Swamp Pink
(Helonias bullata)

5-Year Review:
Summary and Evaluation

USFWS NJFO

U.S. Fish and Wildlife Service
Northeast Region
New Jersey Field Office
Galloway, New Jersey

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5-YEAR REVIEW

Species reviewed: Swamp pink (*Helonias bullata*)

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5-YEAR REVIEW
Swamp pink / *Helonias bullata*

1.0 GENERAL INFORMATION

1.1 Reviewers:

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1.2 Methodology Used to Complete the Review:

This review was prepared by Alicia Protus, lead biologist, with input from cooperating U.S. Fish and Wildlife Service (USFWS) Field Offices, National Wildlife Refuges, state agencies, and other species experts. A draft of Section 2 was provided for technical review to all USFWS Field Offices and Natural Heritage Programs within the species' range, as well as National Wildlife Refuges that are known to host swamp pink. Geospatial analyses were performed using ESRI ArcMap version 10.6.1. Except as necessary to provide context, information provided in the recovery plan (USFWS 1991) or the previous two reviews (USFWS 2008, 2014) is not included in this review. Some of the information cited herein pre-dates the publication of the last review but was not known to the USFWS at that time.

1.3 Background:

1.3.1 Federal Register (FR) Notice citation announcing initiation of this review:
September 4, 2019 (84 FR 46562-46563). Endangered and Threatened Wildlife and Plants; Initiation of 5-Year Reviews of Seven Northeastern Species.

1.3.2 Listing history

FR notice: 53 FR 35076-35080
Date listed: Rule published September 9, 1988; effective October 11, 1988
Entity listed: Species (monotypic genus)
Classification: Threatened

1.3.3 Associated rulemakings: None.

1.3.4 Review History:
The 1991 recovery plan includes an assessment of species status. The first 5-year review was initiated April 21, 2006 (71 FR 20717-20718) and signed October 28, 2008 (USFWS 2008). The second 5-year review was initiated June 8, 2011 (76 FR 33334-33336) and signed December 30, 2014 (USFWS 2014).

1.3.5 Species' Recovery Priority Number at start of 5-year: 7C

1.3.6 Recovery Plan or Outline

Name of plan: Swamp Pink (*Helonias bullata*) Recovery Plan
Date issued: September 8, 1991
Dates of previous revisions, if applicable: Not applicable

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, the species is a plant; therefore, the DPS policy is not applicable.

2.2 Recovery Criteria

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

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?

Although the recovery criteria have not been revised since first published in 1991, the general nature of threats to swamp pink described in the recovery plan have not changed significantly. The recovery criteria are flexible enough to adequately address current threats to the species throughout the range.

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)?

Factor C (predation by deer) and Factor E (climate change) were not considered to be significant threats to swamp pink at the time the recovery criteria were developed; however, the threats associated with these factors can still be adequately addressed through the criteria provided.

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:

According to the recovery plan, swamp pink will be considered for delisting when the following conditions are achieved (quoted in italics).

Condition 1. *Permanent habitat protection is secured for those occurrences that: (a) are ranked as "A" or "B" according to the quality specifications in Appendix B (which follow the Nature Conservancy's ranking system*[1] [and which reflect both habitat conditions and population size/vigor]*), or (b) are representative of the species' range-wide distribution, or (c) are representative of habitat or genetic diversity. . . As a preliminary quantitative objective, 80 sites must be permanently protected to achieve condition 1* (USFWS 1991).
Habitat will be considered permanently protected when: (1) adequate acreage is secured through acquisition or easement by government agencies or conservation organizations with primary responsibilities for resource protection; (2) sites on public lands are formally designated as protected areas; and (3) preserve designs and/or management stipulations, based on definitive research results, are in place for each site (USFWS 1991).

This criterion has not been fully met in terms of either numbers or level of site-specific protection, though significant progress has been made since 1991. The current range-wide protection status of swamp pink is summarized below.

In total, 114 of the 235 known extant occurrences of swamp pink (48.5%) occur at least partly on public or otherwise protected land (New Jersey: 65, Delaware: 4, Virginia: 27, North Carolina: 13, South Carolina: 1, Georgia: 4) (see Table 1 in Section 2.3.1.2). This is over three times the number of swamp pink occurrences known to exist at least partly on protected land in 1991.

[1] The Element Occurrence Data Standard which guides occurrence rankings is now published by NatureServe (2002) in cooperation with the Network of Natural Heritage Programs and Conservation Data Centers.

However, available information is insufficient to assess which of these occurrences, if any, satisfy the standards of protection specified in the recovery criteria, specifically that adequate acreage is secured, swamp pink habitat is formally designated as protected, and preserve designs or management plans are in place. Several threats to swamp pink result indirectly from land-use changes occurring elsewhere in the watershed; adequate acreage of buffer for swamp pink occurrences will vary depending on site-specific factors including site topography, adjacent land uses, and amount of development within the watershed (Dodds 1996). It is likely that a significant number of these "partially protected" sites do not currently receive adequate protection and/or management to ensure the long-term viability of the occurrence, as evidenced by the observed long-term declines at several New Jersey swamp pink occurrences located, at least partially, on protected land (see Table 5 and accompanying analysis in Section 2.3.1.2).

A- and B-ranked Occurrences: Of the 114 occurrences located, at least partly, on protected land, 38 are considered A- or B-ranked (New Jersey: 19, Delaware: 2, Virginia: 13, North Carolina: 3, South Carolina: 1) (Table 1). Except for Maryland and Georgia, all the other states in the range support at least one A- or B-ranked occurrence located, at least partially, on protected lands (Table 1).

Range-wide Distribution, Habitat Diversity, and Genetic Diversity: In addition to A- and B-ranked sites, other swamp pink occurrences may contribute to meeting Condition 1 because they are representative of the species' range-wide distribution, habitat diversity, or genetic diversity. USFWS (2008) identified several priority swamp pink sites that represent one or more of these criteria, including Budd Lake Bog, New Jersey; Pink Beds, North Carolina; Watson-Cooper Heritage Preserve, South Carolina; and Commissioner's Rock Bog, Georgia. USFWS (2008) also identified the swamp pink occurrences in North Carolina, South Carolina, and Georgia (Southern Appalachian/Blue Ridge region) as important representatives of swamp pink genetic diversity based on the range-wide genetic assessment in Godt et al. (1995). Updated information on the identified priority sites is presented in Appendix A, where available. In addition to these priority sites, there are 62 extant swamp pink occurrences that are not A- or B- ranked but occur, at least partly, on public or otherwise protected land (New Jersey: 46, Delaware: 2, Virginia: 14). It is unclear which of these 62 occurrences would be considered representative of the species' range-wide distribution, habitat diversity, or genetic diversity.

<u>New Jersey, Delaware, and Maryland:</u> The swamp pink occurrences in New Jersey, Delaware, and Maryland primarily represent the Embayed Atlantic Coastal Plain physiographic region. Maryland has two outlier swamp pink sites at the edge of the Piedmont Upland physiographic region. New Jersey also has two outlying swamp pink occurrences (Budd Lake Bog and an outplanted occurrence, both located in Morris County) within the Appalachian Highlands/New England Upland region that represent the northern-most extent of the species range. Godt et al. (1995) reported that occurrences in New Jersey (and, presumably, Delaware and Maryland) have low overall genetic diversity relative to the rest of the swamp pink range, likely due to the founder effects associated with post-glacial colonization. Despite the latitudinal trend, Godt et al. (1995) and Novy (2011) did identify some occurrences in New Jersey (i.e., Budd Lake Bog, one occurrence in Atlantic County, one occurrence in Cape May County) that were genetically distinct from all other sampled occurrences in the State.

Approximately 44% (n = 65) of extant swamp pink occurrences in New Jersey are located, at least partly, on protected land, including 70% (n = 19) of known A- or B-ranked occurrences in the State. Protected occurrences in New Jersey are dispersed somewhat evenly across the range of swamp pink in the State, though a lower proportion of occurrences are protected in Atlantic, Camden, Gloucester, and Monmouth counties. Rates of land protection are much lower in Delaware and Maryland, with 19% (n = 4) and 0% of extant swamp pink occurrences located, at least partly, on protected land, respectively. About 18% (n = 2) of the known A- and B-ranked occurrences in Delaware occur, at least partly, on protected lands.

Virginia: The Commonwealth of Virginia represents the central portion of the swamp pink range. The swamp pink occurrences in this state are generally clustered in two distinct areas. The first cluster of swamp pink sites coincides with the Northern Blue Ridge/Middle Valley and Ridge physiographic regions. The second cluster of swamp pink sites coincides with the Embayed Atlantic Coastal Plain region. The swamp pink occurrences within Virginia contain an intermediate level of genetic diversity relative to the other portions of the range, with a few occurrences containing relatively high diversity for the species (Godt et al. 1995). About 79% (n = 27) of extant swamp pink occurrences in Virginia are located, at least partly, on protected land, including 76% (n = 13) of all known A- and B-ranked occurrences in the State (Table 1). In the Northern Blue Ridge/Middle Valley and Ridge regions the protected swamp pink occurrences are clustered in George Washington National Forest and adjacent conservation areas, with three outlying swamp pink occurrences that remain unprotected (VANHP 2020). In the Embayed Atlantic Coastal Plain region, the protected swamp pink occurrences are clustered at Fort A.P. Hill with four outlying swamp pink occurrences remaining unprotected (VANHP 2020).

North Carolina, South Carolina, and Georgia: The swamp pink occurrences in North Carolina, South Carolina, and Georgia represent the Southern Blue Ridge physiographic region and the southern extent of the species' range. Swamp pink occurrences in these states contain the highest level of genetic diversity relative to the rest of the range (Godt et al. 1995). Three-quarters (75%, n = 18) of all known extant swamp pink occurrences in these states, including all A- or B-ranked sites known to occur in this portion of the range (n = 4), are located, at least partly, on protected land (Table 1). The extant occurrences that remain unprotected in this portion of the range are the Commissioner's Rock Bog occurrence in Georgia and five occurrences in North Carolina. Though not protected, the Commissioner's Rock Bog occurrence has had four outplanted safeguarding sites[2] established on protected land to preserve the population's genetic representation and maintain the southern extent of the species range (GADNR 2020, Radcliffe pers. comm. 2020; see Commissioner's Rock Bog summary in Appendix A).

Condition 2. *Regulatory protection is sufficiently strong at the federal, state, and/or local levels to ensure continued rangewide conservation of viable populations and their habitat (including an adequate buffer zone) after the protection afforded by the Endangered Species Act is withdrawn (USFWS 1991).*

As described in Section 2.3.2, the necessary level of regulatory protection has not been fully

[2] A safeguarding site is an outplanted swamp pink occurrence established *in-situ* at a protected location, typically using material representing one or more imperiled genotypes, to maintain the species' representation and improve redundancy within a particular portion of the range.

achieved to satisfy this criterion.

If swamp pink were delisted and no longer received protection under the Endangered Species Act (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*) (ESA), only one or two states in the species range (Maryland, possibly Virginia) would have adequate regulatory mechanisms in place to consider impacts to the species during freshwater wetland permit reviews and prevent direct destruction of swamp pink habitat from fill. In other states, swamp pink would be incidentally protected by state wetland regulatory programs and/or Section 404 of the Clean Water Act (33 U.S.C. 1344 *et seq*.) (CWA) which require avoidance and minimization of wetland impacts, but fill of swamp pink habitat could be ultimately permitted as the species would not be afforded any special protection. The Navigable Waters Protection Rule (85 FR 22250), effective June 20, 2020, amended several definitions (e.g., 'waters of the United States' and 'adjacent wetlands') and generally reduced the scope of wetlands considered jurisdictional under the CWA, in turn reducing the scope of swamp pink habitat that would be incidentally protected by the requirement to minimize fill. No state in the range has regulatory mechanisms in place to routinely require adequately sized (≥ 300-ft, Dodds 1996) upland buffers to prevent indirect degradation of the species' wetland habitat (e.g., as a result of development in adjacent uplands) if swamp pink were delisted and no longer received the protections afforded by the ESA.

