

**U.S. FISH AND WILDLIFE SERVICE
SPECIES ASSESSMENT AND LISTING PRIORITY ASSIGNMENT FORM**

SCIENTIFIC NAME: *Alasmidonta varicosa*

COMMON NAME: Brook floater

LEAD REGION: Region 5

DATE INFORMATION CURRENT AS OF: November 8, 2018

STATUS/ACTION

Species assessment - determined either we do not have sufficient information on threats or the information on the threats does not support a proposal to list the species and, therefore, it was not elevated to Candidate status

Listed species petitioned for uplisting for which we have made a warranted-but-precluded finding for uplisting (this is part of the annual resubmitted petition finding)

Candidate that received funding for a proposed listing determination; assessment not updated

New candidate

Continuing candidate

Listing priority number change

Former LPN: ____

New LPN: ____

Candidate removal: Former LPN: ____

A – Taxon is more abundant or widespread than previously believed or not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status.

U – Taxon not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status due, in part or totally, to conservation efforts that remove or reduce the threats to the species.

F – Range is no longer a U.S. territory.

I – Insufficient information exists on taxonomy, or biological vulnerability and threats, to support listing.

M – Taxon mistakenly included in past notice of review.

N – Taxon does not meet the Act's definition of "species."

X – Taxon believed to be extinct.

Date when the species first became a Candidate (as currently defined): N/A

Petition Information:

Non-petitioned

Petitioned; Date petition received: April 20, 2010

90-day substantial finding FR publication date: September 27, 2011

12-month warranted but precluded finding FR publication date: N/A

FOR PETITIONED CANDIDATE SPECIES:

a. Is listing warranted (if yes, see summary of threats below)? No

b. To date, has publication of a proposal to list been precluded by other higher priority listing actions? N/A

c. Why is listing precluded? N/A

PREVIOUS FEDERAL ACTIONS:

The brook floater was petitioned for listing as a threatened or an endangered species under the Endangered Species Act (Act) on April 20, 2010, by the Center for Biological Diversity, Alabama Rivers Alliance, Clinch Coalition, Dogwood Alliance, Gulf Restoration Network, Tennessee Forests Council, and West Virginia Highlands Conservancy. On September 27, 2011, we published a 90-day finding in the *Federal Register* (76 FR 59835) concluding that the petition presented substantial information indicating that listing the brook floater may be warranted.

ANIMAL/PLANT GROUP AND FAMILY: Clams (Mussels); Unionidae

HISTORICAL STATES/TERRITORIES/COUNTRIES OF OCCURRENCE: District of Columbia, Connecticut, Delaware, Georgia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Pennsylvania, Rhode Island, South Carolina, Vermont, Virginia, and West Virginia and two Canadian provinces (New Brunswick and Nova Scotia).

CURRENT STATES/COUNTIES/TERRITORIES/COUNTRIES OF OCCURRENCE: Connecticut, Georgia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Pennsylvania, South Carolina, Vermont, Virginia, and West Virginia, and two Canadian provinces (New Brunswick and Nova Scotia). Considered extirpated in the District of Columbia, Delaware, and Rhode Island.

LAND OWNERSHIP: Lands adjacent to the rivers and streams within the range of the brook floater are a mix of private, state/provincial, and federal lands. While the exact percentages vary by analytical unit and state, rangewide the adjacent lands are primarily in private ownership.

LEAD REGION CONTACT: Krishna Gifford, Northeast Region Listing Coordinator, 413-253-8619, krishna_gifford@fws.gov.

LEAD FIELD OFFICE CONTACT: Sandra Doran, Biologist, New York Ecological Services Field Office, 607-753-9334 x0586, sandra_doran@fws.gov.

BIOLOGICAL INFORMATION

The *Species Status Assessment Report for the Brook Floater—August 2018, Version 1.1* (SSA Report) is a summary of the information assembled and reviewed by us and incorporates the best scientific and commercial information available for this species. Excerpts of the SSA Report are provided in the sections below. For more detailed information, please refer to the SSA Report (Service 2018, entire).

Species Description

The brook floater (*Alasmidonta varicosa*) (figure 1) is a small freshwater mussel usually less than 75 millimeters (mm) (2.95 inches [in]) in length (Nedeau 2008, p. 76); however, specimens from Maine and South Carolina have been observed at over 75 mm (2.95 in) (Nedeau 2018; Savidge 2018). The shell is yellowish-green in young animals to brownish-black in older specimens, often has broad dark green rays, and individuals have a distinctly orange-colored foot. The brook floater is sexually monomorphic, which means lacking visible differences between males and females.



Figure 1. Brook floater showing orange-colored foot (Nedeau 2008, p. 78).

Taxonomy

The brook floater was first described by Lamarck (1819, pp. 78–79) as *Unio varicosa* from the Schuylkill River in Pennsylvania. The species was subsequently placed in the genus *Alasmidonta* described by Say (1818, p. 459). The brook floater (*Alasmidonta varicosa*) is recognized as a valid taxon in scientific literature and we accept this taxonomy for the purposes of our assessment.

Habitat/Life History

As is the case with most freshwater mussels, the brook floater has a complex life cycle that relies on fish hosts for successful reproduction (figure 2).

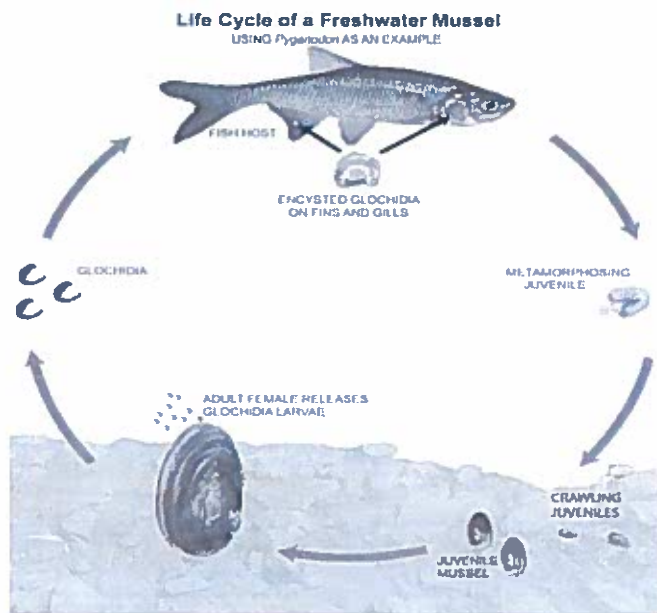


Figure 2. Freshwater mussel life cycle (Martel *et al.* 2010, p. 558).

