Sensitive Joint-Vetch
(*Aeschynomene virginica*)

5-Year Review:
Summary and Evaluation

Sensitive joint-vetch
(Photo credit: Zach Bradford, Virginia Department of Conservation and Recreation-Division of Natural Heritage)

U.S. Fish and Wildlife Service
Virginia Field Office
Gloucester, Virginia

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5-YEAR REVIEW
Sensitive joint-vetch (*Aeschynomene virginica*)

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5-YEAR REVIEW
Sensitive joint-vetch (*Aeschynomene virginica*)

1.0 GENERAL INFORMATION

1.1 Reviewers

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Technical Reviewers/Experts:
See Appendix A (Coordination List of Partners and Experts) for list of technical reviewers and experts.

1.2 Methodology Used to Complete This Review:

This 5-year review, conducted primarily by the lead recovery biologist for sensitive joint-vetch (SJV) (*Aeschynomene virginica*), summarizes and evaluates new information relevant to the listing status of the species under the Endangered Species Act (ESA). New data and information regarding the species' population status and habitat used in this report were based on peer-reviewed literature, survey reports, and Element Occurrence (EO) data from state natural resource agencies. In addition, Service Field Offices (FOs) and refuges, state natural resource agencies, federal agencies (e.g., National Park Service, U.S. Army Corps of Engineers), The Nature Conservancy (TNC), and researchers were contacted for up-to-date information on species' occurrences, threats, and recovery activities. All pertinent literature and documents used for this review are on file at the Virginia (VA) FO.

1.3 Background:

1.3.1 FR Notice citation announcing initiation of this review: 86 FR 61778-61780 (November 8, 2021)

1.3.2 Listing history:
FR notice: 57 FR 21569-21574 (May 20, 1992)
Date listed: June 19, 1992
Entity listed: species
Classification: threatened

1.3.3 Associated rulemakings: None

1.3.4 Review history:
Previous 5-Year Review
Initiated: 76373-76375 (December 16, 2008)
Date Finalized: September 25, 2013
Results: No change needed

1.3.5 Species' Recovery Priority Number at start of review: 2. This designation corresponds to a species experiencing a high degree of threat and a high recovery potential.

1.3.6. Recovery Plan:
Name of plan: Sensitive Joint-Vetch (*Aeschynomene virginica*) Recovery Plan
Date issued: September 29, 1995

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate? No. SJV is a plant; therefore, it is not covered by the DPS policy.

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria? Yes, the species has an approved plan containing objective, measurable criteria.

2.2.2 Adequacy of recovery criteria

2.2.2.1 Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat? Yes, the biology and habitat of the species are relatively unchanged.

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)? Yes.

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information:

The criteria for delisting are:

(1) The sensitive joint-vetch and the ecosystem upon which it depends are fully protected – including conservation of all extant sites (or a combination of extant and future sites identified as viable that is commensurate to at least the current known status of the species) -- within the following six watersheds: Manokin [River] in Maryland (MD); Manumuskin River in New Jersey (NJ); Rappahannock, Pamunkey, Mattaponi, and Chickahominy Rivers in VA. These systems must be protected from present and foreseeable anthropogenic and natural threats that may interfere with the survival of the species. Adequate protection measures comprise protection of wetlands where the plant occurs, protection of water quality and quantity, and protection of an adequate upland buffer.

Criterion 1 has not been met.

Healthy, extant populations (i.e., populations with A or B ranks have excellent or good viability, respectively, and are very likely or likely to persist for the foreseeable future, which are reported by state natural resources agencies; see Appendix C for additional information on ranks [NatureServe 2020b]) are found in the Manumuskin (NJ), Patuxent (MD), Rappahannock (VA), Mattaponi (VA), Pamunkey (VA), and James (VA) River system[1], but they are only partially protected by state and federal lands and non-governmental (NGO) organizations, with the Manumuskin population having the highest percentage of land protected at 85 percent (see table 3). However, protection or conservation of a site may not prevent all threats from affecting SJV, such as competition from invasive species, predation, and sea level rise (SLR) and its associated stressors of saltwater intrusion and flooding/inundation. One or more of these threats have been observed at some populations (e.g., Manumuskin River, Pamunkey River, and James River) and could be affecting their viability and survival, but for multiple populations, they are potential future threats (e.g., SLR) or it is unclear if they are affecting the long-term viability of the population (e.g., predation, competition from marsh dewflower *[Murdannia keisak]*). The Manokin River System (MD) has healthy, extant populations but none are on protected lands. See sections 2.3.1.2 "Abundance, population trends, demographic features, or demographic trends" for additional information about these populations and 2.3.2 "Five-Factor Analysis" for details about these threats, as well as other threats. Therefore, based on documentation that a variety of threats have occurred and may continue to occur in nearly all SJV occurrence watersheds and interfere with their survival (see section 2.3.2 "Five-Factor Analysis"), criterion 1 as stated has not been met.

[1] In the delisting criteria, we are assuming that "watershed" is the same as river system, which is composed of the mainstem river and its tributaries. A river system boundary is generally based on sub-basin (Hydrologic Unit Code [HUC]8) boundaries (see figure 2 and table 3). Although the Chickahominy River is a tributary to the James River (VA), we are treating it as a separate river system because it is named separately from the James River in the recovery plan.

(2) Annual monitoring over a 10-year period indicates that the populations in the six river systems are stable or increasing (expanding) and that threats have been alleviated and/or removed. General population, reproductive, and habitat trends should indicate a capacity for being self-sustaining in the wild over the long term with minimal management intervention.

Criterion 2 has not been met.

Annual monitoring over a 10-year period has only occurred in MD since the 2013 5-year review (Service 2013). Annual monitoring at the two populations (or EOs[2]) in the Manokin River system, which began in 1991, has continued and the SJV appears to be stable to increasing, with large interannual fluctuations from none to thousands observed, as is frequently observed for this annual species (see section 2.3.1.2 "Abundance, population trends, demographic features, or demographic trends" for additional information about these populations). Invasive species have been noted as potential threat in the Manokin River for one population, but no other threats were noted (see Appendix B). Annual monitoring of the Manumuskin population stopped after 2008 and resumed in 2020 by assessing areal coverage (stem counts not recorded); however, the recent monitoring indicated loss of areal coverage in the southern extent and this population is potentially declining. Due to the greater number and extent of populations in VA and the increased cost and logistical challenges of conducting comprehensive monitoring, monitoring is sporadic and inconsistent in the drainages in VA. We conducted an evaluation of status based on the best available information and limited data. The SJV population in the Mattaponi River system appears to be stable but consistent and comprehensive monitoring is recommended to confirm this potential trend. See section 2.3.1.2 "Abundance, population trends, demographic features, or demographic trends" for additional information about these populations. In summary, only the Manokin River system meets this criterion; therefore, criterion 2 as stated has not been met.

(3) Life history and ecological requirements of the species are understood sufficiently to allow for effective protection, monitoring, and, as needed, management.

Criterion 3 has not been fully met.

Our knowledge of the life history and ecological requirements of this species has increased, particularly our understanding of the factors affecting seed germination and seedling establishment, characteristics of seed dispersal, and the existence of a seed bank. More work is needed related to habitat requirements across its range, including the importance of disturbance in creating habitat (e.g., storms, potentially mowing), preferred habitat for seed establishment and reintroduction of propagated SJV, and threats such as the effects of invasive, non-native plant species and SLR. Also, more research is needed to inform potential management tools to promote seed dispersal and overwintering survival rates, especially with the increasing threat of SLR.

[2] An EO is the spatial representation of a species or ecological community at a specific location and defined by State Natural Heritage Programs (NatureServe 2002, 2020a).

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history:

Basic biology and life history requirements are found in the SJV recovery plan (Service 1995) and updated information on biology and habitat are found in the 2013 5-year review (Service 2013). Information obtained obtain since the Service's 2013 5-year review is discussed below and is supplemented where necessary with information obtained prior to February 2012[3].

An individual-based model (i.e., model that simulates a population as being composed of discrete individual organisms) was developed to evaluate metapopulation dynamics of SJV in Holts Creek, VA (subpopulation of EO#001 in Pamunkey River) and to assess the effects of environmental stochasticity and water-based seed dispersal on survival and population maintenance in a tidal wetland ecosystem (Crawford et al. 2015). The model indicated that water-based seed dispersal is likely not an important factor in long-term survival of SJV in Holts Creek but could establish some new, small, short-lived subpopulations within the region under favorable environmental stochasticity. Seed dispersal was predicted to be ineffective because there was a lack of suitable habitat for seeds to implant within this system. Under current environmental stochasticity, the model predicted the 100-year chance of extirpation for this population as 2 percent; however, when environmental stochasticity was increased, the probability of extirpation increased significantly. Habitat destruction and climate change would be factors associated with higher levels of environmental stochasticity. Based on the model results, the authors made recommendations to promote dispersal by collecting and placing seeds at suitable, unoccupied sites and to actively manage currently occupied sites (e.g., harvesting seeds in fall to increase overwintering survival rates). It was also noted that SJV has a carrying capacity of approximately 50 plants/square meter (m^2) based on Dr. Alan Griffith's observations (Crawford et al. 2015).

Griffith (2014a) summarized the results of previous research on SJV seed germination and survival, seed bank formation, and seed dispersal to help assess the source of new SJV plants found in new suitable habitat created after a dam was removed near existing SJV subpopulations. Based on data from Baskin et al. (2005), Griffith (2014a) study "suggests that the longest any seeds will survive in a seed bank is eight years." However, Griffith concluded that the previous research supports SJV having a short-lived or Type III seed bank (Thompson and Grime 1979). Specifically, SJV "seeds maintain physical dormancy for 5–6 months and the majority of seeds germinate, or die, within the first year of production. So, only a small percentage of viable seeds are left in the soil one year after production" (Griffith 2014a). The seed survival prediction of eight years is

[3] The Service's 2013 5-year review was signed in September 2013, but the document was completed in February 2012 and status of EOs were based on population data from 2010 and earlier.

based on greenhouse conditions and expected to be shorter in natural conditions. Based on this information, the likely source of the new SJV plants after the dam was removed are seeds dispersed from nearby SJV subpopulations and not from seeds buried under water and the dam for six decades after the dam was built. Both of these studies did not include effects of salinity, which was previously determined that SJV seeds have reduced germination and viability in response to increasing salinity levels (Baskin et al. 1998). SJV primarily occurs in fresh to slightly brackish tidal river systems (see section 2.3.1.6 "Habitat or ecosystem conditions" for additional information).

Summary of new information on the species' biology and life history
Since the 2013 5-year review (Service 2013), new information on SJV's biology and life history clarified and provided additional details about seed dispersal and survival time, but overall, most information about the species is unchanged. Based on modeling efforts for a SJV subpopulation in VA, seed dispersal is likely not an important factor in long-term survival of SJV but could establish some new, small, short-lived subpopulations within the region. Seed dispersal can be effective when new suitable habitat is created (e.g., after a dam was removed) and can be promoted by collecting and placing seeds at suitable, unoccupied sites and harvesting seeds in the fall to increase overwinter survival rates. Although seed survival was predicted to be up to eight years based on greenhouse condition data, research supports SJV having a short-lived seed bank, in which a "majority of seeds germinate, or die, within the first year of production…[and] only a small percentage of viable seeds are left in the soil one year after production" (Griffith 2014a).

2.3.1.2 Abundance, population trends, demographic features, or demographic trends:

Abundance and populations
To assess the distribution, abundance, and current condition of SJV across its range, data were requested from State Natural Heritage Programs. States and partners provided data on 62 populations (or EOs) where SJV has been documented.

Due to the highly variable annual population numbers typical for this species, coupled with the lack of consistent monitoring at many sites throughout its range and lack of standardized monitoring protocol among the states, an accurate assessment of abundance and population trends is difficult to conduct. Furthermore, states define EOs differently. An EO is the spatial representation of a species or ecological community at a specific location. As defined by NatureServe (2002, 2020a), the recommended default EO minimum separation distance for plants (i.e., considered to be part of a different EO or population) is 0.62 mile (1 kilometer [km]). States may use this standard, but may also use other separation distances (i.e., less than or greater than 0.62 miles) or further refine this separation distance based on NatureServe's (2020a) guidance, which considers if

there is continuous suitable habitat, such as flowing water. When the Service conducted the 2013 5-year review, the Virginia Department of Conservation and Recreation-Division of Natural Heritage (VDCR-DNH; also known as VA Natural Heritage Program) was using a greater separation distance based on continuous suitable habitat to define an EO. They defined an occurrence (e.g., subpopulation or feature) as being part of the same EO when it is less than 10 km from the next nearest occurrence, shares linear water-current flow in the same riparian system, and is not separated by an area of persistently unsuitable habitat greater than 3 km long (NatureServe 2020a). Therefore, some states may appear to have fewer EOs relative to other states. For examples, a single EO with multiple subpopulations in the Rappahannock River spans approximately 20 km. Because of these differences, it is not accurate to compare number of EOs by state.

To attempt to compare and assess population trends, Table 1 provides a summary of the number of historical, extirpated, and extant EOs in 1994, 2010, and 2022. To evaluate the current status of the EOs, Table 2 provides a summary of EO by rank in 2022 reported by state natural resource agencies (except as described for EO#006 for NJ; see below). As defined by NatureServe (2002), "EO ranks provide a succinct assessment of ESTIMATED VIABILITY, or PROBABILITY OF PERSISTENCE (based on condition, size, and landscape context) of occurrences of a given Element [i.e., species or taxon]. In other words, EO ranks provide an assessment of the likelihood that if current conditions prevail an occurrence will persist for a defined period of time, typically 20–100 years." State natural resource agencies assign ranks to their EOs. Based on the definitions, EOs with:

- A or B ranks have excellent or good viability, respectively, and are very likely or likely to persist for the foreseeable future (i.e., at least 20–30 years), respectively, if current conditions prevail (NatureServe 2020b, see Appendix C for additional information);
- C rank have fair viability; the definition for this rank includes EOs that have uncertain persistence under current conditions, may persist with appropriate protection or management, or are likely to persist but may decrease in size or condition; and
- D rank have poor viability and "if current conditions prevail, occurrence has a high risk of extirpation" (NatureServe 2020b).

For the purposes of this review, we assumed that EOs with ranks of F (failed to find), H (historical), or X (extirpated) are not currently extant. It should also be noted that the rank of some extant EOs have not been reviewed for 10 years or more although they have been surveyed, providing some uncertainty about the current status and ranks of these extant EOs. For example, the rank of six extant EOs in VA have not been reviewed since 2007, of which one EO (in the Pamunkey River) with a CD-rank has not been observed since 1999 and was last surveyed in 2014 (VDCR-DNH 2023).

Across the historical range from PA to NC as of 2022, 19 of 62 total historically known EOs are extant (30.6 percent) (table 1). The majority of extant EOs are located in MD and VA (figure 1). Ten EOs have an A or B rank (16.1 percent of historically known EOs) and 7 have a C rank (11.3 percent of historically known EOs) (table 2). Two EOs (3.2 percent of historically known EOs) have a D rank (poor condition). The total number of EOs has increased from 59 to 62 from 2010 to 2022 due to 2 new EOs in MD and 1 new EO in NC from reintroduction. However, there is a net decrease in the number of extant EOs from 27 to 19 (29.6 percent decline), because the rank of 9 EOs was changed to X or H in NJ (1), NC (7), and MD (1) and the rank of 2 EOs was changed to F in MD. As noted in the 2013 5-year review, the total number of EOs reported in 2010 in VA was 12 fewer than reported in the 1994 recovery plan (34 vs. 22) because some previously identified EOs had been merged into larger EOs to conform to guidance from NatureServe on the delimitation of plant occurrences, as described above (Service 2013).

Table 1. Number of EOs reported in 1994 (Service 1994), 2010 (Service 2013), and 2022 by status. H=historical, E=extant, X=extirpated, and F=failed to find. Shaded rows are states with no extant EOs and shaded columns are historical or extirpated EOs. See Appendix C for definitions.

	Number of EOs in 1994 Recovery Plan			Number of EOs in 2010				Number of EOs in 2022				
State	**H**	**E**	**Total**	**H**	**X**	**E**	**Total**	**H**	**X**	**F**	**E**	**Total**
Delaware	1	0	1	1	0	0	1	1	0	0	0	1
Maryland	7	4	11	5	0	6	11	6	0	2	5	13
Pennsylvania	1	0	1	1	1	0	2	1	1	0	0	2
North Carolina	11	2	13	7	0	7	14	7	7	0	1	15
New Jersey	8	1 [a]	9	7	0	2 [a]	9	7	1	0	1	9
Virginia	12	22	34	10	0	12	22 [b]	9	1	0	12	22
All States	**40**	**29**	**69**	**31**	**1**	**27**	**59**	**31**	**10**	**2**	**19**	**62**

[a] The recovery plan considered only the Manumuskin River EO to be extant. Although the Wading River EO has not been observed since 1984, the New Jersey Natural Heritage Program had not classified it as historical because consistent annual monitoring had not been conducted and a seed bank may have existed at that time (D. Snyder, New Jersey Natural Heritage, pers. comm. 2010a *in* Service 2013).

[b] The total number of EOs reported in 2010 in VA was 12 fewer than reported in the 1994 recovery plan because some previously identified EOs had been merged into larger EOs to conform to guidance from NatureServe on the delimitation of plant occurrences, as described above (Service 2013).

Table 2. Number of EOs by rank (i.e., estimated viability by state natural resource agency) in 2022. Extant EOs are those with A, B, C, or D rank. A rank includes A or AB; B rank includes B, BC, or BD; and C rank includes C or CD. Shaded rows are states with no extant EOs. See Appendix C for definitions.

State	**Excellent (A rank)**	**Good (B rank)**	**Fair (C rank)**	**Poor (D rank)**	**Failed to Find (F rank)**	**Historical (H rank)**	**Extirpated (X rank)**	**Total (all ranks)**
Delaware	0	0	0	0	0	1	0	1
Maryland	1	4	0	0	2	6	0	13
New Jersey	1	0	0	0	0	7	1	9
North Carolina	0	0	1	0	0	7	7	15
Pennsylvania	0	0	0	0	0	1	1	2
Virginia	1	3	6	2	0	9	1	22
All States	**3**	**7**	**7**	**2**	**2**	**31**	**10**	**62**

Data for each EO across the range of the SJV are shown in Appendix B. The following is a summary of the available abundance and population trend data for each state in the SJV range from north to south:

Pennsylvania: No new information. Field surveys have been conducted since 2010 in areas of historical records while primarily searching for other plant species and SJV has not been found (S. Grund, Pennsylvania Natural Heritage Program, email to J. Stanhope, Service, April 5, 2022). SJV continues to be extirpated from this state.

New Jersey: Field surveys were conducted via kayak and drone at higher probability locations, based on predicted suitable habitat modeled by Chazal et al. (2017), and at historical EOs along the Cohansey, Menantico, Maurice, Muskee, Bass, Wading, Mullica, and Tuckahoe rivers in 2020 and 2021 (Ray 2022). No new populations were found or historical EOs rediscovered during these surveys.

At EO#006 Wading River, no SJV has been found when visited at least 3 times over the past 10 years, in addition to the 2020/2021 survey referenced above (Ray and Kelly 2021; Ray 2022; J. Kelly, Raritan Valley Community College, email to W. Walsh et al., Service, December 18, 2023). The species was last observed at this site in 1984 and thus, has not seen in more than 36 years. It was observed that parts of the site were "being overrun by *Phragmites*" and "may have been exposed to herbicides in the mid-1980's" (Service 2013). The New Jersey Department of Environmental Protection (NJDEP) appears to consider the species extant with a EO rank of D. However, based on the last reporting of EO data to the Service's NJFO in 2018, the best available information (i.e., repeated surveys over the past 10 years, not seen in more than 36 years) indicates that EO#006 Wading River is extirpated.

Only one population, EO#003 Manumuskin River, remains extant in NJ, with counts as high as 20,000 plants in 1996 and as low as 132 plants in 2003. From 1988–2008, monitoring with approximate counts of plants occurred annually; after 2008, the New Jersey Chapter of TNC stopped monitoring the population. The NJDEP-Office of Natural Land Management (NJDEP-ONLM) surveyed the population in 2020 and 2021 by assessing areal coverage (stem counts not recorded). They observed that the southern areal extent of the population continued to contract, as was also observed between 2007 and 2008 when there was a 50-percent loss of coverage along the marsh edge (Olson and Ray 2022). SJV continued to be observed in large patches in the northern extent of the population during the 2020/2021 surveys but changes in this area could not be quantitatively assessed because its areal extent was not well mapped in earlier surveys. Although plants were not directly counted, NJDEP-ONLM estimated 200 to 2,000 stems in 2020 and 2021 (Ray 2022).