Maryland is the only state in the range of swamp pink that has any kind of regulatory mechanism in place to allow the State to consider potential impacts of groundwater extraction on swamp pink (and other state-listed species) during review of water appropriation and use permits. This protection would likely remain if swamp pink were delisted at the federal level. In all other states in the range of swamp pink, the impact of groundwater extraction and associated water table drawdown on swamp pink is not adequately addressed. Current regulations in all states are also insufficient to address general trends of groundwater depletion and the cumulative adverse effect it has on swamp pink and its habitat.

Stormwater management regulations in New Jersey, Maryland, and Virginia require stormwater infrastructure that is designed to more closely mimic the natural/pre-development hydrologic conditions. These regulations do not address listed plants specifically, but incidentally benefit swamp pink by avoiding and minimizing degradation of swamp pink occurrences in watersheds subject to development pressure in the future. These regulations would remain in place regardless of swamp pink's state or federal status; however, these regulatory mechanisms are inadequate to address the on-going degradation of populations that are already experiencing stormwater impacts in these states (USFWS 2008). In other states within the swamp pink range, stormwater regulations tend to provide minimal protection for swamp pink, either through limitations on the state statutes or lack of adequate enforcement.

Since listing of swamp pink under the ESA, collection of the species from the wild generally appears to be an uncommon occurrence (Crosson 2012). However, there is commercial demand for the species and collection activities may be depressed by real or perceived limitations on collection associated with the ESA or state regulations (Crosson 2012). Regulations exist in all states in the swamp pink range that prohibit the collection or destruction of plants (specifically state-listed plants in Virginia, North Carolina, and Georgia) from state-owned properties, but no

significant protections currently exist for plants on private lands (>50% of all known extant swamp pink sites, Table 1).

Threats to swamp pink from encroachment of woody vegetation, predation by herbivores, disturbance from feral hogs, and flooding by beaver generally aren't addressed by existing regulatory mechanisms, though funding sources used by managers to address these threats would decrease if swamp pink were no longer federally listed. States like Maryland have insufficient state-level funding sources to support rare plant stewardship, monitoring, and research efforts (McCarthy pers. comm. 2021).

Condition 3*. As necessary, representative genotypes are established and maintained in cultivation at plant breeding facilities (USFWS 1991).*

As described in the Swamp Pink Recovery Plan (USFWS 1991), imperiled swamp pink occurrences that contain unique or representative genotypes will have *ex-situ* collections established to safeguard the species' genetic representation. Several priority swamp pink occurrences have been identified throughout the range but detailed genetic analysis across the species range is lacking, so additional priority sites may exist (see Condition 1(c)).

Swamp pink from at least two identified priority sites (Commissioner's Rock Bog, Georgia, and one occurrence in North Carolina) are maintained in *ex-situ* collections by the Atlanta Botanical Garden (NCNHP 2020, Radcliffe pers. comm. 2020). Additional efforts are underway to collect material from another identified priority site in South Carolina (Watson-Cooper Heritage Preserve) and begin an *ex-situ* collection at the Atlanta Botanical Garden (Radcliffe pers. comm. 2020). The goals of these *ex-situ* collections may vary; some collections may be maintained in propagation indefinitely, while others may be maintained temporarily until additional occurrences are established *in-situ* on protected lands.

As described in USFWS (2008) and USFWS (2014), swamp pink plants salvaged in the 1990s from a severely impacted site in Salem County, New Jersey were previously held by Rutgers University and the New York Botanical Garden. Unfortunately, the Rutgers collection was lost due to failure of the watering system (Walsh pers. comm. 2020), and the New York Botanical Garden collection has declined, possibly to extirpation, following the transplant of swamp pink into the new Native Plant Garden circa 2012 (Hagen pers. comm. 2020). This swamp pink lineage remains extant, albeit in small numbers, in a portion of the original wetland habitat that had been restored. No work has been done to characterize the genetics of this swamp pink occurrence, so the significance of this site in terms of swamp pink representation remains unknown.

Cryogenic preservation of seeds and clonal propagation of plant tissue was identified in the Swamp Pink Recovery Plan as an alternative to maintaining live cultivated collections at plant propagation facilities; however, the feasibility of using these long-term storage techniques on swamp pink was unknown at that time (USFWS 1991). As described in Section 2.3.1.1, Perullo et al. (2015) developed the first protocol for successful cryopreservation of swamp pink seeds. At the time of publication, approximately 2,000 swamp pink seeds sourced from Georgia's Smithgall Woods safeguard site (which, in turn, were propagated with material sourced from

Georgia's Commissioner's Rock Bog occurrence) have been cryopreserved for future use (Perullo et al. 2015). At present, no other swamp pink occurrences are known to be maintained in long-term storage.

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:

A recent study by Perullo et al. (2015) demonstrated that swamp pink seeds are capable of withstanding cryopreservation, with the highest rates of success when seeds are preserved promptly after collection (i.e., within a few days to weeks following seed maturation). The study also presented protocols for the successful germination of seeds *in vitro*, asexual multiplication of shoots, and establishment of shoots in soil. Propagated shoots were readily established in soil with 100 percent survival, demonstrating that micropropagation of shoots can be used to rapidly produce identical, disease-free plants when needed for research or conservation projects (Perullo et al. 2015).

Punsalan et al. (2016) characterized the germination ecology of swamp pink seeds in response to different moisture conditions. Swamp pink seeds exhibited high floating capability and tolerance to submersion under water for up to 30 days. Seeds that dispersed into flooded or saturated environments germinated rapidly (10-30 days), whereas seeds that dispersed into drier areas (e.g., elevated substrate with limited moisture availability) were unlikely to germinate and establish. Swamp pink seed dispersal typically coincides with the seasonally high water table in the spring, which increases the likelihood that seeds will arrive in a suitably saturated habitat conducive for germination and seedling establishment when water levels recede in the late summer. Microsite variation including channel meanders, debris (e.g., log sills), and microtopographic (hummock and hollow) relief are important features that promote the establishment of new swamp pink plants, and restoration of these features should be considered where appropriate (Punsalan et al. 2016). Additionally, dispersal of floating seeds by water typically facilitates colonization of habitats downstream from the source (Wubs et al. 2016), so Punsalan et al. (2016) identified assisted upstream dispersal of swamp pink seed as a potential measure to overcome dispersal limitations.

Orcutt (2019) conducted a 2-year study of swamp pink pollinators in Virginia and documented 41 unique insect taxa visiting swamp pink flowers. Insects of the order Hymenoptera made up 91 percent of the total insect visitors. Within Hymenoptera, taxa in the family Halictidae (sweat bees) accounted for 50 percent of all visitors and likely have the highest pollination value for swamp pink due to their intentional pollen-collecting habits (Orcutt 2019). Swamp pink flowers are self-compatible and not reliant solely on pollinators for reproduction; however, it is likely that these insect visitors facilitate cross-pollination and assist with the transfer of genes between swamp pink plants and populations.

Aberrant fall-blooming swamp pink plants were observed at the Watson-Cooper Heritage Preserve, South Carolina in September 2020 (Bradley pers. comm. 2021) and at Fort A.P. Hill,

Virginia in November 2020 (Applegate pers. comm. 2020). The typical flowering period for swamp pink in these areas is April through early May (Weakley et al. 2012). Swamp pink typically begins bud development in the fall, but the aberrant plant likely began bud development in the spring. Atypical weather (e.g., temperature, precipitation) mimicking environmental cues for flowering is one suspected cause of off-season flowering (Thapliyal et al. 2020); however, no significant deviations from typical weather conditions were noted during the spring for these locations.

2.3.1.2 Abundance, population trends (e.g., increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

The total number of extant (A, B, C, D, E-ranked) swamp pink element occurrences has decreased for the first time since listing, declining from 249 to 235 occurrences (-14) between 2011 and 2020 (Table 1, Table 2). The number of extant swamp pink occurrences is influenced by several factors including the discovery of new swamp pink occurrences, the loss/extirpation of occurrences, and the reorganization (i.e., splitting, merging, deleting) of element occurrences (EOs) by Natural Heritage Programs, as summarized in Table 2. States throughout the range of swamp pink use different methodologies for delineating swamp pink element occurrences; uniformly applying habitat-based plant element occurrence delimitation guidance would likely reduce the total number of swamp pink occurrences range-wide.

Between 2011 and 2020 approximately 20 new swamp pink occurrences were discovered or created through the splitting of existing occurrences (Table 2). During the same period of time, approximately 14 occurrences were removed from the tally of extant swamp pink occurrences due to merging (e.g., two or more occurrences combined into one occurrence record) or deletion (e.g., removal of an occurrence from the record due to duplicative or erroneous info). Together, the addition of 20 new occurrences and the elimination of 14 occurrences resulted in the net addition of 6 extant occurrences (Table 2). However, between 2011 and 2020, an additional 20 swamp pink occurrences were "lost" from the extant category and moved to the historic category (i.e., occurrences that were re-ranked as X-, F-, or H-rank). The addition of 6 new occurrences into the extant category (from the discovery/splitting/merging/deletion of occurrences) partially offset the loss of 20 occurrences from the extant category, resulting in a final net loss of 14 swamp pink sites from the extant occurrence category (Table 2).

The 20 new swamp pink occurrences gained between 2011 and 2020 are well distributed across several states throughout the species range (New Jersey: 9, Delaware: 2, Virginia: 5, North Carolina: 3, Georgia: 1). As in past reviews, most new occurrences were found in New Jersey and other states in the northern extent of the range. One of the three new swamp pink occurrences in North Carolina is believed to be outplanted, and the long-term viability of the occurrence is unknown (NCNHP 2020). Additionally, the one new occurrence in Georgia is an outplanted safeguarding site (GADNR 2020, Radcliffe pers. comm. 2020; see Commissioner's Rock Bog summary in Appendix A). Most of these population gains were offset by the loss of extant swamp pink occurrences in the northern extent of the range (New Jersey: 8, Delaware: 6, Maryland: 2, Virginia: 4) (Table 2). These lost occurrences represent a small percentage of total extant swamp pink occurrences; however, the losses in Delaware and Maryland are significant

given so few extant swamp pink occurrences remain in those states (22 and 7 occurrences, respectively) (Table 1).

Summary of Changes in A- and B-ranked Occurrences: The total number of A- or B-ranked swamp pink occurrences declined slightly from 66 to 61 between 2011 and 2020 (Table 1). A total of 14 swamp pink occurrences (New Jersey: 4, Delaware: 5, Maryland: 1, Virginia: 1, North Carolina: 3) dropped out of the A- and B-rank category between 2011 and 2020, though this loss was partially offset by the addition of 9 occurrences (New Jersey: 6, Virginia: 2, North Carolina: 1) into the A- or B-ranked category during the same period of time (Table 2). Changes in A- and B-ranked occurrences between 2011 and 2020, including land protection status and possible factors contributing to rank changes, are summarized in Table 3. The overall distribution of A- and B-ranked populations across the species range remains similar to those reported in 2011; New Jersey supports the majority (44%) of all known A- and B-ranked occurrences, Virginia has the second-highest (28%), and Delaware has the third-highest (18%) (Table 1). With the exception of Georgia, all the other states in the range support at least one A- or B-ranked occurrence (Table 1).

The total number of A- and B-ranked sites on at least partially protected lands increased from 33 to 38 (Table 1). This increase is largely due to increased survey effort on existing conservation lands and subsequent discovery of new areas of swamp pink; however, acquisition of new properties did occur at several sites. Since 2011, partial acquisition of one B-rank swamp pink occurrence (Cumberland County, New Jersey) was completed by the New Jersey Department of Environmental Protection (NJDEP) using funds from the ESA Recovery Land Acquisition Grant (Table 3). The NJDEP also acquired additional land at Thundergut Pond Wildlife Management Area (Salem County, New Jersey) that increased the protection of a B-ranked occurrence. Several occurrences of swamp pink in North Carolina were brought under state ownership within Dupont State Recreational Forest in Transylvania County, North Carolina, including one B-ranked occurrence (Starke pers. comm. 2020; Table 3).