Male brook floaters release sperm into the water column that then flows downstream with the current and is taken in by the female through the incurrent aperture, where water enters the mantle cavity. The sperm fertilizes eggs that are held within the female's gills in the marsupial chamber. The developing larvae remain in the gill chamber until they mature into glochidia and are ready for release. Freshwater mussel species differ from each other regarding the time between spawning and when the larvae are naturally released. The brook floater is presumed to be a long-term brooder, meaning the species undergoes fertilization in the late summer-fall and the female retains larvae until releasing the glochidia the following spring (Wicklow *et al.* 2017, p. 7). The release of brook floater glochidia is highly temperature dependent, typically occurring when the water temperature reaches 14° C (57.2° F) (Wicklow 2008, p. 7). The brook floater is considered a host fish generalist and is capable of using many different families of fish as hosts. While we lack rangewide information on the species' life span, in Canada, brook floaters have been found to live between 7 to 14 years, with an estimated average life span of 10 years (Committee on the Status of Endangered Wildlife in Canada (COSEWIC) 2009, p. 31). Brook floaters are estimated to take approximately 3 to 4 years to reach reproductive maturity.

In general, the most robust populations of the brook floater historically occurred and currently occur in creeks and rivers of varying size, with stable substrates, intact riparian buffers (vegetated areas comprised of forest, shrub or herbaceous plants located adjacent to streams), excellent water quality, and in areas with little to no anthropogenic influences (Haag 2012, p. 107; Massachusetts Division of Fisheries and Wildlife 2009). Brook floaters need clean, low to moderately flowing water, with stable substrate (sand, gravel, and cobble), appropriate food levels, water temperatures above 14°C (57.2°F) for glochidia release (Strayer 1999, p. 468), and

interstitial chemistry and presence of fish hosts for glochidia attachment and dispersal (Haag 2012, p. 42).

Historical Range/Distribution

Historically (prior to 1997), the brook floater was broadly distributed throughout streams and rivers draining into the Atlantic Ocean from Canada (New Brunswick and Nova Scotia) to Georgia, including rivers in the States of Connecticut, Delaware, Georgia, Massachusetts, Maine, Maryland, New Hampshire, New Jersey, New York, North Carolina, Pennsylvania, Rhode Island, South Carolina, Vermont, Virginia, and West Virginia (Johnson 1970, p. 355; Clarke 1981, p. 79–81; Wicklow *et al.* 2017, p. 11) (figure 3).

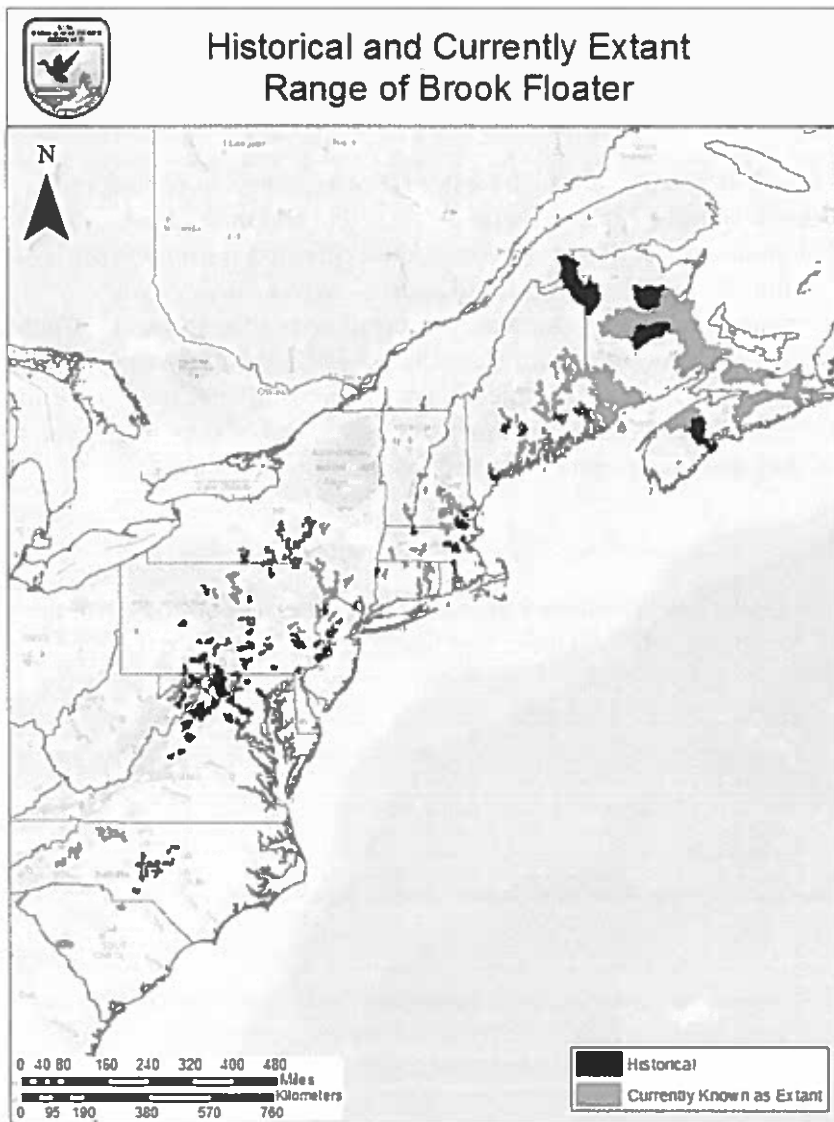


Figure 3. Historical and currently extant range of the brook floater, *Alasmidonta varicosa*, in the U.S and Canada.

Current Range/Distribution

The current range of the brook floater was determined using the best available data from the NatureServe database (NatureServe 2017), which includes state Natural Heritage data and surveys conducted by partners, including state agencies, federal agencies, non-profit organizations and contractors. In some cases, these surveys were conducted specifically for brook floater, while others targeted other mussel species (e.g., federally listed mussels). Data was provided in several formats including count data, catch per unit effort (CPUE), and presence/absence. If presence of the brook floater was noted between 1997 and 2017, we considered it extant (or current). If presence of the brook floater has not been detected since 1997 or no surveys have been conducted between 1997 and 2017, we considered it historical (but not necessarily extirpated).

Brook floaters are currently found in 14 of the 16 historically known States and considered extirpated in Delaware and Rhode Island (Wicklowsky *et al.* 2017, p. 11) and in the District of Columbia (figure 3). In addition, the brook floater appears to be extirpated from multiple rivers across the rest of the range. NatureServe (2017) identified approximately 70 to 90 site extirpations (of 150 or more known historically) that have occurred across the range. In Canada, the brook floater currently occurs in 15 watersheds in New Brunswick and Nova Scotia. It is possible that, based on surveys documenting new populations, the brook floater may occur in other areas within the species' historical range, particularly in Canada and Maine. However, the above information represents the species' known current range and distribution.

Population Estimates/Status

In our assessment of the brook floater, we delineated four representative areas throughout the range of the species: Canada, Northeast, Mid-Atlantic, and Southeast (figure 4).



Figure 4. Four representative areas throughout the range of the brook floater.

