# Candy Darter: Background, Threats, and Conservation for an Endangered Fish

**About this report**: This independent analysis was completed by the Virginia Scientist-Community Interface (V-SCI). V-SCI is a graduate student organization dedicated to reviewing and synthesizing science related to environmental issues across the southeastern United States. V-SCI analysts on this project include graduate students with formal training and expertise in civil and environmental engineering, biosystems engineering, reservoir biogeochemistry, hydrology, and stream ecology. We are happy to discuss our findings in more detail if we can be of greater service.
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## 1. Rationale

Though historically an abundant species, the candy darter (*Etheostoma osburni*) was placed on the Endangered Species List at the end of 2018. The candy darter is considered by both Virginia and West Virginia as a species with the greatest conservation need because of their small, fragmented populations and vulnerability to both habitat destruction and hybridization. Thus, they require conservation. However, multiple ongoing and proposed projects would put candy darter populations at risk. The goal of this white paper is to provide information about this species alongside current policy in order to facilitate and maximize its protection and continued existence.

## 2. Background

### 2.1 Habitat & Ecology of the Candy Darter

The candy darter (previously known as the finescale saddled darter) is a small freshwater fish only found in Virginia and West Virginia. They live in faster flowing stream segments (minimum flow of 7.5 in/s; 19 cm/s) with coarse bottom substrate (USFWS SSA Report, 2018). In West Virginia, this species has been found in streams between 8 to 11 inches deep (Chipps et al., 1994). Candy darters live in temperature ranges from 59°F - 65°F (15°C - 18 °C), but can also tolerate temperatures ranging between 32°F and 86°F (0.2°C and 30°C); (USFWS SSA Report, 2018). Adult candy darters prefer fast flowing streams, while juveniles prefer slower moving areas during spawning season (Dunn & Angermeier, 2016).

Candy darters eat benthic macroinvertebrates, like small insects. **They become sexually mature after two years and have a lifespan of five or more years** (McBaine & Hallerman 2020). They are classified by the United States Fish and Wildlife Service (USFWS) as brood-hiding, benthic spawners, meaning that during reproduction, the female buries the eggs in the spaces between larger rocks and gravel substrate, while the male simultaneously fertilizes the eggs. These processes are hindered when the gravel and rocks become surrounded by or covered with fine sediment particles (a process known as embeddedness; USFWS SSA Report, 2018). This is why spawning often occurs in areas with fast flowing water rather than areas where sediments settle and reduce oxygen supply to fertilized eggs (Burkhead & Jenkins, 1991).

### 2.2 Population Distribution of the Candy Darter

Candy darters are found in larger streams and rivers of the Upper Kanawha basin, as well as the Gauley and greater New River watersheds in West Virginia and Virginia (Dunn, 2018). Historically, candy darters had 35 metapopulations, spatially separated populations of the same species which may or may not interact, spread across Virginia and West Virginia. These included (in West Virginia) the Upper and Lower Gauley, Greenbrier, and Bluestone Rivers as well as (in Virginia) the Middle and Upper New River (USFWS, 2018).

Since then, **candy darters have been extirpated, becoming locally extinct, from almost half of their historical range**. There are now only 17 of 35 known populations remaining in just five of the historical seven sites, as the species is locally extinct in the Bluestone and Lower New Rivers (USFWS, 2018; Dunn, 2018). Additionally, in a large portion of their remaining range, the variegate darter is present with hybridization ongoing (further discussed in the "Threats to the Candy Darter" section). **Of the historic 35 populations, only 8 remain that have not been degraded through land use changes or invaded by the variegate darter** (83 Fed. Reg. 58747, 2018; USFWS SSA Report, 2018).

Now, candy darters can only be found in small and/or isolated populations in the Upper and Lower Gauley, Greenbrier, Middle and Upper New Rivers. The most abundant of these populations occur in the Upper Gauley, upper Greenbrier, and in Stony Creek in the Middle New River Watersheds (Dunn, 2018; USFWS SSA Report, 2018). Physical barriers and long stretches of unoccupied (and potentially unsuitable) habitat separate these populations.

The current metapopulations generally have moderate resiliency, moderate to low representation, and low redundancy (83 Fed. Reg. 58747, 2018; USFWS SSA Report, 2018). Resiliency means having sufficiently large populations for a species to withstand events arising from random factors (e.g., variations in rainfall, random fluctuation in birth rate, and effects from human activities); redundancy means having a sufficient number of populations for the species to withstand catastrophic events (e.g., rare destructive natural event, episode involving many populations); and representation means having the breadth of genetic makeup/diversity for the species to adapt to changing environmental conditions (83 Fed. Reg. 58747, 2018).

Metapopulations in the Gauley and Greenbrier River drainages have been separated long enough to result in high levels of genetic distinctness (83 Fed. Reg. 58747, 2018; USFWS SSA Report, 2018). Therefore, the two populations should be treated as evolutionarily significant units where the loss of one would be a significant loss to the species' genetic diversity (83 Fed. Reg. 58747, 2018). As populations become isolated within their environment, their genetic diversity declines (Schlaepfer et al., 2018). The result is an increased risk of local extinction brought on by a lack of resiliency and inbreeding effects. With so few remaining populations this process also increases rangewide extinction risk.

## 3. Threats to the Candy Darter

Habitat degradation and hybridization with the variegate darter are the two most significant threats the candy darter faces. These two factors have contributed to the steady decline of native candy darter populations and highlight the necessity of protective measures.