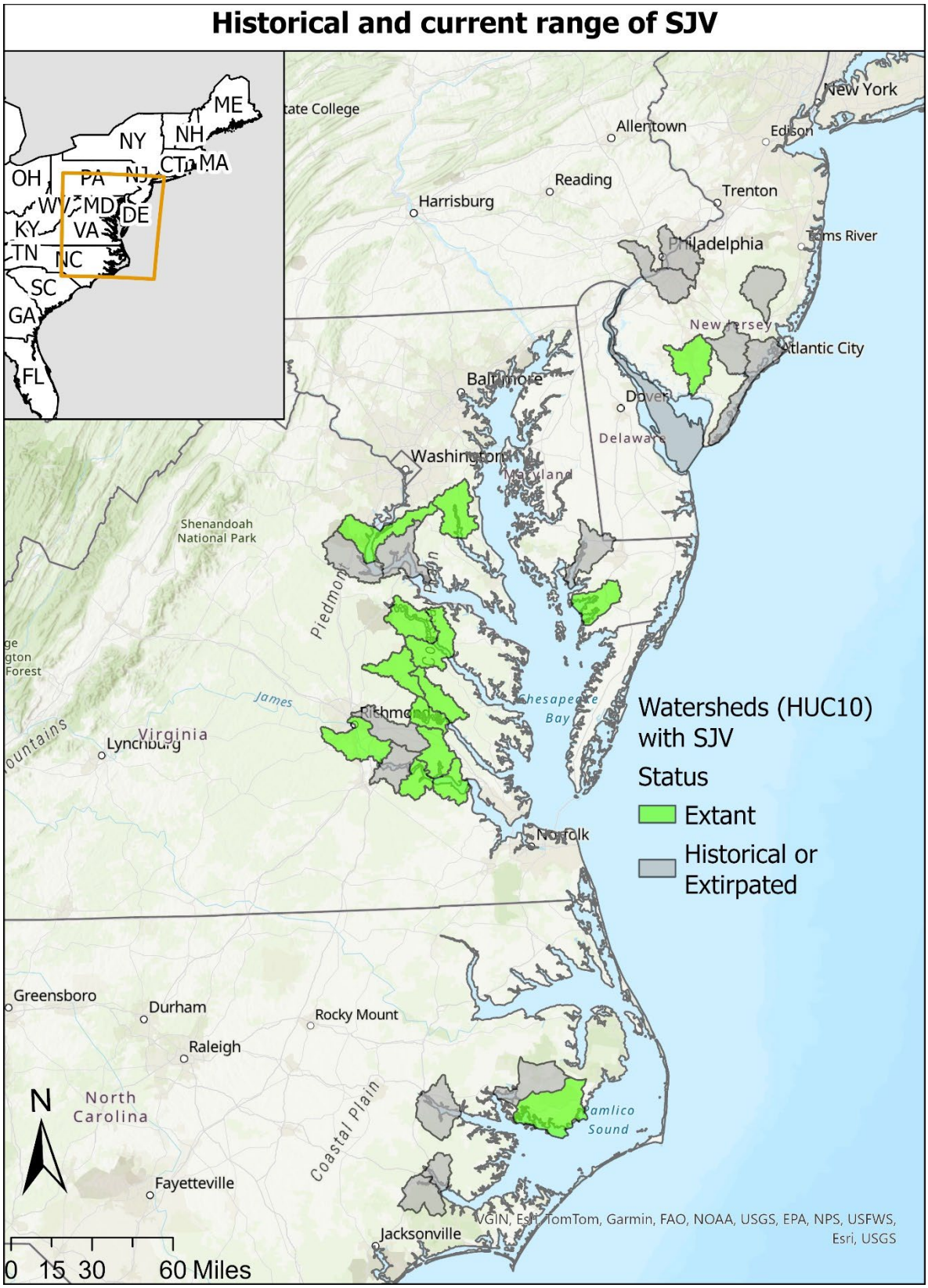

Figure 1. Historical and current range of SJV. Watersheds (HUC10) where SJV is considered extant or historical/extirpated, as of 2022.

In early September 2022, a severe insect herbivory event was observed at EO#003 Manumuskin River where approximately 80 percent of plants displayed extensive damage, with partial to complete loss of leaves, seed, and stem (Ray 2023). The insect was not present and could not be identified because of the timing of surveys. Estimates of abundance based on kayak surveys decreased from approximately 3,000-3,500 plants in 2022 to less than 250 plants in 2023 (Ray 2023). No insect herbivory was observed in 2023.

In summary, there is a single extant population in NJ with large year-to-year fluctuations in number of plants and recent estimates appear to be within normal variation but below the 1980-2008 average (excluding 1994 and 1996 peaks). Due to the loss of areal coverage in the southern extent, this population is potentially declining. NJDEP-ONLM indicated that more thorough surveys are needed to more precisely characterize the apparent declining trend (Olson and Ray 2022).

Delaware: No new information. Field surveys have been conducted annually since 1988 in potential habitat and SJV has not been found (B. McAvoy, Delaware Department of Natural Resources, Delaware Division of Fish and Wildlife, email to J. Stanhope, Service, July 3, 2024). SJV continues to be extirpated from this state.

Maryland: SJV is currently found in the Patuxent River and Manokin River drainages, with multiple locations documented historically along the Nanticoke, Patuxent and Potomac rivers. Thirteen EOs are currently recognized by the Maryland Department of Natural Resources (MDDNR) with five of those considered extant (table 1). Although two new EOs were discovered in the Patuxent River since the 2013 5-year review (Service 2013), ranks of two extant EOs were changed to F in the Patuxent River and rank of one extant EO was changed to H in the Potomac River. Therefore, there is a net decrease in the number of extant EOs from six to five. MDDNR monitors extant populations annually and was able to provide recent assessments of the status of MD populations (L. Davidson, MDDNR, email to J. Stanhope, Service, May 12, 2022 and November 14, 2023). The following provides a summary of surveys at EOs since the 2013 5-year review. See Appendix B for additional details.

Patuxent River: The farthest upstream EO is the Mataponi Creek (EO#006), a tributary to the Patuxent River. Annual surveys from 2015 to 2018 had abundance estimates from 450 to 800 plants, but abundance estimates declined to 12 and 6 plants in 2019 and 2020, respectively (L. Davidson, MDDNR, emails to J. Stanhope, Service, May 12, 2022 and November 14, 2023). Due to observations of low abundance in 2019 and 2020 and common reed (*Phragmites australis*; commonly known as *Phragmites*) invading the habitat, the marsh was treated with herbicide to remove the *Phragmites* in 2021. SJV was discovered in Yellow Bank Marsh (EO#012) and Airport Marsh (EO#013) on the Patuxent River in 2015 and 2014, respectively. Annual surveys from 2015 to 2020 at Yellow Bank Marsh documented fluctuating abundance from no plants to a high of 162 plants. Annual

surveys from 2014 to 2019 at Airport Marsh documented fluctuating abundance from a low of 30–35 plants to a high of 188 plants. Annual surveys from 2013 to 2015 at Graham Creek Marsh (EO#011) documented no SJV plants, where it was last observed in 1996; therefore, its EO rank was changed to F. Annual surveys from 2013 to 2015 and in 2020 were conducted at Magruder Ferry Seep/Springy Marsh (EO#010) and two plants were observed in 2014 but none in the other years; the EO rank was changed to F.

Overall, the SJV in the Patuxent River system has a contracted range with the loss of two EOs on the downstream end of the river. For one EO, it is unclear if the population is stable due to significant declines in the last two years of monitoring and invasion of *Phragmites*; however, the low recent abundance may be part of the natural large fluctuations or "boom and crash" population dynamics observed for this species. For the two new extant EOs, the long-term trends are unknown because monitoring has been conducted for less than 10 years but they both have EO ranks that include B (i.e., estimated good viability) and have extensive potential habitat. Additional monitoring of these EOs is needed to better assess their status.

Potomac River: Surveys in 2017 and 2019 at Chicamuxen Creek Marsh (EO#005) failed to observe SJV, which had not been observed there since 1994; this EO is now considered H. Potential causes of the loss of this population include competition with indigo bush (*Amorpha fruticosa*) and *Phragmites* and erosion (L. Davidson, MDDNR, email to J. Stanhope, Service, May 12, 2022). There are no extant EOs in the MD portion of the Potomac River system (see VA below).

Manokin River (Eastern Shore): Annual monitoring has continued at the two EOs on the Eastern Shore, which began in 1991. The upper Manokin River EO (EO#001) had as many as 10,000 plants counted in 2015 and as few as 3,000 plants (estimated) in 2017. In many of the years since 2011, actual number of plants were not counted and were noted as "present and dense" in 2012–2014 and "present-average year (no count)" in 2018–2020. This population has expanded northward up the Manokin River over time. At the Taylor Branch EO (EO#008), the annual total has fluctuated from 0 to as high as 793 plants and habitat is judged as excellent (C. Frye, MDDNR, email to J. Stanhope, Service, July 5, 2024). The average number of plants from 1991–2020 was 351 with large fluctuations. In summary, SJV in the Manokin River system appear to be stable to increasing.

Virginia: SJV has been documented from six river drainages or systems, with multiple locations documented historically along stretches of these rivers (north to south): Potomac, Rappahannock, Mattaponi, Pamunkey, Chickahominy, and James. It is difficult to assess the overall status of EOs in VA due to the lack of recent and consistent monitoring data and known interannual variability in abundance, but we provide an evaluation based on the best available information.

There is a recent find in Powhatan Creek (tributary to the James River) and an apparent expansion of an EO in the upper James River (Turkey Island Marshes). Five historical EOs in the Mattaponi River, Morris Creek (tributary to Chickahominy River), and James River were resurveyed since the 2013 5-year review (Service 2013) and no SJV were observed. The number of extant EOs (12) is unchanged since 2012, but the ranks for 6 EOs have not been evaluated since 2007 and 1 EO rank may merit change to X or F because it has not been observed since 1999. The overall trend may be a more contracted range and/or possible dwindling or loss of small subpopulations within the Rappahannock, Pamunkey, Chickahominy, and James River systems. The status of SJV in the Potomac River is unknown. The SJV population in the Mattaponi River system appears to be stable. The following provides a summary of surveys at extant EOs since the 2013 5-year review. See Appendix B for additional details.

Potomac River: A survey conducted in 2013 at Brent Marsh (EO#016) documented hundreds of flowering and fruiting plants. No plants were observed in a 2021 survey but the marsh was surveyed from a boat along the eastern edge and the boat could not get close to the marsh edge due to thick submerged aquatic vegetation (VDCR-DNH 2023).

Brent Marsh (EO#016) is the only remaining EO in the Potomac River system in VA and MD. Its status is unknown due to infrequent and limited survey effort; consistent monitoring with additional survey work within the marsh is needed to verify its status.

Rappahannock River: EO#028 spans approximately 20 km along the Rappahannock River. Surveys conducted in 2013, 2014, and 2016 were inconsistent in their survey areal extents, where they were surveyed at different number of subpopulations; numbers of SJV varied from 62 plants in 2014 to 1,832 plants in 2016 (Griffith 2014b; VDCR-DNH 2023; D. Berry, College of William and Mary [W&M], email to J. Stanhope, Service, July 12, 2022). Most recently, a survey in 2024 found approximately 27,500 plants in several new subpopulations immediately adjacent to corn or soybean fields in habitat that is not considered tidal freshwater marsh but in wet areas that may be subject to flooding and located near other known subpopulations (approximately 10 to 470 meters [m] away) (D. DeBerry, W&M, email to K. Tignor, Virginia Department of Agriculture and Consumer Services, October 10, 2024; J. Stanhope, Service, email to S. Dutilly and D. DeBerry, W&M, October 11, 2024). Due to the lack of consistent monitoring, it is difficult to assess spatial and demographic trends over time, however, there may be losses of some small subpopulations in other areas of the 20-km range of the population.

Surveys conducted in 2017 in Piscataway Creek (EO#009) and Mount Landing Creek (EO#034) observed at least 15 plants and 22 plants, respectively (Van Alstine 2018). One site in Mount Landing Creek that previously had SJV and lower reaches of both of these creeks, downstream of the SJV occurrences, were

dominated by big cordgrass (*Spartina cynosuroides*). Species composition shift to big cordgrass is indicative of increasing salinity from freshwater to oligohaline (salinity of 0.5 to 5 parts per thousand [ppt]) conditions) (Perry and Hershner 1999). Both of these populations are at the downstream end of the range in the Rappahannock River.

Overall with three extant EOs, the SJV in the Rappahannock River system appears to have maintained its range but has possibly lost some small subpopulations in some areas and gained new subpopulations in other areas.

Mattaponi River: EO#025 spans approximately 16 km along the Mattaponi River and includes one small tributary at the downstream end of the EO. In 2014, 1,844 stems were counted at 13 subpopulations in this EO, which is likely an underestimate because the surveyor was unable to access the most upstream area due to time constraints and low tide (Griffith 2014b, VDCR-DNH 2023). The majority of plants were found within 3 to 4 m of the river's edge with highest densities on the berm of the marsh. Griffith (2014b) observed an expansion of the extent of this EO by approximately 200 m into the tributary, which is located at the downstream end of the EO. A survey in 2019 documented hundreds of plants at three subpopulations and at least 20 plants at another subpopulation, but this was not a comprehensive survey of all areas of marshes in the EO. Overall, the SJV in the Mattaponi River system appears to be stable and expanding at the downstream end of the EO in a small tributary.

Pamunkey River: EO#001 spans approximately 10 km along the Pamunkey River and includes multiple small tributaries to the river with marsh habitat. Surveys in 2012, 2014, 2016, 2018, and 2020 conducted at varying numbers of subpopulations found from 793 plants in 2014 at 17 different subpopulations to 24 plants in 2016 at a single subpopulation (Griffith 2014b, VDCR-DNH 2023).

EO#023 at Sweet Hall Marsh, downstream of EO#001, was surveyed in 2014 and no SJV were observed. Although still considered extant by VDCR-DNH, the species has not been observed at this EO since 1999 and Chesapeake Bay National Estuarine Research Reserve of VA (CBNERR-VA) staff indicated that they have not observed the plant during monitoring conducted every 2–3 years along established vegetation transects in Sweet Hall Marsh. Increasing tidal inundation, bank erosion, and shifts in species composition to non-freshwater plant species (e.g., saltmarsh cordgrass *[Spartina alterniflora]*) have been observed at this site (S. Lerberg, CBNERR-VA, pers. comm. October 3, 2019; S. Lerberg, CBNERR-VA, email to, J. Stanhope, Service, July 28, 2022). Saltmarsh cordgrass is typically found in brackish to saline habitats (salinity of 8 to 33 ppt). Confirming increasing salinity at the Sweet Hall Marsh EO over time, big cordgrass was documented as a dominant species in the marsh in vegetation surveys in 1987 but not in 1974 (Perry and Hershner 1999). The status of this EO needs to be reevaluated by VDCR-DNH (last reviewed in 2007), as this EO is likely extirpated.

Overall, the SJV in the Pamunkey River system appears to have maintained its range but has possibly lost some small subpopulations. However, if the EO at Sweet Hall Marsh is reevaluated and determined to be extirpated, the range in the Pamunkey River would be contracted.

James River

Mainstem and immediate tributaries: Surveys in 2013 and 2017 at the most upstream SJV EO in the James River (EO#035 Turkey Island Marshes) found 2 and 335 plants, respectively. During the 2017 survey, new locations were found approximately 0.3 km upstream and 0.2 km downstream of previously mapped locations within Turkey Island Creek, expanding the extent of this population (Van Alstine 2018). A new location along the marsh edge of Turkey Island (only SJV in marsh habitat fronting the James River), approximately 2.4 km downstream of a previously mapped location, was found and is located within the Service's Presquile National Wildlife Refuge (NWR). At Kittewan Creek (EO#007), a survey in 2017 did not find any plants at three previously mapped sites but found three plants nearby.

The farthest downstream SJV EO in the James River (EO#018 Sandy Bay Marsh/Back River Marsh) is located within the National Park Service's Colonial National Historical Park and has not been observed since 2007 (two plants). The site was last surveyed in 2010, which included other areas of potential habitat (National Park Service 2010). Big cordgrass was the dominant plant in areas where SJV was previously observed (e.g., western portions of the marsh), comprising over 85 percent of the vegetive cover. A range of salinity was observed on the marsh from west to east with freshwater to oligohaline to more mesohaline (higher salinity, $\geq$5 ppt) conditions with saltmarsh cordgrass becoming the dominant plant species. The dominant species composition shift to saltmarsh cordgrass in the eastern portion of the marsh is indicative of increasing salinity at Back River Marsh (Sutter et al. 2014).

A new occurrence of SJV (determination by VDCR-DNH of whether it is a new EO or sub-EO is pending) was discovered in Powhatan Creek, a tributary to Back River Marsh, on August 15, 2022 with approximately 140 plants (DeBerry 2022). When the surveyor, VDCR biologist, and a Service biologist visited the site on October 6, 2022, almost all leaves were defoliated from all plants and very few seed pods remained (J. Stanhope, Service, email to B. Cartica, NJDEP, October 14, 2022). See section 2.3.2.3 (Factor C. Disease or predation) about the potential causes of the defoliation. In 2023, six plants were counted. Also see section 2.3.1.6 "Habitat or ecosystem conditions" for additional information about habitat conditions.

Overall, SJV in the James River system appears to have maintained its range but possibly lost some small subpopulations at two EOs. The EO at the upstream end

of the range appears to be expanding in extent. Additionally, one new occurrence was discovered.

Chickahominy River: No SJV plants were observed during 2017 surveys conducted at two small EOs in Yarmouth Creek (EO#006) and Old Neck Creek (EO#014), at which SJV were last observed in 2003 and 1996, respectively (Van Alstine 2018). It was noted that additional survey further back into the Old Neck Creek marsh should be conducted.

Overall, the SJV in the Chickahominy River system appears to be decreasing in abundance and extent; however, consistent monitoring with additional survey work within the marsh should be conducted to verify its status.

North Carolina: North Carolina Natural Heritage Program (NCNHP) conducted monitoring survey efforts in 2013-2014 at known EOs and in suitable habitat near these EOs along roadside ditches and via boat at marsh habitats (NCNHP 2013). No new SJV occurrences were found. Only one known EO (#002) was found to have SJV in 2013 (two plants), but surveys in 2014 and 2019 found no plants. In known EO locations, NCNHP observed possible herbicide usage in 2014 next to railroad tracks and hydrologic changes due to canal digging (J. Amoroso, NCNHP, email to J. Stanhope, Service, April 11, 2022). NCNHP changed the EO (#002) rank from F to possibly H in 2021. As a result, all 14 previously known EOs are currently either extirpated, possibly historical, or historical (tables 1 and 2).

There is one new EO (#021) due to reintroduction of propagated SJV in 2021 at Mattamuskeet NWR, funded by the Service's Coastal Program (D. Suiter, Service, email to J. Stanhope, November 18, 2021). In 2020, Mike Kunz at the North Carolina Botanical Gardens (NCBG) conducted a seed increase project at the garden in Chapel Hill, NC, in which he grew plants from seeds that originated from EO#020 (sub-EOs 2 and 11; from the same roadside ditch near Lake Mattamuskeet approximately 2–3 km apart) and collected new seeds for the reintroduction effort at Mattamuskeet NWR (M. Kunz, NCBG, email to J. Stanhope, Service, January 24, 2024). The seeds used for the project were previously held in long-term storage for 5 and 9 years from sub-EOs 2 and 11, respectively. This project resulted in the production of more than 10,000 seeds and leftover seeds went into long-term storage as described below. In spring 2021, the NCBG planted about 300 seeds in containers and on June 17, 2021, the Service and NCBG planted 266 plants in a prepared area (mowed and burned during the previous winter) at Mattamuskeet NWR. NWR staff reported problems with aphid invasions through the growing season. In fall 2021, it was estimated that 182 of 266 plants (68 percent) survived through the growing season and produced seeds (D. Suiter, Service, email to J. Stanhope, Service, February 8, 2022). The average height of 28 plants that remained standing was 81 cm, which may be shorter than typically observed of SJV in roadside ditches in NC. A total of 18 plants were found in November 2022, but no plants were found in

September 2023; an obvious reason for lack of plants in 2023 could not be determined (D. Suiter, Service, email to J. Stanhope, Service, January 24, 2024). At this time, the status of the reintroduced population is considered extant but uncertain.

Seed collections

Seeds from SJV are held at four locations. Five seeds collected from the Manumuskin River, NJ (EO#003) in 1990 are held in long-term storage at the Desert Legume Program seed bank in Tucson, AZ, which were transferred there from the Native Plant Trust (formerly New England Wild Flower Society) (M. Johnson, Desert Legume Program, to J. Stanhope, Service, October 25, 2022). As described above, the NCBG conducted a seed increase project from EO#020 (near Lake Mattamuskeet, NC) and placed leftover seeds into long-term storage at the NCBG and the National Laboratory for Genetic Resource Preservation in Fort Collins, CO (D. Suiter, Service, email to J. Stanhope, November 18, 2021). Over 4,800 seeds are held in dry storage (e.g., room temperature in laboratory environment) at University of Mary Washington from multiple EOs: (1) four EOs in VA (EO#001 Pamunkey River; EO#025 Mattaponi River; unknown location in Chickahominy River; EO#028 Rappahannock River); (2) two locations in MD (EO#008 Manokin River; unknown location); and (3) one location in NJ (EO#003 Manumuskin River) (A. Griffith, University of Mary Washington, email to J. Stanhope, Service, and others, March 14, 2025). The seeds were collected from 2004 to 2015.

Summary of abundance, population trends, demographic features, or demographic trend

Data gathered since the recovery plan (1995) and 2013 5-year review provide additional information on the number of populations, abundance, and viability of SJV throughout its range, but it is difficult to assess population trends due to the highly variable annual population numbers typical for this species, lack of consistent monitoring at many sites, and lack of standardized monitoring protocol among the states. There are also differences among the states in how EOs or populations are defined (e.g., minimum separation distance) and when EOs are considered F or X.