For more details on the specific watersheds and rivers in each representative area, please refer to section 3.3.2 *Species Representation* in our SSA Report (Service 2018, p. 41). We defined populations as “analysis units” (AUs), which are geographically-defined watersheds that encompass historical and currently documented occupied habitat and cover diverse geographic areas throughout the range of the brook floater. In the U.S. (Northeast, Mid-Atlantic, and Southeast representative areas), we used the National Hydrography Dataset, which further divides watershed boundaries into Hydrologic Unit Codes (HUCs). Each AU is comprised of one or more HUC 12s and is typically defined by a confluence with another water body or by blockages such as dams. For the Canadian representative area, we used the National Hydro

Network database to define AU boundaries. We defined a total of 239 AUs throughout the species' range (see figure 5).

We do not have total abundance information for brook floaters, nor do we have data on the abundance of individuals in most populations, but we estimated abundance in each AU based on available data from visual searches of the surfaces of stream beds. We also used occupied stream length, stream width, and estimated catch per unit effort (number of mussels found per hour) to assess abundance per AU. Because population size is based on multiple assumptions and can have a large and/or undefined variance, we assigned a more general magnitude (<10, 10s, 100s, or 1000s) of brook floater abundance to each AU. For additional information on how we used these characteristics to evaluate AUs, refer to section 3.3.1 *Population Condition Metrics* and section 3.4.1 *Methodology* in our SSA Report (Service 2018, pp. 38–46).

SUMMARY OF BIOLOGICAL INFORMATION

The brook floater is a small freshwater mussel usually less than 75 mm (2.95 in) in length. The species is an Atlantic slope freshwater mussel historically native to the District of Columbia, 16 States in the eastern United States, and two Canadian provinces. The mussel has a widespread distribution and is currently found in 14 of the 16 historically known States and considered extirpated in Delaware and Rhode Island and in the District of Columbia.

Brook floaters inhabit creeks and rivers of varying size with stable substrates, intact riparian buffers (vegetated areas comprised of forest, shrub or herbaceous plants located adjacent to streams), excellent water quality and in areas with little to no anthropogenic influences. The species needs clean, low to moderately flowing water, with stable substrate (sand, gravel, and cobble), appropriate food levels, water temperatures above 14°C (57.2°F) for glochidia release, and interstitial chemistry and presence of fish hosts for glochidia attachment and dispersal.

THREATS

We define “threat” as any action or condition that is known to or is reasonably likely to negatively affect individuals of a species. This includes those actions or conditions that have a direct impact on individuals, as well as those that affect individuals through alteration of their habitat or required resources. The mere identification of “threats” is not sufficient to compel a finding that listing is warranted. Describing the negative effects of the action or condition (i.e., “threats”) in light of the exposure, timing, and scale at the individual, population, and species levels provides a clear basis upon which to make our determination. In determining whether a species meets the definition of an “endangered species” or a “threatened species,” we have considered the factors under section 4(a)(1) and assessed the cumulative effect that the threats identified within the factors—as ameliorated or exacerbated by any existing regulatory mechanisms or conservation efforts—will have on the species now and in the foreseeable future. We also use the term “stressor,” which we generally define as any physical, chemical, or biological alteration of the environment that can lead to an adverse individual response.

We evaluated the current and future biological status of the brook floater by assessing the primary factors negatively and positively affecting the species to describe its condition in terms of resiliency (the species' ability to withstand environmental or demographic stochastic disturbance), redundancy (the species' ability to withstand catastrophic events), and representation (the species' ability to adapt to changing environmental conditions over time, characterized by genetic and ecological diversity). Redundancy, resiliency, and representation are concepts from conservation biology, and collectively known as the "3 Rs." The primary factors we explored in our analysis of the species' condition include water quality (i.e., sedimentation and water chemistry) and habitat fragmentation (i.e., dams). Other influencing factors included effects from climate change and stress from nonnative fish via increased predation, competitive interactions, transmission of pathogens, or hybridization.

Current Condition

Factors Influencing Viability:

Based on the brook floater's life history and habitat needs, we identified the potential stressors and the contributing sources of those influences that are likely to affect the species' viability. These factors are primarily related to disjunct populations facing habitat loss or fragmentation, changes in water flows, and degraded water quality from development, including urbanization, energy production (e.g., oil and gas extraction), and agriculture. In this section, we discuss the stressors we assessed related to water quality and other factors (summarized in table 1). Then we discuss beneficial factors/conservation measures. Finally, we summarize the viability of the species in terms of its resiliency, redundancy, and representation.

Water Quality—We examined several stressors related to water quality that may be affecting the viability of the brook floater, including increased fine sediments, water quality impairment, and changes in water flows. We found that these stressors cause varying types and degrees of effects to the brook floater, ranging from degradation of habitat for sheltering and reproduction to direct effects on individuals. Because all of these stressors related to water quality may have population- or species-level effects on the brook floater, we carry these forward into our analysis of the future viability of the species. Table 1, below, summarizes these stressors and their impacts on brook floaters.

Table 1. Summary of stressors potentially affecting brook floater viability (Service 2018, pp. 54-63).

STRESSOR	SOURCE	POTENTIAL EFFECTS
Increased Fine Sediment	<ul style="list-style-type: none"> • Sources of sediment include development (urbanization, agriculture and energy), streambank erosion from poorly planned/managed land use such as commercial, residential and agricultural activities (e.g., livestock grazing, channelization, dredging, upland drainage piped through tile drains that eventually flow to streams), forestry practices, energy development and infrastructure such as roads and utilities 	<ul style="list-style-type: none"> • Sedimentation from upland sources affects baseline water quality and increases the amount of silt, sand, gravel, and/or cobble present in the river. • Impacts may include abrasion of mussels by suspended particles, burial by sediment, increased mortality of fish eggs, and clogging of gills and respiratory systems in aquatic species. • Increased silt directly impacts mussels because, in heavily silted water, they are forced to close their valves and wait for better water conditions in order to feed. Extended valve closure can result in starvation or a state of semi-starvation.
Water Quality Impairment	<ul style="list-style-type: none"> • Impairment is alteration of water quality parameters such as dissolved oxygen, temperature, and salinity levels. • Development - Contamination or alteration of water chemistry through both point and nonpoint discharges, including spills, industrial sources, municipal effluents, and agricultural runoff. These sources contribute organic compounds, heavy metals, pesticides, herbicides, and a wide variety of newly emerging contaminants (e.g., untreated antibiotics and hormones from wastewater treatment facilities) to the aquatic environment. 	<ul style="list-style-type: none"> • Brook floaters may be particularly sensitive to eutrophication (over-enrichment of water by nutrients causing algal blooms and depleting water of oxygen) and nitrogen loading. • Freshwater mollusks are more sensitive than previously known to some chemical pollutants, including chlorine, ammonia, copper, fungicides, and herbicide surfactants. • Increased water temperature from climate change and from low flows during drought can exacerbate low dissolved oxygen levels, increase metabolic processes, and outstrip energy reserves of mussels.

