Chickamauga Creek, Sequatchie River, Paint Rock River, Elk River, Bear Creek) compared to score at time of delisting (e.g., Overall Resiliency categories identified in Table 1).
3. If evidence of reproduction or recruitment is seen in fewer than 50% of the reservoir populations known at the time of delisting.
4. If snail darters are collected at none of the tributary sites where they have only occasionally been collected during past sampling (Holston River, Little River, South Chickamauga Creek, Sequatchie River, or Elk River).

In the case of the first three conditions, the monitoring period should be extended five years, the IBI metrics will be examined to determine a possible cause, and modifications to sampling effort will be discussed with TVA and the states. In the case of condition 3, surveys and research may also be included to determine the cause of the loss of recruitment. In the case of condition 4, monitoring should be extended long enough to make additional targeted surveys for the snail darter in appropriate habitat within those tributaries to determine if there are site specific factors precluding snail darter detections. Any extension will be coordinated with cooperating agencies and species experts to determine the appropriate surveys and assessments and will result in an update to the PDM plan.

C. Category III: Declining

PDM yields substantial information indicating that threats are causing a decline of the snail darter since the time of delisting, such that listing the species as threatened or endangered may be warranted.

This would be true if **any** of the following occurs:

1. Either of the large populations (e.g., French Broad and Hiwassee rivers) declines to an overall resilience score of Low.
2. If overall resilience scores decline at six or more of the midsized populations.
3. If snail darters fail to be collected twice in two or more midsized populations and show no recruitment.
4. There is no evidence of mainstem reproduction.

If any these conditions are true, the Service should initiate a status review to assess changes in threats to the species, its abundance, population structure, and distribution to determine if a proposal for relisting is appropriate.

VII. Data Compilation and Reporting Procedures

Microsoft Excel spreadsheets containing all data collected and copies of all completed field data sheets will be submitted to the Service's Tennessee Ecological Services Field Office, in a format collaboratively designed with TVA biologists. These spreadsheets should be submitted by the end of each calendar year to ensure that adequate data are being collected and analyzed, to allow evaluation of the efficacy of the monitoring program, and to provide a periodic assessment of the status of snail darter. The Service will review these data annually within the context of the response triggers outlined above to determine whether additional action is necessary. After five years of data are available, the field collection data will be reviewed to determine overall population change and status with respect to threats. We will prepare a final monitoring report that will be made available to the public, which will include a description of the geographic areas surveyed, the survey protocol, and updated population metrics for each population surveyed.

If the response triggers described in Section V above are met or exceeded, then the Service will coordinate with TVA and other partners to determine whether to conclude the PDM process or to pursue alternative actions as described in Section V. Our determination will also include, if necessary, an evaluation of the threats to snail darter using the five factors required under the Act to list a species on the Federal List of Threatened and Endangered Species.

VIII. Estimated Funding Requirements and Sources

Post-delisting monitoring is a cooperative effort among the Service; state, tribal, and foreign governments; other Federal agencies; and other non-governmental partners under the Act. Although the Act authorizes expenditures of both recovery funds and section 6 grants to the states to plan and implement PDM, Congress has not allocated nor earmarked any special funds for this purpose. To the extent feasible, the Service intends to provide funding for PDM efforts from annual Endangered Species general appropriations. Nonetheless, nothing in this Plan should be construed as a commitment or requirement that any Federal agency obligate or pay funds in

contravention of the Anti-Deficiency Act (31 U.S.C. 1341) or any other law or regulation.

The primary entity conducting the PDM and preparing reports will be TVA with cooperation from the Service. Based on TVA costs associated with tributary IBI and reservoir monitoring efforts, annual PDM expenditures for TVA are not expected to exceed \$35,000. The Service will provide assistance as resources permit. Annual costs to the Service are not expected to exceed \$1,600 in the first four years and are not expected to exceed \$3,200 during year five.

IX. PDM Implementation Schedule

As described in IV. Monitoring Methods and Locations, above, TVA monitors stream IBI sites on a two-year or roughly five-year cycle (Table 6). The fixed stations sampled biannually will be sampled twice or three times during the PDM period. The sites surveyed as part of other monitoring projects will be sampled at least once during the survey period, with the preference for sampling during the first three years of the PDM to allow for follow up visits if necessary. Sampling cycle for each tributary site is noted in Table 3. Reservoir monitoring will take place at least three times during the five-year period.

Table 6. Summary of sampling and implementation responsibilities of the PDM.

Task	Number of Locations	Monitoring Purpose	Frequency	Responsible Party
Tributary monitoring	13 sites	Species and threats	Every 2-5 years (see Table 5)	TVA
Reservoir monitoring	7 reservoir sites	Species and threats	At least 3 times each during the 5 years	TVA
Ad-hoc monitoring	TBD	TBD	As available.	All cooperators
Annual data call	NA	NA	Annually – due by Dec 31 in each PDM year	All cooperators
Annual PDM call or meeting	NA	NA	Annually – Jan-Mar in each PDM year	All cooperators
Annual Report	NA	NA	Annually – Mar of each PDM year	FWS

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