Table 1. Summary of swamp pink occurrences

	1991						2007					
	Historic (XHF-rank)	Total Extant (ABCDE-rank)	A- or B-rank	Total Extant Protected	A or B Protected	Total # EOs	Historic (XHF-rank)	Total Extant (ABCDE-rank)	A- or B-rank	Total Extant Protected	A or B Protected	Total # EOs
NY	1	0	na	na	na	1	1	0	na	na	na	1
NJ	68	71	29	14 (20%)	unavail.	139	76	140	22	46 33%)	12 (55%)	216
DE	8	15		3 (20%)	unavail.	23	16	19	5	4 (21%)	2 (40%)	35
MD	2	5		0 (0%)	unavail.	7	2	7	1	2 (29%)	0 (0%)	9
VA	0	22		14 (64%)	unavail.	22	0	43	15	33 (77%)	12 (80%)	43
NC	0	8		3 (38%)	unavail.	8	2	16	6	5 (31%)	3 (50%)	18
SC	0	1	1	1 (100%)	1 (100%)	1	0	1	1	1 (100%)	1 (100%)	1
GA	0	1		0 (0%)	unavail.	1	0	3	0	2 (67%)	na	3
Total	79	**123**	<56	35 (28%)		**202**	97	**229**	50	93 (41%)	30 (60%)	**326**

	2011						2020					
	Historic (XHF-rank)	Total Extant (ABCDE-rank)	A- or B-rank	Total Extant Protected	A or B Protected	Total # EOs	Historic (XHF-rank)	Total Extant (ABCDE-rank)	A- or B-rank	Total Extant Protected	A or B Protected	Total # EOs
NY	1	0	na	na	na	1	1	0	na	na	na	1
NJ	76	153	25	57 (37%)	14 (56%)	229	84	148	27	65 (44%)	19 (70%)	232
DE	14[1]	26	16[1]	4[1] (15%)	2[1] (13%)	40[1]	20	22	11	4 (19%)	2 (18%)	42
MD	3	9	3[2]	1 (11%)	0 (0%)	12	5	7	2	0 (0%)	0 (0%)	12
VA	0	41	16	30 (73%)	13 (81%)	41	4	34	17	27 (79%)	13 (76%)	38
NC	2	15[3]	5[3]	5 (33%)	3 (60%)	17[3]	2	18	3	13 (72%)	3 (100%)	20
SC	0	1	1	1 (100%)	1 (100%)	1	0	1	1	1 (100%)	1 (100%)	1
GA	0	4	0	3 (75%)	na	4	0	5	0	4 (80%)	na	5
Total	96	**249**	66	101 (40%)	33 (50%)	**345**	116	**235**	61	114 (49%)	38 (62%)	**351**

- **A- or B-rank** = Number of occurrences that meet, or likely meet, the A or B ranking. Note that this category also includes B? and BC-ranked occurrences, though there is uncertainty regarding the rank. See the Proposed Helonias bullata Element Occurrence Quality Specifications (USFWS 1991) and the NatureServe (2002) Element Occurrence Data Standard for more details on ranking methodology.
- **Protected** = extant swamp pink occurrence located at least partly on public or otherwise conserved land.
- **Total # EOs** = total number of swamp pink element occurrences (any rank) known in the state.

[1] = The 2011 Delaware occurrence counts contained errors; marked counts were lowered by two to account for duplicate/erroneous entries.

[2] = The 2011 Maryland count of A- or B-ranked occurrences was increased by one to account for a miscategorized occurrence.

[3] = The 2011 North Carolina occurrence counts contained errors; marked counts were lowered by one to account for a duplicate entry.

Table 2. Change (Δ) in Swamp Pink Element Occurrences Between 2011 and 2020

State	Net Δ in Historic EOs (XHF-rank)	Net Δ in Total Extant EOs (ABCDE-rank)	Net Δ in Total # EOs	EOs Gained (New Occurrences and Splitting of EOs)	EOs Lost (EOs Merged or Deleted)	A- or B-rank EOs Gained	A- or B-rank EOs Lost
NY	0	0	0	0	0	0	0
NJ	+8	-5	+3	+9	-6	+6	-4
DE	+6	-4	+2	+2	0	0	-5
MD	+2	-2	0	0	0	0	-1
VA	+4	-7	-3	+5	-8	+2	-1
NC	0	+3	+3	+3	0	+1	-3
SC	0	0	0	0	0	0	0
GA	0	+1	+1	+1	0	0	0
Total	**+20**	**-14**	**+6**	**+20**	**-14**	**+9**	**-14**

Table 3. Change in A- and B-Ranked Element Occurrences between 2011 and 2020

State	EO #	Change in EO Rank	Land Status	Factors Contributing to Rank Change
New Jersey	045	BC to D-rank	Not protected	Habitat degradation (hydrologic modification, erosion), herbivory
	046	B to D-rank	Not protected	Habitat degradation (hydrologic modification, erosion), herbivory
	115	B to C-rank	Not protected	Off-road vehicle use crushing plants, habitat degradation (hydrologic modification, erosion), herbivory
	179	B to D-rank	Not protected	Habitat degradation (drawdown of water table), herbivory
	108	C to B-rank	At least partially protected	New subpopulation discovered
	168	C to B-rank	At least partially protected	New subpopulation discovered
	178	D to B-rank	At least partially protected, new acquisition	Merged with another EO (C-rank) to form a single B-rank EO
	209	New	Not protected	New B-rank occurrence in Gloucester County
	XXX	New	At least partially protected	New A-rank occurrence in Ocean County
	XXX	New	At least partially protected	New B-rank occurrence in Ocean County
Delaware	13	B to X-rank	Not protected	Habitat degradation (storm surge flooding)
	35	A to D-rank	Not protected	Unknown
	30	A/B to F-rank	Not protected	Habitat degradation (beaver flooding), herbivory
	37	A/B to C-rank	Not protected	A/B-rank EO split into several smaller EOs
	40	A/B to C-rank	Not protected	A/B-rank EO split into several smaller EOs
Virginia	12	B to H-rank	Not protected	Unknown
	23	B? to H-rank	At least partially protected	25+ years without observation, threats unknown
	50	C to BC-rank	Not protected	Merged with another EO (unknown rank)
North Carolina	3	B to C-rank	At least partially protected	Unknown
	7	B to C-rank	At least partially protected	Encroachment by woody vegetation
	8	B to C-rank	Not protected	Habitat degradation (hydrologic modification), encroachment by vegetation
	13	C to B-rank	At least partially protected, new acquisition	New subpopulation discovered

Swamp Pink Population Trends by State:

New Jersey: A study by Kelly (2013) assessed trends for 48 swamp pink occurrences in New Jersey that had been surveyed by Johnson during 1997-2001 (Johnson 1998a, 1998b, 1999, 2000, 2001) and also surveyed by Kelly and Johnson in 2010-2013. The study controlled for variables including surveyor accuracy, clump/rosette counting methodology, and the extent of the surveyed area. Comparison of the mean number of clumps, rosettes, racemes and combined clumps+rosettes observed 1997-2001 and 2010-2013 showed declines in all variables (clumps -47%, rosettes -65%, racemes -12%, clumps+rosettes -61%); however, only the declines observed for rosettes and clumps+rosettes were statistically significant ($p < 0.05$). The clumps+rosettes count declined by more than 66 percent at half of the occurrences (53%). The clumps+rosettes declined by more than 20 percent at another quarter (26%) of occurrences. Only 17 percent of the sites showed some positive change in clumps+rosettes counts (Kelly 2013).

To roughly assess long-term population trends for New Jersey's swamp pink occurrences, the USFWS New Jersey Field Office tracked changes in EO rankings (which follow the quality specifications in Appendix B of the Swamp Pink Recovery Plan (USFWS 1991), reflecting population size/vigor, habitat conditions, and general viability of the occurrence) for 98 occurrences that were ranked A, B, C, or D in 1997. Occurrences that were ranked as E, F, X or H (or unranked) in 1997 were excluded from the analysis. For each occurrence, the 1997 EO rank was compared to the 2020 EO rank to determine the long-term (20+ year) trend for the occurrence. Occurrences that had range ranks (i.e., double letter ranks) or used the "?" qualifier to convey rank uncertainty were considered to be stable if the probable range of the uncertain rank overlapped with the comparison rank[3] (e.g., an occurrence ranked as CD in 1997 and D in 2020). Occurrences ranked as E or F in 2020 were categorized as having an unknown trend. Additionally, occurrences lacking recent survey data (i.e., no surveys in last 20 years) and occurrences with less than 10 years between the survey/observation dates supporting the 1997 and 2020 rankings were reviewed on a case-by-case basis, but typically categorized as having an unknown trend. The results of the EO rank trend analysis summarized based on the starting rank of the EO in 1997 are displayed in Table 4. The results of the same EO rank trend analysis summarized by 2020 land protection status are displayed in Table 5.

Table 4. New Jersey Swamp Pink 1997 – 2020 EO Rank Trend by Initial Rank

EO Rank in 1997	Increased by one letter rank	No Rank Change	Declined by 1 letter rank	Declined by 2+ letter ranks	Declined 1 rank to Extirpation	Unknown Trend	Total
A-ranked	N/A	2 (50%)	1 (25%)	1 (25%)	0	0	4 (4%)
B-ranked	0	9 (56%)	5 (31%)	2 (13%)	0	0	16 (16%)
C-ranked	1 (4%)	8 (32%)	8 (32%)	N/A	0	8 (32%)	25 (26%)
D-ranked	5 (9%)	18 (34%)	N/A	N/A	4 (8%)	26 (49%)	53 (54%)
Total	6 (6%)	37 (38%)	14 (12%)	3 (3%)	4 (4%)	34 (35%)	98 (100%)

Across all letter ranks, roughly one-third to one-half of the occurrences had no change in letter rank between 1997 and 2020 (Table 4, NJNHP 2018). Similarly, across all letter ranks

[3] See NatureServe (2002) for additional details on interpretation of range ranks and the "?" qualifier.

approximately one-third to one-half of occurrences declined by at least one rank, except for the D-ranked category which could not have trends determined for almost 50 percent of the occurrences due to data deficiencies (e.g., E, F, H-rankings; lack of recent survey data) or confounding variables (e.g., significant changes to the spatial extent of the EO) (Table 4, NJNHP 2018). This EO rank trend analysis is a coarse assessment; EO ranks consider additional qualitative factors in addition to plant numbers, so these trends may reflect changes in other landscape factors to some degree. Additionally, this trend analysis methodology is not sensitive to more subtle trends within letter ranks or shorter-term trends in response to recent changes in the habitat. For example, several occurrences that had no change in letter rank according to the USFWS 1997-2020 EO trend analysis were determined by Kelly (2013) to have declined significantly between 1997 and 2013 based on plant count data alone.

Table 5. New Jersey Swamp Pink 1997 – 2020 EO Rank Trend by Land Protection Status

Land Protection Status in 2020	Increased by one letter rank	No Rank Change	Declined by 1 letter rank	Declined by 2+ letter ranks	Declined to Extirpation	Unknown Trend	Total
At least partly protected	3 (7%)	23 (51%)	6 (13%)	0	3 (7%)	10 (22%)	45 (46%)
Not protected	3 (6%)	14 (26%)	8 (15%)	3 (6%)	1 (2%)	24 (45%)	53 (54%)
Total	6 (6%)	37 (38%)	14 (12%)	3 (3%)	4 (4%)	34 (35%)	98 (100%)

When summarizing EO rank trends by land protection status, a greater percentage of swamp pink occurrences located at least partially on protected lands experienced an increase in rank or had no change in rank (58%) compared to occurrences on unprotected land (32%), but both land categories had similar percentages of occurrences that declined by at least one letter rank (20% and 23%, respectively) (Table 5, NJNHP 2018). The unprotected land category contained a higher number of data-deficient occurrences (i.e., unknown trend), likely due to access limitations associated with private lands. When the 'unknown trend' category was excluded from the EO trend summary, the 'at least partially protected' land category had a lower percentage of swamp pink occurrences that declined by at least one letter rank (26%) and a higher percentage of occurrences that experienced an increase in rank or had no change in rank (74%) relative to unprotected lands (41% and 59%, respectively). In this swamp pink trend analysis, approximately one-fifth to one-quarter of swamp pink occurrences located "at least partly" on protected land in New Jersey have declined in rank. This may indicate that not enough land has been acquired or otherwise protected to adequately insulate swamp pink from the threats causing declines, or that the threats causing the declines may persist even on public or otherwise protected lands. Additionally, this EO rank trend summary used the 2020 land protection status for swamp pink occurrences; insufficient time may have passed for the impact of recent land acquisitions/protections to be reflected in the long-term swamp pink trends.