Table 1. Summary of stressors potentially affecting brook floater viability (Service 2018, pp. 54-63).

STRESSOR	SOURCE	POTENTIAL EFFECTS
Alteration of Water Flows	<ul style="list-style-type: none"> • Extreme drought and extreme flooding events • Dams or other barriers such as culverts • Water withdrawals for municipal water, sewage treatment, cooling towers at power plants, irrigation, and natural gas extraction 	<ul style="list-style-type: none"> • Low flow events and habitat inundation can eliminate appropriate brook floater habitat; if events are prolonged or occur regularly, species may be at risk. • Upstream of dams in impounded water, there is an increased build-up of sediments and decreased dissolved oxygen content. There can also be alterations in resident fish populations, which can limit fish host availability and therefore reproductive success of brook floaters. • Downstream of dams, the instability of sediment from scour, flushing, and deposition of eroded bank material can result in juveniles failing to settle and stay in interstitial spaces, and may prevent attachment to substrates using byssal threads. • If low flows persist, mussels face oxygen deprivation, increased water temperatures, and, ultimately, stranding (which means the inability to move or relocate to find flows), reducing survivorship, reproduction, and recruitment in the population. • High flows can dislodge or displace mussels and destabilize habitat. Flooding can cause mussels to be covered in silt, crushed by large substrate, dislodged, and moved to downstream habitat (which may be more or less suitable) and/or displaced to a riverbank that soon dries and results in desiccation of the mussels.
Habitat Loss/Fragmentation	<ul style="list-style-type: none"> • Fragmentation – natural and human-induced factors that can interact to create patches of suitable and unsuitable 	<ul style="list-style-type: none"> • Barriers directly and permanently fragment habitat. • Dams can cause genetic isolation.

Table 1. Summary of stressors potentially affecting brook floater viability (Service 2018, pp. 54-63).

STRESSOR	SOURCE	POTENTIAL EFFECTS
	habitat. Factors include barriers (such as dams), drought, water quality impairments (such as pollution), host fish movement, substrate stability, adjacent land use, etc.	<ul style="list-style-type: none">• Loss of connectivity between patches (mussel beds or occupied habitat).• Detrimental effects on host fish populations from changes in habitat and temperature.• Dams can negatively affect mussel reproduction by altering temperature regimes, flows, and habitats.

Table 1. Summary of stressors potentially affecting brook floater viability (Service 2018, pp. 54-63).

STRESSOR	SOURCE	POTENTIAL EFFECTS
<p>Other Factors (Inherent factors, predation, invasive species)</p>	<ul style="list-style-type: none"> • Inherent factors – small population size and low fecundity. • Predation by rusty crayfish (<i>Orconectes rusticus</i>), flatworms, and changes in water levels that increase mussel exposure. • Invasive species – rusty crayfish, Asiatic clam (<i>Corbicula fluminea</i>), Dreisseneid mussels, invasive plants 	<ul style="list-style-type: none"> • Greater risk of extirpation from stochastic events (e.g., drought) or anthropogenic changes and management activities that affect habitat. • Reduced genetic diversity, less genetic fitness and therefore more susceptibility to disease and extreme environmental conditions. • Direct predation by rusty crayfish and other species of crayfish, raccoons, muskrats, otters, and flatworms. • Asiatic clam alters benthic surfaces, competes with native species for limited resources, and causes ammonia spikes in surrounding water when they die off en masse, causing stress and mortality to brook floaters. • Dreisseneid mussels and invasive plants can alter stream habitat, decrease flows, and contribute to sediment buildup in streams. Direct effects on native freshwater mussels that can lead to local extirpation. Effects can include attachment to shells of native mussels, which can kill them, outcompeting native mussels for food, and reduction of suitable habitat (clean substrates). • Invasive plants (such as <i>Didymosphenia geminata</i>) can alter habitat, change flow dynamics by forming dense mats, and cause increased water temperatures.
<p>Climate Change Effects (increases in water temperature, changes in precipitation, changes in extreme</p>	<ul style="list-style-type: none"> • Climate change 	<ul style="list-style-type: none"> • Increases in water temperatures may alter habitat suitability for brook floaters, as well as their distribution. • Changes and shifts in seasonal patterns of precipitation and runoff will alter hydrology of streams,

Table 1. Summary of stressors potentially affecting brook floater viability (Service 2018, pp. 54-63).

STRESSOR	SOURCE	POTENTIAL EFFECTS
events (flooding, droughts)		affecting species composition and ecosystem productivity. <ul style="list-style-type: none">• Changes in frequency, duration, and timing of floods or droughts can potentially interfere with reproduction.• Changes in water quality parameters, including dissolved oxygen.

CONSERVATION MEASURES PLANNED OR IMPLEMENTED

There are limited conservation programs that specifically target the brook floater or are significantly reducing any of the primary stressors. Conservation efforts could improve already degraded habitat; however, specific measures would be needed in those areas to ensure good water quality, sufficient flows, temperatures, and substrate for brook floaters remain suitable.

Current Condition and the 3 Rs:

To assess the current condition of the brook floater, we considered the resiliency of each AU together with the number and distribution (redundancy) of the AUs across the species' range (representation). We first used the metrics of abundance, reproduction, and occupied stream length to evaluate the resiliency of each AU within each of the four representative areas (Canadian Provinces, Northeast, Mid-Atlantic, and Southeast) shown above (figure 4). We assigned each AU a current condition of high, medium, low, very low, or unknown. Unknown condition refers to any occurrence documented prior to 1997, but for which no surveys have been conducted in the past 20 years. For detailed descriptions of the condition categories, refer to section 3.4.1 *Methodology—table 1* in our SSA Report (Service 2018, pp. 43–46). Based on our analysis, of the 239 total AUs rangewide, we classified 36 (15 percent) in high condition, 31 (13 percent) in medium condition, 34 (14 percent) in low condition, 79 (33 percent) in very low condition, and 59 (25 percent) in unknown condition (figure 5) (*note, percentages may not sum to 100 percent due to rounding*).

The brook floater has a wide distribution and shows variation in habitat use as well as host fish use. However, there has been range contraction. Brook floater populations are considered entirely extirpated in Delaware and Rhode Island and in the District of Columbia. While brook floater populations are represented across all four representative areas, the proportion of AUs in medium to high condition varies across these areas.