### 3.1 Habitat Degradation

Habitat degradation is a serious threat to candy darters, as they are unable to survive in streams with excessive sedimentation

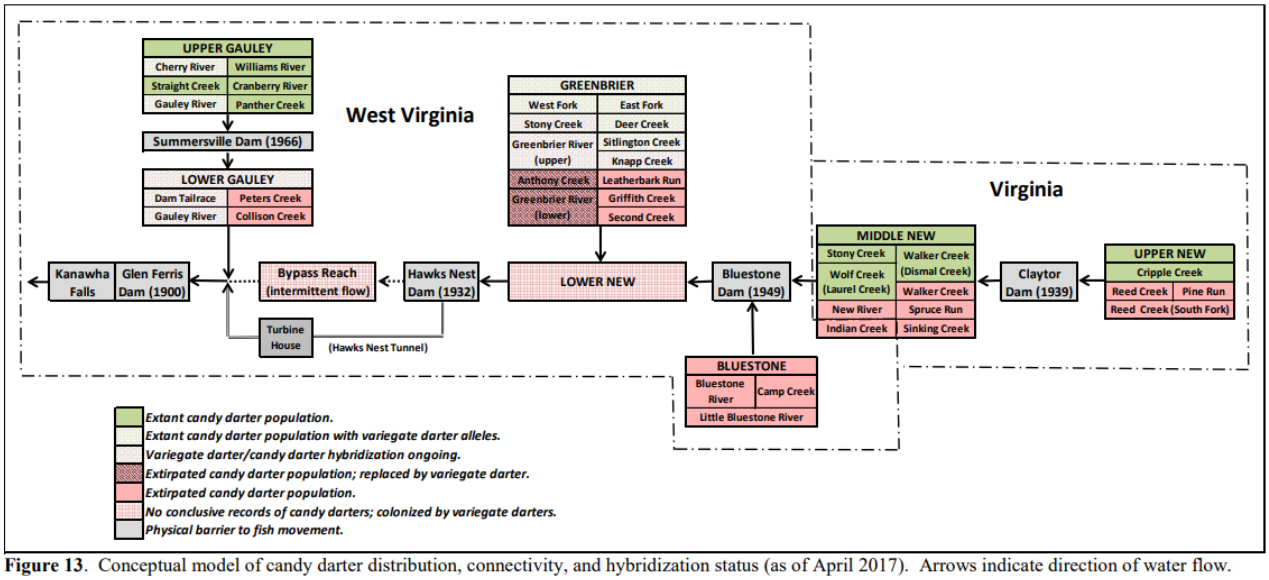



**Figure 13**. Conceptual model of candy darter distribution, connectivity, and hybridization status (as of April 2017). Arrows indicate direction of water flow.

**Figure 1.** Status of candy darter metapopulations (USFWS SSA Report, 2018).

and bottom embeddedness. The crucial habitat characteristics for the candy darter include sufficiently stabilized forest streambanks throughout the watersheds such that water quality allows for normal feeding, breeding, and sheltering in an area with sufficiently low numbers of nonnative species. Features essential to the conservation of the candy darter may require special management considerations or protections to reduce the following threats:

1. **Excessive sedimentation and stream bottom embeddedness** (the degree to which gravel, cobble, rocks, and boulders are surrounded by, or covered with, fine sediment particles) (USFWS SSA Report, 2018). According to the West Virginia Department of Environmental Protection:

   > *"Excessive stream sedimentation (or siltation) results from soil erosion associated with upland activities (e.g., agriculture, forestry, mining, unpaved roads, road or pipeline construction, and general urbanization) as well as activities that can destabilize stream channels themselves (e.g., dredging or channelization, construction of dams, culverts, pipeline crossings, or other instream structures)."* (WVDEP, 2012)

   Adult candy darters are intolerant of bottom sedimentation and will almost completely avoid all areas where silt cover and embeddedness are greater than 25% (Dunn & Angermeier, 2016).

2. **Habitat fragmentation** primarily due to construction of barriers and impoundments.

3. **Changes in water chemistry**, including, but not limited to, changes in pH, dissolved oxygen, or increases in concentrations of contaminants including coliform bacteria (e.g., from sewage or livestock wastes) and chemical herbicides and pesticides (USFWS SSA Report, 2018).

   Candy darters need well oxygenated (> 8 mg/L) circumneutral pH (6.5-7.5) waters (USFWS SSA Report, 2018).

4. General **increase in water temperature**, primarily attributed to land use changes such as deforestation. This trend is expected to continue (Mohseni et al., 1999), making coldwater stream conservation an especially important consideration for managers.

#### 3.1.1 Human contributions to habitat degradation

Construction and deforestation can cause elevated levels of silt and embeddedness, which results in low habitat suitability. Deforestation in riparian areas can reduce shading of streams, increasing water temperature. These factors should be kept in mind when planning, approving, or evaluating projects. There are currently multiple plans being developed that could potentially harm candy darters (Table 1). It is vital to consider the cumulative effect that multiple projects/sources of degradation can have on a population and the habitat they might occupy, especially when they impact the same watershed. Many projects are being proposed and carried out by the same agency, which should allow for taking cumulative effects into consideration more easily.

#### 3.1.2 Road Construction and its Effects on Streams

Sedimentation of streams is a major threat to habitat quality. One major source of sedimentation is road construction.