Delaware: Five previously known occurrences (an A-rank, B-rank, two C-rank, and a D-rank) were moved into the historic category (re-ranked to F or X) between 2011 and 2020 (Table 1, Table 2, Table 3; DE NHESP 2020). Two new D-ranked occurrences were also discovered in Delaware on State land in 2012; however, subsequent survey efforts in 2019 failed to relocate the plants (Table 1, Table 2; DE NHESP 2020). Three additional occurrences decreased in rank but remained extant (2 A/B to C, 1 A to D), two occurrences increased in rank (one B to A, one F-

rank that was rediscovered and determined to be D-rank), and 16 occurrences had no rank changes or had not been surveyed since 2011 (Table 1, Table 2, Table 3; DE NHESP 2020).

Maryland: Two occurrences (a B-rank and D-rank) were moved into the historic category (re-ranked to H-rank and F-rank, respectively) between 2011 and 2020 (Table 1, Table 2, Table 3; MDWHS 2020). Three additional occurrences decreased in rank (AB to BC; C to D; and C to CD) since 2011; the other 4 occurrences had no rank change or had not been surveyed since 2011 (MDWHS 2020).

Virginia: Four occurrences (a B?-rank, C-rank, and two D-rank) were moved into the historic category (re-ranked to H) between 2011 and 2020 (Table 1, Table 2, Table 3; VANHP 2020). Six additional occurrences decreased in rank (2 A to AB; 1 A to B; 2 AB to B; and 1 B to BC), 2 occurrences improved in rank (C to BC and D? to B; Table 2, Table 3), 2 new occurrences (E-ranked) were discovered, and 24 occurrences had no rank change or had not been visited since 2011 (VANHP 2020). The swamp pink occurrence at the Blue Ridge Parkway in Virginia has declined by 50 percent between 2005 and 2018 [4] (Ulrey pers. comm. 2020), though its EO letter rank (C-rank) has not changed since 2011 (VANHP 2020).

North Carolina: Between 2011 and 2020, four occurrences decreased in rank (three B to C, one CD to D), four occurrences improved in rank (C to B, X? to Cr, E to CD, and E to D), three new occurrences were discovered (F-, C- and Ei-rank), and nine occurrences had no rank change or had not been surveyed since 2011 (Table 2, Table 3; NCNHP 2020, Ulrey pers. comm. 2020).

South Carolina: The single occurrence in South Carolina has remained stable (B-rank) (SCDNR 2020).

Georgia: One new swamp pink safeguarding site was established between 2011 and 2020 (Table 1, Table 2; Radcliffe pers. comm. 2020). No occurrences changed rank since 2011 but Radcliffe (pers. comm. 2020) reports the Commissioners Rock Bog occurrence is decreasing, the three existing safeguard sites are increasing, and the newly established safeguard site is stable.

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

Novy (2011) utilized amplified fragment length polymorphism markers (AFLPs) to characterize the population structure of nine swamp pink sites across seven counties in New Jersey (one site each in Atlantic, Camden, Cape May, Cumberland, Monmouth, and Morris counties, three sites in Salem County). Across the sampled locations, 71 percent of genetic variance was represented within sites and 21 percent of genetic variance was represented among sites, as determined by analysis of molecular variance. Principle coordinate analysis indicated that most populations were relatively similar based on genetic profiling. Pairwise analysis of differentiation, as calculated by Φ_{PT} (a standard statistic to quantify population differentiation), showed that the majority of sites are significantly differentiated ($p < 0.05$) from each other, but that only the

[4] The National Park Service hopes to conduct some canopy thinning to improve habitat conditions at the Blue Ridge Parkway site (Ulrey pers. comm. 2020).

Morris County site (Budd Lake Bog priority site), Atlantic County site, and Cape May County site significantly differentiated from all other sites (Novy 2011).

Geography and separation distance can explain some, but not all, of the observed trends in genetic differences between sampled sites (Novy 2011). Sites located closer together tended to be genetically similar, but a few sites didn't follow this trend. For example, the Atlantic County site and Cape May County site were both found to be significantly different ($p < 0.05$) from all other sampled sites, including each other, despite being relatively close to each other and other sampled sites in southern New Jersey. Similarly, the sampled swamp pink site in Monmouth County was unexpectedly similar to one of the sites in Salem County despite having a relatively large separation distance (Novy 2011).

The findings of Novy (2011) support the previously reported conclusions in Godt et al. (1995) that genetic diversity is generally low for occurrences in the northern portion of the swamp pink range, with the Budd Lake Bog site representing a unique genetic outlier in New Jersey. These results affirm the uniqueness of Budd Lake Bog and its status as a priority site for swamp pink conservation. The results of Novy (2011) also suggest that the Atlantic County and Cape May County sites should be high priorities for swamp pink conservation, from a genetic uniqueness point of view. Still, all of the sampled swamp pink sites were differentiated from at least two-thirds of the other sites; therefore, all have the potential to possess some novel genetics that may be important for the continued survival of the species. However, it is important to note that neutral genetic markers data, such as AFLPs, cannot alone determine the presence of adaptively significant genetic variation. Performance studies meant to measure adaptively significant performance traits, such as common garden experiments on traits such as drought, light, and temperature tolerance, could help inform efforts to identify swamp pink priority sites possessing unique and adaptively significant genotypes. It should also be noted that only a subset of swamp pink populations in New Jersey were sampled; more complete sampling efforts are likely to uncover additional genetic variation that is meaningful for the species' future adaptive success (Novy 2011).

2.3.1.4 Taxonomic classification or changes in nomenclature:

There continues to be disagreement among taxonomic literature regarding the composition of the genus *Helonias* and the taxonomic status of closely related genera *Heloniopsis* and *Ypsilandra*. As described in the previous 5-year review (USFWS 2014), several studies by Tanaka (1997a, b, c, d, 1998) have described the morphological similarities among the *Helonias*, *Heloniopsis*, and *Ypsilandra* taxa. Tanaka (1998) recommended the reduction of the genera *Heloniopsis* and *Ypsilandra* to synonymy under the genus *Helonias*; however, phylogenetic analysis by Fuse and Tamura (2000) indicated a taxonomic reduction of the genera may be unnecessary. Subsequent publications vary, with several studies (e.g., Givnish et al. 2016, Hsu et al. 2011, Kim et al. 2016) continuing to present *Helonias*, *Heloniopsis*, and *Ypsilandra* as separate genera and other studies (e.g., Chakraborty et al. 2012, Kawano et al. 2007, Mochizuki et al. 2019) using the Tanaka's (1998) congeneric taxonomic interpretation.

Expanding on the previous studies, new literature by Tanaka (2019) presents additional comparisons of floral morphology and evolutionary evidence to support the congeneric status of *Heloniopsis* and *Ypsilandra* with *Helonias*, and provides a complete taxonomic treatment for the

revised genus. Tanaka (2019) acknowledges the incongruence of the congeneric *Helonias* phylogeny with those proposed in several molecular studies (e.g., Fuse and Tamura 2000, Kim et al. 2016), but notes that the molecular studies support the monophyly of the tribe Heloniadeae (family Melanthiaceae) containing only *Heloniopsis, Ypsilandra,* and *Helonias.* Additionally, Tanaka (2019) states that results of the aforementioned molecular studies do not contradict an attempt to classify the plants into infrageneric categories because "the independent clades (or clades unclustered with other related ones) resulting from such molecular studies do not necessarily represent different genera". The taxonomic authority Angiosperm Phylogeny Website (Stevens 2020) references Kim et al. (2016) and continues to present *Helonias, Heloniopsis,* and *Ypsilandra* as separate genera in the family Melanthiaceae; however, it is unclear if Stevens (2020) is familiar with the expanded evidence presented in Tanaka (2019).

Coalescing other genera with *Helonias* could affect the recovery priority assigned to swamp pink (using the criteria in 48 FR 43099). Resolution of the taxonomic uncertainties discussed above is not a conservation priority for swamp pink because there is no controversy regarding the validity of *Helonias bullata* as a species.

2.3.1.5 Spatial distribution, trends in spatial distribution (e.g., increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g., corrections to the historical range, change in distribution of the species' within its historic range, etc.):

Range wide, swamp pink persists across 7 states in 27 of the 28 counties in which it was known in 2007, but is currently extirpated in Dorchester County, Maryland (Table 6). The swamp pink occurrence in Dorchester County had 12 rosettes observed in May 1999; however, at least 2 surveys were conducted since then which failed to find any swamp pink plants (McCarthy pers. comm. 2021, MDWHS 2020).

There have also been county-level range expansions in North Carolina (Macon County) and Georgia (White County), though all are human-mediated (Table 6). The swamp pink occurrence in Macon County, North Carolina represents a small population located in wetlands along a nature trail at an environmental education center (NCNHP 2020). The plants in Macon County are believed to have been propagated and introduced to the site in the late 1980s to early 1990s, likely using material sourced from an occurrence in nearby Jackson County (NCNHP 2020). The swamp pink occurrence in White County, Georgia is a new safeguarding site introduced on State land by the Georgia Plant Conservation Alliance in 2012 using material sourced from Commissioners Rock Bog (Radcliffe pers. comm. 2020).

An observation of swamp pink in Massachusetts was published on a community science database in 2019 (Ueda 2020). Massachusetts is outside the species' known range and naturally occurring populations have never been documented there (Wernerehl pers. comm. 2020). Spatial information for rare species sightings is restricted so the exact location of the plants observed could not be confirmed (Ueda 2020). Swamp pink is an attractive plant to hobbyists (see Section 2.3.2.2 for discussion on this topic in greater detail) and the species was previously propagated and distributed in Massachusetts by the New England Wildflower Society (Cullina 2000); it is likely this observation represents swamp pink outplanted from a cultivated collection.

Table 6. Counties with extant occurrences of swamp pink

State	County	2007	2011	2020
New Jersey	Atlantic	5	6	7
	Burlington	10	13	12
	Camden	28	29	25
	Cape May	13	13	11
	Cumberland	14	14	14
	Gloucester	13	17	14
	Middlesex	1	1	1
	Monmouth	10	10	10
	Morris[1]	2	1	2
	Ocean	24	30	35
	Salem	20	19	17
Delaware	Kent	4	3	2
	New Castle	1	1	1
	Sussex	14	22	19
Maryland	Anne Arundel	4	5	4
	Cecil	2	3	3
	Dorchester	1	1	**0**
Virginia	Augusta	21	21	15
	Caroline	16	14	15
	Henrico	5	5	3
	Nelson	1	1	1
North Carolina	Ashe	1	1	1
	Henderson	2	2	2
	Jackson	1	1	1
	Transylvania	12	12	13
	Macon[2]	0	0	1
South Carolina	Greenville	1	1	1
Georgia[3]	Rabun	2	3	3
	Union	1	1	1
	White	0	0	1
Total		**229**	**250**	**235**

[1] The 2020 Morris County count includes an outplanted population.

[2] The Macon County occurrence is an outplanted population.

[3] 2007: One each in Rabun and Union counties are outplanted.
2011: Two in Rabun County & 1 in Union County are outplanted.
2020: Two in Rabun, 1 in Union, & 1 in White County are outplanted.