Across the historical range from PA to NC, as of 2022 the data indicates that 19 of 62 (30.6 percent) historically known EOs are extant. The majority of extant EOs are located in MD and VA with only one remaining each in NJ and NC. The status of the extant EO (reintroduced) in NC is uncertain. SJV continues to be extirpated from DE and PA. Across the range, 10 EOs, 5 in MD, 1 in NJ, and 4 in VA (16.1 percent of historically known EOs), are considered to have excellent or good viability (A or B rank) and are very likely or likely to persist, respectively, if current conditions prevail. However, seven EOs (11.3 percent of historically known EOs) have an uncertain probability of persisting (fair viability; C rank) and two EOs (3.2 percent of historically known EOs) have a poor probability of

persisting (D rank) and a high risk of extirpation, if current conditions prevail. Although the total number of EOs has increased from 59 to 62 from 2010 to 2022 due to 2 new EOs in MD and 1 new EO in NC from reintroduction, there is a net decrease in the number of extant EOs from 27 to 19 (29.6 percent decline). Since 2010, the ranks of 9 EOs were changed to X or H in NJ (1), NC (7), and MD (1) and the ranks of 2 EOs were changed to F in MD.

Many small populations or subpopulations appear to be dwindling, possibly disappearing, or have already disappeared, such as populations in the Patuxent (MD), Potomac (MD/VA), and Chickahominy (VA) Rivers and subpopulations in the Rappahannock (VA), Pamunkey (VA), and James (VA) Rivers. The range also appears to be contracting at the downriver end of the Patuxent population and potentially the Pamunkey population, likely to due to increasing salinity. Consistent monitoring with additional survey work for some of the populations should be conducted to verify their status. SJV's continued presence in NC is tenuous and only due to a reintroduction effort. At the same time, populations/subpopulations on the Manumuskin (NJ), Manokin (MD), and Rappahannock (VA) Rivers, all with histories of fluctuating but at times large (at least several thousand plants) population sizes, are persisting; the Manokin River populations appear to be stable to increasing. Other generally more modest-sized populations, such as along the Mattaponi and Pamunkey Rivers (VA), are persisting, with the Mattaponi population appearing to be stable. A new subpopulation in a tributary and an expanding population at the upstream end of the James River (VA) range have increased the importance of this river system (or drainage) since the recovery plan.

Since the 2013 5-year review, annual monitoring has been conducted over at least 10 years at the most robust SJV populations/subpopulations in MD only. Annual monitoring of the Manumuskin population stopped after 2008, and most recently resumed in 2020 by assessing areal coverage (stem counts not recorded). Populations/subpopulations in VA are monitored sporadically and inconsistently, with larger scale surveys conducted in 2014 at almost all historically known sites in the Mattaponi, Pamunkey, and Rappahannock River systems and one historically known site in the Chickahominy River system (Griffith 2014b) and in 2017 at seven historically known sites within the Rappahannock, Chickahominy, James River systems (Van Alstine 2018). Gaps in our knowledge of the status of many of the smaller subpopulations/populations, particularly in VA where the majority of extant occurrences are located, makes it difficult to confirm with confidence some of the trends suggested above.

2.3.1.3 Genetics, genetic variation, or trends in genetic variation:

No new information was discovered during the course of this review.

2.3.1.4 Taxonomic classification or changes in nomenclature:

No changes in taxonomic classification or nomenclature have been published for this species since the recovery plan was completed in 1995.

2.3.1.5 Spatial distribution, trends in spatial distribution, or historic range:

The historical range of the species can be divided into three regions (based on HUC6 sub-regions) of the Coastal Plain physiographic province: (1) Lower Delaware/Mid-Atlantic Coastal, (2) Chesapeake Bay, and (3) Neuse/Pamlico. The current spatial distribution of SJV extends from the Manumuskin River (NJ) to Lake Mattamuskeet (NC) with 89 percent of extant EOs (17 of 19) in the Chesapeake Bay (figure 2, table 3). Since 2010, the spatial extent has contracted with losses of SJV EOs in one HUC10 watershed in NJ and two HUC10 watersheds in NC, leaving a single extant EO each in the Lower Delaware/Mid-Atlantic Coastal and Neuse/Pamlico regions.

To better understand the distribution of SJV occurrences, table 3 provides a summary of watersheds (HUC10s) and EOs by river system in each region and their status in terms of A, B, or C rank and land management. Across the range, SJV is extant in 14 of 30 historically occupied watersheds (46.7 percent).

Lower Delaware/Mid-Atlantic Coastal region: one of eight historically occupied watersheds (12.5 percent) has extant EOs (in the Manumuskin River). One of 12 historically known EOs (8.3 percent) has an A or B rank, for which most of the population is on permanently managed/protected land.

Chesapeake Bay region: 12 of 17 historically occupied watersheds (70.6 percent) have extant EOs. Nine of 34 historically known EOs (26.5 percent) have an A or B rank, for which 6 of these EOs have partially managed/protected land. Six of 34 historically known EOs (17.6 percent) have a C rank.

Neuse/Pamlico region: one of five historically occupied watersheds (20.0 percent) has extant EOs, which is the reintroduced EO at Mattamuskeet NWR. Although on protected/managed land, the only extant EO has a C rank. Although protection and management of a site may prevent direct impacts of habitat loss due to development, it does not prevent other threats (e.g., *Phragmites*, SLR) from affecting SJV, as has been observed at sites in the Manumuskin River, Pamunkey River, and James River.

Assuming EOs with A or B rank are populations that are sufficiently healthy and have adequate habitat to likely persist for the foreseeable future, based on the detailed EO rank definitions (NatureServe 2020b), figure 3 provides a map of the number of "healthy" EOs within each river system. Healthy EOs are found in the northern and middle portion of the range but are not evenly distributed. All but two of the river systems in the Chesapeake Bay have at least one healthy EO,

while the single river system in the Neuse/Pamlico region has no healthy EOs. The number of C-ranked EOs are also included in figure 3. Although their probability of persistence is uncertain under current conditions, they may persist for the foreseeable future if managed or protected.

Summary of spatial distribution, trends in spatial distribution, or historic range

The current spatial distribution of SJV extends from the Manumuskin River (NJ) to Lake Mattamuskeet (NC) with 89 percent of extant EOs (17 of 19) in the tributaries of the Chesapeake Bay in MD and VA. Since 2010, the spatial extent of SJV has contracted with losses of EOs (or populations) in one HUC10 watershed in NJ and two HUC10 watersheds in NC, leaving a single extant EO each in the Lower Delaware/Mid-Atlantic Coastal and Neuse/Pamlico regions. Across the range, SJV is extant in 14 of 30 historically occupied watersheds (46.7 percent). Within the Chesapeake Bay region, 12 of 17 historically occupied watersheds (70.6 percent) have extant EOs and 9 of 34 historically known EOs (26.5 percent) have an A or B rank, for which 6 of these EOs have partially managed/protected land. Although protection and management of a site may prevent direct impacts of habitat loss due to development, it does not prevent indirect or other threats (e.g., competition from invasive species, SLR) from affecting SJV. Assuming EOs with A or B rank are populations that are sufficiently healthy and have adequate habitat to likely persist for the foreseeable future, healthy EOs are found in the northern (Lower Delaware/Mid-Atlantic Coastal) and middle portion (Chesapeake Bay) of the range but are not evenly distributed. Six of the eight river systems in the Chesapeake Bay have at least one healthy EO, while the single river system in the Lower Delaware/Mid-Atlantic Coastal has one healthy EO and the Neuse/Pamlico region has no healthy EOs.

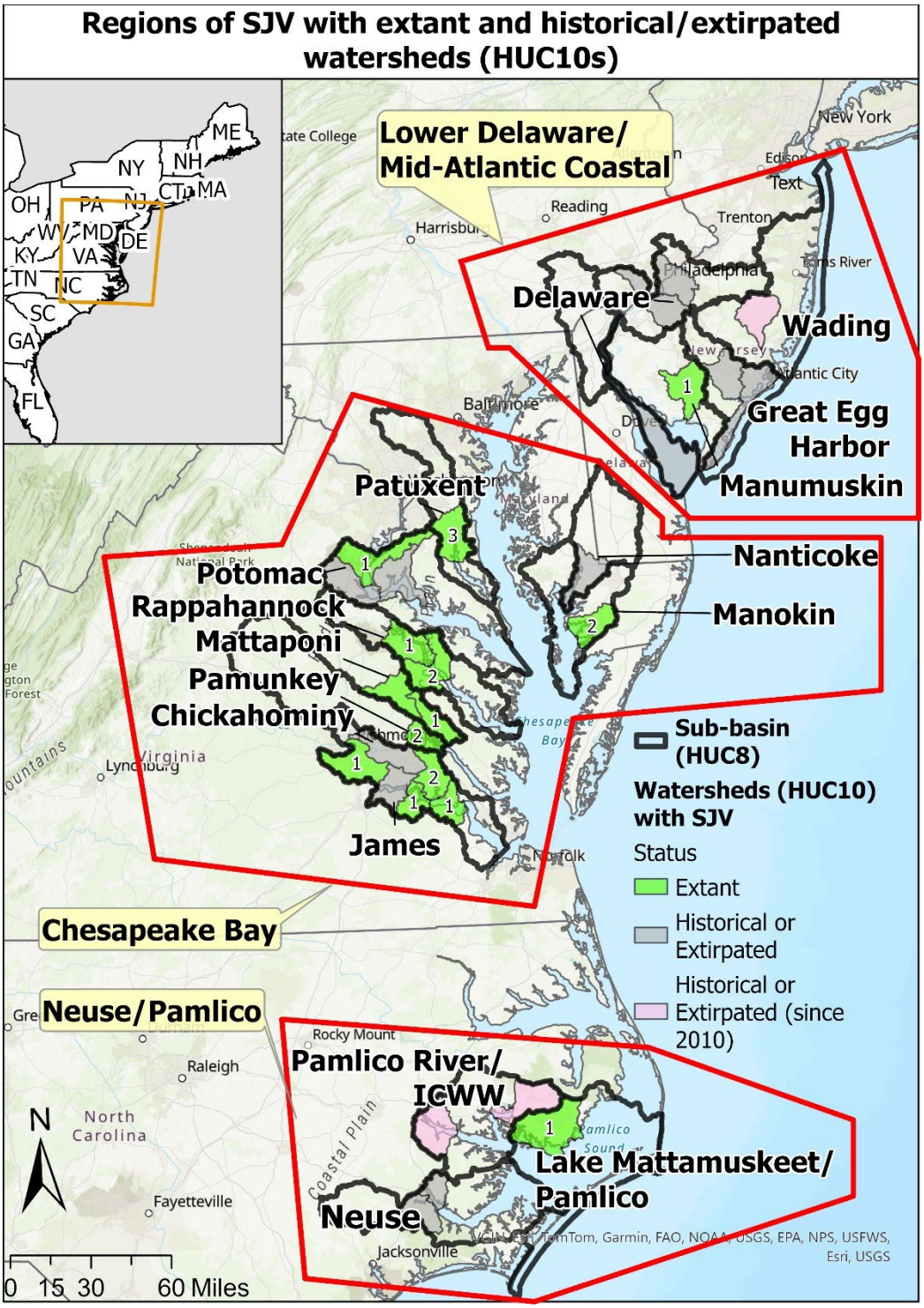

Figure 2. Regions of SJV delineated (within red polygons) with extant and historical/extirpated watersheds (HUC10) and sub-basins (HUC8), as of 2022. The number of extant EOs are provided within the extant watersheds. The major river systems (composed of one or more sub-basins) are labeled.
Note: For the Mattaponi River, only one EO is extant but it occurs in two watersheds. The Chickahominy and James Rivers occur in the same sub-basin.

Table 3. Number of extant and total watersheds (HUC10s) and EOs, including A, B, or C rank (i.e., estimated viability by state natural resource agency) in 2022, by region and river system. Extant EOs are those with A, B, C, or D rank (see table 1). Protected EOs are those with some level of protected or managed land. A rank includes A or AB; B rank includes B, BC, or BD; and C rank includes C or CD. Shaded rows are river systems with no extant EOs. NA=not applicable (i.e., no A or B rank EOs)

Region / River system (state)	Sub-basins (HUC8s)	Total Watersheds (HUC10s)	Extant Watersheds (HUC10s)	Total EOs (all)	Total Extant EOs	A or B rank EOs	C rank EOs	Protected A or B rank EOs
Lower Delaware/Mid-Atlantic Coastal								
Delaware River (PA, DE, NJ)	Lower Delaware, Brandywine-Christina*, Delaware Bay*	4	0	7	0	0	0	NA
Wading River (NJ)	Mullica-Toms	1	0	1	0	0	0	NA
Great Egg Harbor River (NJ)	Great Egg Harbor	2	0	2	0	0	0	NA
Manumuskin River (NJ)	Cohansey-Maurice	1	1	2	1	1	0	1 [a]
Chesapeake Bay**								
Nanticoke River (MD)	Nanticoke	1	0	1	0	0	0	NA
Manokin River (MD)	Tangier	1	1	2	2	2	0	0
Patuxent River (MD)	Patuxent	1	1	7	3	3	0	2 [b]
Potomac River (MD, VA)	Lower Potomac	3	1	5	1	0	1	NA
Rappahannock River (VA)	Lower Rappahannock	2	2	5	3	1	2	1 [c]
Mattaponi River (VA)	Mattaponi	2	2	2	1 [d]	1	0	1 [e]
Pamunkey River (VA)	Pamunkey	1	1	2	2	1	1	1 [f]
Chickahominy River (VA)	Lower James	2	1	5	2	0	1	NA
James River (VA)	Lower James	4	3	6	3	1	1	1 [g]
Neuse/Pamlico								
Lake Mattamuskeet/ Pamlico Sound (NC)	Pamlico Sound	1	1	9	1	0	1	NA
Pamlico River/ Intracoastal Waterway (NC)	Pamlico	2	0	3	0	0	0	NA
Neuse River (NC)	Lower Neuse	2	0	2	0	0	0	NA
	Total	30	14	61 [h]	19	10	7	7

* Exact HUC10 could not be determined, but based on EO site description the EO is likely in this HUC8.

** Includes sub-regions (HUC6) Potomac, Upper Chesapeake Bay, Lower Chesapeake Bay.

[a] TNC owns and protects approximately 85 percent of the land for NJ's only extant SJV occurrence.

[b] MDDNR indicates the EOs are on state-owned land.

[c] Partially protected land. Mixture of state (VA Department of Wildlife Resources [VDWR]), private individuals, and NGOs (TNC and VA Outdoors Foundation).

[d] The extant EO occurs in two watersheds (HUC10s).

[e] Partially protected land. Mixture of private and state land throughout the entire site (VA Department of Forestry and VDWR); adjacent to Mattaponi Indian Reservation.

[f] Partially protected land. Mixture of private individuals (MC Marshes, PR-CC Marsh) and NGOs (TNC's Vandell Preserve at Cumberland Marsh).

[g] Partially protected land. Northern: mostly private and NGO (James River Association); Southern: Federal (Service's Presquile NWR).

[h] One EO in NC has an unknown location; therefore, it was not assigned to a river system. As a result, the column total is 61 EOs although the total number of EOs is 62.

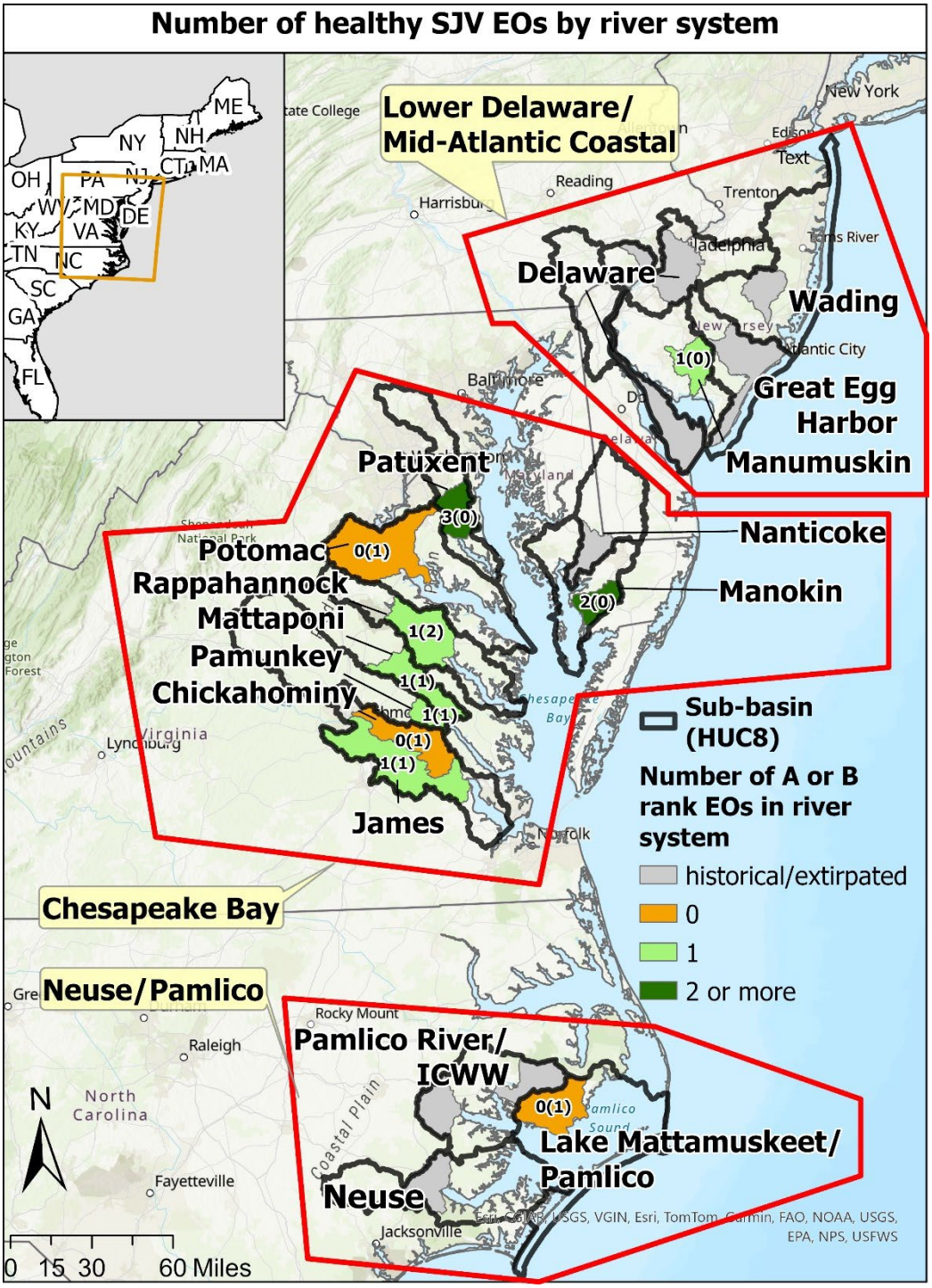

Figure 3. The number of healthy EOs (A or B rank) within the extant river systems as of 2022. The number of C rank EOs are provided in parentheses. Regions of SJV are delineated within red polygons. The major river systems (composed of one or more sub-basins) are labeled.

2.3.1.6 Habitat or ecosystem conditions:

Habitat and ecosystem conditions across the range of this species are well documented in the recovery plan (Service 1995) and 2013 5-year review (Service 2013). As described in the recovery plan, the species occurs in fresh to slightly brackish tidal river systems, within the intertidal zone where populations are flooded twice daily. It also seems to favor microhabitats where there is a reduction in competition from other plant species, such as fringes or raised banks of marshes, accreting point bars, and other areas on the upper limits of tidal fluctuation. The species is also found in marsh interiors, where there may be less nitrogen available to competitors. SJV is generally found on substrates that are sparsely vegetated due to natural disturbances such as storms, ice scour, accreting sediments, or muskrat (*Ondatra zibethica*) disrupting vegetation cover. SJV is typically found in marshes where plant diversity is high and annual species are prevalent. However, in NC all recent SJV occurrences were only found in habitats affected by anthropogenic disturbances, such as roadside ditches and wet cornfields that were nearly tidal; these occurrences have proven to be unstable and have all become extirpated. The 2013 5-year review (Service 2013) noted that several populations in VA were also found at habitats disturbed by anthropogenic activities (e.g., pocket marsh wetland created by excavation in uplands, edge of soybean field, and in a mowed grassy strip between a manmade drainage channel and dirt road). Additionally, MD occurrences were typically found in habitat with tall, dense, species-rich vegetation and not areas with little standing vegetation.

Since the 2013 5-year review, observations of SJV habitat support the descriptions of habitat and ecosystem conditions in the recovery plan and 2013 5-year review. For example, a subpopulation on the Rappahannock River (VA; EO #028) is located in a marsh that has very high species richness (143 species), very low percentage of non-native species (3 percent), and low anthropogenic disturbances (DeBerry 2013). However, two other subpopulations on the Rappahannock River are mowed and appear to be abundant. It was reported in 2013 that a caretaker mows the area where a SJV subpopulation grows (Broad Creek Marsh; Rappahannock River) and waits until after seeds set to mow; he claimed that he only saw few plants in the beginning and now “a fairly dense colony exists” (VDCR-DNH 2023). At the 2nd subpopulation (along a road in Bridge Creek Marsh; Rappahannock River), 247 SJV plants were counted and many were cut and along the mowed area in 2016 (D. DeBerry, W&M, email to J. Stanhope, Service, July 12, 2022). However, it is unknown if mowing is beneficial to the species without further study.