| Project | Agency/Company Responsible | Location (State & Counties) | Relevant Proposed Action | Status |
|---|---|---|---|---|
| Gauley Healthy Forest Restoration Project | US Forest Service | WV- Nicholas, Pocahontas | Harvest & thinning<br>Prescribed fire<br>**Skid road construction** | Final Decision Announced 6/23/22 (as a categorical exclusion**) |
| Brushy Mountain Wildlife Habitat Improvement Project | US Forest Service | WV- Greenbrier | Create early successional wildlife habitat<br>**Categorical exclusion**** | NEPA or Forest Plan Amendment Decision Document was estimated to complete 8/2022 |
| Upper Elk Ecological Restoration Project | US Forest Service | WV- Pocahontas, Randolph, Webster | Adding woody material to streams for habitat<br>Thinning<br>Planting by streams<br>**Road removal/ construction**<br>Timber sales | Under Analysis |
| Cranberry Spring Creek Project | US Forest Service | WV- Nicholas, Pocahontas, Webster | Thinning<br>**Road construction**<br>Prescribed fire | Under Analysis |
| Mountain Valley Pipeline | Federal Energy Regulatory Comission (FERC)<br>Mountain Valley Pipeline LLC | Many in WV & VA | **Construction near streams**<br>**Boring under streams**<br>**Spill risk** | Partially complete Construction currently on hold |
| Greenbrier Southeast Project | US Forest Service | WV- Pocahontas | Harvest & thinning<br>Herbicides<br>Prescribed fire | Final decision announced 3/18/22 |
| Deer Creek | US Forest Service | WV- Arborvale, project does not yet specify where they will be conducting work | Road maintenance<br>**Road construction & decomissioning**<br>Habitat & watershed improvements<br>Timber sales | Notice of Initiation was estimated to complete 8/1/22 |

**Table 1.** Proposed actions affecting candy darter populations either within or near critical habitat. List is not exhaustive. Forest Service information provided through their project dashboard (USDA). Highlighted actions have the potential to have the greatest impact on candy darters. **Categorical exclusions ignore NEPA requirements for an environmental assessment or impact statement.

When done improperly (i.e., without planting the cut areas, appropriate use of berms, or other erosion control measures) the Forest Service has seen up to 160 tons of soil per acre of erosion (Swift, 1985). When best management practices are followed the severity of erosion and stream sedimentation is substantially reduced, however there is still an increase in stream sedimentation when roads pass over streams (Brown et al., 2013). Additionally, roads continue to cause issues for aquatic habitats long after they are constructed. For example, it takes multiple decades for roads to return to pre-construction levels of sediment runoff due to lack of adequate re-vegetation (Foltz et al., 2009). Best management practices (BMPs) used during project implementation often focus on lowering the average amount of pollutants making their way into streams. For example, silt fences around a project site are rated to stop sediment entering a stream on a daily average basis, but storms lead to erosion that those silt fences can't handle. Climatic shifts causing more severe and frequent storms and increased temperature make them even less effective. This unmanaged material can cause harm and therefore needs to be considered during project planning. Additionally, many widely used BMPs are ineffective in certain terrains. For example, projects in steep areas with karst topography, such as in the Appalachians, where sedimentation is a bigger threat should not rely on just silt fences to protect nearby streams. This is important to take into consideration for any projects that either move soil or require creating roads.

We recommend that any agency or company that needs to create roads for a project do so sparingly, and take care to place them in areas where runoff and erosion will be minimal. Additionally, even less impactful actions such as reopening previously used roads will still increase the amount of sedimentation candy darters must contend with, and careful consideration should be given before their implementation.

### 3.1.3 Stream Acidification

> ***"[pH] is one of the most important environmental factors limiting species distributions in aquatic habitats"*** (U.S. EPA, pH)

Fluctuation of sustained pH outside the preferred range can be harmful to fish. Acidic water damages the skin and gills of fish, increasing fish susceptibility to fungal infections

leading to disease (U.S. EPA, pH). Gill and skin damage and associated mucus production reduce the ability of fish to take in oxygen or regulate salt and water intake (Morris et al., 1989). **Low pH can cause local extinction of fish populations**. Different species flourish within different ranges of pH. While the exact pH preferred by candy darters is unknown, the pH of the streams they have been found in is circumneutral (6.5-7.5; USFWS SSA, 2018).

Historically, streams in the Mid-Atlantic Appalachians were considered "chronically acidic" (U.S. EPA, Report on the Environment). Since then, the number of chronically acidic streams has decreased as a result of improved air quality and the resulting reduction in acid deposition (sulfur dioxide and nitrogen oxides; Kahl et al., 2004) as well as less mining activity, and therefore reduced acid mine drainage (WVDEP, 1997; USDA, AMD; Sangree, 2020). However, the improvement is slowed by local geology and soil characteristics. Areas where soil buffering capacity is poor, including the Mid-Atlantic Appalachians, are particularly vulnerable to stream acidification. The greatest number of chronically acidic streams in the Appalachians are found in the George Washington and Jefferson National Forests - both known to house candy darters (USDA Forest Service, Acidification Impacts).

Acidification of a stream reduces a stream's ability to buffer against additional acids or other pollutants or disturbances entering the system; making an environment more fragile. Acidified streams also contain high concentrations of toxic heavy metals like mercury, aluminum, and cadmium (Pidwirny, 2006). Projects that increase sediment runoff result in enhanced acidification of nearby streams and further degrade already fragile habitat. Historic acid deposition and poor background buffering capacity has made the outlook for these areas grim:

> *"There are areas in the southern Appalachians where the damage is so severe that acidic deposition reductions alone will not be sufficient for ecosystem recovery (Sullivan et al., 2011)."* (USDA Forest Service, Acidification Impacts)

In other words, these ecosystems no longer have the capacity to fix themselves. This makes the candy darter habitat in these areas precarious.

### 3.2 Hybridization with Variegate Darters (*Etheostoma variatum*)

The variegate darter has historically been restricted to the Kanawha River Basin by Kanawha Falls. By the late 20th century, however, they were found in candy darter territory (USFWA SSA Report, 2018). Variegate darters are physically larger and more numerous than candy darters, enabling them to **outcompete candy darters** for habitat, food, instream resources, and mating opportunities. Additionally, because variegate darters may be more tolerant to a wider range of habitat conditions, negative habitat changes could selectively benefit variegate darters (83 Fed. Reg. 58747, 2018; USFWS SSA Report, 2018).