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):

Floyd et al. (2018) investigated swamp pink response to prescribed burns at Fort A.P. Hill, Virginia. Swamp pink rosettes were significantly larger and had more leaves in plots that had burned recently (i.e., burned within < 2 years) when compared to swamp pink rosettes in unburned plots (i.e., >2 years since last burn). However, there were no significant differences when comparing the characteristics of the wetland vegetation community (e.g., tree, shrub, and herb density; species dominance; species richness) within burned and unburned plots. The results suggest that wildland fire may have some direct or indirect effect on swamp pink growth, but further study (including finer-scale assessment of short- and long-term effects of prescribed fire, abiotic variables such as light penetration, and other biotic variables such as herbivore presence) is needed to identify the specific variable(s) that swamp pink may be responding to. The results of Floyd et al. (2018) also suggest that wetlands may serve as a protective fire-break for the majority of swamp pink plants within them during low- to moderate-intensity burns, and that swamp pink is generally not negatively impacted by non-catastrophic fire.

Kelly (2013) collected soil samples from five swamp pink sites in New Jersey (two in Burlington County, two in Ocean County, one in Morris County) and analyzed the soil chemistry (e.g., pH, available nutrients, soluble salts, organic matter, etc.). The soil pH ranged from 3.75 - 4.80 (Kelly 2013), which is slightly more acidic than the typical (4.5 – 8.5 pH) New Jersey soils (Murphy 2007). Nitrogen (N) content within the soil samples was generally low across all sampled sites (Total Kjeldahl N: 1.76 - 2.28%; Nitrate-N: <1 ppm; Ammonium-N: 1-8 ppm). Soil nutrients concentrations generally varied only slightly between locations, with the exception of phosphorus (P), potassium (K), and iron (Kelly 2013). Phosphorus and potassium concentrations were generally low (P: <1 mg/L; K: 6.5 – 9.2 mg/L) in four of the five swamp pink soil samples; however, the concentration of both nutrients were elevated (P: 1.8 mg/L; K: 21.1 mg/L) in the soil sample from a swamp pink occurrence located adjacent to an active agricultural (cranberry bog) operation. Iron levels were also documented to be low (0.13 – 0.39 mg/L) in three of the five soil samples, but much higher concentrations (3.20 and 3.06m/L) were recorded in two samples from swamp pink sites located in Burlington and Ocean counties, respectively (Kelly 2013). These swamp pink sites likely contain iron-rich soils associated with bog iron deposits, which are common in rivers and swamps throughout southern New Jersey (Brady 2012).

2.3.1.7 Other: None

2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

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 Present or threatened destruction, modification or curtailment of its habitat or range:

Habitat Loss: Direct destruction of forested wetland for development was fairly common prior to the listing of swamp pink in 1988 (USFWS 1988), but the practice has declined under the current regulatory environment and "no net wetland loss" policies. Biologists providing information for this review did not identify the development or fill of habitat as an important ongoing threat to swamp pink in any state in its range, though most direct disturbance to swamp pink habitat is presently regulated through the CWA Section 404 program and associated ESA authorities based on the species' federal status. In addition to regulatory changes, the number of swamp pink occurrences located at least partially on protected land (where significant fill of wetlands is unlikely to be proposed) has increased from approximately 35 occurrences in 1991 to 114 occurrences in 2020 that are well distributed throughout the swamp pink range (Table 1).

Several states in the swamp pink range (e.g., New Jersey, Delaware, Maryland, Virginia, and North Carolina) have state-level statutes that regulate fill of freshwater non-tidal wetlands; however, the jurisdictional scope of these regulations and the extent to they can prevent fill of swamp pink habitat if the species were no longer federally listed varies significantly between states. For example, it's estimated that up to 30,000 acres of freshwater wetlands in Delaware are not covered by either federal or state regulations and would not require a permit for placement of fill (DE DNREC 2017). In comparison, wetland regulatory programs in New Jersey, Maryland, and Virginia generally regulate all non-tidal freshwater wetland, but protections that can be afforded to swamp pink vary significantly based on the scope of the state statute and the species' status (or lack thereof) in each state. If swamp pink were delisted and no longer received protection under the ESA, only one or two states in the range (Maryland, possibly Virginia) would have adequate regulatory mechanisms in place to consider impacts to the species during freshwater wetland permit reviews and prevent direct destruction of swamp pink habitat from fill. In other states, swamp pink could be incidentally protected by state wetland regulatory programs and/or Section 404 of the CWA which require avoidance and minimization of wetland impacts, but fill of swamp pink habitat could be ultimately permitted. See Section 2.3.2.4 for additional analysis of state wetland programs.

Habitat Degradation: Degradation of swamp pink habitat continues to be a major threat to the species, primarily in the northern extent of the range where many swamp pink populations occur in highly developed watersheds. Modification of wetland hydrology was the most commonly named threat to swamp pink, with several responses specifically identifying land conversion for development in the watershed, and the associated impervious surface, stormwater modification, and groundwater extraction, as the causal factors (Dodds pers. comm. 2020, DuBois pers. comm. 2020, Hafstad pers. comm. 2020, Hanlon pers. comm. 2020, Kunz pers. comm. 2020, McAvoy pers. comm. 2020, Starke pers. comm. 2020, and Torok pers. comm. 2020).

Groundwater Extraction: Underground water table aquifers discharge into wetlands, streams, and

other surface bodies where the water table elevation intersects the surface water elevation (Canace and Sugarman 2009). Groundwater extraction (i.e., pumping) can cause the water table elevation to drop below surface-water elevations; this leads to surface water leaking into the aquifer, impairing water levels in wetlands and diminishing stream flow (Canace and Sugarman 2009). Drawdown of the water table is associated with land conversion and development of the landscape because it facilitates human occupancy, which subsequently increases water demands to support human uses (e.g., agricultural irrigation, drinking water) at that location (Sharp et al. 2003).

Torok and Hafstad (pers. comm. 2020) specifically identified drawdown of the water table as a threat to swamp pink sites occurring in developed watersheds in New Jersey. Kelly (2013) surveyed 63 extant swamp pink occurrences across 10 counties in New Jersey and reported that water table drawdown was suspected to be impacting the majority of the sites to some degree, with conditions at several wetlands significantly impacted and described as "too dry to support swamp pink long-term based on the species' observed habitat preferences at other sites". Water table drawdown was also noted as a possible or apparent cause of extirpation at several sites where swamp pink was not relocated (Kelly 2013). However, confirmation of water table drawdown and quantifying the impact at swamp pink sites is difficult based on qualitative assessments alone. The effects of drawdown tend to be subtle and occur over a long period of time, so installation of monitoring wells or other specialized equipment is typically required. Additionally, inter-year (e.g., drought vs non-drought) and intra-year (e.g., seasonal) variation in water table levels makes it difficult to determine if, or how much, drawdown is occurring, especially where extensive baseline/reference data are unavailable.

Specific hydrologic requirements of swamp pink limit its occurrence within wetlands to areas that are perennially saturated (but not inundated) by floodwater, which makes the species vulnerable to activities that draw down (i.e., lower) the water table. As discussed in USFWS (2014), swamp pink is sensitive to relatively small (5-15 cm) water-level drawdowns, and significantly impacted by drawdowns in excess of 30 cm (Laidig et al. 2009). The amount of groundwater drawdown occurring and the extent to which it's impacting swamp pink habitat depends on a variety of site-specific factors (e.g., whether the community is extracting water from a water table aquifer, the volume of water withdrawal occurring, the rate of water withdrawal, the proximity of wetlands to pumping sites, aquifer storage and recharge rate, etc.) that can vary significantly between locations. As a result, the exact extent of swamp pink habitat currently impacted by or vulnerable to groundwater drawdown is unknown. Nonetheless, we do know that some areas within the swamp pink range are experiencing groundwater drawdown. For example, Hammonton Township in Atlantic County, New Jersey is a primarily agricultural town that sources some of its water supplies from the Kirkwood-Cohansey aquifer, an unconfined water table aquifer that's connected to the surface waters and wetlands (Van Abs et al. 2014). A study by the Pineland Preservation Alliance evaluated all regulated agricultural and non-agricultural withdrawals in 2012 to estimate the impact of groundwater extraction on wetlands across nine sub-watersheds (hydrologic unit code 14) that intersect Hammonton Township. The preliminary results of the study demonstrated that a significant proportion of the wetlands within the sub-watersheds are likely to be impacted by drawdown. Across the nine sub-watersheds, 5,252 acres of wetlands (42% of wetlands) were estimated to be impacted by ≥ 5 cm drawdown, 3,040 acres of wetland (24% of wetlands) were estimated to be impacted by ≥ 15 cm

drawdown, and 1,670 acres of wetland (13% of wetlands) were estimated to be impacted by ≥ 30 cm drawdown (Van Abs et al. 2014). Hammonton Township contains only one known swamp pink occurrence (currently ranked as historic), but it is unknown whether that site overlaps with the estimated areas of drawdown.

The greatest effects of groundwater extraction tend to be centered around the cone of drawdown associated with water pumping sites as discussed above; however, widespread groundwater drawdown can occur over time through depletion of aquifer storage (i.e., groundwater depletion) when the rate of water extraction exceeds the rate of water replenishment (Canace and Sugarman 2009). It can be difficult to generalize how groundwater extraction may be impacting swamp pink across its range, but trends in long-term cumulative groundwater depletion volumes across the swamp pink range may be an indicator of where this threat is most likely occurring. The North Atlantic Coastal Plain aquifer system collectively supports the majority of known occurrences of swamp pink (98% of occurrences in New Jersey, all occurrences in Delaware and Maryland, and 53% of occurrences in Virginia), and consists of six regional aquifers extending northward from the North Carolina/South Carolina boundary to Raritan Bay, New Jersey, and westward to the edge of the Piedmont physiographic province (Trapp and Horn 1997). This aquifer system is experiencing low to moderate levels of total volumetric groundwater depletion (1.2 km^3 in New Jersey, 1.9 km^3 in Delaware/Maryland, 4.5 km^3 in Virginia) relative to the early 1900s before groundwater withdrawal was a significant source for water supplies (Konikow 2013). Rates of groundwater depletion in the coastal plain have significantly increased over time in Delaware, Maryland, and Virginia, especially during 2000-2008. Regulation of water withdrawals in New Jersey in the 1970s and 1980s has allowed the State to balance water withdrawal with recharge (no net increase in groundwater depletion) in recent decades; however, New Jersey's coastal plain still has a 1.2 km^3 total deficit in volumetric groundwater due to depletion associated with earlier decades of pumping (Konikow 2013). No comprehensive data were available to assess the occurrence of groundwater depletion in the other portions of the range. Anthropogenic influences on the environment and climate change may indirectly increase human reliance on groundwater withdrawals to meet consumption demands in the future, possibly exacerbating the observed increasing trends of groundwater depletion.

Groundwater withdrawals typically lack a federal nexus for review under ESA Section 7 because the activities are typically regulated at the state- or municipality-level. Maryland is the only state in the range where consideration of potential impacts to swamp pink and other state-listed species is required during the review of water appropriation and use permits, though agricultural uses less than 10,000 gallons/day are exempted from the permit process (Maryland Water Supply Program 2021) and reviews for swamp pink are uncommon (McCarthy pers. comm. 2021). In New Jersey, minimal consideration is given to impacts on federally or state-listed species due to limitations in State statutes, but applicants have typically been willing to minimize impacts because of the species' federal status (Torok pers. comm. 2021). Where groundwater extraction is regulated in Delaware, Virginia, North Carolina, South Carolina, and Georgia, no consideration is given for potential impacts to swamp pink. The current state-level regulations on groundwater extraction activities in Maryland can prevent or minimize direct impacts of groundwater drawdown on swamp pink habitat, and this protection would likely remain if swamp pink were delisted at the federal level. In all other states in the range, impacts of groundwater drawdown on swamp pink are not adequately addressed. Current regulations in all

states are also insufficient to address general trends of groundwater depletion and the cumulative adverse effect it has on swamp pink and its habitat.