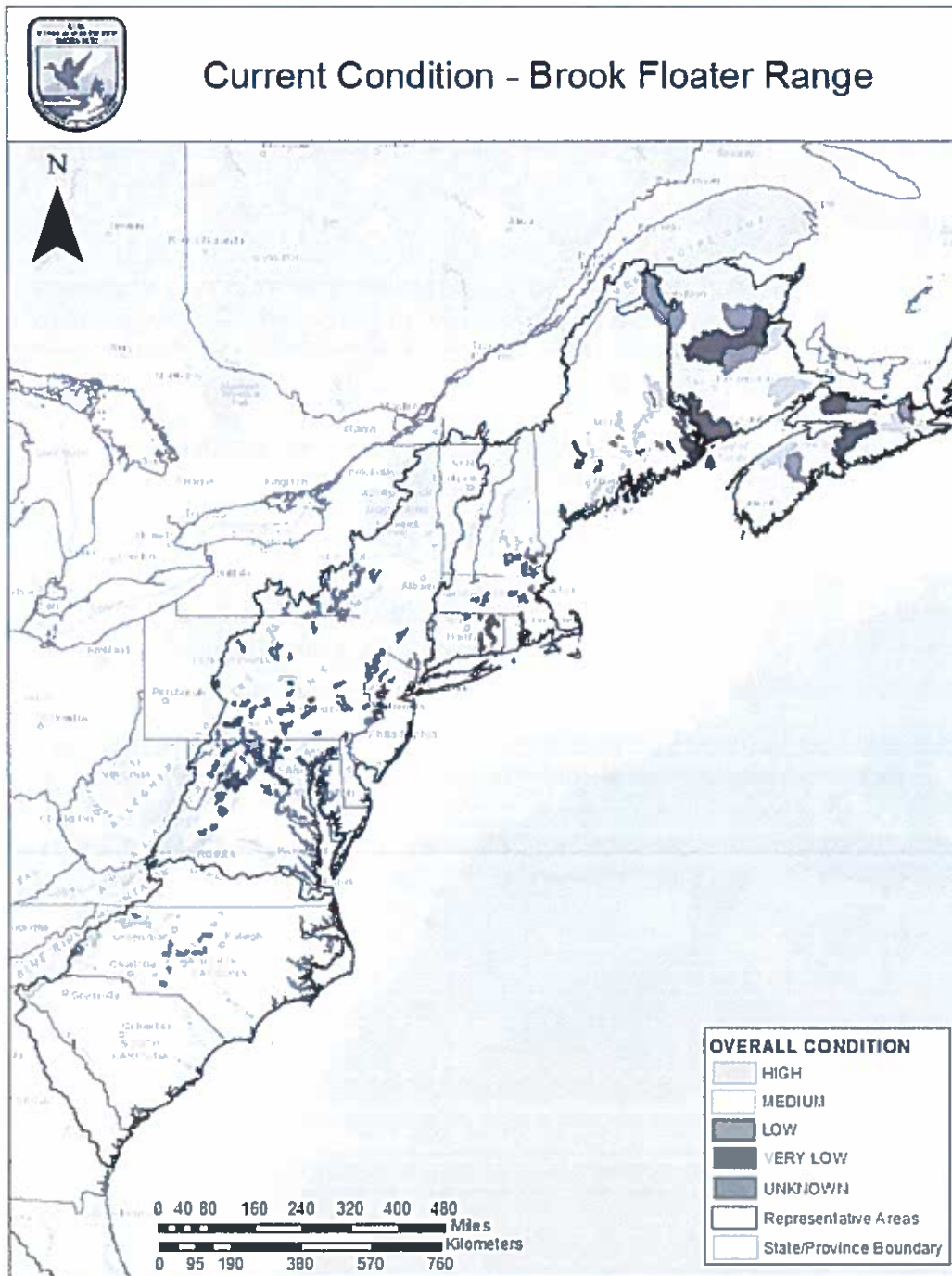


Figure 5. Current condition of brook floater (*Alasmidonta varicosa*) populations across its range.

Future Conditions

Using the same methodology and criteria described above for assessing current condition, we modeled two scenarios to assess the potential viability of the brook floater at 15 and 30 years in the future. Only the primary stressors found to be affecting the brook floater were carried forward in our analysis of future condition. Because the primary factors (habitat loss/fragmentation, changes in water flows, and degradation of water quality) affecting the brook floater's viability are influenced by land use, we developed two future scenarios using economic-based land use projections and predicted energy development. The time frames associated with the scenarios are based on models of economic-based land use development that project development about 30 years into the future. The interim time frame of 15 years assumes a linear change between current and future condition at 30 years and represents a midpoint for our analysis. Scenario 1 (1a at 15 years, 1b at 30 years) models more conversion to agricultural land use (similar to trends from 2007-2012), and Scenario 2 (2a at 15 years, 2b at 30 years) models more conversion to urban land use (similar to trends from 1992-1997) (Service 2018, pp. 68-69). In both scenarios, agricultural and urban land use is projected to increase. However, Scenario 1 incorporates a 10 percent increase in crop prices every 5 years relative to Scenario 2. As a result, Scenario 1 has a higher rate of increase in conversion of land to agricultural use than does Scenario 2. The predicted energy development model showed that energy development is expected to increase in the mid-Atlantic representative area under both future scenarios. The two future scenarios capture the range of likely outcomes in viability that the brook floater could exhibit within the next 30 years. See *chapter 5 and Appendix A* of our SSA Report for more details (Service 2018, pp. 68-93, 105-107).

We analyzed the empirical relationship between the species' current biological condition and land use, and we used those relationships to inform the species' projected response to the future scenarios. This relationship between biological condition and land use does not attempt to estimate the effects of individual stressors, but rather uses the level of land use to integrate the stressor level effects. We then predicted the future condition of the species based on the species' projected response to the future scenarios.

Based on our analysis under Scenario 1, out of a total of 239 AUs in the U.S. and Canada, approximately 8 percent fewer AUs are expected to be in high condition (33 total AUs) and 13 percent more AUs are expected to be in very low condition (90 total AUs) within the next 30 years (table 2). While brook floater populations continue to occur in scattered populations across all representative areas under this scenario, redundancy will be reduced especially in the mid-Atlantic as the AUs experience decreased resiliency.

Table 2. Species Status Assessment summary for brook floater.

3Rs	Needs	Current Condition	Future Condition (viability)
<p>Resiliency: <i>large populations (AUs) able to withstand stochastic events</i></p>	<ul style="list-style-type: none"> • Suitable substrate • Sufficient water quality • Flowing river ecosystems • Sufficient occupied stream length 	<p>239 Total AUs</p> <ul style="list-style-type: none"> • 36 (15%) high • 31 (13%) medium • 34 (14%) low • 79 (33%) very low • 59 (25%) unknown 	<ul style="list-style-type: none"> • Projections based on future scenarios over 30 years. • Scenario 1b (30 yrs): Drop in resiliency for 3 of 4 representative areas: moderate decrease for mid-Atlantic, light decline for Northeast, very slight decline for Southeast AUs. No change in Canadian AUs. 239 AUs: 33 (14%) high, 27 (11%) medium, 30 (13%) low, 90 (38%) very low, 59 (25%) unknown. • Scenario 2b (30 yrs): Moderate decrease for mid-Atlantic and Northeast, slight decline for Southeast AUs. No change in resiliency of Canadian AUs. 239 AUs: 28 (12%) high, 26 (11%) medium, 31 (13%) low, 95 (40%) very low, 59 (25%) unknown. • See chapter 5 of the SSA Report for other scenarios (Service 2018, pp. 68–93)

Table 2. Species Status Assessment summary for brook floater.