Where variegate and candy darter ranges overlap, "the two species will hybridize, and consistent, repeated contact will quickly result in genetic swamping" of the native candy darter population (83 Fed. Reg. 58747, 2018). The increasing hybridisation between candy darters and the more genetically dominant variegate darters poses a threat to the future of the candy darter. Hybridization results in **fewer genetically pure candy darters** (i.e., 100% candy darter genes); if hybridization continues, eventually candy darter genes, and the species, will be lost (Gibson et al., 2019; Bhargav, 2021). This will eventually lead to the complete replacement of candy darters with variegate darters or hybrids (USFWS SSA Report, 2018).

Active hybridization with variegate darters has occurred or is currently occurring in multiple streams within the Lower New, Lower Gauley, and Greenbrier River watersheds in West Virginia (83 Fed. Reg. 58747, 2018; USFWS SSA Report, 2018). **The risk for further introductions of variegate darter to candy darter watersheds is "moderately high" due to live bait fish collections and transport to other streams** (83 Fed. Reg. 58747, 2018).

## 4. Conservation Actions Relating to the Candy Darter

### 4.1 Ongoing Research

- Methods to distinguish different darter species through environmental DNA (eDNA) are being developed currently in VA and WV (Angermeier & Hallerman, in prep). eDNA tests DNA samples found in a given environment with much less effort and potential risk to species than traditional means (netting, electrofishing, etc.) while being more accurate (USGS, 2018). However, eDNA is not able to determine the number of individuals present in an area. Development and implementation of these methods would give managers a better idea of where candy darters exist on the landscape.
- The U.S. Geological Survey, the West Virginia Department of Natural Resources, and the Virginia Department of Game and Inland Fisheries have been working together to better understand candy darter genetic diversity, life history, population structure, movement, and presence/absence via non-invasive sampling (USFWS, Recovery Outline, 2018).
- Development and application of habitat suitability models by Virginia Tech faculty are planned to run from 2021-2023 (VDWR, 2021). This is a key effort for finding the best locations for reintroduction, as well as providing predictive power for where projects might pose the greatest risk to candy darter populations.

### 4.2 Ongoing Conservation Efforts

There are also projects that are aiming to directly benefit candy darters such as the West Virginia Division of Natural Resources and the U.S. Fish and Wildlife's captive breeding