Stormwater Modifications: The creation of new impervious surface and subsequent stormwater modifications have been associated with habitat degradation and decline of several swamp pink populations, particularly in highly developed watersheds in New Jersey. The concentration of stormwater to a limited number of outfall points can impact the timing, velocity, and volume of stormwater entering a wetland, causing erosion, stream channelization, and increasing the overall frequency, duration, and depth of flooding events (i.e., water level fluctuations) in the habitat (Wright et al. 2006). Stormwater runoff from developed areas often contains pollutants (e.g., nutrients, road salts, oil) that can degrade wetland habitat and favor growth of invasive species (Wright et al. 2006). Modern stormwater infrastructure can be designed to minimize impacts to site hydrology and water quality, but efficacy can diminish over time if the infrastructure is not properly maintained or upgraded as needed to accommodate changes in precipitation patterns over time (i.e., increased frequency and intensity of heavy rain events in the Northeastern U.S.; see Section 2.3.2.5 Climate Change).

The State of New Jersey adopted changes to its stormwater management rules (N.J.A.C. 7:8) in 2020 which took full effect on March 2, 2021, following a 12-month implementation period (NJDEP 2020). The amendment does not make any substantive changes to the underlying water quality standards but requires the use of green infrastructure to meet the existing standards. The amended rule prioritizes the implementation of decentralized stormwater management features that treat stormwater close to its source and reduce the volume of stormwater runoff (e.g., dry wells, grass swales, pervious pavement systems, small bioretention systems, small infiltration basins) (NJDEP 2020). The Maryland Stormwater Management Act (Environment Article 4 Subtitle 2) and Virginia Stormwater Management Act (Va. Code § 62.1-44.15:24 *et seq*.) contain similar requirements for new developments to design stormwater infrastructure to mimic natural/pre-development hydrologic conditions. In other states within the swamp pink range, stormwater regulations tend to provide minimal protection for swamp pink, either through limitations on state statutes or lack of adequate enforcement.

Kunz (pers. comm. 2020) noted that many of the structures (e.g., roads, culverts, stormwater discharges) actively degrading swamp pink habitat pre-date modern wetland regulations and listing of the swamp pink under the ESA. Although retrofitting and improving old systems is encouraged, existing state-level funding sources are inadequate to encourage voluntary upgrades (Kunz pers. comm. 2020). Additionally, improved stormwater systems often require larger areas for water storage and infiltration, limiting opportunities to remediate this threat on a developed landscape. As a result, the current stormwater management regulations will help avoid degradation of swamp pink occurrences in watersheds subject to development pressure in the future but will do little to ease the degradation of populations already experiencing stormwater impacts (USFWS 2008).

Figure 1. Failing upstream stormwater intake structure observed at a swamp pink occurrence in Cape May County, New Jersey. (Photo: USFWS, A. Protus)

Figure 2. Channelization downstream of a stormwater outfall observed at a swamp pink occurrence in Cape May County, New Jersey. (Photo: USFWS, A. Protus)

Habitat Succession and Invasive Plants: Swamp pink habitat in the southern extent of the range tends to exhibit a more open, herb-dominated understory compared to the northern extent of the range. Encroachment by native woody vegetation (including shrubs and trees), and subsequent dense shading of swamp pink plants, was named as a significant threat to some swamp pink occurrences in North Carolina (NCNHP 2020, Fruchey pers. comm. 2020, Starke pers. comm. 2020), South Carolina (Bradley pers. comm. 2020, Fowler pers. comm. 2020) and Georgia (Radcliffe pers. comm. 2020). Specifically, encroaching dog hobble (*Leucothoe* spp.) was noted to be an issue at several North Carolina swamp pink occurrences (NCNHP 2020). The South Carolina Department of Natural Resources considers encroachment of native woody vegetation to be the biggest threat to the Watson-Cooper Heritage Preserve swamp pink occurrence in South Carolina and conducts mechanical and chemical treatments to control encroachment of native shrubs (e.g., *Rhododendron maximum, Alnus serrulata*) and trees (e.g., *Liriodendron tulipifera*) at the site (Bradley pers. comm. 2021). Habitat management to control woody vegetation has also been conducted at the four swamp pink safeguarding sites in Georgia (GADNR 2020). Invasive plant species (both woody and herbaceous) can also encroach into swamp pink habitat throughout its range, but generally poses a less significant threat. Kelly (2013) documented the presence of various invasive species (e.g., Phragmites (*Phragmites australis*), Japanese stiltgrass (*Microstegium vimineum*), and multiflora rose (*Rosa multiflora*)) during surveys in New Jersey, but noted that direct impacts to swamp pink were uncommon. If swamp pink were no longer federally listed, sources of funding for targeted habitat management at swamp pink sites would be reduced, but the severity of the threat would not be expected to change significantly.

Feral Hog Activity: Radcliffe (pers. comm. 2020) identified habitat damage by invasive feral hogs as the most important threat to swamp pink at four safeguarding sites in Georgia. Feral hog activity in mountain fens and bogs has increased dramatically since 2010, with visitation

expanding from summer months to nearly year-round, as well as into remote areas where they had not been seen previously. Frequent damage at multiple fen and bog sites has been observed since 2017, including one event which uprooted swamp pink at a safeguarding site. The Georgia Plant Conservation Alliance has successfully implemented a hog management plan for bog safeguarding sites that includes monitoring in person and by trail cameras, construction of hog exclusion structures ("armored hog-tents") around sensitive rare plant microsites, and hog trapping (Radcliffe pers. comm. 2020). Feral hog activity has also been noted in South Carolina at the Watson-Cooper Heritage Preserve, but it is not believed to be a major threat to swamp pink at this time (Fowler pers. comm. 2020). A county map of feral hog occupancy overlaps with the range of swamp pink in North Carolina (APHIS 2019); feral hog activity was not identified as a major threat to any swamp pink populations in North Carolina at the time of review, but the magnitude of this threat may increase in the future. If swamp pink were no longer federally listed, sources of funding for feral hog management at swamp pink sites would be reduced, but the severity of the threat would not be expected to change significantly.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:

At least one instance of seed collection from a swamp pink occurrence on private land (which is not prohibited under the general trade prohibitions set forth by the ESA) occurred in New Jersey since the species became federally listed in 1988 (Crosson 2012). Collection of swamp pink from the wild generally appears to be an uncommon occurrence, though there is commercial demand for swamp pink as a bog garden plant and the species is sold by a small number of vendors (Crosson 2012). Poaching of other rare or desirable plant species (e.g., pitcher plants (*Sarracenia* spp.), Venus flytrap (*Dionaea muscipula*), American ginseng (*Panax quinquefolius*)) is an ongoing issue in several states within the swamp pink range. In Georgia, poaching of pitcher plants has occurred in at least two wetlands supporting swamp pink occurrences, though swamp pink was not targeted on these occasions (Radcliffe pers. comm. 2021).

State rules or regulations exist in New Jersey (N.J.S.A. § 7:2-2.10(a)), Delaware (3 Del. Admin. C. § 402-5.7), Maryland (Md. Code Regs. § 08.07.06.13), Virginia (2006 Va. Code Ann. § 3.1-1023), North Carolina (N.C. Gen. Stat. § 106-202.19.), South Carolina (S.C. Code Ann. Regs. § 123-203L), and Georgia (Ga. Comp. R. & Regs. 391-4-10-.06(b)(1)) that prohibit the collection of plants (only state-listed/protected plants, in the case of Virginia, North Carolina, and Georgia) from state-owned properties. In addition, there are other regulations and policies that protect swamp pink plants on federal lands, though exact protections vary between agencies. For example, U.S. Forest Service (USFS) regulation 36 CFR 261.9 prohibits removing or damaging any plant that is classified as a threatened, endangered, sensitive, rare, or unique species from USFS property (USFWS 2019). Additionally, Forest Service Manual 2673 establishes policy that prohibits the removal and collection of any threatened or endangered plants on lands under federal jurisdiction except when authorized by permits (USFWS 2019). Although the regulations and policies for federal lands should provide some protection to swamp pink, lack of resources generally prevents monitoring of compliance and enforcement. The frequency of swamp pink collection, propagation, and/or sale activities may be depressed by real or perceived restrictions on federally threatened plant species under the ESA (Crosson 2012); demand for swamp pink and associated collection activities may increase to some degree if swamp pink were de-listed

and the protections of the ESA were removed. If enforced, state-level regulations may be adequate to discourage illegal collection from state-owned properties, but swamp pink on private lands (>50% of all known extant swamp pink sites, Table 1) would still have inadequate protection.

2.3.2.3 Disease or predation:

The Swamp Pink Recovery Plan (USFWS 1991) reported that herbivory was not a major threat to the species; however, as described in USFWS (2014), herbivory is now believed to be adversely impacting many swamp pink occurrences, primarily in New Jersey, Delaware, and Maryland (Arsenault pers. comm. 2020, Dodds pers. comm. 2020, Hafstad pers. comm. 2020, Hanlon pers. comm. 2020, Kelly 2013, Kunz pers. comm. 2020, McAvoy pers. comm. 2020, and MDWHS 2020, Smith pers. comm. 2020, Turner pers. comm. 2020). In New Jersey, white-tailed deer (*Odocoileus virginianus*) were the most prevalent herbivore documented to browse swamp pink plants, though damage caused by insects, rabbits, and beaver has also been observed (Kelly 2013). Current estimates of overall white-tailed deer abundance in the Eastern U.S. are believed to be only slightly higher than historic (pre-European settlement) abundance (VerCauteren 2003). However, land conversion for agricultural and suburban growth has inadvertently created concentrated areas of optimal deer habitat (i.e., transitional/edge habitats and intermediate growth forest) and high-quality food sources (e.g., agricultural fields, fertilized gardens, and lawns), leading to localized deer densities in some portions of the northeastern United States that far exceed historic density estimates (Van Clef 2004). For example, historic densities in New Jersey were estimated to be 8-11 deer/mi^2 (Van Clef 2004), but modern deer densities across 8 counties in New Jersey are estimated to be 103-111 deer/mi^2, with as many as 208-213 deer/mi^2 estimated in portions of Cumberland County, New Jersey (Steward Green, LLC 2019).

Severity of Threat: Dodds (pers. comm. 2020) believes that the detrimental effects of herbivory on swamp pink are poorly understood and seriously underestimated. Plants growing in shady forest understory conditions tend to be slow-growing and have a lower tolerance to deer browsing, particularly if such browsing is repeated (Côté et al. 2004). Swamp pink appears to be particularly vulnerable and sensitive to herbivory damage, exhibiting significant declines in areas with high deer density. These observations lend support to Dodds' hypothesis (Dodds pers. comm. 2011, as cited in USFWS 2014) that photosynthesis during winter months (i.e., during leaf-off for many other tree and shrub species in swamp pink habitat) may be critical to swamp pink's energy budget and survival strategy as a perennial understory plant. Browsing damage to swamp pink leaves reduces the plant's ability to exploit this critical period of increased light availability and, subsequently, reduces the plant's capacity for growth and flowering during the following spring. Repeat browsing incidents, potentially in combination with other stressors, seem to cause the eventual demise of the rosette (Dodds pers. comm. 2011, as cited in USFWS 2014). Browsing damage to swamp pink flowers alone (i.e., without damage to leaves) is unlikely to pose a significant threat to swamp pink given the species' generally low success reproducing by seed, though it may hinder dispersal and colonization of new habitats in the long-term.

Deer browse is suspected to have caused significant declines even at large, relatively pristine swamp pink sites. Two intensively studied swamp pink occurrences (A- and B-ranked) in Camden County, New Jersey experienced gradual but persistent declines over a 19-year period

based on 12 years of monitoring data (Amy S. Greene Environmental Consultants, LLC 2018). Rosette densities declined significantly at both sites (from an average of 18.6 and 15.1 rosettes per plot in 1998 to 5.6 and 5.8 rosettes per plot in 2017) despite no changes to the quality of the wetland habitats, based on long-term monitoring of the hydrologic conditions and vegetative community. Flowering at both swamp pink sites was also documented to be extremely low. Comparative sampling of swamp pink within and outside of the study plots at both sites also ruled out the monitoring activities as the source of the disturbance. Although the monitoring study was not designed to assess the impact of deer herbivory specifically, evidence of deer was noted to be abundant in both wetlands; thus, persistent deer browse damage is believed to play a role in the observed swamp pink declines. Based on the observed rates of decline in swamp pink densities over the 19-year period, both populations are projected to decline from current condition to near extirpation in less than a decade without management intervention (Amy S. Greene Environmental Consultants, LLC 2018). In November 2020, the USFWS and the New Jersey Audubon installed a deer-exclusion fence around the A-ranked swamp pink occurrence; the site will be monitored for several years to assess how the exclusion of deer impacts the trajectory of the population. Initial data from the April 2021 flower survey (5 months after installation of deer-exclusion fence) showed a substantial increase in flowering at the site (16 flower racemes on sampling transects) compared to the 2020 baseline conditions (1 flower raceme on sampling transects) (Bara pers. comm. 2021).