3Rs	Needs	Current Condition	Future Condition (viability)
<p>Representation: <i>genetic and ecological diversity to maintain adaptive potential</i></p>	<p>Ecological variation between small spring-fed headwater streams and larger rivers to preserve the breadth of a species' adaptive diversity.</p>	<p>The brook floater has a wide distribution and shows variation in habitat use as well as host fish use.</p> <p>Brook floater currently occurs in all representative areas.</p>	<ul style="list-style-type: none"> • Projections based on future scenarios over 30 years. • Scenario 1b and 2b: AUs in all representative areas are likely to persist, however the US areas will have lower resiliency. The resiliency of Canadian AUs remains unchanged. • See chapter 5 of the SSA Report for other scenarios (Service 2018, pp. 68–93)
<p>Redundancy: <i>number and distribution of populations (AUs) to help withstand catastrophic events</i></p>	<p>Multiple AUs in each area of genetic representation</p>	<p>In Canada, the majority of AUs are in high condition. In the U.S., AUs in high condition occur in areas of relatively good habitat and water quality, but vary in size and abundance. The Northeast and Southeast representative areas have the largest number of AUs in high condition.</p>	<ul style="list-style-type: none"> • Projections based on future scenarios over 30 years. • Scenario 1b and 2b: AUs in all representative areas are likely to persist, however the US areas will have lower resiliency. The resiliency of the Canadian AUs remains unchanged. • See chapter 5 of the SSA Report for other scenarios (Service 2018, pp. 68–93)

Based on our analysis under Scenario 2, reductions in resilience and redundancy are expected to be greater than under Scenario 1. Out of a total of 239 AUs in the U.S. and Canada, approximately 21 percent fewer AUs are expected to be in high condition (28 total AUs), and 21 percent more AUs are expected to be in very low condition (95 total AUs) within the next 30 years. While brook floater populations continue to occur in scattered populations across all representative areas under this scenario, redundancy will be reduced especially in the mid-Atlantic as the AUs experience decreased resiliency (table 2).

Summary of Threats

We evaluated all relevant threats at the individual, population, and species level, including any regulatory and nonregulatory actions that may be ameliorating those threats. We also considered any potential synergistic effects that may be affecting the species' viability. The primary stressors affecting the brook floater's biological status include disjunct populations facing habitat loss or fragmentation, changes in water flows, and degraded water quality from development, energy production, and agriculture. We also assessed impacts to the brook floater from climate change. There are uncertainties in predicting precipitation changes over such a wide range and assessing the species' response, but we do not expect effects from climate change to be a primary stressor affecting the species' viability. We examined a number of other factors, including inherent factors (small population size and low fecundity), predation, invasive species, and hybridization, and found that these factors did not rise to such a level that affected multiple populations or the species as a whole. Despite impacts from the primary stressors, the species has maintained resilient populations throughout its range. Although we predict some continued impacts from these stressors in the future, we anticipate the species will continue to maintain resilient populations that are distributed widely throughout each of its representative units.

FINDING

Standard for Review

Section 4 of the Act (16 U.S.C. 1533) and its implementing regulations (50 CFR part 424) set forth the procedures for determining whether a species meets the definition of "endangered species" or "threatened species." The term "species" includes "any subspecies of fish or wildlife or plants, and any distinct population segment [DPS] of any species of vertebrate fish or wildlife which interbreeds when mature." The Act defines an "endangered species" as a species that is "in danger of extinction throughout all or a significant portion of its range," and a "threatened species" as a species that is "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." The Act requires that we determine whether a species meets the definition of "endangered species" or "threatened species" because of any of the following factors (i.e., collectively, the "five factors"):

- (A) The present or threatened destruction, modification, or curtailment of its habitat or range;
- (B) Overutilization for commercial, recreational, scientific, or educational purposes;
- (C) Disease or predation;

- (D) The inadequacy of existing regulatory mechanisms; or
- (E) Other natural or manmade factors affecting its continued existence.

Summary of Analysis

The biological information that serves as the basis for our finding is presented in detail in our SSA Report for the Brook Floater (Service 2018, entire) and is summarized above under the BIOLOGICAL INFORMATION section of this Species Assessment Form. In our SSA, we evaluated all threats to the brook floater, which fall under Factor A of section 4(a)(1) of the Act and include the following: habitat loss or fragmentation, changes in water flows, and degraded water quality (e.g., sedimentation and other impairments, as a result of development, energy production, and agriculture. We also evaluated existing regulatory mechanisms (Factor D) for brook floater habitat (e.g., the Clean Water Act) in the context of relevant threats. We assessed the impacts of other actions such as implementation of the U.S. Environmental Protection Agency's (EPA's) recommended water quality criteria by states in the brook floater's range, but these measures are not tied to existing regulatory mechanisms, so we assessed their impact on the brook floater as they related to Factors A, B, C, or E. In addition, we found no information indicating that the brook floater is overutilized for commercial, recreational, scientific, or educational purposes (Factor B). Lastly, we explored any potential stressors related to Factors C and E, which were related to the introduction of invasive species and included increased predation, transmission of disease, and competition for resources (Factor C) and the effects of small population size and low fecundity (Factor E). In all, we found that habitat loss or fragmentation, changes in water flows, and degraded water quality from development, energy production, and agriculture are the primary stressors affecting the brook floater. While the other stressors we analyzed may be affecting individuals of the species, those stressors were not affecting brook floaters at the species level.

To make the determination of whether the brook floater warrants protection as an endangered or threatened species under the Act, we evaluated the current factors and the species' potential future viability given projections of future factors (taking into account the risk factors and their effects on individuals and populations). As described below, we first evaluated whether the brook floater is in danger of extinction throughout its range (an endangered species). Second, we evaluated whether the species is likely to become in danger of extinction throughout its range within the foreseeable future (a threatened species). Third and finally, we considered whether the brook floater is an endangered or threatened species in a significant portion of its range.

Determination of Endangered Throughout Its Range

Under the Act, an endangered species is any species that is "in danger of extinction throughout all or a significant portion of its range." We used the best available scientific and commercial information to evaluate the current viability (and thus risk of extinction) of the brook floater to determine if it meets the definition of an endangered species.

The brook floater currently has a wide distribution and shows variation in habitat use as well as host fish use. Currently, brook floaters are found in 14 of the 16 States where the species was known to occur historically, and in 15 watersheds in Canada. There are 36 populations in high condition and 31 populations in medium condition scattered across the range of the species. The Northeast and Southeast representative areas have the largest number of populations in high condition.

Overall, we found that populations of the brook floater are well-distributed across a large geography, including four representative areas ranging from Canada to the Southeastern United States. With 239 total populations distributed across the species' range, there is adequate redundancy for the species to withstand catastrophic events should any populations become extirpated. There are multiple resilient populations (overall condition in the high and medium categories) in each of the four representative areas and populations have shown persistence over time. The species' variation in habitat use and host fish use demonstrates an adequate level of adaptive capacity (representation) to withstand different environmental conditions.