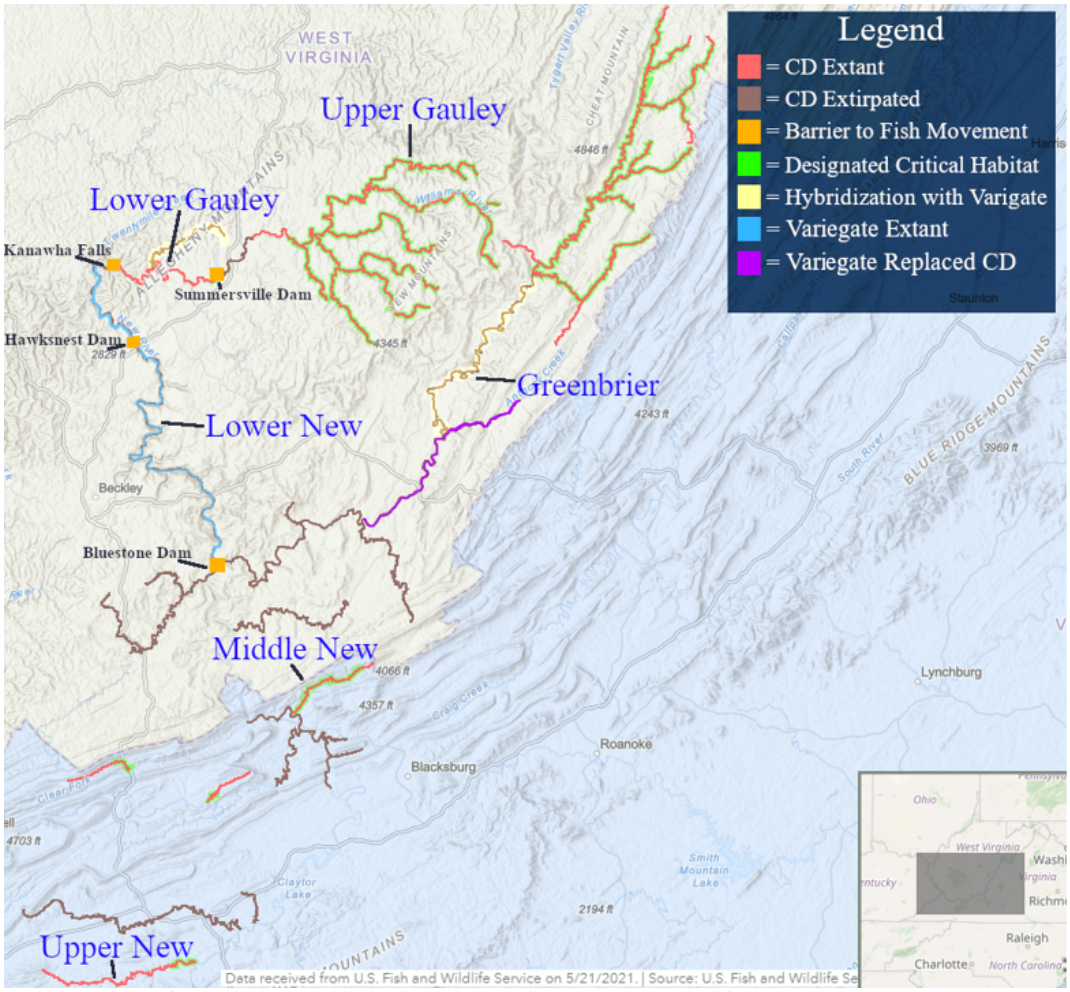



**Figure 2.** ArcGIS map of candy darter populations and their status. Adapted from ABRA, 2020 (link) and Dunn, 2018.

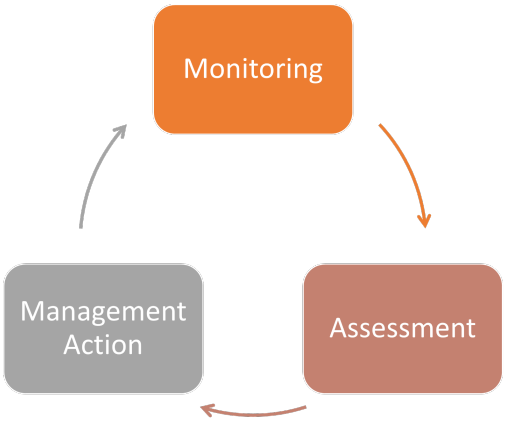
efforts at the White Sulphur Springs National Fish Hatchery (USFWS Northeast Region, 2021). The hope is to successfully breed and reintroduce candy darters back into the wild where they won't have to contend with variegate darters. After multiple years of work they have recently found great success with captive breeding efforts - successfully releasing 80 candy darters in November 2022 (Riley 2022). This will not only increase the current range of candy darters, but could be used to bolster known populations as well.

### 4.3 Environmental Management

The system currently in place for decision making regarding actions like construction and other activities that may impact the environment is that the action can continue unless harm is proved.

There are a lot of uncertainties regarding candy darter in the environment, including knowing exactly where they are, how abundant they are, and how robust a region's population is. Additionally, estimating the damage that increased sedimentation (associated with multiple projects) can cause to candy darter populations is a challenge. Studying them is complicated, thus gathering data on them and what impacts them is a difficult task. Because of these uncertainties and the lack of information about them, we can't provide detailed guidelines on how to best conserve this species. What we do know is that **candy darters are a sensitive species on the brink of extinction**. To best ensure their continued existence, there are two project management frameworks that should be used in addition to the conservation actions discussed above. The use of these two management frameworks will protect the candy darters as well as other sensitive species.

The first is the **precautionary principle**, a philosophy that emphasizes caution before potentially irreversible actions are taken. This is a good framework to use when decisions are being made that may impact threatened and endangered species when the most relevant science is not yet available. Existing policy does not account for the best available science still being in development, however making management decisions without taking ongoing research into account can lead to unforeseen consequences. In the case of candy darters, there is information on the way that can reduce the uncertainty (see Ongoing Research on p. 5). This information is vital for managers and policy makers when planning projects, but unfortunately scientific publishing has been delayed due




*"The appropriate action is likely to change through time, as understanding evolves and the resource system responds to environmental conditions and management actions. That is, management is adjusted in response to both changing resource status and learning. It is the influence of reduced uncertainty (or increased understanding) that renders the decision process adaptive." (Williams, 2011)*

**Figure 3.** Illustration of the cyclic nature of adaptive management. Management is followed by post-decision monitoring, assessment of the monitoring data, and re-evaluation of the management action as well as input of the new knowledge into future decision making.

to the COVID-19 pandemic.

The second framework is ***adaptive management***, a management scheme that can be used when there is uncertainty surrounding whatever is being managed. Reducing the uncertainty surrounding candy darter will improve management, but acquiring that knowledge takes time. In the meantime, management actions must be taken even while that uncertainty remains. Thus, use of a management scheme that acknowledges areas of uncertainty while utilizing adaptive decision making involving identification of management alternatives, predictions of management consequences, and monitoring is recommended.

**Monitoring is key in the use of adaptive management**. Monitoring is used to track both the status of the resource as well as to understand its response to management actions. This informs what management actions should be taken moving forward. Additionally, comparison of model predictions with monitoring data can provide important feedback to the accuracy of models and inform their continued use. It is recommended monitoring take place before a project starts, during construction or while activities are ongoing, and after projects are completed. Parameters to be monitored are discussed in the "Recommended Actions" section on p. 10.

## 5. The Candy Darter and Policy

An understanding of the current federal and state policies that offer protection to the candy darter is critical to its continued conservation. With that in mind, the following list of policies is not comprehensive but may serve as a guide for the most relevant policies that pertain to candy darter conservation.

### 5.1 The Endangered Species Act

The Endangered Species Act (ESA) is an important legislative tool passed in 1973 for the protection of threatened and endangered species in the United States (NRC, 1995). When a species is listed as endangered or threatened under the ESA, the USFWS and the National Marine Fisheries Service (NMFS) must consider whether there is habitat that is essential to the species' conservation. These habitat areas may be proposed for designation as critical to the species. A critical habitat designation does not prohibit activities within the protected area, but instead requires federal agencies to ensure that actions federally undertaken, funded, or authorized do not destroy or adversely modify the designated habitat.

Endangered species like the candy darter and their critical habitat receive extremely strong protection. Section 9 of the ESA states it is illegal to "take", meaning *"to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect"*, and Section 7 of the ESA prohibits any federal action that will jeopardize the future of the species, including threats to designated critical habitat (16 U.S.C. §1531). Enforcement of the ESA occurs through citizen suits as well as civil and criminal penalties.

#### 5.1.1 The Candy Darter ESA Timeline

The candy darter was first identified as being in need of federal protection in 1982 (47 Fed. Reg. 58454, 1982). In 2010, private groups including the Center for Biological Diversity, West Virginia Highlands Conservancy, the Clinch Coalition and other groups petitioned the USFWS for protection of the candy darter. They had previously been a category 2 candidate species for listing (a term no longer used), meaning the USFWS had some indication that listing as threatened or endangered might be warranted, but there were insufficient data to justify an official listing (76 Fed. Reg. 59835, 2011; USFWS Midwest Region, 2021). Candy darters finally gained Endangered Species Act protection in 2018, and had its critical habitat designated in 2021 (83 Fed. Reg. 58747, 2018; 86 Fed. Reg. 17956, 2021).