Similar declines in swamp pink have also been observed in Delaware, where at least one A-ranked swamp pink occurrence declined to extirpation over a period of only ten years despite seemingly stable habitat conditions; overgrazing by deer is believed to be behind the observed trends (McAvoy pers. comm. 2021).

Synergy with Other Threats: Herbivore damage is a stressor that often co-occurs with other threats to swamp pink, including the development of uplands in the watershed (Section 2.3.2.1), water table drawdown (Section 2.3.2.1), and climate change (Section 2.3.2.5). These threats can indirectly facilitate white-tailed deer herbivory of swamp pink, resulting in a more severe cumulative effect (Figure 3). The synergistic effects of these co-occurring threats may explain why deer browse was not a significant threat to swamp pink at the time of listing but appears to have become a more severe threat over time in conjunction with continued development, habitat degradation, and the progression of climate change.

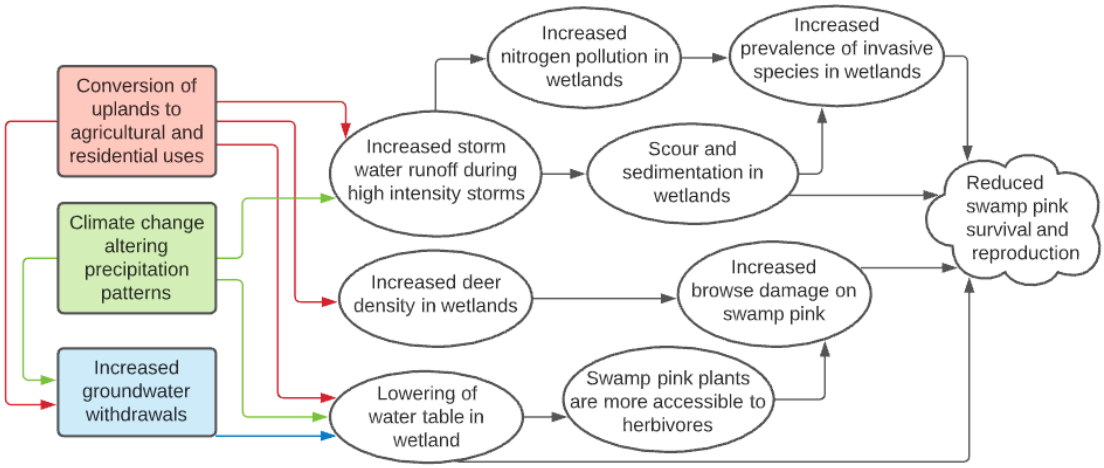

Figure 3. Influence diagram demonstrating potential synergistic threats to swamp pink.

Uncertainty: It remains unclear how the intensity and frequency of herbivory affect the growth and survival of swamp pink plants in the short-term, whether the effects of herbivory are compounded in the long-term over the life of the plant, and if swamp pink is more sensitive to leaf browse at particular times of the year. Similarly, it's unclear if deer herbivory may be exacerbated by other co-occurring threats. Investigating these questions could help clarify the significance of the threat posed by herbivory and inform management actions to address it.

Conservation Measures to Control Herbivory: Installation of deer-exclusion fence (Figure 4) or anti-herbivory cages (Figure 5) over swamp pink plants has enabled managers to immediately halt and reverse declines at several swamp pink occurrences in New Jersey. The installation of deer-exclosures has been funded primarily by the USFWS's Ecological Service Program, ESA Cooperative Endangered Species Conservation Fund (Section 6) Grants to states, and mitigation funds associated with ESA Section 7 consultations. This work is unlikely to continue if swamp pink were delisted and the protections of the ESA were removed.

Figure 4. Eight-foot tall deer exclusion fence. (Photo: USFWS, M. Virgilio)

Figure 5. Anti-herbivory cage around swamp pink. (Photo: USFWS, A. Protus)

In one case study, the South Jersey Land and Water Trust installed 145 anti-herbivory cages in 2015 at a C-ranked swamp pink occurrence in Cape May County, New Jersey which was being severely impacted by deer herbivory (Arsenault 2016). One year following installation of the cages, swamp pink rosettes increased by 28 percent (286 to 367 rosettes), leaves increased by 24 percent (1,697 to 2,108 leaves), and the number of flowering stalks increased by 103 percent (31 to 63 flower stalks) (Arsenault 2016). By 2018 (3 years post-cage installation), rosettes had increased by 65 percent (286 to 472 rosettes), leaves increased by 109 percent (1,697 to 3,541 leaves), and flowering stalks increased by 306 percent (31 to 126 flower stalks) when compared to baseline conditions in 2015 (Arsenault 2019). Deer continued to browse any swamp pink leaves or flowers that extended beyond the boundary of the cage (13 percent of flowers and many leaf tips were noted as browsed in 2018), but the losses were minor when compared to the significant gains in swamp pink biomass achieved through the herbivore-exclusion efforts (Arsenault 2019).

Since 2011, nine swamp pink occurrences (ranging from A-rank to D-rank) across six counties in New Jersey (Burlington, Camden, Cape May, Gloucester, Monmouth, and Salem counties) have had deer-exclusion fence or anti-herbivory cages installed. Projects are planned at four additional swamp pink occurrences (three B-rank, one D-rank) for completion in 2021 in Cumberland, Middlesex, Ocean, and Burlington counties, New Jersey. Deer-exclusion fencing and anti-herbivory cages are labor intensive to install and must be maintained frequently to see a continued benefit to the swamp pink plants. Human vandalism and fallen trees can create access points within a deer-exclusion fence, allowing deer to quickly resume browsing inside the fenced area (Arsenault 2019). Similarly, deer can overturn cages that are not thoroughly secured (Hanlon pers. comm. 2020) and cages may need to be expanded or added to protect flowering stalks, accommodate growing swamp pink clumps, or protect new rosettes growing outside of existing cages (Arsenault 2019).

In summary, deer herbivory may be responsible for dramatic declines in some swamp pink occurrences and likely plays some role in negatively influencing the status of other occurrences throughout the species' range. Without continued human intervention and management efforts, this threat will continue to have significant impacts on swamp pink occurrences.

2.3.2.4 Inadequacy of existing regulatory mechanisms:

Relevant regulations and their adequacy to address threats to swamp pink are discussed below on a state-by-state basis. The inadequacy of existing regulatory mechanisms for groundwater extraction (Section 2.3.2.1), stormwater modification (Section 2.3.2.1), collection of swamp pink (Section 2.3.2.2), and the impacts of climate change (Section 2.3.2.5) are addressed in other portions of the Five-Factor Analysis (Section 2.3.2).

Wetland Regulations:
Clean Water Act Section 404: Discharge of dredged or fill material into waters of the United States, including wetlands, is regulated by the U.S. Army Corps of Engineers (Corps) and the U.S. Environmental Protection Agency (EPA) through the permit program under Section 404 of the CWA. This permit program operates concurrently with state-level wetland regulatory programs where they exist; however, this mechanism is the primary means by which fill of swamp pink habitat is regulated in Delaware, North Carolina, South Carolina, and Georgia.

Federal jurisdiction to regulate wetlands has changed over time in response to litigation and amendments to the CWA. In 2015, the Clean Water Rule (80 FR 37053) was published which created or revised existing definitions for several key CWA terms (e.g., 'tributary'), and is largely regarded to have expanded the scope of wetlands considered to be jurisdictional under the CWA. More recently in 2020, the Corps and EPA published the Navigable Waters Protection Rule (85 FR 22250), effective June 20, 2020, which revised the definition of "waters of the United States" to exclude ephemeral tributaries (i.e., surface water flowing or pooling only in direct response to precipitation) and their adjacent wetlands. The rule also limited the scope of "adjacent wetlands" to only those meaningfully connected to, or typically inundated by, tributaries and other jurisdictional waterbodies. The Navigable Waters Protection Rule reduced the overall scope of wetlands and waterways that are considered jurisdictional under the CWA, but the extent to which these changes impact protections afforded to swamp pink varies

throughout the species' range. In Delaware and Maryland, many swamp pink occurrences already fell outside of CWA jurisdiction before the 2020 rule change (Keller pers. comm. 2020). In Virginia and North Carolina few swamp pink occurrences are known to be associated with ephemeral tributaries or isolated wetlands (i.e., non-jurisdictional features), so the impact of the revised "waters of the United States" definition is expected to be limited (Reid pers. comm. 2020, Stanhope pers. comm. 2020). The single natural swamp pink occurrence in Georgia is still likely to qualify as jurisdictional under the CWA based on the relatively direct connection to a tributary of a navigable waterway (Hill pers. comm. 2021, Wiedl pers. comm. 2021). States with comprehensive wetland regulatory programs independent of Section 404 (e.g., Maryland, New Jersey, Virginia) would not experience any reduction in state-level jurisdiction over swamp pink habitats (Environmental Law Institute 2008, Torok pers. comm. 2020).

As a federally listed species, the Corps consults with the USFWS when a CWA Section 404 permit applicant's proposed activity may affect swamp pink. Section 7 consultation on CWA 404 permit applications has been effective at minimizing destruction of swamp pink habitat when plants occur directly in the wetland being regulated, but the regulatory mechanism is inadequate to prevent destruction of habitat when the plants are located outside the immediate project area under Corps jurisdiction (e.g., a wetland that does not meet the definition of "waters of the United States") but would not be impacted "but for" the Corps-permitted activity (USFWS 2008). Similarly, the regulatory mechanism is inadequate at securing the minimum 300-foot upland buffer necessary to avoid degradation of habitat because the jurisdiction of Section 404 does not directly cover adjacent upland habitats. In practice, upland buffers are often truncated at widths agreed to by the applicant (USFWS 2008). If swamp pink were no longer federally listed under the ESA, potential impacts to the species would not be considered by the Corps during permit reviews. Swamp pink may be incidentally protected through the continued minimization of fill in jurisdictional wetlands; however, this regulatory mechanism would remain inadequate to address the threat of habitat destruction and would provide no protections against habitat degradation from development of adjacent uplands. Similarly, protections afforded to swamp pink through comprehensive state-level wetland regulatory programs (i.e., in New Jersey, Maryland, and Virginia) are dependent on swamp pink's listing status in each state; see the state-by-state assessment of how swamp pink's state-status and associated regulatory protections may change if the species were no longer federally listed under the ESA.

New Jersey: New Jersey provides habitat for over 62 percent of all extant swamp pink occurrences within the nation's most densely populated state. Swamp pink in New Jersey is state-listed as endangered under the New Jersey Endangered Plant Species List Act (N.J.A.S. 13:1B-15.151) because of its current status as a federally listed species under the ESA. If swamp pink were no longer federally listed, the species' status in New Jersey could be reduced to a 'plant species of concern' or could be removed altogether due to the relatively large number of swamp pink occurrences (relative to other state-listed species) in New Jersey (Hafstad pers. comm. 2021).