Most recently in 2024, new subpopulations in EO#28, Rappahannock River, had high numbers of SJV (approximately 27,500 plants) in habitat immediately adjacent to corn and soybean fields in wet areas with some tidal flooding that may be subject to agricultural activities along the edges (e.g., herbicide spraying, tilling) (D. DeBerry, W&M, email to K. Tignor, Virginia Department of Agriculture and Consumer Services, October 10, 2024; J. Stanhope, Service, pers.

obs. October 7, 2024). Researchers at W&M are planning to study the role of disturbance in removing competition and enhancing SJV habitat at these sites.

Marsh dewflower, an invasive species in VA, was observed as a dominant species at a new SJV occurrence in Powhatan Creek, VA. DeBerry (2022) hypothesized that this species is an indicator of potential anthropogenic disturbance, possibly due to sedimentation from the upland area. Preliminary analysis of soil samples, conducted by researchers from W&M (DeCesare 2024), supported this hypothesis with evidence of higher sand and lower organic matter content in the stream and SJV sites compared to the adjacent marsh.

A species distribution model for SJV in the majority of its range (NJ, DE, MD, and VA) was developed by Chazal et al. (2017) using Random Forest modelling that predicts potential suitable habitat at a 30-m pixel resolution based on occurrence data. The model variables most important to predicting suitable habitat were distance to river, mean wetland cover, elevation, distance to estuary, and distance to coastal waters. The predicted suitable habitat in VA was further refined by VDCR-DNH and VAFO by limiting it to tidal habitats, excluding areas based on salinity (areas with average salinity greater than 5 ppt; brackish wetlands based on National Wetland Inventory), and including several higher-suitability sites with community types known to co-occur with the species (VDCR-DNH 2022). Both models showed potential areas for suitable habitat that could be surveyed for new populations, but we are unaware if they have been used for that purpose.

An early attempt at using remote sensing data (i.e., Digital Multispectral Video System and Landsat imagery) to identify SJV populations in the Mattaponi River, VA, was unsuccessful (Mountz 2002). Using high resolution sUAS multispectral areal imagery from multispectral cameras on drones, preliminary analysis found that that mapping in the fall was able to detect dense clumps of SJV but not less dense clumps or few individual SJV plants in a NJ population (Ray and Kelly 2021).

Summary of habitat or ecosystem conditions

The habitat and ecosystem conditions for SJV described in the recovery plan (Service 1995) and 2013 5-year review (Service 2013) appear relatively unchanged. SJV occurs in fresh to slightly brackish tidal river systems and favors microhabitats where there is a reduction in competition from other plant species, from either natural or anthropogenic causes. The species is generally found on substrates that are sparsely vegetated but also occur in densely vegetated, species-rich habitats. SJV may also be found in habitats disturbed by anthropogenic activities, such as roadside ditches, wet corn and soybean fields, and mowed areas. Species distribution models for SJV have been developed for the current range, except NC, and show potential areas for suitable habitat that could be surveyed for new populations.

2.3.2 Five-Factor Analysis:

The purpose of a 5-Year Review is to recommend whether a listed taxon continues to warrant protection under the ESA and, if so, whether it should be reclassified (from threatened to endangered or from endangered to threatened). This task requires that the analysis of the threats to the species be performed while assuming that the species is not receiving the regulatory protections, funding, recognition, and other benefits of ESA listing. Summaries of ongoing applications of ESA protections may shed light on some future activities that constitute threats to the species. However, the analysis under Factor D (Inadequacy of Existing Regulatory Mechanisms) focuses on the adequacy of existing alternative (i.e., non-ESA) mechanisms to address the continuing and foreseeable threats.

2.3.2.1 Factor A. Present or threatened destruction, modification, or curtailment of its habitat or range:

The final listing rule described habitat alteration as the primary threat to SJV and the cause of its extirpation from PA and DE (57 FR 21569–27693). Adverse habitat changes were caused historically by dredging and/or filling of marshes and shoreline stabilization of riverbanks (e.g., bulkheads, riprap). At the time of final listing, sources of habitat alteration included impoundments and water withdrawal projects, road construction, commercial and residential development, recreational use, point and non-point source discharges, and sedimentation from construction and development. The final listing rule also indicated that sedimentation from construction and development activities may contribute to inhibited seed germination due to smothering and/or promote spread of invasive species (e.g., *Phragmites*), which may displace SJV by competing for habitat and shading (i.e., decreasing light availability). Recent information shows that some of the threats described in the final listing remain ongoing and occur throughout the species' range, in particular road construction, commercial and residential development, recreational use, sedimentation from construction and development activities, and the resulting spread of invasive species, and that they are expected to continue in the future. The ongoing threats are described below.

Anthropogenic disturbance and habitat modification: Anthropogenic factors include agricultural activities and many types of commercial and residential development such as construction and maintenance of roads, railroads, utilities, and canals/ditches. Land disturbance due to development and maintenance of streamside habitat, such as clearing, mowing, filling, or herbicide application, can directly kill or crush plants and alter habitat by creating conditions conducive to invasive plants. The effects of invasive plants are discussed separately below. Of 29 EO records (for 27 populations extant in 2010 plus 2 additional EOs discovered since 2010 with threats described in the occurrence data) (Appendix B), 11 EO records (38 percent) indicated anthropogenic disturbance activities as one of their current or potential threats (table 4). Anthropogenic disturbance activities were listed as a threat only for EOs in NC and VA. For seven EOs in VA that were surveyed in 2017, "Threats to most of the *Aeschynomene virginica*

colonies found were not obvious or imminent on the ground," therefore threats described may be considered potential threats (Van Alstine 2018).

Table 4. Total number and percentage of EOs affected by each threat for 29 EO records (for 27 populations extant in 2010 plus 2 additional EOs discovered since 2010 with threats described in the occurrence data (see Appendix B). Note that the percentages do not add up to 100 percent because some EOs had multiple threats. Saltwater intrusion and erosion (due to storms/inundation) are stressors associated with SLR but were frequently mentioned as individual threats; therefore they are indicated below in this table.

State	Number of EOs affected						**Total EOs**
	All anthropogenic disturbances	Invasive species/ competition	Herbivory/ predation	Sea level rise (SLR)	Saltwater intrusion	Erosion (due to storms/ inundation)	
Maryland	0	6	0	2	0	3	7
New Jersey	0	2	1	1	1	0	2
North Carolina	6	6	2	0	0	0	8
Virginia	5	6	7	1	5	1	12
Total by threat	**11**	**20**	**10**	**4**	**6**	**4**	**29**
Percentage	**38%**	**69%**	**34%**	**14%**	**21%**	**14%**	

Table 5 provides additional details about the types of anthropogenic disturbance that are or were affecting the EOs. Maintenance of canals/ditches and roadsides may involve digging, mowing, and herbicide use and these activities have impacted three to four EOs; some EOs experienced one or more of these threats. "Mowing and herbicide are commonly reported as threats for all occurrences that were present from 1985 to 2013" (J. Amoroso, NCNHP, email to J. Stanhope, Service, April 11, 2022). Digging within canals/ditches in NC have also led to hydrological changes. All EOs in NC are either extirpated or historical, except for a single reintroduced EO, which is affected by predation. As noted in section 2.3.1.6 "Habitat or ecosystem conditions," some disturbances could be beneficial to SJV habitat, and it is unclear if mowing is beneficial without further study. Anecdotal observations indicate that two subpopulations on the Rappahannock River have been mowed and appeared to be abundant.

Table 5. Total number and percentage of EOs by type of anthropogenic threat (11 EOs total from table 4; see Appendix B). Note that the percentages do not add up to 100 percent because some EOs had multiple threats.

State	Number of EOs affected				
	Canal/ditch digging	Mowing	Herbicide application	Recreational activity	Other anthropogenic disturbance
North Carolina	3	3	3	0	3
Virginia	0	1 (unclear)	0	5	1
Total	**3**	**4**	**3**	**5**	**4**
Percentage	**27%**	**36%**	**27%**	**45%**	**36%**

Another threat is recreational activities in or near SJV habitat, including boat ramps (resulting in increased boat traffic), hunting via duck blinds, and shore

fishing, all of which may disturb/erode habitat and/or crush plants via direct trampling by people, boats, and boat wakes. Of 29 EO records where threats were described in the occurrence data, 5 EO records (all in VA), indicated recreational activities as a current or potential threat. For example, there is a small canoe/kayak launch on Turkey Island Creek, operated by Henrico County, VA, near EO#020. A non-profit organization is planning to build a new riverside park in this area, which may increase public access and canoe/kayaking activities near SJV habitat and potentially could have adverse impacts to SJV plants and habitat if public access and the park are not carefully managed (Van Alstine 2018; C. Brame, Service, to J. Stanhope, Service, April 11, 2022).

For four EOs (table 5), other anthropogenic disturbances noted for the SJV include road work, corn field harvest, and disturbance in powerline and roadside rights-of-way.

Sedimentation from construction and development projects was not noted as a specific threat for any of the EOs, but sedimentation and water quality degradation were generally indicated as potential threats for SJV, respectively by MD Natural Heritage Program (2021) and VDCR-DNH (Recommendation for the Designation of Sensitive Joint-vetch *Aeschynomene virginica* (L.) Britton, Sterns, and Poggenburg as a Virginia Species of Greatest Conservation Need; https://dwr.virginia.gov/wp-content/uploads/media/SGCN-Summary-Aeschynomene-virginica.pdf; accessed September 20, 2024).

Proposed water withdrawal projects in the York and Rappahannock Rivers, VA were documented as potential threats in the recovery plan (Service 1995) because "withdrawals of large amounts of fresh water could raise the salinity of the marsh systems occupied by this species, possibly beyond the species' tolerance limits." None of the EOs in VA indicated water withdrawal projects as threats, however, saltwater intrusion (i.e., increasing salinity as indicated by salt tolerant vegetation and/or SLR) was documented as a threat for five EOs in VA (table 5). Additional or new water withdrawals of large quantities of water may exacerbate saltwater intrusion into SJV marshes, especially under prolonged drought conditions (See section 2.3.2.5 "Factor E. Other natural or manmade factors affecting its continued existence" for additional information).

Invasive native and non-native plant species: Invasive non-native plant species, such as *Phragmites*, marsh dewflower, porcelain berry (*Ampelopsis brevipedunculata*), Japanese clematis (*Clematis terniflora*), and Asiatic tearthumb (*Persicaria perfoliata*), are threats to SJV by competing with the species, in particular by taking over the habitat and/or shading and reducing light. Native plant species, such as indigo bush, may also compete with SJV. *Phragmites* is known to destroy diverse freshwater tidal marshes through forming dense monotypic stands by means of dispersed rhizome fragments and seeds. Due to their aggressive and pervasive nature, *Phragmites* is likely the most serious invasive species threat to SJV. Disturbance to marsh habitat, including direct

impacts such as shoreline riprap and indirect effects such as sedimentation, increased nutrients, and hydrologic changes from development and agricultural activities in the watershed, promotes the ability of invasive species to spread, especially *Phragmites* (Sciance et al. 2016). Saltwater intrusion associated with SLR may also contribute to the spread of invasive species (See section 2.3.2.5 "Factor E. Other natural or manmade factors affecting its continued existence" for additional information). Of 29 EO records where threats were described in the occurrence data, 20 EO records (69 percent) indicated competing vegetation or invasive species as a current or potential threat (note: many EO records noted multiple threats).

Eight of the 29 EOs (28 percent) specifically indicated *Phragmites* as a current or potential threat. *Phragmites* is documented as spreading into and near SJV habitat predominantly at EOs in NJ and MD (Appendix B; Olson and Ray 2022; K. Rossini, Citizens United for the Maurice River [CUMR], email to W. Walsh, Service, December 7, 2023) and likely contributed to extirpation of the NJ population in Wading River (EO#006) and the MD population in Chicamuxen Creek Marsh (EO#005; indigo bush was also indicated to have invaded the habitat). At a MD population in Mataponi Creek (EO#006), *Phragmites* has also been observed to encroach on SJV habitat and displace SJV (e.g., caused decreased spatial extent). MDDNR conducted herbicide spraying of *Phragmites* in 2021 but results are not known. They also attempted to eradicate *Phragmites* at another population in the Middle Patuxent Marshes (EO#010) before 2007, but *Phragmites* returned to the area in the marsh where SJV was last found in 1996; the status of this EO is F. *Phragmites* is increasing in Manumuskin River, just downstream of EO#003, from approximately 15 acres in 2002 to 47 acres in 2020 and in habitat preferred by SJV (e.g., marsh edges) (K. Rossini, CUMR, email to W. Walsh, Service, December 7, 2023). *Phragmites* is documented as spreading throughout the tidal marshes of the Chesapeake Bay, occurring along 14.6 percent of MD estuarine shorelines and 2.0 percent of VA shorelines (Chambers et al. 2008). The lower percentage of *Phragmites* in VA may be the reason why *Phragmites* has not been indicated as a specific threat in VA.

It is unclear if marsh dewflower, an annual plant and non-native invasive species that is considered a threat to tidal freshwater marsh (The Natural Communities of Virginia Classification of Ecological Groups and Community Types, Version 3.3; https://www.dcr.virginia.gov/natural-heritage/natural-communities/ncea1; accessed February 23, 2024), has long-term negative impacts to SJV populations. As SJV is frequently found on berm marsh sites, which are affected by natural scouring from waves and current, these sites are also susceptible to invasion by marsh dewflower. The recovery plan indicated that marsh dewflower was observed as a dominant species in many pristine SJV sites in VA (Service 1995). At four SJV subpopulations in the Mattaponi River, VA, which are considered pristine marsh sites, marsh dewflower was observed to have spread substantially and become a dominant species over a 13-year period, from 1987 to 2000 (Mountz 2002) and was observed to be more prevalent in fall than summer. SJV

abundances were high in 2000 and appeared to have remained high during surveys in 2014 and 2019, suggesting that marsh dewflower may not be having a negative impact on SJV at these sites. The 2013 5-year review (Service 2013) also found no evidence that marsh dewflower was a serious threat to SJV in Cumberland Marsh, a subpopulation in the Pamunkey River (EO#001).

Native cattails (*Typha* spp.) may spread aggressively and form dense stands in response to anthropogenic disturbances and were noted in the recovery plan as a potential threat (Service 1995), but it is unclear if it has negative impacts to SJV populations. At the Manumuskin River population (EO#003), cattails are spreading upstream along the marsh edges with *Phragmites* and are present at the southern edge of the SJV population (K. Rossini, Citizens United for the Maurice River [CUMR], email to W. Walsh, Service, December 7, 2023). Land managers suspect cattails may be displacing the SJV and are proposing to experiment with some thinning of cattails.

For EO#001 in MD, bald cypress has been introduced to the Manokin River (Appendix B), but it is unclear if this species is a threat.

In summary, anthropogenic disturbances, including agricultural activities and many types of commercial and residential development such as construction and maintenance of roads, railroads, utilities, and canals/ditches, continue to be current and potential threats to SJV. The spread of invasive plant species, promoted by anthropogenic disturbance, is a current and potentially increasing threat to SJV by competing with the species. *Phragmites* is likely the most serious invasive plant species threat to SJV. Saltwater intrusion associated with SLR may also contribute to the spread of invasive species (See section 2.3.2.5 “Factor E. Other natural or manmade factors affecting its continued existence” for additional information).

2.3.2.2 Factor B. Overutilization for commercial, recreational, scientific, or educational purposes:

At the time of listing there was no specific information available to suggest that this factor presented a threat to SJV (57 FR 21569–27693). This continues to be accurate. There is no new relevant information regarding overutilization.

2.3.2.3 Factor C. Disease or predation:

Disease was not identified as affecting SJV in the final listing rule and there is no new relevant information regarding disease specific to this species. The final listing rule described severe predation of seeds by caterpillars of tobacco budworms (*Heliothis virescens*) and corn earworms (*Helicoverpa zea*) in NC but did not consider them to be a threat throughout the species’ range because it was believed that “they do not occur in typical wetland habitat” (57 FR 21569–27693). However, the recovery plan (Service 1995) reported seed predation by these caterpillars on SJV in the Mattaponi River (43 percent of seeds predated) and 2 tobacco budworm caterpillars feeding on SJV in the Manumuskin River.

The 2013 5-year review (Service 2013) and recent information indicate that insect predation or herbivory on seeds and most recently on leaves and stems, are occurring at populations in VA, NJ, and NC. Of 29 EO records where threats were described in the occurrence data, 10 (34 percent) EO records indicated herbivory/predation as one of their current or potential threats. All of these EOs specifically indicated insects as the predator; one EO also indicated herbivory by muskrats and another EO had evidence of herbivory (e.g., gnaw marks and cut stems) on stems by unidentified predator, possibly white-tailed deer (*Odocoileus virginianus*).

The caterpillars of tobacco budworm and corn earworm, both non-native insects and known agricultural pests, continue to be identified as predators on SJV seeds in VA at multiple EOs and in NC at one EO (Service 2013; VDCR-DNH 2023; Z. Bradford, VDCR-DNH, email to J. Stanhope, Service, September 21, 2022 and September 14, 2023; D. Suiter, Service, email to B. Cartica et al., NJDEP, September 26, 2022). The corn earworm is a highly migratory pest and generally reaches peak abundance in mid-August to mid-September within the SJV range; the SJV range is generally within the "transition zone" of the species where their overwintering survivorship is uncertain and depends on winter temperatures (Lawton et al. 2022). At a subpopulation in Cumberland Marsh on the Pamunkey River (EO#001), caterpillars of corn earworm were observed predating seeds in September 2023, with approximately 60 percent of seeds predated (Z. Bradford, VDCR-DNH, email to J. Stanhope, Service, September 14, 2023) (figure 4). Caterpillars of tobacco budworm or corn earworm were also found to predate SJV leaves at a subpopulation in Occupacia Marsh on the Rappahannock River (EO#028) in mid-September 2016; at 14 sites surveyed, it was observed that 10 to 90 percent of plants within each site showed significant levels of herbivory (D. DeBerry, W&M, email to J. Stanhope, July 12, 2022 and March 14, 2024).

Figure 4. Seed predation by caterpillars of corn earworm (photo A and B) and possible leaf predation by tobacco budworm or corn earworm, with banded-wing whitefly also on leaves (photo C). Photo credit: Zach Bradford, VDCR-DNH.

A new insect threat was identified in 2022 at two EOs in VA where heavy loss of leaves was observed. The banded-wing whitefly (*Trialeurodes albutiloneus*) was observed on the leaves, and it was the potential cause of the leaf loss/herbivory (figure 5) (Z. Bradford, VDCR-DNH, email to J. Stanhope, Service, September 29, 2022). The banded-wing whitefly is a native plant pest in the U.S. that feeds on leaves; in Europe "heavy infestations [of this insect]…result in chlorotic spotting, premature leaf shedding, dieback of stems and wilting" (Malumphy et al. 2010). This insect was found on SJV in VA on a 1939 herbarium specimen (National Academy of Natural Sciences of Drexel University, http://mam.ansp.org/image/PH/Fullsize/00055/PH00055563.jpg, accessed March 14, 2024). The banded-wing whitefly may have been affecting SJV prior to 2022 when it was identified as a threat.

At a SJV subpopulation in Cumberland Marsh on the Pamunkey River (EO#001), banded-wing whitefly was observed in 2022 and 2023 on plants with varying levels of defoliation, in addition to caterpillars of tobacco budworm and/or corn earworm being observed (Z. Bradford, VDCR-DNH, email to J. Stanhope, Service, September 26, 2022, September 29, 2022, September 14, 2023, and October 25, 2023). In September 2022, the banded-wing whitefly was observed on multiple leaves and approximately 5 percent of plants were fully defoliated and many plants partially defoliated. Bore holes on stems were also observed, but the cause was unknown (figure 5). In September 2023, in addition to the corn earworm seed predation, the banded-wing whitefly was observed on all plants and leaves were generally yellowish in color but only one plant was observed to be fully defoliated. In late October 2023, SJV plants had lost all their leaves except for few remaining leaves on top, with evidence of banded-wing whitefly predation. However, there were few late season maturing seeds observed with little seed predation and no caterpillars, leaving some viable seeds for the next year.

At the SJV subpopulation in Powhatan Creek (EO#018), near the James River, the banded-wing whitefly was observed on a few plants and almost all leaves were defoliated from all plants and very few seed pods remained (figure 5; J. Stanhope, Service, email to B. Cartica, NJDEP, October 14, 2022). It is not clear if the banded-wing whitefly lead to the loss of seed pods or if they were predated by other insects or animals. Depending on timing and level of predation, loss of leaves may contribute to increased stress on SJV plants and reduced flowering and seed production.