We examined a number of factors, including small population size, low fecundity, predation, invasive species, and hybridization, and found that these factors did not rise to such a level that affected multiple populations or the species as a whole. The effects of climate change are not expected to be uniformly negative across the species' range. Effects from the primary stressors of habitat loss or fragmentation, changes in water flows, and degraded water quality from development, energy production, and agriculture likely affect individuals in some areas more than others, thereby influencing the species' current distribution. However, these stressors do not appear to preclude the species from maintaining resilient populations across its range in the near term. Additionally, habitat currently occupied by the species continues to be of sufficient quality and quantity to support the needs of individuals and populations in the near term.

As a result, brook floater populations are currently at a low risk of extirpation due to habitat fragmentation, changes in water flows and water quality degradation. Overall, we find that stressors acting on the brook floater are not projected to substantially reduce the overall resiliency, redundancy, or representation of the species in the near term. Therefore, we conclude that the current risk of extinction of the brook floater is sufficiently low such that the species does not meet the definition of an endangered species under the Act.

Determination of Threatened Throughout Its Range

Under the Act, a threatened species is any species that is "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." The foreseeable future refers to the extent to which the Secretary can reasonably rely on predictions about the future in making determinations about the future conservation status of the species (U.S. Department of the Interior, Solicitor's Memorandum, M-37021, January 16, 2009). A key statutory difference between a threatened species and an endangered species is the timing of when the relevant threats would begin acting upon a species such that it may be in danger of extinction, either now (endangered species) or in the foreseeable future (threatened species).

We forecasted the viability of the brook floater under two plausible scenarios at both 15 and 30 years in the future (summarized above under Future Conditions). We assessed relevant risk factors that may be acting on the brook floater in the future, whether we could make reliable predictions about these factors, and how they may impact the viability of the species.

As discussed above, development (e.g., urbanization, agriculture and oil and gas development) is a primary source of the major stressors (e.g., sedimentation, water quality impairment, fragmentation) influencing population resilience and ultimately species viability. Thus, we structured future scenarios around levels of development, which results in land use change. As described in Future Conditions, above, the level of land use integrated the expected stressor effects and we then predicted the future condition of the species based on the response to the future scenarios.

In considering the foreseeable future and whether we could reasonably rely on predictions of land use changes, we determined we could not look beyond 30 years in the future to assess impacts of the primary stressors to the brook floater.

We also assessed data on impacts to brook floater habitat from climate change. Expected effects from climate change are not uniform across the species' wide range and are difficult to predict. In particular, there is considerable uncertainty associated with predicting changes in precipitation. Therefore, although our analysis could not relate climate change quantitatively to population condition, we did consider regional climate summaries and down-scaled projections qualitatively along with the land-use scenarios when evaluating future population condition.

Despite constraints on the certainty of data regarding stressors affecting the brook floater, we used the limited information we had on species' response to inform our timeframe for the foreseeable future. We also used the average lifespan (10 years) and generation time of the brook floater to inform our understanding of the foreseeable future. Specifically, since the brook floater has a relatively short lifespan and generation time, fluctuations in population level demographics that occur over multiple generations may be detectable within a relatively short timeframe.

In all, our estimate of the foreseeable future was shaped by the stressors projected to act on the brook floater, the species' response to those stressors, and the species' lifespan and generation time. Therefore, our estimate of foreseeable future extended approximately 30 years into the future, beyond which we could not reasonably predict the species' status.

Overall, we project that all current populations of brook floaters are likely to persist within the next 30 years, providing adequate representation and redundancy for the species. Resiliency of the U.S. populations is expected to decrease from 36 AUs currently in high condition to 28 AUs and from 31 AUs currently in medium condition to 26 AUs within the foreseeable future. The future condition of populations in Canada did not change relative to current condition because no new information regarding future condition was received during our analysis. However, despite

the decrease in resiliency in the U.S. portion of the range, the species retains sufficient resiliency across its range. Additionally, brook floater redundancy and representation is projected to remain largely unchanged within the foreseeable future, with its numerous populations distributed throughout its range and in each of its four representative areas. Therefore, we conclude that the brook floater's risk of extinction is sufficiently low within the foreseeable future such that the species does not meet the definition of a threatened species under the Act.

Determination of Endangered or Threatened in a Significant Portion of Its Range

Under the Act and our implementing regulations, a species may warrant listing if it is in danger of extinction or likely to become so in the foreseeable future throughout all or a significant portion of its range (SPR). Having determined that the brook floater is not in danger of extinction now or likely to become so in the foreseeable future throughout all of its range, we now consider whether it may be in danger of extinction or likely to become so in the foreseeable future in an SPR. The range of a species can theoretically be divided into portions in an infinite number of ways, so we first screen the potential portions of the species' range to determine if there are any portions that warrant further consideration. To do this we look for portions of the species' range for which there is substantial information indicating that: (1) the portion may be significant, and (2) the species may be in danger of extinction or likely to become so in the foreseeable future in that portion. No portion would warrant further consideration if, for that portion, either one of these initial elements is not present. Therefore, if we determine that either of the initial elements is not present for a particular portion of the species' range, then the species does not warrant listing because of its status in that portion of its range.

We emphasize that the presence of both of the initial elements is not equivalent to a determination that the species should be listed—rather, it is a determination that a portion warrants further consideration. If we identify any portions that meet both of the initial elements, we conduct a more thorough analysis to determine whether the portion does indeed meet both of the SPR standards: (1) the portion is significant and (2) the species is in danger of extinction or likely to become so in the foreseeable future in that portion. Confirmation that a geographic area does indeed meet one of these standards (either the portion is significant or the species is endangered or threatened in that portion of its range) does not create a presumption, prejudgment, or other determination as to whether the species is endangered or threatened in a significant portion of its range. Rather, we must then undertake a more detailed analysis of the other standard to make that determination. If the portion does indeed meet both SPR standards, then the species is endangered or threatened in that significant portion of its range.

At both stages in this process—the stage of screening potential portions to identify any portions that warrant further consideration and the stage of undertaking the more detailed analysis of any portions that do warrant further consideration—it might be more efficient for us to address first the “significance” question or the “status” question. Our selection of which question to address first for a particular portion depends on the biology of the species, its range, and the threats it faces. Regardless of which question we address first, if we reach a negative answer with respect

to the first question that we address, we do not need to evaluate the second question for that portion of the species' range.