#### 5.1.2 Designation as *Endangered*

Candy darters gained federal protections in 2018 when they were officially listed as an endangered species. Initially it was proposed to list candy darters as "threatened", however

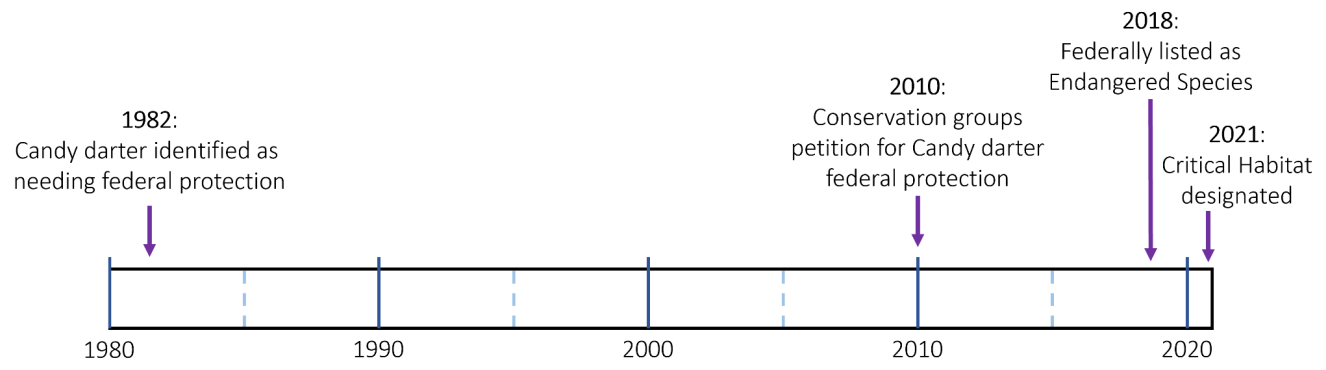



**Figure 4.** The candy darter Endangered Species Act protection timeline.

upon research required for listing, the USFWS found that *"the candy darter's current condition is more degraded than we understood [... and] the risk of extinction is greater than we had previously understood"* and thus more protection is needed than previously thought (83 Fed. Reg. 58747, 2018).

USFWS found *"that the candy darter is presently in danger of extinction throughout its entire range based on the severity and immediacy of threats currently affecting the species"* and that the *"overall range has been significantly reduced, and the remaining populations are threatened by hybridization and, to a lesser extent, a combination of other threats, reducing the overall viability of the species."* ***"The risk of extinction is high..."***(83 Fed. Reg. 58747, 2018).

The USFWS determination found that at the species level, hybridization with variegate darters is the most influential factor affecting the candy darter. Degraded and fragmented habitat due to excessive sedimentation and increased water temperatures having caused historical and continued population declines.

#### 5.1.3 Designation of Critical Habitat

In 2018, a rule to designate the critical habitat for the candy darter was proposed under the Endangered Species Act, where 596 stream kilometers (370 stream miles) would fall within the boundaries of the proposed critical habitat designation in three rivers in Virginia and West Virginia. The designation was finalized and became effective on May 7th, 2021. A few minor changes were made to the initial designation proposal resulting in a reduction in stream miles protected from 370 to 368. Specifics of the areas designated can be found in the table below (Table 2).

Areas that are designated critical habitats include regions of the Greenbrier River, middle & upper New River, and lower & upper Gauley River (86 Fed. Reg. 17956, 2021) (Figure 3). As mentioned previously, the regions that are now protected as designated critical habitat to the candy darter only includes currently occupied areas, some of which are very isolated and small. Thus, **because the designated habitat is relatively limited, it is particularly important to protect it from degradation.**

### 5.2 Federal Water Pollution Control Act (also called The Clean Water Act; CWA)

The Clean Water Act (CWA) establishes a basic structure for regulating discharges of pollutants into the waters of the United States and establishes quality standards for surface waters like rivers, creeks, and lakes. Under the CWA, the EPA sets nationwide minimum water quality standards and discharge limits and the states individually enforce these standards. In addition to these standards, a permit under the National Pollutant Discharge Elimination System (NPDES) is required to discharge any point source pollution. The CWA also imposes discharge monitoring and recordkeeping requirements on dischargers (33 U.S.C. §1318(a)(A)).

| Critical Habitat Distance Within Each River Segment | | | | | | |
|---|---|---|---|---|---|---|
| Units: miles (km) | | | | | | |
| | **Greenbrier** | **Upper Gauley** | **Lower Gauley** | **Middle New** | **Upper New** | **Total by land ownership** |
| **Federal** | 78 (125) | 90 (145) | 2 (3) | 12 (19) | 0 (0) | 182 (282) |
| **State** | 6 (10) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 6 (10) |
| **Private** | 70 (113) | 92 (148) | 0 (0) | 14 (22) | 5 (8) | 181 (291) |
| ***Unit Total*** | *154 (248)* | *182 (293)* | *2 (3)* | *25 (41)* | *5 (8)* | ***368 (593)*** |

**Table 2.** Candy darter designated Critical Habitat stream miles.

The NPDES program has strict requirements, but it only applies to certain types of water pollution. The program regulates only point source pollution (i.e., pollutants carried to the water body by an individual and direct conveyance like a pipe or storm drain), not nonpoint source pollution like that from runoff. Further, the pollutant must reach "navigable waters," meaning that the polluted water body must directly connect to larger rivers, lakes, and oceans used for shipping and commerce. Groundwater and unconnected water bodies (e.g., ponds, drainage ditches) are not subject to CWA jurisdiction but are protected under other statutes.

All substances discharged into America's navigable surface waters by means of point sources are covered under the NPDES program. Those subject to NPDES regulations must apply for and receive a permit that authorizes the water pollution under strict standards and in specifically limited amounts. Failure to comply can give rise to civil or criminal liability.