Heavy herbivory of leaves, stems, and seeds was observed at one EO (EO#003 Manumuskin River) in NJ in 2022. The insect(s) could not be identified or confirmed because they were not present at the time of surveys. Predation was observed to have affected approximately 80 percent of plants surveyed, with partial to complete loss of leaves, stems, and seeds. An unidentifiable pupa was found next to a bore hole on a stem (figure 6) (Ray 2023). Holes and browning were observed on stems, pedicles, and peduncles (stalks of a flower) as well as

browning above of these structures (Ray 2023). Evidence of potential predators was documented in several photos taken in late August 2021, which showed four caterpillars of tobacco budworm or corn earworm on SJV stems and seeds and black and white spots on leaves that look similar to the banded-wing whitefly (W. Walsh, Service, email to J. Kelly, Raritan Valley Community College, and J. Stanhope, Service, November 8, 2023; T. Besselman, local resident, email to W. Walsh, March 18, 2024; K. Rossini, CUMR, to W. Walsh and M. Virgilio, Service, September 10, 2024).

Aphid predation (species unidentified) is a possible threat to propagated and reintroduced SJV at the new EO (#021) in NC. High numbers of aphids were found on SJV plants, particularly SJV plants in less wet areas. Although a high percentage of SJV plants survived, they showed signs of stress and scarring (black lines), possibly from the aphids, in late July 2021 (Suiter et al. 2023).

Another new insect was identified in 2024 at two SJV subpopulations in the Rappahannock River (EO#028), adjacent to corn and soybean fields, where significant loss of leaves (approximately 30–50% of individual plants) and seeds was observed on the upper half of multiple plants (J. Stanhope, pers. obs. October 7, 2024). The insect is likely the legume caterpillar (*Selenisa sueroides*), a native species to the U.S; it was observed on the leaves and seed pods and is likely the cause of the leaf and seed loss/herbivory (S. Dutilly, W&M, email to J. Stanhope, Service, and D. DeBerry, W&M, October 10, 2024; iNaturalist, https://www.inaturalist.org/observations/244030720; accessed October 10, 2024). This species appears to occur commonly in the southern U.S. and this is the first documentation in VA (iNaturalist, https://www.inaturalist.org/taxa/325320-Selenisa-sueroides, accessed October 11, 2024). It is unknown at this time if this insect is increasing in range and/or if it is an emerging threat to SJV.

Canada goose (*Branta canadensis*) herbivory is another potential threat to SJV. Their grazing on wild rice (*Zizania aquatica*), a species that co-occurs with SJV in freshwater marshes, led to significant declines of wild rice densities in the Maurice River, NJ (Nichols 2014). Canada geese have also been observed to negatively impact wild rice meadows in the Manumuskin River, NJ (K. Rossini, CUMR, email to W. Walsh, December 7, 2023). However, it is unknown if Canada geese consume SJV or how they may impact SJV, such as increased disturbance/erosion of the marsh surface and thus potentially increased inundation, reduction in seeds becoming established, and/or increased invasive plant species.

The effects of seed and leaf predation on reproduction and population dynamics are not well understood. As observed for both the NJ population and VA subpopulation (in Powhatan Creek) (See section 2.3.1.2 “Abundance, population trends, demographic features, or demographic trends” for additional information about these populations), plant abundance decreased sharply from 2022 to 2023

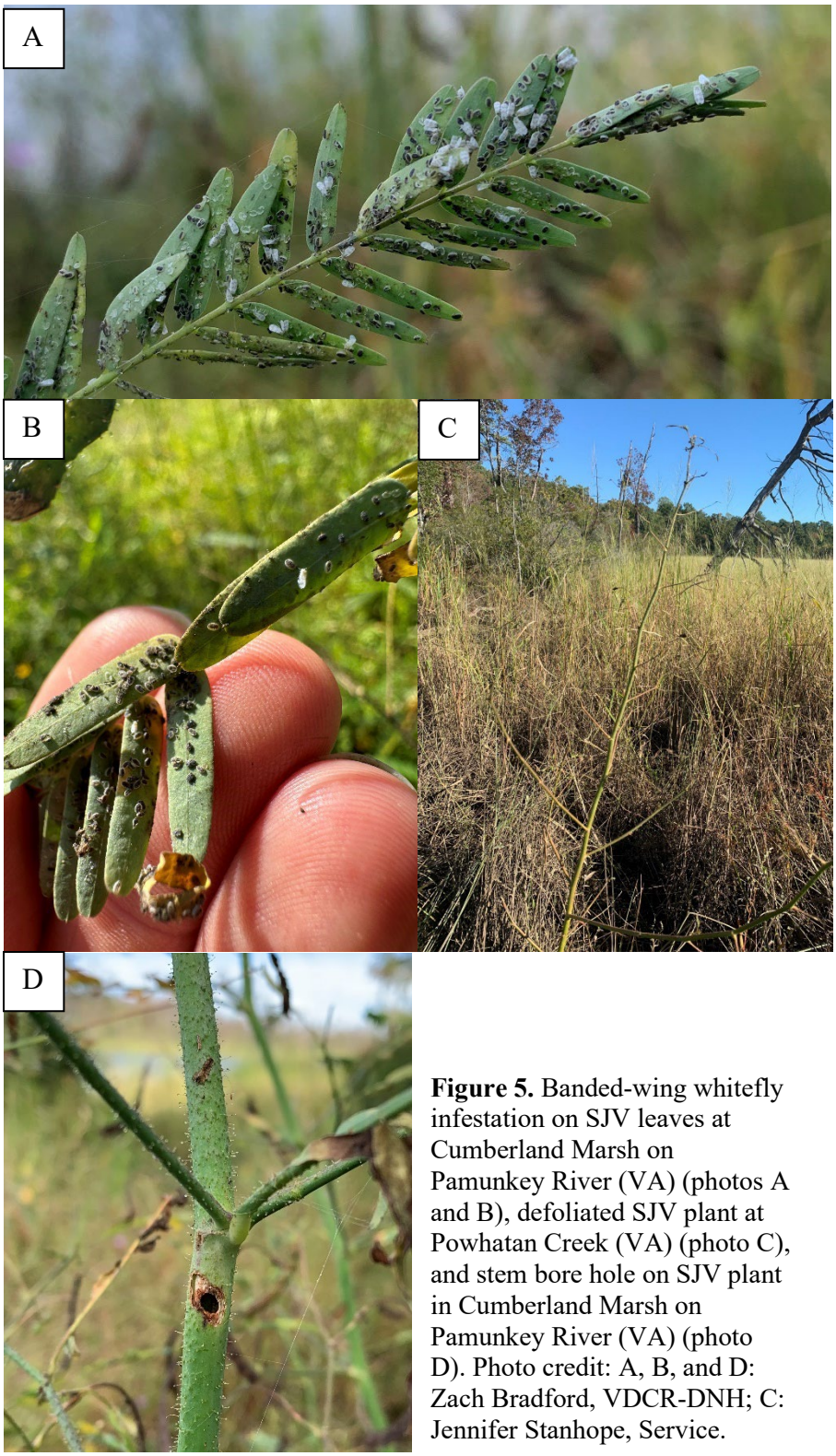

Figure 5. Banded-wing whitefly infestation on SJV leaves at Cumberland Marsh on Pamunkey River (VA) (photos A and B), defoliated SJV plant at Powhatan Creek (VA) (photo C), and stem bore hole on SJV plant in Cumberland Marsh on Pamunkey River (VA) (photo D). Photo credit: A, B, and D: Zach Bradford, VDCR-DNH; C: Jennifer Stanhope, Service.

Figure 6. Unidentifiable pupa (left) and hole observed on different plant (right) of SJV in Manumuskin River. Photos from Ray (2023).

after the severe herbivory event, but herbivory was not observed in 2023. Presumably a reduced seed bank would reduce a population's ability to rebound subsequent years, which could have a more serious impact on consistently small populations.

Research was conducted (Griffith et al. unpublished manuscript) to determine if seed predation is a cause of large SJV population fluctuations (e.g., boom-and-bust cycles of abundance). Results of this 4-year study (2005-2008) did not indicate that seed predation was a significant factor in the population fluctuations for the sites (or subpopulations) monitored (10 to 14 sites); however, predation appeared to be relatively minor ranging from 6.4 to 25.4 percent of seeds predated per plant in 2006 and 2007, respectively. There was also large variability in the average plant abundance per site and seed production per year, with averages ranging from approximately 15 plants to 280 plants in a site in 2005 and 2008, respectively and 1798 seeds (average of ~200 seeds per plant) to 73,892 seeds per site (average of ~390 seeds per plant) in 2005 and 2007, respectively.

Predation by insects likely poses a short-term threat, but data are lacking to determine long-term effects to SJV or if predation by insects is an increasing threat. Many insect herbivores demonstrate boom-and-bust population fluctuations, and thus this threat may be infrequent. However, increasing temperatures are likely increasing the pest insects' ability to survive over winter and thus increasing their range, as was predicted for corn earworm (Lawton et al. 2022) (See section 2.3.2.5 "Factor E. Other natural or manmade factors affecting its continued existence" for additional information). Monitoring is needed to determine long-term effects and the prevalence and severity of insect predation. Monitoring of most SJV populations is infrequent (once every 3–5 years) and

monitoring at least twice within the flowering season (August and September/ October) each year would likely help to document insect predation.

In summary, seed and leaf predation by caterpillars of tobacco budworm, corn earworm, and other insects is likely a short-term threat, but it is unknown how predation affects the viability of a population over time, especially if it occurs frequently. High levels of seed predation likely represent a serious threat to the persistence of small populations of SJV.

2.3.2.4 Factor D. Inadequacy of existing regulatory mechanisms:

The final listing rule indicated that the species was state listed as endangered in MD, NC, and NJ, but not in VA, and described limited protections provided by these designations within each state (57 FR 21569–27693). The laws in these states provide varying levels of limited protections, with some states prohibiting some activities (e.g., digging, removing, collecting, transporting, or selling) only on public lands until receiving approval from their designated state agency and other states prohibiting some of these activities (e.g., digging, removing, collecting) on private property without written permission of landowners. None of the states endangered plant laws regulate destruction or alteration of habitat; however, MD and NJ have additional laws to provide some protections to SJV habitat but only if the species is state and/or federally listed.

Updated existing regulatory mechanisms for the protection of SJV and its habitat in each state are provided below.

New Jersey: SJV continues to be state listed as endangered under the New Jersey Endangered Plant Species List Act (N.J.A.S. 13:1B-15.151), which provides for the creation of a list of rare plants and offers no protection from take or habitat alteration. However, other NJ state laws provide more substantial protection of SJV habitat for federally listed plants and sometimes state listed plants.

The Pinelands Comprehensive Management Plan (N.J.A.C. 7:50) (CMP), under the authority of the Pineland Protection Act, prohibits development unless designed to avoid irreversible adverse impacts upon the survival of any local populations of federally listed species, state-listed species, and species designated as “threatened or endangered plants of the Pinelands,” which includes the Wading River (where the SJV population is extirpated) and the eastern half of the Manumuskin population, including portions on private land (Service 1995, 2013). The Pinelands CMP (N.J.A.C. 7:50-6.14) establishes 300-ft buffers on wetlands in the Pinelands Area, unless an applicant can demonstrate that a proposed project would not result in a significant adverse impact on the wetland (Service 2021). The Pinelands CMP also regulates development in the upland areas within the Pinelands Area. The majority of the eastern half of the Manumuskin River is within the “Forest Area,” which limits residential and commercial development

(New Jersey Pinelands CMP Management Areas, https://www.nj.gov/pinelands/cmp/summary/ma/; accessed September 27, 2024).

The New Jersey Coastal Zone Management rules (N.J.A.C. 7:7) apply to all areas containing tidal wetlands (N.J.A.C. 7:7-1.2(b)4); thus, we conclude these rules apply to all historic, extant, and potential SJV habitat in the State. At N.J.A.C. 7:7-9.26 and 9.27, the rules regulate activities in riparian zones and wetlands, respectively. At N.J.A.C. 7:7-9.36, the rules define endangered or threatened plant species habitats to include "areas known to be inhabited on a seasonal or permanent basis by or to be critical at any stage in the life cycle of any … plant identified as "endangered" or "threatened" species on official Federal or State lists of endangered or threatened species, or under active consideration for State or Federal listing." Development of endangered or threatened plant species habitat is prohibited unless it can be demonstrated "that the habitat would not directly or through secondary impacts on the relevant site or in the surrounding area be adversely affected." (Coastal Zone Management Rules, https://dep.nj.gov/wp-content/uploads/rules/rules/njac7_7.pdf, accessed October 8, 2024).

The State of NJ defines tidelands, also known as riparian lands, as all lands that are now or were formerly flowed by the mean high tide of a natural waterbody (such as the ocean, bays, and tidal sections of rivers and creeks, and also includes marshlands inundated by the tide) (N.J.S.A. 12:3). This definition covers all SJV habitat. The State of NJ owns in fee simple all lands that are flowed by the tide up to the high-water line and claims ownership of those formerly flowed tidelands as delineated on the Tidelands Claims Maps. Most activities tidelands require issuance of a license or lease from the Tidelands Resource Council (Tidelands, https://dep.nj.gov/wlm/tidelands/, accessed March 14, 2025).

The Maurice River and its tributaries (including the portion of the Manumuskin River supporting the SJV population) were designated as part of the National Wild and Scenic River System (Service 1995). The pristine water quality of the Manumuskin River and the SJV population were listed as outstanding national resources. Designation under the Wild and Scenic River does not give federal agencies authority to regulate or zone private land but does authorize the purchase of easements within the river corridor (National Wild and Scenic Rivers System Questions and Answers, https://www.rivers.gov/questions-and-answers; accessed September 27, 2024). It does prohibit a federal agency from assisting in construction of any water resources project that would have a "direct and adverse" effect on the values for which the river segment was established (e.g., its free-flowing condition, water quality, and outstandingly remarkable values). Designation does not appear to provide any state regulatory mechanisms.

NJ's Stormwater Management rules (N.J.A.C. 7:8), with amendments in 2021 and 2023, regulate stormwater runoff for new residential or development projects and may reduce the effects of stormwater runoff (e.g., water quality degradation,

sedimentation) to streams and rivers in NJ (Post-Construction Stormwater Management, https://dep.nj.gov/stormwater/; accessed September 27, 2024).

Maryland: SJV continues to be state listed as endangered under the Nongame and Endangered Species Conservation Act (Annotated Code of Maryland 10-2A-01; Code of Maryland Regulations, COMAR 08.03.08), which prohibits sale and interstate trade without a special permit, taking from State property except by special permit, and taking from private property without the written permission of the landowner (Service 1995, 2013). Therefore, SJV plants may be vulnerable to actions by private landowners (e.g., mowing, herbicide application). These regulations also do not prohibit alteration of the habitat in which these species occur. However, protection of habitat for SJV is provided under Maryland's Critical Areas regulations (COMAR 27.01.09), which prohibits any activity that may adversely affect any federal or state listed endangered and threatened species, species in need of conservation, and their habitats within designated Critical Areas. Protection is also required for the buffer area within 100 ft of the upper limit of a tidal wetland or stream (Service 1995). However, implementation of these regulations may be variable because protection measures are developed and administered by local jurisdictions.

The Maryland Stormwater Management Act (Environment Article 4 Subtitle 2) has requirements for new development and redevelopment activities to design stormwater infrastructure to mimic natural/pre-development hydrologic conditions to the maximum extent practicable, which may reduce the effects of stormwater runoff (e.g., water quality degradation, sedimentation) to streams and rivers in MD. This law is also implemented at the local level.

Virginia: SJV became state listing as threatened in 2004 under Virginia's Endangered Plant and Insect Species Act (Title 3.1, Chapter 39), which provides limited protections, including prohibiting some activities on state land and prohibiting taking on private property without written permission of landowners, but it exempts private landowners from the provisions of the law. It does not regulate destruction or alteration of habitat. Therefore, SJV plants are vulnerable to actions by private landowners (e.g., mowing, herbicide application). The Chesapeake Bay Preservation Act (sections 10.1–2100 to 10.1–2115 of Chapter 21, Title 10.1 of the Code of Virginia) provides some protections for SJV habitat in VA, which all occur in the Chesapeake Bay, by requiring a 100-ft vegetated buffer adjacent to and landward of tidal wetlands and tributary streams. Other sites can be included as necessary to protect water quality. The 100-ft buffer may be reduced through the use of best management practices, soil and water conservation plans, etc. In addition, redevelopment and water-dependent activities may be allowed within the buffer area.

Virginia Stormwater Management Act and the erosion and sediment control requirements in the Erosion and Sediment Control Law were combined in to create the Virginia Erosion and Stormwater Management Act (Va. Code § 62.1–

44.15:24 et seq.), which became effective on July 1, 2024. The Virginia Erosion and Stormwater Management Regulation (9VAC25–875) has requirements for new development projects to include steps and techniques to reduce pollutants in stormwater runoff during and after construction, which may reduce the effects of stormwater runoff (e.g., water quality degradation, sedimentation) to streams and rivers in VA.

North Carolina: The state listing status of SJV was changed to threatened under the North Carolina Plant Protection Act (N.C.G.S. 19B § 106–202.12 *et seq.*) to match federal status under the ESA (02 NCAC 48F.030), but the downlisting did not change their limited protection. The law prohibits interstate trade without a permit and taking without written permission of landowners but provides for monitoring and management of state listed species (Service 1995). It does not regulate destruction or alteration of habitat. Therefore, SJV plants are vulnerable to actions by private landowners (e.g., mowing, herbicide application).

Effects of delisting under the ESA: If this species is delisted under the ESA, state listing status would not automatically change because each state has their own independent review process (Service 2021). SJV is included on NJ's Pinelands list of threatened and endangered plants, which has never been revised since publication in 1981 and would require revision separate from the State endangered species list.

The Corps of Engineers issues permits for projects affecting tidal wetlands (e.g., water supply, shoreline stabilization, and other development projects) under the authority of section 401 (33 U.S.C 1341) or 404 (33 U.S.C 1344) of the Clean Water Act and the Rivers and Harbors Act (33 U.S.C. 403). If SJV is delisted, the Corps of Engineers could issue permits without consideration of effects on SJV and its habitat, and thus, projects/permits would not include avoidance and minimization measures. Although Section 7 ESA consultations are infrequent, listing SJV under the ESA provides additional protection.

Neither state laws nor the local governments with jurisdictions within the watersheds of rivers and wetlands/marshes supporting populations of SJV currently have regulations/ordinances that adequately protect the species from many of the adverse effects of residential and commercial development, agriculture, and private forestry activities, except for as described above for NJ. For example, they generally do not restrict development in SJV watersheds outside of the 100-ft vegetated buffer of streams and wetlands, therefore not adequately addressing stormwater runoff of sediments and other non-point source pollutants from existing developed areas (e.g., increased impervious surfaces). They also do not prevent development behind marshes beyond the 100 ft, which reduces the ability of marshes to migrate with SLR.

In summary, existing regulatory mechanisms provide some protections to SJV and its habitat but are inadequate to protect SJV from some threats, such as take

of SJV by private landowners, development in the watershed (except in NJ), and sediment from runoff and other non-point source discharges from existing developed areas. Removing ESA protections would exacerbate threats by removing requirements to implement measures that avoid and minimize impacts to the species and their habitat for projects with a Federal nexus, including construction projects requiring Corps of Engineers permits, and by removing resources/funding to support propagation/reintroduction, phragmites eradication, and other recovery efforts.

2.3.2.5 Factor E. Other natural or manmade factors affecting its continued existence:

The final listing rule (57 FR 21573) speculates that SLR could affect SJV over the long-term by causing migration of the species habitat (i.e., freshwater marshes) upstream from its present location, but these areas may be blocked or unavailable because of development upstream of the marshes. There is new relevant information regarding increasing temperatures, drought, and the dual stressors of saltwater intrusion and increased tidal inundation/flooding from SLR potentially affecting SJV.

Widespread changes in precipitation and flood events, extreme temperature patterns, SLR, storm surges, and aspects of extreme weather including droughts, heavy precipitation and flooding, and hurricanes are well documented for the United States (Jay et al. 2023). Since 1900, temperature has increased 3.5 degrees Fahrenheit (ºF), 2.5ºF, 1.5ºF, and 1ºF for NJ, MD, VA, and NC, respectively (Runkle et al. 2022a, b, c; Frankson et al. 2022). The state summary models project unprecedented warming during the 21st century under higher emissions pathways (all four states in the range of SJV), more intense droughts (MD, VA, NC), a decrease in intensity of cold waves (all four states), and an increase in the number and intensity of heat and precipitation events (all four states). In NC, hurricane-associated storm intensity and rainfall rates are also projected to increase as the climate warms (Frankson et al. 2022).

The effects of increasing temperatures on SJV and its habitat are unclear and depend on the balance of productivity and decomposition rates and their effects on accretion of the marsh (Smith et al. 2022). Increased temperatures may increase the range of pest insects, such as corn earworm. With projected increases in air and soil temperature, the southern range of the corn earworm (areas where the species is able to persist through winter) is predicted to increase from 24 to 56 percent and expand northward (Lawton et al. 2022).