In the first stage of the process described above, the stage of screening potential portions to identify any portions for which both of the initial elements are present, we ask whether there is substantial information indicating that a species may be in danger of extinction or likely to become so in the foreseeable future in any portion of its range that may be significant. The Service's most-recent definition of "significant" has been invalidated by the courts (for example, *Desert Survivors v. Dep't of the Interior*, 321 F. Supp.3d 1011 (N.D. Cal. 2018)). Therefore, we screen for the first prong (identifying portions that may be significant) by looking for portions of the species' range that could be significant under any reasonable definition of "significant." To do this, we look for any portions that may be biologically important in terms of the resiliency, redundancy, or representation of the species. To screen for the second prong (identifying portions where the brook floater may be in danger of extinction or likely to become so in the foreseeable future), we consider whether the threats are geographically concentrated in any portion of the species' range at a biologically meaningful scale. If a species is not in danger of extinction or likely to become so in the foreseeable future throughout all of its range and the threats to the species are essentially uniform throughout its range, then the species would not have a greater level of imperilment in any portion of its range than it does throughout all of its range.

After reviewing the biology of the species and potential threats, we have identified portions for which both (1) the species may be in danger of extinction or likely to become so in the foreseeable future and (2) the portion may be significant. We next turned to a detailed analysis of whether the species is in danger of extinction or likely to become so in the foreseeable future in these portions and whether these portions meet the definition of "significant" described above. We first determined whether any of the portions are in fact significant. For any portions that are in fact significant, we would next determine whether the species is in fact in danger of extinction or likely to become so in the foreseeable future in the portion. If there are no portions that are in fact significant, we do not need to evaluate whether the species is in danger of extinction or likely to become so in the foreseeable future in any of the portions we have identified for further consideration.

We first screened the potential portions of the brook floater's range to determine if there are any portions that warrant further consideration. To conduct this screening, we first considered whether the threats are geographically concentrated in any portion of the species' range at a biologically meaningful scale. If the threats to the species are essentially uniform throughout its range, then the species would not have a greater level of imperilment in any portion of its range than it does throughout all of its range and no portion would constitute a significant portion of the range.

We examined the following potential threats: development, including urbanization, energy production (e.g., oil and gas extraction), and agriculture, including cumulative effects. We found that there is a concentration of threats from development in the mid-Atlantic representative

area—development from urbanization and agriculture occur throughout the species' range, but energy production (e.g., oil and gas extraction) is concentrated in the mid-Atlantic. Energy production only occurs to the west of 8 AU's out of the mid-Atlantic's 116 AUs. This means that the mid-Atlantic portion of the range may constitute a significant portion of the species' range because the threats are not uniform throughout the range and the species may face a greater level of imperilment where threats are concentrated.

We next examined the question of whether the mid-Atlantic portion could be a significant portion of the brook floater's range by examining its contribution to the resiliency, redundancy, and representation of the species. We examined whether the portion of the range where threats are concentrated (the mid-Atlantic representative area) is significant at a biologically meaningful scale. Although the mid-Atlantic representative area contains 116 of the total 239 extant populations (49 percent) of the species, only a minority of those 116 populations are currently in high or medium condition (10 percent). Those populations in high and medium condition are projected to worsen under both future scenarios, meaning that the mid-Atlantic representative area is not contributing either currently or in the foreseeable future to the species' total resiliency at a biologically meaningful scale compared to other representative areas. The Northeast and Southeast representative areas, by contrast, are strongholds of resiliency for the brook floater and have the highest numbers of populations in high condition currently and in the foreseeable future. Even if the mid-Atlantic representative area were to become extirpated, the species would maintain sufficient levels of resiliency, representation, and redundancy in the three other representative areas across its range, supporting the viability of the species as a whole.

The best scientific and commercial information available indicates that the mid-Atlantic representative area is not significant; therefore, we did not determine whether the species may be in danger of extinction or likely to become so in the foreseeable future in that portion of the species' range. Our understanding of "significance" in this finding has been arrived at independently and is not precedential. Further, our approach to analyzing SPR in this determination is consistent with the court's holding in *Desert Survivors*.

Our review of the best available scientific and commercial information indicates that the brook floater is not in danger of extinction nor likely to become endangered within the foreseeable future, throughout all or a significant portion of its range. Therefore, we find that listing the brook floater as an endangered or threatened species under the Act is not warranted at this time.

RECOMMENDED CONSERVATION MEASURES

The following are priority conservation measures that may provide benefits to the brook floater:

- State adoption of the EPA's 2013 ammonia criteria recommendations.
- The Brook Floater Working Group (BFWG) is a collection of managers and scientists from federal and state agencies and academic institutions who specialize in mussel ecology and conservation and technical advisors that specialize in mussel survey methods, propagation and decision science. The BFWG is working on the following goals:

- Standardized survey protocols;
- Species distribution models;
- Development of propagation methods to aid in population restoration; and
- Consistent monitoring designs including rapid assessment and long term survey designs to be used throughout the range.
- Continue propagation efforts by multiple States including Massachusetts, North Carolina, South Carolina, and Virginia.

We request that you submit any new information concerning the status of, or threats to, the brook floater to our New York Ecological Services Field Office (see **ADDRESSES** section of the Federal Register Notice for the 12-month finding) whenever it becomes available. New information will help us monitor this species and encourage its conservation. If an emergency situation develops for the species, we will act to provide immediate protection.

DESCRIPTION OF MONITORING

Monitoring is primarily done by the states and Canada, and the level of effort varies. In Canada, the Department of Fisheries and Oceans is conducting research and monitoring to improve knowledge of the brook floater. In the U.S., there are multiple state wildlife action plans across the range of the brook floater. In Vermont, for example, a State recovery plan includes multiple recommended actions including monitoring, addressing spills, addressing dam relicensing, and protecting stream buffers.

COORDINATION WITH STATES

While conducting our SSA for the brook floater, we coordinated with and received information from all the States within the species' current range (Connecticut, Georgia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Pennsylvania, South Carolina, Vermont, Virginia, and West Virginia). The species is considered extirpated in Delaware, the District of Columbia, and Rhode Island.

A draft of the SSA Report was provided to all of the States within the species' range, and we received comments from Canada, Maine, Massachusetts, New York, North Carolina, and West Virginia.

Indicate which State(s) did not provide any information or comments: Connecticut, Georgia, Maryland, New Hampshire, New Jersey, Pennsylvania, South Carolina, Vermont, and Virginia.

REFERENCES CITED

See the references cited section of the Species Status Assessment for the Brook Floater (*Alasmidonta varicosa*), Version 1.1.1, dated August 2018.

APPROVAL/CONCURRENCE: Lead Regions must obtain written concurrence from all other Regions within the range of the species before recommending changes, including elevations or removals from candidate status and listing priority changes; the Regional Director must approve all such recommendations. The Director must concur on all resubmitted 12-month petition findings, additions or removal of species from candidate status, and listing priority changes.

Approve: 
Regional Director, Fish and Wildlife Service

1/31/19
Date

Concur:
Principal Deputy 
Director, Fish and Wildlife Service

7-25-19
Date

Do not concur: _____
Director, Fish and Wildlife Service

Date

Director's Remarks:

Date of annual review:
Conducted by: _____