State governments often opt to administer and enforce NPDES requirements within their borders, otherwise the EPA is responsible. All permit holders must utilize "Best Available Control Technology" as determined by the EPA to limit water pollution discharges. Beyond this baseline requirement, individual NPDES permits are tailored to integrate local water quality concerns by requiring polluters to adhere to mandatory Water Quality Standards (WQS) developed by state and federal agencies. The agencies assess how a water body is used by the human public, and designate water quality criteria to ensure the site is suitable for that use. For example, a water body used for swimming and fishing is held to more stringent health and safety standards than a waterway used for commercial shipping. Waters that do not meet the WQS are designated as "impaired" and subject to additional protections. For every pollutant exceeding the WQS, the governing agency calculates a daily maximum amount of the pollutant that can be discharged from all sources and still ultimately achieve the WQS. This "Total Maximum Daily Load (TMDL)" is integrated into each NPDES permit issued in the area. For waters that exceed the WQS, states have the discretion to allow water quality to fall to the WQS, however the EPA requires implementation of stringent best management practices to control degradation.

Other aspects of water quality including groundwater, wetlands, and storm and wastewater discharges are not included in the NPDES system but are addressed in other statutes. It is also important to note that there are exceptions. The CWA exempts from permitting discharge associated with normal farming and forestry activities as well as construction or maintenance of farm, forest, or temporary roads and farm and stock ponds, irrigation ditches, or maintenance of drainage ditches.

#### 5.2.1 The CWA and Candy darters

It is important to note that, while the CWA requires certain water quality activities, the specific water quality needs of the candy darter are unknown at this time; as such, CWA regulations may not provide protection for this species. CWA-required monitoring for water quality can create a record of the cumulative impacts of ongoing projects, an important consideration for areas with multiple projects. Additionally, proposed projects must work within CWA regulations regardless of the presence of threatened or endangered species; while there are some protections for aquatic life, they may not be enough for species that are sensitive or otherwise at risk. Because of this, the ESA is an important partner statute that provides additional water quality thresholds that must be met for threatened and endangered species.

Proper project planning that takes protection of sensitive/endangered species into account and use of best management practices can protect candy darter populations as well as prevent project managers from litigation and project delays and the added costs those entail.

### 5.3 State Policy

Federal law, including the ESA and CWA, supersedes state law in regards to protecting the candy darter. With that in mind, the Commonwealth of Virginia and State of West Virginia have established regulations that can be interpreted as providing additional state-level protections to the candy darter, namely through protection of endangered species and water quality regulations. Enforcement of water quality standards set forth by the EPA varies by state, as seen by the differences in regulatory frameworks.

#### 5.3.1 Virginia

§ 29.1-564 of the Code of Virginia explicitly prohibits

> *"[t]he taking, transportation, possession, sale, or offer for sale within the Commonwealth of any fish or wildlife appearing on any list of threatened or endangered species published by the United States Secretary of the Interior pursuant to the provisions of the federal Endangered Species Act of 1973 (P.L. 93-205), or any modifications or amendments thereto."*

9VAC25-260-10. Designation of Uses of the Virginia Administrative Code states

> *"A. All state waters, including wetlands, are designated for the following uses… the propagation and growth of a balanced, indigenous population of aquatic life, including game fish, which might reasonably be expected to inhabit them…"*
>
> *"C. In designating uses of a water body and the appropriate criteria for those uses, the board shall take into consideration the water quality standards of downstream waters and shall ensure that its water quality standards provide for the attainment and maintenance of the water quality standards of downstream waters."*

9VAC25-260-20. General criteria of the Virginia Administrative Code states

*"A. State waters, including wetlands, shall be free from substances attributable to sewage, industrial waste, or other waste in concentrations, amounts, or combinations which contravene established standards or interfere directly or indirectly with designated uses of such water or which are inimical or harmful to human, animal, plant, or aquatic life.*

*Specific substances to be controlled include, but are not limited to: floating debris, oil, scum, and other floating materials; toxic substances (including those which bioaccumulate); substances that produce color, tastes, turbidity, odors, or settle to form sludge deposits; and substances which nourish undesirable or nuisance aquatic plant life. Effluents which tend to raise the temperature of the receiving water will also be controlled. . . "*

#### 5.3.2 West Virginia

Fishing regulations in West Virginia dictate the following (WV DNR, 2021):

1. *It is illegal to possess any darter in West Virginia*
2. *Zero possession limit of all fish species other than game fish, and no fish (including dead or packaged minnows) may be used as bait in the following waters:*
   (a) *East and West Forks of the Greenbrier River including all tributaries.*
   (b) *Gauley River upstream of the Route 55/20 bridge (i.e., Curtin, W.Va.) including the Cherry, Williams, Cranberry, and upper Gauley rivers and all respective tributaries.*
   (c) *Camp Creek (Mercer County) and all tributaries.*
   (d) *Manns Creek including Glade Creek in Babcock State Park and all tributaries.*
3. *It is illegal to release any fish into public waters other than the location where it was captured.*

West Virginia Code §22-13-5. Designation of protected streams states

*"The following streams are hereby designated as protected streams within the natural streams preservation system, namely:*

(a) *Greenbrier River from its confluence with Knapps Creek to its confluence with the New River.*
(b) *Anthony Creek from its headwaters to its confluence with the Greenbrier River.*
(c) *Cranberry River from its headwaters to its confluence with the Gauley River.*
(d) *Birch River from the Cora Brown bridge in Nicholas county to the confluence of the river with the Elk River.*
(e) *New River from its confluence with the Gauley River to its confluence with the Greenbrier River."*

## 6. Recommended Actions

Implementing policies that both follow the letter of the law and also satisfy various stakeholders is a monumentally difficult task, especially in the case of guaranteeing protection to a federally listed species that is present across multiple locations owned by a mix of public and private entities. Here we provide a suite of recommendations that focus on using management and policy strategies for the conservation of candy darters over other considerations.