SLR and coastal/tidal flooding are projected to increase in frequency and severity as well (all four states) (Runkle et al. 2022a, b, c; Frankson et al. 2022). Impacts from SLR include increased shore erosion, inundation of low-lying lands and marshes, and saltwater intrusion (Runkle et al. 2022b). Over the past 100 years, the average rate of SLR (including effects of land subsidence) in the Chesapeake

Bay (MD, VA) is 1.3 to 1.5 inches per decade. SLR along coastal regions of the United States is predicted to be greater than estimates for global mean SLR (Sweet et al. 2022). For the Northeast region, estimates of median relative SLR (compared to baseline of 2000) range from 0.36 to 0.54 m by 2050 and for the Southeast region, estimates of median relative SLR (compared to baseline of 2000) range from 0.27 to 0.49 m (Sweet et al. 2022). Table 6 provides estimates, by different scenarios, of global mean SLR for the Northeast and Southeast regions by 2050 and the probabilities of exceeding each scenario by 2100 (note: probabilities are not provided for 2050). These changes in SLR can have negative impacts on SJV and its habitat. Of 29 EO records, four EO records (14 percent) indicated SLR as one of their current or potential threats (table 4).

Table 6. Median [likely ranges] regionalized global mean sea level scenario–based estimates of relative SLR in 2050 relative to a baseline of 2000 for the Northeast and Southeast regions of the U.S and probability of exceeding Global Mean Sea Level (GMSL; median value) rise scenarios in 2100. Table adapted from tables 2.2 and 2.4 in Sweet et al. (2022).

GMSL Rise Scenario	Northeast: Relative SLR (m) in 2050	Southeast: Relative SLR (m) in 2050	Probability of exceeding scenario by global mean surface air temperature increase in 2100		
			2.0ºC [1]	3.0ºC [2]	4.0ºC [3]
Low (0.3 m)	0.36 [0.27, 0.45]	0.28 [0.20, 0.35]	98%	>99%	>99%
Intermediate-Low (0.5 m)	0.40 [0.31, 0.49]	0.32 [0.25, 0.40]	50%	82%	97%
Intermediate (1.0 m)	0.43 [0.34, 0.54]	0.36 [0.28, 0.46]	2%	5%	10%
Intermediate-High (1.5 m)	0.49 [0.38, 0.64]	0.43 [0.32, 0.58]	<1%	<1%	1%
High (2.0 m)	0.54 [0.40, 0.69]	0.49 [0.35, 0.64]	<1%	<1%	<1%

[1] The closest emissions scenario-based GMSL projection is Intermediate (Shared Socio-Economic Pathways [SSP] 1-2.6) to Intermediate (SSP 2-4.5). SSP is based on the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment (2022).
[2] The closest emissions scenario-based GMSL projection is Intermediate (SSP 2-4.5) to High (SSP 3-7.0).
[3] The closest emissions scenario-based GMSL projection is High (SSP 3-7.0).

Saltwater intrusion was indicated as a current or potential threat for 6 EOs (21 percent of 29 EO records) (table 4). Increasing salinity due to saltwater intrusion will likely significantly reduce germination and viability of SJV seeds, as was observed when seeds were exposed to sodium chloride concentrations of approximately 10 ppt salinity and greater (Baskin et al. 1998). Changes in marsh vegetation to more salt-tolerant plants have also been observed, such as big cordgrass in the Rappahannock River (EO#009 Piscataway Creek, EO#034 Mount Landing Creek) and Chickahominy River (EO#006 Yarmouth Creek) and saltmarsh cordgrass in the Pamunkey River (EO#023 Sweet Hall Marsh) and James River (EO#018 Sandy Bay Marsh/Back River Marsh) in VA. Other freshwater marsh plants (e.g., arrow arum [*Peltandra virginica*] and rice cutgrass [*Leersia oryzoides*]), which are usually located in water with less than 0.5 ppt salinity, have been shown to be affected by salinity levels 1.5 ppt and greater (Sutter et al. 2014, 2015). “Sea-level rise with the resulting expansion of higher salinity waters upstream is still the greatest danger to the long-term survival of [VA SJV] occurrences” (Van Alstine 2018). Saltwater intrusion may also stress SJV and its habitat by affecting nutrient sorption and availability, reduce rates of vertical accretion and carbon/nutrient sequestration in the marsh, and affect microbial processes, which may allow invasion of non-native plants such as *Phragmites* (Neubauer and Craft 2009, Schroeder et al. 2022).

Prolonged drought may also increase salinity at a site via decreased freshwater discharge from rivers. At Sweet Hall Marsh (EO#023) on the Pamunkey River salinity increased to approximately 11 ppt in summer months during a 2002 drought (Perry et al. 2009). However, the predicted increase in the number and intensity of precipitation events may periodically increase freshwater discharge and counteract saltwater intrusion from SLR.

Increased tidal inundation and flooding from SLR and associated wave action may increase erosion of marshes (Mariotti and Fagherazzi 2010), which is a current or potential threats for four EOs in MD and VA (table 4). Although erosion may be beneficial in removing competition (see section 2.3.1.6 "Habitat or ecosystem conditions"), excessive erosion on the marsh surface/edge may cause SJV to be exposed to more frequent, longer, or deeper inundation of overlying water and eventual loss of preferred SJV habitat (e.g., upper limits of tidal fluctuation). Inundation-tolerant plants may also colonize the habitat and outcompete SJV (Mitchell 2018).

The dual stressors of saltwater intrusion and increased tidal inundation/flooding from SLR are considered to be the most significant on-going threats to SJV that will continue into the future for tidal freshwater marshes (Neubauer and Craft 2009, Van Alstine 2018, Olson and Ray 2022). If there is no appropriate low-lying land for tidal freshwater marshes to migrate upstream (e.g., limited by development or topography) or if SLR is occurring faster than marshes can migrate or accrete to keep up with rising waters, tidal freshwater marshes and SJV will decrease in areal extent. The areal extent of tidal freshwater marshes is predicted to decrease by more than 60 percent by 2050 in the VA portion of the Chesapeake Bay (Mitchell et al. 2020). Some upstream movement has been observed at the SJV population in Manumuskin River, NJ (Ray 2023). In a study of changes of marsh plant communities in the Pamunkey and Mattaponi Rivers (VA) between historical (1979–1987) and current (2010) surveys, there are indicators of increased inundation and increased salinity in portions of both rivers (Mitchell 2018).

In summary, effects of SLR and its associated stressors of saltwater intrusion and tidal inundation/flooding have been observed and are likely to increase and negatively impact SJV and its habitat into the future. Saltwater intrusion associated with SLR may also contribute to the spread of invasive species. Prolonged drought may be a threat by increasing salinity. The effects of temperature increase are unclear on accretion rates of marshes but may increase the range of pests such as corn earworm, which will increase predation.

2.4 Synthesis

Across the SJV historical range from PA to NC, as of 2022 the data indicates that 19 of 62 (30.6 percent) historically known EOs are extant. The current spatial distribution of SJV extends from the Manumuskin River (NJ) to Lake Mattamuskeet (NC) with 89 percent of extant EOs (17 of

19) in the tributaries of the Chesapeake Bay in MD and VA. SJV continues to be extirpated from DE and PA. Since 2010, the spatial extent has contracted further with losses of SJV EOs in one HUC10 watershed in NJ and two HUC10 watersheds in NC, leaving a single extant EO each in the Lower Delaware/Mid-Atlantic Coastal region in NJ and Neuse/Pamlico region in NC. Although the total number of EOs has increased from 59 to 62 from 2010 to 2022 due to 2 new EOs in MD and 1 new EO in NC from reintroduction, there is a net decrease in the number of extant EOs from 27 to 19 (29.6 percent decline). The status of the reintroduced EO in NC is considered extant but uncertain. Since 2010, the ranks of nine EOs were changed to extirpated or historical in NJ (1), NC (7), and MD (1) and the ranks of two EOs were changed to F (failed to find) in MD.

Many small populations or subpopulations appear to be dwindling, possibly disappearing, or have already disappeared, such as populations in the Patuxent (MD), Potomac (MD/VA), and Chickahominy (VA) rivers and subpopulations in the Rappahannock (VA), Pamunkey (VA), and James (VA) rivers. The range also appears to be contracting at the downriver end of the Patuxent population and potentially Pamunkey population, likely to due to increasing salinity. Consistent monitoring with additional survey work for some of the populations should be conducted to verify their status. SJV continued presence in NC is tenuous and only due to a reintroduction effort. At the same time, populations/subpopulations on the Manumuskin (NJ), Manokin (MD), and Rappahannock (VA) rivers, all with histories of fluctuating but at times large (at least several thousand plants) population sizes, are persisting; and the Manokin River populations appear to be stable to increasing. Other more modest-sized populations, such as along the Mattaponi and Pamunkey Rivers (VA), are persisting, with the Mattaponi population appearing to be stable. A new subpopulation in a tributary and an expanding population at the upstream end of the James River (VA) range have increased the importance of this river system (or drainage) since the recovery plan.

The Service established a framework in which we consider what a species needs to maintain viability over time by characterizing the biological status of the species in terms of its Resiliency, Redundancy, and Representation ("the 3 Rs"; Smith et al. 2018). **Resiliency** means having sufficiently healthy populations for the species to withstand stochastic events (arising from random factors). We can measure resiliency based on metrics of population health; for example, population size, if that information exists. Resilient populations are better able to withstand disturbances such as random fluctuations in birth rates (demographic stochasticity), variations in rainfall (environmental stochasticity), and the effects of human activities. **Redundancy** means having a sufficient number of populations for the species to withstand catastrophic events (such as a rare destructive natural event or episode involving many populations). Redundancy is about spreading the risk and can be measured through the duplication and distribution of populations across the range of the species. Generally, the greater the number of populations a species has distributed over a larger landscape, the better it can withstand catastrophic events. **Representation** means having the breadth of genetic makeup of the species to adapt to changing environmental conditions. Representation can be measured through the genetic diversity within and among populations and the ecological diversity (also called environmental variation or diversity) of populations across the species' range. The more representation, or diversity, a species has, the more it is capable of adapting to changes (natural or human caused) in its environment. Table 7 summarizes the information provided in this report in terms of the 3 Rs.

Table 7. Resiliency, redundancy, and representation (3Rs) for SJV and its current condition.

3Rs	Requisites	Description	Current Condition
Resiliency (ability to withstand stochastic events)	Healthy populations and habitat.	Populations with: • Sufficient habitat in tidal freshwater marshes: within the intertidal zone where populations are flooded twice daily, and microhabitats where there is a reduction in competition from other plant species, from either natural or anthropogenic sources; • Sufficient freshwater quantity from upstream sources to maintain zero to very low (e.g., <0.5 ppt) salinity; and • Lack of invasive, non-native plant species to compete for habitat and resources, such as light and nutrients.	Each population or EO with excellent or good (A or B rank) current condition is thought to be healthy and have adequate habitat, thus has high or moderate resiliency, respectively. • 19 of 62 EOs (30.6%) are known to be extant. • EO status: – 10 EOs (16.1%) excellent/good condition – 7 EOs (11.3%) fair condition (C rank) – 2 EOs (3.2%) poor condition (D rank) – 43 EOs (69.4%) presumed extirpated (F or X rank) or historical
Redundancy (ability to withstand catastrophic events)	Sufficient distribution of healthy populations.	Sufficient distribution of healthy populations to prevent catastrophic losses of species' adaptive capacity due to natural events (e.g., severe drought, flooding). Multiple healthy populations and occupied HUC10 watersheds in river systems within the species' range are important for the species' redundancy.	• Healthy populations (good to excellent condition) are found in the northern and middle portion of the range but are not evenly distributed. • Loss of occupied HUC10 watersheds in the northern and southern extents of the range (both historically and since 2010). • All but two of the river systems in the Chesapeake Bay region have at least one healthy EO, while the single remaining river system in the Lower Delaware/Mid-Atlantic region has one healthy EO and the Neuse/Pamlico region has no healthy EOs. • 17 of 19 (89%) extant EOs in the Chesapeake Bay region.
Redundancy (ability to withstand catastrophic events)	Sufficient number of healthy populations.	Sufficient number of healthy populations and occupied HUC10 watersheds to prevent catastrophic losses of adaptive capacity.	• 10 of 62 EOs (16.1%) with good to excellent condition across the range. – Lower Delaware/Mid-Atlantic region: 1 of 12 EOs (8.3%) with good to excellent condition. – Chesapeake Bay region: 9 of 35 EOs (25.7%) with good to excellent condition. 6 of 35 EOs (17.1%) with fair condition. – Neuse/Pamlico region: 0 of 17 EOs (0%) with good to excellent condition. 1 of 17 EOs (5.9%) with fair condition. • 14 of 30 HUC10 watersheds (46.7%) currently occupied.
Representation (ability to adapt)	Sufficient capacity to adapt to new, continually changing environments.	Genetic diversity within and among populations contribute to and maintain adaptive capacity. Occupied HUC10 watersheds and river systems distributed across the range, including the ecological diversity of major geographic regions that contribute to and maintain adaptive capacity. Adequate dispersal ability for the species to migrate to suitable habitat and climate over time.	Genetic diversity has not been analyzed and is unknown. **Lower Delaware/Mid-Atlantic region:** • 1 of 8 HUC10s (12.5%) occupied. • 1 of 4 (25%) river systems occupied. **Chesapeake Bay region:** • 7 of 9 HUC10s (77.8%) occupied. • 8 of 9 (88.9) river systems occupied. **Neuse/Pamlico region:** • 1 of 5 HUC10s (20%) occupied. • 1 of 3 (33.3%) river systems occupied.

We found during the Five-Factor Analysis that threats from Factor A (Present or threatened destruction, modification, or curtailment of its habitat or range), C (Predation), D (Inadequacy of existing regulatory mechanisms), and E (Other natural or manmade factors affecting its continued existence) are on-going and are expected to continue into the future for SJV and its habitat. Anthropogenic disturbances, including agricultural activities and many types of commercial and residential development such as construction and maintenance of roads, railroads, utilities, and canals/ditches (Factor A), continue to be a current and potential threat to SJV. The spread of invasive plant species, promoted by anthropogenic disturbance, is a current and potentially increasing threat to SJV by competing with the species. *Phragmites* is likely the most serious invasive plant species threat to SJV.

Seed and leaf predation by caterpillars of tobacco budworm and corn earworm, and other insects are likely a short-term threat (Factor C), but it is unknown how predation affects the viability of a population over time, especially if it occurs frequently. High levels of seed predation likely represent a serious threat to the persistence of small populations of SJV.

Existing regulatory mechanisms provide some protections to SJV and its habitat but are inadequate protection from some threats, such as development in the watershed (except in NJ) and sediment from runoff and other non-point source discharges (Factor D). Removing ESA protections would exacerbate the threats by removing requirements to implement measures that avoid and minimize impacts to the species and its habitat for projects with a Federal nexus, including construction projects requiring Corps of Engineers' permits, and by removing resources/funding to support propagation/reintroduction, *Phragmites* eradication, and other recovery efforts.

Effects of SLR and its associated stressors of saltwater intrusion and tidal inundation/flooding (Factor E) have been observed and are likely to increase and negatively impact SJV and its habitat into the future. Saltwater intrusion may also contribute to the spread of invasive species. Prolonged drought may be a threat by increasing salinity. The effects of temperature increase are unclear on accretion rates of marshes but may increase the range of pests such as corn earworm, which will increase predation.

In summary, as a whole, the range-wide status of the species has declined and SJV continues to face ongoing and likely increasing threats to its continued existence throughout its range, in particular competition from invasive plant species and the dual stressors of saltwater intrusion and increased tidal inundation/flooding from SLR. When evaluating the status of the species and current and future threats, we conclude that the SJV continues to meet the definition of a threatened species under the ESA[4].

[4] The ESA 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."

3.0 RESULTS

3.1 Recommended Classification:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist (*Indicate reasons for delisting per 50 CFR 424.11):*
____ *Extinction*
____ *No longer meets the definition of threatened or endangered*
____ *No longer meets the definition of a species*
_X___ No change is needed

3.2 New Recovery Priority Number: No change

Brief Rationale: The species continues to experience a high degree of threat and has a high recovery potential if recommendations for future actions are implemented.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

Recommendations for specific recovery actions as related to recovery plan task number and priority number (1-3, based on priority number definitions in the SJV recovery plan [Service 1995]):

Monitoring and surveys

1. Conduct consistent and regular monitoring in NJ and VA to confirm population trends and status of SJV. This monitoring can also serve to detect current threats and identify areas where management actions such as *Phragmites* control may be needed (recovery plan task number 4.5; priority number 2).

2. Conduct a review of the monitoring methodologies used across the range of SJV with the purpose of increasing standardization and determining the most efficient, cost-effective, and accurate method to monitor the species status/viability over time. New methodologies may need to be developed to accomplish this goal (recovery plan task numbers 4.1, 4.2, 4.3, and 4.4; priority number 2).

3. Conduct surveys in known and potential habitat throughout the range of the species to find new SJV populations/subpopulations. Also identify suitable habitat that may serve as sites for future seed additions or outplantings of propagated plants (recovery plan task number 3.2; priority number 2).

Research and management activities

4. Conduct genetic research to assess genetic diversity of SJV across the species range and ensure that seeds representing genetic diversity of SJV (e.g., from different river systems and regions) are in the collection of the National Laboratory for Genetic Resource Preservation in Fort Collins, CO, North Carolina Botanical Garden, or another Center for

Plant Conservation (CPC) institution's seed bank. Storing at more than one seed bank is recommended to provide a back-up location. If seed collections are small, a seed increase may be appropriate, following CPC guidelines (CPC 2019) (recovery plan task numbers 2.22 and 5; priority number 2).

5. With the state natural resource agencies, botanical gardens, NGOs, and other partners, identify opportunities for augmentation of extant populations and reintroduction to historical locations with seeds and/or plants grown from seed (recovery plan task numbers 2.22 and 5; priority number 2).

6. Research and conduct adaptive management activities, with monitoring sufficient to inform iterative management decisions. Activities include, but are not limited to habitat management, seed storage over the winter to increase survival rates, seed additions, methods to deter insect predation of leaves and seeds, and introductions in upstream habitat to increase resiliency of populations and to address the threats from SLR (e.g., saltwater intrusion and erosion). Guidelines and methods should be developed for the use of vegetation management and seed additions for the conservation and management of SJV in case more aggressive management strategies are warranted, based on this research and published literature (Griffith and Forseth 2003, 2005; Crawford et al. 2015) (recovery plan task number 2.22 and 5; priority number 2).

7. Investigate the role of natural and anthropogenic disturbance (e.g., storms, mowing, removal of competitive plants) in creating and maintaining SJV habitat (recovery plan task number 5; priority number 3).

8. Conduct studies about the effects of invasive plants, such as *Phragmites* and marsh dewflower*,* on SJV population dynamics and habitat availability. Studies may also include competition from native plants, such as big cordgrass and cattails. Implement invasive species management if they are determined to have a significant impact on the SJV and its habitat and there are effective treatment options (recovery plan task number 2.21; priority number 2).

9. Conduct studies on the long-term effects of predation by insect species, including but limited to tobacco budworm, corn earworm, and banded-wing whitefly, on SJV population dynamics. Studies may also include direct and indirect effects of herbivory by animals, such as goose, on SJV and its habitat (recovery plan task number 2.21; priority number 2).

10. With the state natural resource agencies, NGOs, municipal and county planning boards, and other partners, identify opportunities for conserving, protecting, or acquiring land to allow for upstream migration of SJV and tidal freshwater marshes in response to SLR (recovery plan task numbers 1.2 and 1.3; priority number 2).

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of the Sensitive joint-vetch (*Aeschynomene virginica*)

Current classification: Threatened

Recommendation resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
__X_ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable:

Review Conducted By: Jennifer Stanhope, Virginia Field Office

LEAD REGIONAL OFFICE APPROVAL

Assistant Regional Director, Fish and Wildlife Service

Approve Lowell Whitney Acting Date 7/17/25

APPENDIX A: COORDINATION LIST OF PARTNERS AND EXPERTS.

The following partners and experts were contacted for information to support the 5-year review and provided responses, in addition to those listed in section 1.1 (Reviewers):

State and Federal agencies

- Delaware Department of Natural Resources and Environmental Control (Bill McAvoy*)
- Maryland Department of Natural Resources (Lynn Davidson, Christopher Frye*)
- New Jersey Department of Environmental Protection (Bob Cartica)
- North Carolina Natural Heritage Program (Jame Amoroso*, Andy Walker*)
- Pennsylvania Department of Conservation and Natural Resources (Steve Grund, Cheyenne Moore*)
- Virginia Department of Conservation and Recreation, Division of National Heritage (Johnny Townsend, Rene' Hypes, David Boyd, Zach Bradford)
- Virginia Institute of Marine Science (Scott Lerberg*)
- National Park Service (Mark Eberle*)
- USFWS Eastern Virginia Rivers National Wildlife Refuge (Marcie Kapsch, Cyrus Brame)
- USFWS Mattamuskeet National Wildlife Refuge (Wendy Stanton)

Other

- College of William and Mary (Doug DeBerry)
- North Carolina Botanical Garden (Michael Kunz)
- Mary Washington University (Alan Griffith)
- Raritan Valley Community College (Jay Kelly)

All State and other partners listed above were provided a draft 5-year review document for technical review.
* Provided comments on the draft 5-year review or indicated that they had no comments.

APPENDIX B: SUMMARY OF OCCURRENCE DATA FOR SENSITIVE JOINT-VETCH.

Gray shaded rows are historical/extirpated EOs. Orange shaded row are failed to find EO. See Appendix C for definitions of EO Ranks. Blank cells indicate that no information is available to the Service and it is unknown.

State	EO NO.	EO ID	River System	County	Site Location	2010 EO Rank	Population Data (numbers represent individual plants)	2022 Status	Primary Threats	Land Ownership	2022 EO Rank
DE	001	N/A	Delaware River	New Castle	Wilmington, Delaware River	H	1846: Observed/ collected 1899: Observed/ collected 1988-2021: 0	Historical. Historical collections 1846-1899, all from tidal marsh habitat on Delaware River in New Castle County. Annual surveys conducted 1988-2021 without success although freshwater tidal habitat still exists.	SLR and saltwater intrusion into potential habitat; establishment of *Phragmites*.		H
MD	002	Not in GIS	Unknown	Anne Arundel	Unknown	H	1949: Observed	Historical			H
MD	005	4744	Potomac River	Charles	Chicamuxen Creek Marsh (Potomac River)	E	1951: Observed 1994: 5 plants in 2 locations 1995: 0 1996: 0 2000: 0 2004: 0 2017: 0 2019: 0	Historical	Competition (*Amorpha fruticosa*, *Phragmites*); erosion.	State	H
MD	009	7708	Potomac River	Charles	Unknown	H	1921: Observed	Historical. Habitat degraded by *Phragmites* and partially developed.			H
MD	007	6139	Patuxent River	Calvert	Unknown (Middle Patuxent Marshes)	H	1904: Observed	Historical			H
MD	011	5255	Patuxent River	Calvert	Graham Creek Marsh (Middle Patuxent Marshes)	E	1904: Observed 1994: 3 1995: 6 1996: 10 2008: 0 2013: 0 2014: 0 2015: 0	Failed to Find. Population last observed in 1996. Subsequent surveys yielded zero observations. While it is normal to see population numbers vary dramatically year to year in MD, this site has not been observed to support SJV in over 20 years.			F
MD	012 (new)	9587	Patuxent River	Calvert	Patuxent - Yellow Bank Marsh	N/A	2015: 162 2016: 40 2017: 0 2018: 20 2019: 20 2020: 25	Good, fair, or poor estimated viability. Long-term trend unknown, but fairly established population located within a marsh that provides fairly extensive potential habitat.	Erosion; SLR; *Phragmites*.	State	BD
MD	004	3680			Patuxent River	H		Historical			H

State	EO NO.	EO ID	River System	County	Site Location	2010 EO Rank	Population Data (numbers represent individual plants)	2022 Status	Primary Threats	Land Ownership	2022 EO Rank
			Patuxent River	Calvert, Prince Georges			1947: Observed 1994: 0		Habitat likely destroyed by development. Converted to waterfowl pond surrounded by *Phragmites*.		
MD	006	783	Patuxent River	Prince Georges	Mataponi Creek	E	1950: Observed 1994: 1 1995: 0 1996: 0 2000: 0 2004:0 2015: 500-600 2016: 450 (estimated) 2017: 800 (estimated) 2018: 650 (estimated) 2019: 12 (estimated) 2020: 6 (estimated)	Good, fair, or poor estimated viability. This population seems to be fairly established within an area that provides extensive potential habitat. It is also located on public land. Over the years, population size has significantly dropped, possibly due to extensive, albeit sparse, *Phragmites* incursion. Marsh was treated for *Phragmites* in fall 2021.	*Phragmites* treated fall of 2021; monitor spread of *Phragmites* from surrounding areas.	State, Prince Georges County portion of regional Maryland-National Capital Park & Planning Commission (MNCPPC)	BD
MD	010	7709	Patuxent River	Prince Georges	Magruder Ferry Seep, Springy Marsh (Middle Patuxent Marshes)	E	1949: 1 1994: 6 1995: 0 1996: 3 2000: 0 2001: 3 2004: 0 2008: 1 2013: 0 2014: 2 2015: 0 2020: 0	Failed to Find. Population varies from zero to a few plants year to year. While over the long-term this is concerning, this site may go several years before another few plants germinate and seed.	Phragmites eradication measures implemented pre-2007 helped to restore part of the marsh. Since then, *Phragmites* has re-established near backside of marsh where SJV was known to last occur in 2008.	–Prince Georges County portion of regional MNCPPC.	F
MD	013 (new)	9588	Patuxent River	Prince Georges	Patuxent - River Airport Marsh	N/A	2014: 35 2015: 188 2016: 152 2017: 40-50 2018: 30-35 2019: 65 2020: 510	Good or fair viability. Long-term trend unknown, but established population of decent size; located within a marsh that provides fairly extensive potential habitat.	Erosion; SLR; *Phragmites*		BC
MD	001	2437	Manokin River	Somerset	Upper Manokin River (Princess Anne Marshes)	E	1941: Abundant 1987: 200+ 1989: 1,000+ 1991: 786 1992: 751 1993: Present (no count) 1994: 1,086 1995: 832 1996: 1,458 1997: 715	Excellent or good viability. Has expanded northward up Manokin River over time.	Invasives noted as potential concern (Porcelain Berry, *Phragmites*, Japanese Hops, *Clematis terniflora*). Introduction of Bald Cypress.		AB

State	EO NO.	EO ID	River System	County	Site Location	2010 EO Rank	Population Data (numbers represent individual plants)	2022 Status	Primary Threats	Land Ownership	2022 EO Rank
							1998: 999 1999: 1,852 2000: 1,069 2001: 2,108 2002: 1,861 2003: 719 2004: 2,498 2005: 1,416 2006: 2,242 2007: 3,441 2008: 3,179 2009: 4,394 2010: 2,808 2011: 3,121 2012: Present and dense (no count) 2013: Present and dense (no count) 2014: Present and dense (no count) 2015: 10,000+ 2016: 4,500 (estimated) 2017: 3,000 (estimated) 2018: Present-average year (no count) 2019: Present-average year (no count) 2020: Present-average year (no count)				
MD	008	1214	Manokin River	Somerset	Taylor Branch (Princess Anne Marshes)	E	1991: 1,120 in 5 distinct areas 1992: 1,307 in 3 distinct areas 1993: Present (no count) 1994: 125 1995: 239 1996: 587 1997: 131 1998: 170 1999: 42 2000: 84 2001: 310 2002: 48 2003: 160 2004: 1,797 2005: 766 2006: 49 2007: 88	Good or fair viability. Average number 351 from 1991-2020; population has fluctuated over time.	Population crash, following unusual weather in 1993.		BC

State	EO NO.	EO ID	River System	County	Site Location	2010 EO Rank	Population Data (numbers represent individual plants)	2022 Status	Primary Threats	Land Ownership	2022 EO Rank
							2008: 113 2009: 69 2010: 31 2011: 0 2012: 0 2013: 350 2014: 508 2015: 585 2016: 793 2017: 248 2018: 234 2019: 227 2020: 4 2023: 38				
MD	003	2734	Nanticoke River	Wicomico	Nanticoke River	H	1906: Observed 1996: 0; surveyed extensively	Historical			H
NJ	008	N/A	Great Egg Harbor River	Atlantic	Great Egg Harbor River	H	1937: Observed 1985: 0 1991: 0 1992: 0	Historical. Developed with homes and marina facility.			H
NJ	006	N/A	Wading River	Burlington	Wading River Tidal Marsh	E? **	1914: Observed 1970s: Extensive surveys in early 1970s were unsuccessful 1984: 12 + 38 +1 1985: 0 1991: 0 1992: 0 1994: 0 1997: 0 2006: 0 2007: 0 2020/21: 0 (plus visited 3 times in past 10 years; J. Kelly, Raritan Valley Community College, pers. comm 2023)	Extirpated (last observed 1984; NJDEP considers it Extant with D rank, based on last time they provided EO data/Biotics data to NJFO)	*Phragmites*. May have been exposed to herbicides in mid-1980s.		X
NJ	001	N/A	Delaware River	Camden	Unknown	H	1874: Collected 3 old collections	Historical. Possibly an introduced occurrence.			H
NJ	009	N/A	Great Egg Harbor River?	Cape May	Unknown	H	1892: Observed/collected	Historical. Unable to relocate from directions.			H
NJ	002	N/A	Manumuskin River	Cumberland	Manumuskin River	H	1973: Observed 1974: Observed 1984: 0 1991: 0 1992: 0 2007: 0	Historical. Site impacted by dredging and channeling; suitable habitat does not exist.			H
NJ	003	N/A		Cumberland		E		Areal extent likely decreasing.			A

State	EO NO.	EO ID	River System	County	Site Location	2010 EO Rank	Population Data (numbers represent individual plants)	2022 Status	Primary Threats	Land Ownership	2022 EO Rank
			Manumuskin River		Manumuskin River		1982: 229 1983: 1,498 1984: 2,085 1985-1987: No data 1988: 838 1989: 1,616 1990: 1,628 1991: 5,039 1992: 645 1993: 3,007; large patch plus single S side 1994: 10,714 1995: 1,800 1996: 20,000 + stems 1997: 6,800 1998: 3,265 1999: 6,300 2000: 3,100 2001: 800 2002: 775 2003: 132 2004: 574 2005: 2,804 2006: 25-50 (brief survey) 2007: 200 2007: 29 plus more uncounted 2008-2010: well over 1,000 observed each year; no actual count made 2020-2021: no counts made; likely between 200-2,000.		*Phragmites*; cattails (*Typhus* spp.); SLR and associated increasing salinity (saltwater intrusion); herbivory (2022).	TNC (owns and protects ~85% of land with SJV)	
NJ	004	N/A	Delaware River	Gloucester	Oldman's Creek	H	1882: Observed/collected 1897: Observed/collected 1991: Site not thoroughly surveyed; habitat conditions appear suitable and further surveys recommended	Historical. (Several collections.) Now all dredge spoil.			H
NJ	005	N/A	Delaware River	Salem	Unknown	H	1881: frequent 1992: 0	Historical. 1992: Much suitable habitat remains to be searched in part of the county.			H
NJ	007	N/A	Delaware River	Salem	Unknown	H	1934: Observed 1992: 0; likely extant as much suitable habitat exists	Historical.			H
NC	002	16665		Beaufort			1985: several thousand estimated			Private	H?

State	EO NO.	EO ID	River System	County	Site Location	2010 EO Rank	Population Data (numbers represent individual plants)	2022 Status	Primary Threats	Land Ownership	2022 EO Rank
			Pamlico River/ ICWW		Near Washington (Whichards Beach Road)	E (was H in the 1995 Recovery Plan).	1986: 200 large plants; number visible 400-500 1991: 300 1996: several hundred to several thousand; another source indicated 400-500 1997: 13 in July/300 in September 1998: 0 2002: 7 2004: 0 2005: 3 2006:14 2007: 0; may have been mowed 2013: 2 2014: 0 2019: 0	Possibly historical (changed from Failed to Find to historical? in 2021)	Herbicide (2014); mowing (2007); herbivory by tobacco budworm caterpillars; competition (woody vegetation); hydrological changes due to canal digging. Ditch where the plants occurred during the 1990s seems drier than in the past, with less standing water (2004).		
NC	008	19798	Pamlico River/ ICWW	Beaufort	South of Washington	H	1953: Observed/ collected 1957: Observed/ collected 1985: 0 1998: 0	Possibly historical (changed from Failed to Find to historical? in 2021).	Suitable habitat diminished by hardening of estuarine shoreline through riprap and wooden bulkheads	Private	H?
NC	009	18719	Neuse River	Craven	Trent River	H (X?)	1949: Observed/collected 1983: 0 1985: 0 2013: 0	Extirpated	Road construction (realignment of US 70 ramp and bypass likely destroyed habitat and plant (1985).	Private	X
NC	010	18720	Neuse River	Craven	Southwest of James City	H	1956: Observed/collected 1985: Could not verify 2013: 0	Historical	Disturbance around shoreline made site unsuitable habitat (1985).	Private	H
NC	001	995	Lake Mattamuskeet/ Pamlico Sound	Hyde	Lake Mattamuskeet	E	1990: 3 1995: 1 2007: 0 2013: 0 2019: 0	Possibly historical	Competition (“Roadside, weedy overgrown ditch”).	Mattamuskeet NWR	H?
NC	003	2479	Lake Mattamuskeet/ Pamlico Sound	Hyde	Avenue Farm	E	1985: 60 in ditch + 5 1986: 40-50; more vigorous than before 1988: 80 1990: 0 1991: 100+ in ditch, dry road shoulder 2001: 0; no suitable habitat 2004: No suitable habitat so did not explore further	Extirpated	Competition ("ditches in this area are choked with weedy species"); roadside ditch cleaned by highway maintenance crews and a water link installed (before July 1991); mowing (1985).	Private	X

State	EO NO.	EO ID	River System	County	Site Location	2010 EO Rank	Population Data (numbers represent individual plants)	2022 Status	Primary Threats	Land Ownership	2022 EO Rank
							2007: 0 2013: 0 2019: 0				
NC	004	9889	Lake Mattamuskeet/ Pamlico Sound	Hyde	U.S. 264 West of Lake Landing	E	1985: 10-12 in ditch, 1,000s in field 1986: 0 1990: large (common) 1991: 40 + 4 1997: 66 2001: 0 2004: 0 2007: 0 2013: 0 2019: 0	Extirpated	Disturbance (in area with powerline and roadside right-of-way); herbicide use; competition ("many weedy species"); loss of hydrology (no standing water in ditch).	Private	X
NC	005	4337	Lake Mattamuskeet/ Pamlico Sound	Hyde	Engelhard	E	1985: 4 1986: 0 1990: 0 1991: 6 2001: 0 2004: 0 2007: 0 2013: 0 2019: 0 (marginal habitat)	Extirpated	Herbicide use; mowing; competition ("near end of a small; totally overgrown canal"); ditch cleaned out prior to 1991.	Private	X
NC	006	18867	Lake Mattamuskeet/ Pamlico Sound	Hyde	State Route 1311	H (X?)	1985: 4 1986: 0 1990: 0 2001: 0 2004: 0 2007: 0 2013: 0 2019: 0	Extirpated	Loss of hydrology (no standing water in ditch) (2004).	Private	X
NC	007	7549	Lake Mattamuskeet/ Pamlico Sound	Hyde	Near Fairfield	H (X?)	1985: 4 Probably sporadic here 1986: 0 1990: 0 2007: 0 2013: 0 2019: 0	Extirpated	Disturbance ("agricultural fields are maintained right up to the edge of the ditch slopes which does not leave much natural vegetation," 2020); herbicide use, competition ("Deep ditch overgrown with *Polygonum punctatum, Polygonum hydropiper, Alternanthera philoxeroides*, and *Salix caroliniana*," 1985).	Private	X
NC	011	5219		Hyde		H (X?)	1985: could not verify	Extirpated		Private	X

State	EO NO.	EO ID	River System	County	Site Location	2010 EO Rank	Population Data (numbers represent individual plants)	2022 Status	Primary Threats	Land Ownership	2022 EO Rank
			Lake Mattamuskeet/ Pamlico Sound		West of New Holland		2007: 0 2013: 0 2019: 0		Disturbance (adjacent to farm fields); competition ("habitat in this area is weedy and wet").		
NC	012	16126	Pamlico River/ ICWW	Hyde	Highway 264 North of Scranton Creek	E	1986: 40 1995: 0; may have been present before cornfield harvested 2001: 30 2002: 12 2004: 5 2007: 0 2013: 0 2019: 0	Possibly historical (changed from Failed to Find to historical? in 2021).	Rutting, mowing (2002); disturbance (corn field harvest, 1995)	NC Division of Mitigation Services Easement	H?
NC	020	28843	Lake Mattamuskeet/ Pamlico Sound	Hyde	Highway 264 near Lake Landing	E	2010: Present 2011: 9 in October, 5 in November 2012: 0 2013: 0 2019: 0	Possibly historical (changed from Failed to Find to historical? in 2021).	Competition ("both sides of the road have grown considerably compared to 2010"); disturbance (between two agricultural fields).	Private	H?
NC	021	41625	Lake Mattamuskeet/ Pamlico Sound	Hyde	Mattamuskeet NWR	n/a	2021: 266 planted/reintroduced 2022: 182	Stable/decreasing (266 container grown plants were planted in 2021. 182 plants estimated in January 2022; evidence of reproduction [e.g., stipules, fruit hanging on]).	Predation (aphid invasion in 2021).	Mattamuskeet NWR	C
NC	013	N/A	Unknown	Lenoir?		H	Pre-1900: No data	Historical.			H
PA	502		Delaware River	Delaware	Tinicum Island (Little Tinicum Island)	H	1864: Observed/collected 1865: Observed/collected 1983: 0 1991: 0 2009: 0	Historical. Extirpated. Specimens collected at Tinicum Island (believed to be Little Tinicum Island) in 1864 and 1865. Probably other surveys have been conducted in the drastically reduced remaining potential habitat since 2010 as a secondary target but none found.			H
PA	501		Delaware River	Philadelphia	Philadelphia	X	1827: Observed/collected 1865: Observed/collected 1983: 0 1991: 0 2008: 0	Extirpated. Numerous surveys in Philadelphia area have failed to locate the species. Much habitat destruction. Probably other surveys have been conducted in the drastically reduced remaining potential habitat since 2010 as a secondary target but none found.			X
VA	016	5881	Potomac River	Stafford	Brent Marsh	C?	1947: Occasional 1987: North - 30+ (predation on seeds), South - 5 on sunken barge 1995: 0 1996: 0	Stable/Decreasing?	Invasive species (*Persicaria perfoliata*) may degrade habitat	State Park (VDCR)	C? (last reviewed in 2014)

State	EO NO.	EO ID	River System	County	Site Location	2010 EO Rank	Population Data (numbers represent individual plants)	2022 Status	Primary Threats	Land Ownership	2022 EO Rank
							1997: 85 (central subpopulation) (possibly high due to flooding in 9/1996, which scoured the site of any vegetation) 2013: hundreds of flowering and fruiting stems 2021: 0 (marsh only observed via boat along eastern edge and could not get very close to edge due to thick submerged aquatic vegetation				
VA	017	788	Potomac River	Stafford	Youbedamn Landing? (Shore of Potomac River, 3.5 mi east of Brooke)	H	1939: Observed/collected 1987: Not seen in marsh habitat in area of historical record	Historical. Potomac River Drainage. Exact area not known. Near mouth of Aquia Creek. Plant collected at edge of thicket on sandy shore, and the shoreline in this area has undergone erosion.		Private, local county park	H
VA	009	1922	Rappahannock River	Essex	Piscataway Creek	E	**North side subpopulation: (SF 2258)** 1984: 11 1987: 0 1991: 0 1996: 0 2001: 0 2014: 0 2017: 0 (Not found by scanning with binoculars; could not get into site) **South side subpopulation (VDOT created marsh): (SF 10367, 32891)** 1997: less than 30 2001: 100 2003: Abundant, similar to 2001 2004-2010: Several hundred 2014: 0 2017: At least 15 seen from boat ca. 15-20 m farther back from marsh edge than previously mapped	Decreasing?	Competition (lower marshes downstream of occurrence dominated by *Spartina cynosuroides*); saltwater intrusion (as indicated by spread of *S. cynosuroides*)	State (VDOT)	C? (last reviewed in 2007)

State	EO NO.	EO ID	River System	County	Site Location	2010 EO Rank	Population Data (numbers represent individual plants)	2022 Status	Primary Threats	Land Ownership	2022 EO Rank
VA	028	3613	Rappahannock River	Essex, Westmoreland, Richmond	Occupacia, Drakes and Otterburn Marshes, Fones Cliff, Mulberry Island, Jones Landing	B?	Multiple subpopulations** (See supplemental table of VA data because of large amount of data)	Stable?	Previously, insect predation of seeds in 1986 and 1993; herbivory by muskrat in 1987. One new site is at active boat ramp and at risk of trampling. High leaf predation mostly by caterpillars (10-90%) observed at subpopulation D in 2016; unclear if mowing is a threat.	Scattered mixture of state (VA Department of Wildlife Resources), private, and NGOs (TNC and VA Outdoors Foundation). At one private, caretaker mows after plant seed set and numbers appear to be increasing under mowing regime.	B? (last reviewed in 2014)
VA	034	4081	Rappahannock River	Essex	Mount Landing Creek	C?	1987: several excellent occurrences along Mount Landing Creek 2001: 21 2003: 20 to 25 2017: 22 found slightly outside previously mapped polygon. Do not know if location shift is real or a result of more accurate mapping with GPS	Stable?	Competition (Lower reaches of Mount Landing Creek dominated by *Spartina cynosuroide*s); saltwater intrusion (as indicated by one site that previously had SJV is now dominated by *S. cynosuroides*); at least one plant with predation on seed pods.	Private	C? (last reviewed in 2007)
VA	038	11982	Rappahannock River?	Middlesex	Rappahannock River	H	None; last observed in 1700s	Historical. Rappahannock River. Type Locality, collection by John Clayton. Locality unspecified. Within 15 to 20 miles farther downstream than recent Rappahannock River/tributary records. (This unmappable occurrence not been previously included in VA data.)		Private?	H
VA	020	2686	Rappahannock River?	Essex County?	Blaudfield Wharf/Blandfield? (Rappahannock River?)	H	1915: Collected. Unmappable. Location can't be determined.	Historical		NGO (VA Outdoors Foundation conservation easement)?	H
VA	003	5000				H	1939: Observed	Historical			H