### 6.1 State Recommendations

In the 2015 Virginia Wildlife Action Plan, candy darters were ranked as Tier 1, rank b: a species in greatest need of conservation. Tier 1 indicates their conservation need: they are a species of "Critical Conservation Need" that faces an "extremely high risk of extinction or extirpation" and require "intense and immediate management action". Ranking indicates their conservation opportunity: a B ranking indicates that "Managers have only identified research needs for the species or managers have only identified "on the ground" conservation actions that cannot be implemented due to lack of personnel, funding, or other circumstance" (VA DGIF, 2015).

Their management recommendations for conservation of candy darters are to:

- *"Establish/restore forest corridors around streams and rivers*
- *Decrease nutrient, sediment, and pollution runoff through better management of agriculture and livestock waste and stormwater*
- *Control invasive species*
- *Improve connectivity."*

Additionally they recommend investigating reintroduction into historic range, habitat modeling, and population viability analysis/genetics.

### 6.2 Federal Recommendations

The U.S. Fish and Wildlife Service listed these recommendations in the Species Status Assessment Report for the candy darter:

- Reduction of other watershed disturbances that release sediments, pollutants, or nutrients into the water
- Monitor stream water quality parameters before, during, and after activities that may affect candy darter
- Monitoring parameters should include embeddedness and sedimentation, chemical toxicants, water temperature, water flow rate, and pH.

- Protection of riparian corridors and retention of sufficient canopy cover along streambanks
- Riparian corridors provide shade to keep water temperatures cool and filter sediment and other pollutants from entering streams (Schilling et al., 2021).
- Public outreach requesting the public's assistance with stopping the movement of nonnative aquatic species (actions already taken include a bait fish regulations, discussed on pg 10-11)
- Increased enforcement and education regarding existing regulations prohibiting the movement of bait fish
- Research, development, and application of tools and techniques that can be used to address the preservation of candy darters in habitats where they compete and hybridize with variegate darters (including candy darter captive breeding and release programs)

Due to the candy darter's sensitivity to sedimentation, stream crossings for pipelines or bridges for roads should be as low impact as possible when they are found within 1km of candy darter habitat. Additionally, we strongly recommend in-stream turbidity/sedimentation monitoring for not only baseline information, but for influxes of sediment due to active or past projects in order to create an effective adaptive management plan.. Management decisions should take into consideration when relevant science is being conducted but is yet to be published. Waiting for these data to be published before approving major projects that would impact candy darter populations will prevent damage that is irreversible and avoidable. Agencies and corporations should provide proof that their proposed programs, activities or projects comply with relevant existing environmental rules and regulations. Furthermore, proposed impact mitigation measures must be robust, geographically appropriate, and species-specific. Accomplishing these goals will help protect candy darters, additional species of interest such as bull trout and Roanoke logperch, and other aquatic life that share their habitat.

> ***"As long as we have candy darters, we know we have quality habitat for all of our fish species"*** - Barb Douglas, USFWS Senior Endangered Species Biologist in West Virginia (McCoy, 2001).

## 7. Summary

Candy darters, once abundant in the West Virginia and Virginia water basins, now require substantial conservation efforts due to habitat destruction and hybridization with the variegate darter species. Direct human effects have also escalated the destruction of candy darter habitats, making the protection of this important species and what remains of their habitat of utmost importance. With the designation of candy darter as an endangered species and the designation of their critical habitat under the Endangered Species Act, they are afforded powerful legal protections they have not had in the past.

While instances of proactive legislation have been implemented, many proposed and ongoing projects (including infrastructure, extraction, and forest management) are potentially overlooking their risks to candy darters. Any long term impacts on candy darter populations are not easily remedied at this time, and would increase the risk of extinction for an already endangered species. To this end, both future and ongoing projects should carefully consider their direct and indirect impacts on waterways and protected critical habitats. Due to difficulties in obtaining data on candy darters, we recommend the precautionary principle be implemented for any ongoing or upcoming projects that impact either current candy darter range and their critical habitat. We also recommend the completion of relevant research before management decisions are made, especially if the decision would be difficult to revert - otherwise an adaptive management framework can be used. Agencies (e.g., US Fish and Wildlife Service) have already published multiple documents advising how to avoid further harming candy darter populations, and we suggest any other agencies or private entities follow their recommendations during project creation, implementation, completion, and monitoring.

## 8. Glossary

**Embeddedness**: the degree to which gravel, cobble, rocks, and boulders are surrounded by, or covered with, fine sediment particles (USFWS SSA Report, 2018)

**Extant**: remaining population

**Extirpated**: local extinction - population no longer exists in a specific geographical location

**Genetic swamping**: the loss of rare genes in a population, resulting in homogenization or replacement of native genes with newly introduced ones

**Habitat Fragmentation**: when physical barriers and stretches of unoccupied (and potentially unsuitable) habitat split an environment into pieces and prevent the movement of individuals between locations

**Hybridization**: two different species are reproductively compatible, leading to a new species that is reproductively isolated from the parent species

**Metapopulations**: spatially separated populations of the same species which may or may not interact

**Occupancy**: Is a particular species found in a given area? Only a metric of presence/absence, does not say how many individuals of a particular species live there.

**Sedimentation**: the process of sediments being deposited in a streambed and accumulating over time

**USDA**: United States Department of Agriculture

**USFWS**: United States Fish and Wildlife Service

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## 10. Conflicts of interest

This report was prepared by members of Virginia Scientist-Community Interface. The analysis presented is entirely our own and does not represent the position of our respective affiliations. Affiliation is for identification purposes only. We have no conflicts of interest to declare.

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