State	EO NO.	EO ID	River System	County	Site Location	2010 EO Rank	Population Data (numbers represent individual plants)	2022 Status	Primary Threats	Land Ownership	2022 EO Rank
			Mattaponi River	King William, King and Queen	Mattaponi River-Horse Landing		1987: 0 2010: 0 2014: 0			NGO (VA Outdoors Foundation conservation easement)	
VA	025	2805	Mattaponi River	King William, King and Queen	Garnetts Creek, Gum Marsh, Wakema, Lower Mattaponi River Marshes (=Gleason Marsh/Melrose Landing)	B?	Multiple subpopulations** (See supplemental table of VA data because of large amount of data)	Stable?	Garnetts Creek: natural herbivores and wave action; Gleason Marsh/Melrose Landing: possible trampling; duck blinds on population; Wakema: shore fishing and boat wake erosion; Gum Marsh: heavy predation of seeds by tobacco budworm	Mixture of private and State throughout EO (VA Department of Forestry and Department of Wildlife Resources); adjacent to Mattaponi Indian Reservation	B? (last reviewed in 2013)
VA	001	2947	Pamunkey River	New Kent, King William	Clayborne Creek Wetlands, Cumberland Marsh-Chamberlayne Point, Macon Creek Marshes	A	Multiple subpopulations** (See supplemental table of VA data because of large amount of data)	Stable/Decreasing?	Herbivory (observed numerous plants with damage from white flies (Aleyrodidae) and seed pod damage from corn earworm or tobacco budworm at multiple sites). High number of plants in 2010 despite heavy infestation and predation by larvae of corn earworm in 2009.	Private (MC Marshes, PR-CC Marsh) and NGO (TNC's Vandell Preserve at Cumberland Marsh)	A (last reviewed in 2022)
VA	023	1548	Pamunkey River	King William	Sweet Hall Marsh	E?	1987: 11 to 50 individuals 1994: 0 despite monthly searches during growing season. Probably extirpated due to road work. 1998: 5 1999: 5 2006: 0 2007: 0 2008: 0 2009: 0 2010: 0 2014: 0	Unknown, but likely failed to find or extirpated from site (not observed since 1999). Last survey in 2014 did not detect the species and Chesapeake Bay National Estuarine Research Reserve (CBNERRS) did not observe plant during monitoring along established vegetation transects (every 2-3 years).	Competition from invasive species (*Murdannia keisak*); disturbance from road work and boat ramp traffic; increased tidal inundation; shift in species composition to non-freshwater species (e.g., *Spartina alterniflora*), indicating saltwater intrusion; increased bank erosion.	Private (Tacoma Hunting and Fishing Club), Federal (Sweet Hall Marsh National Estuarine Research Reserve)	CD (last reviewed in 2007) (possibly F since last observed in 1999)
VA	006	8913	Chickahominy River	James City	Yarmouth Creek	CD	1984: 49 + 1 1991: 0 1995: 6 East source (15482)	Decreasing?	Competition (both source features in areas with tall dense *Spartina*	NGO (VA Outdoors Foundation	CD (last reviewe

State	EO NO.	EO ID	River System	County	Site Location	2010 EO Rank	Population Data (numbers represent individual plants)	2022 Status	Primary Threats	Land Ownership	2022 EO Rank
							2003: 1 East source (15482) 2017: 0 (both east and west source features)		*cynosuroides*); saltwater intrusion (as indicated by spread of *S. cynosuroides*).	conservation easement)	d in 2007)
VA	014	3652	Chickahominy River	Charles City	Old Neck Creek	D?	1991: 2 subpopulations, 40 + 7 1993: 26 1996: 6 2017: 0 (although a more thorough survey farther back into the marsh should be done)	Decreasing?	"History of disturbance," Old Neck Creek appears to be a manmade channel and levy where species grows may be old dredge spoils.	Private (individual)	D? (last reviewed in 2007)
VA	019	2683	Chickahominy River	Charles City	Morris Creek	H	1939: Observed, collected 2004: 0 2014: 0 2017: 0 (none found as far upstream as could be navigated)	Historical		State (VA Department of Wildlife Resources)	H
VA	031	9121	Chickahominy River	New Kent	Windsor Shades	H	1939: Observed, collected	Historical		Private	H
VA	033	9468	Chickahominy River	Charles City	Ferry Point	H	1938: Observed, collected 2014: 0 2017: no likely habitat seen in area, disturbed with houses, piers, and riprap	Historical	Area disturbed with houses, piers, and riprap.	Private	H
VA	004	3727	James River	Charles City, Prince George	James River-near Hopewell	H	Northern source (15525) and Southern source (15515)**: 1937: Observed, collected 1939: Observed 1981: 0 1996: 0 1998: 0 2017: 0 (surveyed only Northern source)	Historical		Private	H
VA	007	7789	James River	Charles City	Kittewan Creek	C?	1939: Observed, collected 1985: 8, several subpopulations 1996: 40-50 in western, only subpopulation located 2000: 5 2 subpopulations 2017: 3 found outside of these sources; 0 at all 3 previously mapped sources	Decreasing?	Predation on seed pods.	State (VA Department of Wildlife Resources)	C? (last reviewed in 2018)
VA	018	7712	James River	James City	Sandy Bay Marsh (Jamestown Island)	D	1938: Observed 2000: 13 2001: 0 2003: 0 2004: > 456 2005: 6 2007: 2	Decreasing?	Population in habitat modified by past disturbance (road); possibly a muskrat eat-out zone; population is far enough away from the river channel that boat	Federal (Colonial National Historical Park); private	D (last reviewed in 2007)

State	EO NO.	EO ID	River System	County	Site Location	2010 EO Rank	Population Data (numbers represent individual plants)	2022 Status	Primary Threats	Land Ownership	2022 EO Rank
							2009: 0 2010: 0 2021: 0 for project area searched (not at previously known site) 2022: 140 at new subpopulation in Powhatan Creek (to be determined if part of this EO) 2023: 6 at new subpopulation in Powhatan Creek (to be determined if part of this EO)		traffic and public access should not be an issue but oil sheens seen in same area as SJV. Some stands of *Phragmites* seen. Also transition from freshwater to oligohaline to more mesohaline plant species noted from west to east on Back River Marsh, indicating saltwater intrusion (2010). Significant insect herbivory of leaves and gnaw marks on stem (unknown predator) at new subpopulation in Powhatan Creek (2022).		
VA	029	4518	James River	Charles City	Wilcox Wharf	H	1936: Observed, collected 1996: 0 2017: 0	Presumed extirpated (no likely marsh habitat present)		Partially Chickahominy Indian Tribe (VA Outdoors Foundation), partially local government (Charles City County)	X? (last reviewed in 2018)
VA	032	8461	James River	Surry	Crouch Creek	H	1939: Observed, collected 1995: 0 1998: 0 (in 1998 revised table, but source of data unknown)	Historical (Low level density residential development at site [1995]).		Private	H
VA	035	9088	James River	Charles City, Chesterfield, Henrico	Turkey Island Marshes	B	**Northern subpopulation** 1995: 5 2000: 34 2013: 2 2017: 308 (more sites visited) **Southern subpopulation** 1995: 5 2001: 38 2017: 0 **Turkey Island** 2017: 27	Increasing/stable? (more sites were visited in 2017 than previous years; many new colonies found upstream/downstream of previously mapped locations including on Turkey Island).	Predation by tobacco budworm first observed in 2001 in southern sites; public access canoe/kayak boat launch in northern sites.	Northern: mostly private and NGO (James River Association); Southern/Turkey Island: Federal (U.S. Fish and Wildlife Service Presquile NWR)	B (last reviewed in 2018)

** See 2013 5-year review (Service 2013) for additional details about merging of EOs into a single EO.

Supplemental Table: Virginia population monitoring data (see above table for additional details).

EO NO./ID	EO ID	River System/ site location	Population Data for EO				
028	3613	**Rappahannock River**/ Occupacia, Drakes and Otterburn Marshes, Fones Cliff, Mulberry Island, Jones Landing	**Drakes and Otterburn Marshes** (formerly Drakes) 2 overlapping population areas so data has been combined: 1987: 11-50, entire population cropped by muskrats 1989: 0 1993: 7 1995: 200+ 1998: approximately 22 2001: 15 2010: 0 2014: 40 2014: 40 **Fones Cliff (Formerly Fones Cliff' Brockenbrough Creek)** 1989: approximately 20 mature plants 2000: approximately 7 2001: 10 2003: 12 mature, 2 to 3 little plants	**Occupacia Marshes** Consists of 9 subpopulation polygons grouped into subpopulations A, B, C, and D for reporting purposes**.** **Subpopulation A (Beverly Marsh):** 1984: 58 at 3 subpopulations 2001: 0 2010: 0 2013: 54 at 3 subpopulations 2014: 24 at 1 subpopulation; 0 at 2 subpopulations	**Subpopulation B: (Occupacia Marshes, southern cluster)** 1984: 300, most frequent near edge of marsh, especially near points of land. 1986: 25 in 4 subpopulations. Seeds being eaten by insect larvae. 1987: 0 1993: 200+ noted from 1 subpopulation. 1995: Approximately 48 in 4 suboccurrences; plants did not reach maturity until late August-early September. Only 23 in main population. Plants diminutive (in September). 1998: 0 2000: No plants seen but not all habitat checked. 2001: 0 2010: 0 (All but 1 of previously known source features were searched) 2014: 0 (All but 1 of previously known source features were searched)	**Subpopulation C (Jones Landing)** 1984: 3 plants in 2 subpopulations. 2001: 0 2010: 0 2014: 0 **Subpopulation D (Occupacia Marshes, northern cluster, and Bridge Creek Marsh)** 1984: Small colony 1998: 0 (in revised 1998 table but don't know source) 2000: 5 plants in 2 locations. Not all habitat checked. 2001: 50-100 in 3 locations. 2002: 38 (37 and 1) at 2 stations. Not all habitat checked. 2010: All but northernmost of these colonies checked by researcher, but no plants seen. However, landowner in area did see plants in 2010. No further details on location. 2013: 87 in 4 subpopulations 2014: 0 at 6 subpopulations 2016: 1832 in 3 subpopulations	**Broad Creek Marsh** 2013: A: fairly dense colony; B: 1 **Mulberry Island** 2001: Approximately 24 (not yet in bloom in July) 2010: 0 2014: 1 **Carter's Wharf (across from Beverly Marsh)** 2014: 1

EO NO./ID	EO ID	River System/ site location	Population Data for EO				
025	2805	**Mattaponi River/** Garnetts Creek, Gum Marsh, Wakema, Lower Mattaponi River Marshes (=Gleason Marsh/Melrose Landing)	**Reported by site arranged from upstream to downstream.** **Garnetts Creek:** 1987: 11 to 50 1990: 27 - perhaps as many as 100. 1992: 75 1993: 49 1994: 88 1995: 200+ north side and 3 south side (Rouse 2000) 1996: 460+ and 6 south side = 466+ 1997: 134 north side + 0 south side = 134 1998: 69 north side + 3 south side=72 1999: 1,585 north side + 33 south side= 1,618 2000: 1,481 north side + 3 south side = 1,484 2001: 607 north side + 3 south side = 610 2003: 50 or more but not searched thoroughly. 2010: 131 (minimum number; not all plants counted) 2012: numerous individuals in flower and fruit 2014: 1,167 at 4 subpopulations (north side) 2019: hundreds at 3 subpopulations (north side; not comprehensive survey)	**Sandy Point/Gum Marsh:** 1984: 200 1987: 101 to 1,000 1993: 362, predation *H. virescens.* 1994: 134 1997: 73 1998: 2 + 1 (new single plant subpopulation at Sandy Point significantly further upstream from other Gum Marsh plants.) 1999: 85 2000: 149 (2 subpopulations) 2001: 133 (2 subpopulations) 2003: 10-15, no thorough search. 2010: 39 2012: 16 (1 subpopulation) 2014: 32 (1 subpopulation), 0 (1 subpopulation) 2019: 20+ (2 subpopulations, not comprehensive survey)	**Wakema:** 1987: 1 to 10 1992: 0 1993: 0 1994: 0 1997: 0 1998: 0 1999: 0 2000: 0 2003: 0 2010: 0	**Lower Mattaponi River Marshes (=Gleason Marsh/Melrose Landing)** 1987: 1 to 10 + 11 to 50 (2 subpopulations) 1988: 3 1992: 3 1993: 16 + 82 = 98 1994: 0 + 30 + 14 = 44 1997: 0 (3 subpopulations) 1998: 0 + 4 + 0 = 4 1999: 0 + 12 + 1 = 13 2000: (0?) + 23 + 13 = 36 2001: (0?) + 196 + 4 = 200 2003: abundant, but many lying down. Difficult to count. 2010: 0 + 195 + 0 (only observed in 1 subpopulation of the 3 surveyed) 2014: 646 at 8 subpopulations, 0 at 2 subpopulations 2019: 0 at 1 subpopulation (not comprehensive survey)	

EO NO./ID	EO ID	River System/ site location	Population Data for EO				
001	2947	**Pamunkey River**/ Clayborne Creek Wetlands, Cumberland Marsh-Chamberlayne Point, Macon Creek Marshes	**Cumberland Marsh – Chamberlayne Point:** 1949: specimen collected 1983: 300 (unclear if represents total count) 1986: 210 1987: 0 1990: 1,043 (unclear if represents total count.) 1991: 500 +8 1995: 589 1996: 509 1997: 758 1998: 58 (40? In annual report) 1999: 343 2000: 716 2001: 2,745 2002: 5,808, stunted, shriveled pods	**Cumberland Marsh – Chamberlayne Point (continued):** 2003: 374 2004: 3,092 2005: 76 2006: 698 2007: 1,957 + 2008: 1,440 2009: 1,968, heavy infestation, seed predation by corn earworm 2010: 2,998 2012: 222 2014: 720 across approximately 13 sites 2016: 24 at 1 site 2018: 50+ at 1 site 2020: 50-75 at 3 sites	**Macon Creek Marshes:** 1999: 9 2010: 0 2014: 73 at 4 sites **Pamunkey River-Clayborne Creek Marsh:** 1986: 9+13 at 2 subpopulations, seeds being eaten, most likely by insect larvae. 1987: 11-50 (southern subpopulation) 1992: 0, but only southern subpopulation checked. 1998: 0 1999: 0 2010: 0 2014: 0		

APPENDIX C: GENERAL EO RANKS DEFINITIONS

General Element Occurrence Rank Definitions
(from NatureServe 2020b)

A: Excellent viability
Occurrence exhibits optimal or at least exceptionally favorable characteristics with respect to population size and/or quality and quantity of occupied habitat; and, if current conditions prevail, the occurrence is very likely to persist for the foreseeable future (i.e., at least 20-30 years) in its current condition or better. These occurrences have characteristics (e.g., size, condition, landscape context) that make them relatively invulnerable to extirpation or sustained population declines, even if they have declined somewhat relative to historical levels. For species associated with habitat patches or ephemeral or particularly dynamic habitats, occurrences warranting an A rank generally consist of metapopulations rather than single demes (unless exceptionally large and robust). Occurrences of this rank typically include at least 1,000 mature individuals but may be smaller (100s) or might require larger populations (10,000s), depending on the species and its demographic characteristics. However, occurrences can be ranked A even if population size is not known. For example, for occurrences lacking information on population size, an A rank may be appropriate under the following circumstances: the population is clearly very large but it is not known how large; the area of occupied habitat is exceptionally large; or the occurrence has excellent condition and landscape context and a long history of occurrence persistence. Occurrences with excellent estimated viability are ranked A even if one or more other occurrences have a much larger population size and/or much greater quantity of occupied habitat. In most cases, occurrences ranked A will occupy natural habitats. However, "natural" is an ambiguous concept, and occurrences in "unnatural" conditions (e.g., somewhat modified by human actions) may still be assigned a rank of A if they otherwise meet the criteria.

B: Good viability
Occurrence exhibits favorable characteristics with respect to population size and/or quality and quantity of occupied habitat; and, if current conditions prevail, the occurrence is likely to persist for the foreseeable future (i.e., at least 20-30 years) in its current condition or better. B-ranked occurrences have good estimated viability and, if protected, contribute importantly to maintaining or improving the conservation status of threatened or declining species. For species associated with habitat patches or ephemeral or particularly dynamic habitats, a high-quality occurrence may warrant a B rank if it consists of a single deme rather than a metapopulation (unless the single deme is exceptionally large and robust, in which case an A rank may be appropriate).

C: Fair viability
Occurrence characteristics (size, condition, and landscape context) are non-optimal such that occurrence persistence is uncertain under current conditions, or the occurrence does not meet A or B criteria but may persist for the foreseeable future with appropriate protection or management, or the occurrence is likely to persist but not necessarily maintain current or historical levels of population size or genetic variability. This rank may be applied to relatively low-quality occurrences with respect to size, condition, and/or landscape context if they still

appear to have reasonable prospects for persistence for the foreseeable future (at least 20-30 years). Examples include very small non-degraded relict occurrences as well as some remnant occurrences of former landscape-level species such as many extant occurrences of tall-grass prairie insects. These occurrences represent the lower bound of occurrences worthy of protection.

D: Poor viability
If current conditions prevail, occurrence has a high risk of extirpation (because of small population size or area of occupancy, deteriorated habitat, poor conditions for reproduction, ongoing inappropriate management that is unlikely to change, or other factors). Questionably viable occurrences that could be restored to at least fair viability should not be ranked D if restoration is deemed feasible and plausible; in most such cases CD should be used. Very small occurrences that may be vulnerable to deleterious stochastic events may be ranked as follows: If the stochastic event is highly theoretical or of very low probability in the appropriate time frame (e.g., 20-30 years), then a C or CD rank may be appropriate. If a minority of other similar occurrences have disappeared as a result of, say, disease or inbreeding, then perhaps CD is best. If most of these small occurrences have been extirpated or are disappearing due to such events, then D is probably appropriate. The D rank also applies if the population is so small that there will inevitably be a year (or generation) in the near future in which by chance all adults will be the same gender.

E: Verified extant
Occurrence recently has been verified as still existing, but sufficient information on the factors used to estimate viability of the occurrence has not yet been obtained. Use of the E rank should be reserved for those situations in which the occurrence is thought to be extant, but an A, B, C, D, or combination rank cannot be assigned.

H: Historical
Recent field information verifying the continued existence of the occurrence is lacking. Examples of this rank include occurrences based only on historical collection data, or occurrences that previously were ranked A, B, C, D, or E but that are now, without field survey work, considered to be possibly extirpated due to general habitat loss or degradation of the environment in the area. H may be applied to recently verified occurrences if two or more competent subsequent efforts that should have found the species did not, or if there has been a known major disturbance since the last observation such that continued existence of the occurrence is in doubt (for example, an isolated Lepidoptera occurrence that was sprayed with Dimilin®).

In the absence of known disturbance and with the habitat still extant, H is generally recommended for occurrences that have not been reconfirmed for 20 or more years, but for many short-lived insects a shorter interval may be appropriate, and for unusually stable habitats (like undisturbed caves), or for certain plants whose seeds may persist and remain viable in the soil for decades, a longer interval, up to 40 years, may be used. With very few exceptions, occurrences are to be regarded as H after 40 years without confirmation, even with no effort to locate the species. The time frame for H occurrences is necessarily arbitrary, and the values specified here should be regarded as generally appropriate but somewhat flexible rules. The professional judgment of the assessor should determine when resurveys with negative results have been

sufficient in quantity and quality to warrant updating an occurrence rank from F to H or from H to X. Deviations from the suggested time frame should be explained in the EO RANK Comment field.

In some cases, H may indicate occurrences with imprecise locational information such that it may be difficult or impossible to determine whether subsequent observations are of the same occurrence; many of these occurrences may remain H indefinitely. Nevertheless, occurrences with imprecise locational information sometimes may be mapped using an appropriate and reasonable indication of the degree of locational uncertainty.

F: Failed to find
Occurrence has not been found despite a search by an experienced observer at a time and under conditions appropriate for the Element at a location where it was previously reported, but the occurrence still might be confirmed to exist at that location with additional field survey efforts. For occurrences with vague locational information, the search must include areas of appropriate habitat within the range of locational uncertainty.

X: Extirpated
Adequate surveys by one or more experienced observers at times and under conditions appropriate for the species at the occurrence location, or other persuasive evidence, indicate that the species no longer exists there or that the habitat or environment of the occurrence has been destroyed to such an extent that it can no longer support the species.

Unrankable
An occurrence rank (including E) cannot be assigned due to lack of sufficient information on the occurrence. As currently defined, this category is not clearly distinguishable from H, and use of U is discouraged until this issue is resolved (perhaps by elimination of the U category). Occurrences that currently cannot be surveyed because of access issues (e.g., a cave entrance has been permanently sealed, or an uncooperative landowner denies access) may be ranked A, B, C, D, E, F, H, or X if the rank is based on recent survey data obtained when access was still possible. Currently inaccessible occurrences that are based only on old (historical) information should be ranked H. Note that access issues often are temporary and may be overcome by negotiation, change in ownership, use of novel survey techniques, or other methods. The U code sometimes has been used to indicate occurrences with "unknown" viability, but such occurrences generally should be coded as H, F, or NR, depending on the circumstances.