New Jersey assumed regulation of freshwater wetlands under Section 404 of the CWA in 1993. The Freshwater Wetlands Protection Act (N.J.S.A 13:9B-l *et seq.*) (FWPA) and implementing regulations (N.J.AC. 7:7A) maintain jurisdiction over all freshwater wetlands in the State with few exemptions. The FWPA requires 150-foot buffers on wetlands that support federally listed

species or state-listed wildlife (but not state-listed plants or plant species of concern). With the current protection of the ESA, 300-foot buffers on wetlands supporting swamp pink, presence/absence surveys of suitable habitat, and species-specific conservation measures are often negotiated by the USFWS during the coordinated review of freshwater permit applications. Removal of ESA protection for swamp pink would preclude any specific consideration for impacts to the species and limit the state-mandated buffer to a maximum of 50 feet (or 150 feet if a state-listed animal occupies the same habitat). A wetland buffer of 300 feet is generally considered the minimum necessary to protect swamp pink's sensitive habitat from surrounding land-use changes (Dodds 1996), so either a 50-ft or 150-ft buffer is likely to provide inadequate protection.

The Pinelands Comprehensive Management Plan (N.J.A.C. 7:50) (covering 37 swamp pink occurrences) 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 swamp pink. The list of "threatened or endangered plants of the Pinelands" has never been revised since publication; however, it is possible that if swamp pink were delisted under the ESA and the Pinelands list was subsequently revised, swamp pink may be removed from the category (Hafstad pers. comm. 2021).

The Coastal Zone Management rules (N.J.A.C. 7:7E) (covering the same 37 swamp pink occurrences as the Pinelands Comprehensive Management Plan) prohibit the development of habitat for federal- or state-listed species unless such habitat would not be adversely affected either directly or through secondary impacts. This regulation could provide protection to swamp pink where the Coastal Zone overlaps with the Pinelands National Reserve and the Pinelands Protection Area if the species remained designated as "threatened or endangered plants of the Pinelands" in the Pinelands Comprehensive Management Plan (N.J.A.C. 7:7E-3.38, Hafstad pers. comm. 2021). However, if the species had no state-status or was no longer listed as a "threatened or endangered plant of the Pinelands", then this protection would not apply (Hafstad pers. comm. 2021).

The Highlands Water Protection and Planning Act rules (N.J.S.A. 13:20-1 *et seq.*) (covering only one swamp pink occurrence, Budd Lake Bog) require 300-ft buffers on wetlands and open waters and prohibit major developments unless the proposed activity will not jeopardize the continued existence of (or result in the likelihood of the destruction or adverse modification of habitat for) any rare species of plant or animal, including plant species of concern. As a 'plant species of concern', this protection would remain in place absent of ESA protections; if swamp pink has no special status in New Jersey, then this protection would not apply.

Delaware: Section 404 of the CWA is the primary authority by which discharge of dredged material or fill into wetlands is regulated in Delaware, though the jurisdiction of the CWA may not apply to all swamp pink habitats in the State (DE DNREC 2017). See more detailed discussion in the 'Clean Water Act Section 404' section. Direct disturbance of non-tidal wetlands of 400 or more contiguous acres is regulated under the Delaware Wetlands Act (7 Del. Code, Chapter 66) and the Wetlands Regulations (7 DE Admin. Code 7502), but this regulation is unlikely to have significant overlap with the small tributaries and associated wetlands preferred

by swamp pink. It's estimated that up to 30,000 acres of freshwater wetlands in Delaware are not covered by either federal or state regulations and would not need a permit to place fill (DE DNREC 2017). Additionally, swamp pink in Delaware is only considered to be state-rare; where State jurisdiction does overlap with swamp pink habitat the species may be incidentally protected from direct habitat destruction, but upland buffers are likely insufficient to avoid indirect degradation of the wetland habitat (McAvoy pers. comm. 2021).

County-level land use regulations in Delaware require small buffers on some streams and/or wetlands (Haywood 2019). Sussex County, which contains 19 of the 22 extant swamp pink occurrences in Delaware, applies a 50-ft buffer to non-tidal streams which protect some stream adjacent wetlands. New Castle County Land Use, Riparian Buffer Area Requirements include a 50-ft buffer for non-tidal wetlands greater than 20,000 ft^2 (0.46 acre). Kent County applies a 25-ft buffer on all wetlands (Haywood 2019). To the extent that these wetland buffers overlap with swamp pink habitat, the 25 to 50-ft buffers are inadequate to prevent indirect degradation of the habitat within the wetland as a result of development in the surrounding uplands (Dodds 1996).

Maryland: Swamp pink in Maryland is state-listed as endangered under the Maryland Nongame and Endangered Species Conservation Act (Md. Code Ann. 10-2A-01 to -09) and implementing regulations (Md. Code Regs. 08.03.08). The Nongame and Endangered Species Conservation Act requires that State agencies take any action necessary to ensure that actions they fund, authorize or carry out do not jeopardize the continued existence of threatened or endangered species (McCarthy pers. comm. 2021). The state-status of swamp pink in Maryland is independent of the species' status at the federal level (McCarthy pers. comm. 2021), so state-level protections for this species could remain in place if swamp pink were delisted under the ESA.

The Maryland Nontidal Wetlands Protection Act of 1989 (COMAR 26.23.01 *et seq*.) regulates impacts to all non-tidal wetlands, including isolated wetlands outside of the jurisdiction of the CWA 404 program, but does not currently regulate ephemeral streams (Sigillito 2018). Activities that require permits include activities such as excavating, filling, changing drainage patterns, disturbing the water level or water table, grading and removing vegetation in a nontidal wetland or within required upland buffers (Maryland Department of the Environment 2017). Wetlands supporting swamp pink are regulated as "wetlands of concern" and are afforded a 100-ft regulated upland buffer; all other wetlands get a 25-ft upland buffer (McCarthy pers. comm. 2021). If swamp pink were delisted at the federal level, this state-level regulation would provide some of the strongest habitat protections for the species in the range; however, the 100-ft upland buffer afforded to swamp pink sites is still inadequate to prevent indirect degradation of the habitat within the wetland as a result of development in the surrounding uplands (Dodds 1996).

Virginia: Swamp pink is state-listed as endangered under the Virginia Endangered Plant and Insect Species Act (VA Code Ann. § 3.2-1000 *et seq*.). If swamp pink were delisted at the federal level, the species would need to go through a formal reevaluation process to make any change to the species' state-status, although such reevaluations of species status are infrequent (Townsend pers. comm. 2019, as cited in USFWS 2020). Virginia currently has several species that are listed at the State level but not at the federal level, so a case could potentially be made for swamp pink to remain state-listed as a threatened or endangered species (Townsend pers.

comm. 2019, as cited in USFWS 2020). However, swamp pink is currently considered to be an S2/S3 ranked species in Virginia while all other state-listed plants are considered to be S1 or S2 (Townsend 2021); therefore, it is unknown whether swamp pink would retain a state-listed status if the federal protections of the ESA were removed.

The Virginia Nontidal Wetlands Act (Va. Code Ann. § 62.1-44.15 *et seq*.), as amended, and the Virginia Water Protection Program (VWPP) allow the Virginia Department of Environmental Quality (VDEQ) to regulate all state waters, regardless of the jurisdiction established in the CWA or the Rivers and Harbors Act (VDEQ 2019). A State/U.S. Army Corps of Engineers (Corps) joint permit is needed to dredge, fill, or discharge any pollutant into, or adjacent to surface waters; withdraw surface water; excavate in wetlands; cause permanent flooding or impounding; conduct any activity that will alter or degrade existing wetland acreage or functions, among other activities (Zollitsch 2015). According to a Memorandum of Understanding between VDEQ, Virginia Department of Conservation and Recreation (VDCR), and Virginia Department of Game and Inland Fisheries (VDGIF), the VDCR and VDGIF can review permit applications under the VWPP and provide comments or recommendations related to threatened and endangered species; for a state-listed species, surveys can be required, and permits may be denied based on the project's anticipated impacts to the listed species (Hypes pers. comm. 2021). For species that are not state-listed, a survey and other recommendations may be recommended but would not be required of the applicant by VDEQ (Hypes pers. comm. 2021). If swamp pink were delisted at the federal level but remained a state-listed species, the VWPP could provide species-specific recommendations and protection during the wetland permit process that may be sufficient to avoid most impacts to swamp pink and its habitat. If swamp pink were delisted at the state and federal levels, voluntary recommendations to avoid impacts to the species would be inadequate to address the direct and indirect threats from development and other land-use changes.

North Carolina: Swamp pink in North Carolina is state-listed as threatened under the North Carolina Plant Protection Act (N.C.G.S. § 106-202.12 *et seq.*). In the event swamp pink was delisted at the federal level, the species would be evaluated by the North Carolina Plant Conservation Board during the next and subsequent North Carolina Protected Plant Species List review periods (Starke pers. comm. 2021). Swamp pink is considered to be an S2 ranked species in North Carolina; state-listed threatened and endangered plants in North Carolina include species ranked S1 to S3, but a significant number of other plant species in North Carolina also ranked S1 to S3 are only considered to be 'special concern', 'significantly rare', or 'watch list' species (Wichmann 2021). Therefore, it is unknown whether swamp pink would retain a state-listed status if the federal protections of the ESA were removed.

Section 404 of the CWA is the primary authority by which discharge of dredged or fill material into non-coastal wetlands is regulated in North Carolina. See more detailed discussion in the 'Clean Water Act Section 404' section). Though the Corps and the EPA maintain responsibility for permitting fill of CWA jurisdictional wetlands, the North Carolina Department of Environmental Quality does issue CWA Section 401 (33 U.S.C. 1341) certifications of water quality for proposed projects in CWA jurisdictional wetlands and may consider impacts to state-listed species during that process. In addition, Article 21 of Chapter 143, General Statutes of North Carolina (N.C. Gen. Stat. § 143-21) as amended, also regulates significant impacts to isolated wetlands/waterbodies outside of CWA Section 404 jurisdiction (impacts <0.1 acre to

isolated wetland and impacts <150 linear feet to isolated streams are excluded from regulation in the portions of the State occupied by swamp pink) (Environmental Law Institute 2008). If swamp pink were delisted and the protections of the ESA were removed, impacts to state-listed species may still be considered to some degree during issuance of CWA Section 401 certifications of water quality and permit reviews for fill of isolated wetlands/waterbodies. If swamp pink did not retain a state-listed status, these regulatory mechanisms would provide only incidental protection to swamp pink and would be considered inadequate to avoid direct and indirect impacts to the species and its habitat. That said, a high proportion of swamp pink occurrences in North Carolina occur at least partially on conservation lands where the threat of development or other land-use changes are lower (Table 1); these occurrences may remain protected from direct impacts (and, potentially, indirect impacts if adequate buffer is preserved) in the event swamp pink was delisted.

South Carolina: Swamp pink does not have any state-status in South Carolina, though it is tracked as an S1 (critically imperiled) species (Bradley pers. comm. 2021). Section 404 of the CWA is the primary authority by which discharge of dredged or fill material into non-coastal wetlands is regulated in South Carolina (Environmental Law Institute 2008). See more detailed discussion in the 'Clean Water Act Section 404' section. However, South Carolina has only one known swamp pink occurrence that is located on a well-buffered portion of a State-owned Heritage Preserve containing the only existing montane bog habitat in the State. If swamp pink were delisted and the protections of the ESA were removed, this swamp occurrence is likely to remain adequately protected from development or other land-use changes adjacent to the wetlands.

Georgia: Section 404 of the CWA is the primary authority by which discharge of dredged or fill material into non-coastal wetlands is regulated in Georgia (Environmental Law Institute 2008). See more detailed discussion in the 'Clean Water Act Section 404' section. Georgia has one naturally occurring swamp pink population on private land which is likely to fall within CWA 404 jurisdiction (Hill pers. comm. 2021, Wiedl pers. comm. 2021). In the event swamp pink were delisted and no longer protected under the ESA, swamp pink at this site could be incidentally protected by the CWA, but fill of the swamp pink habitat could still be permitted. Four additional swamp pink safeguarding sites have been established in Georgia on protected lands; these occurrences would likely remain protected from direct or indirect impacts in the event swamp pink was no longer protected under the ESA.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

Beaver (*Castor canadensis*): Several biologists report that hydrologic impact associated with beaver activity poses a severe, but localized, threat to swamp pink populations where the species co-occur. All swamp pink colonies at Fort A.P. Hill, Virginia were assessed in late 2018; beaver activity was identified as a significant threat to 22 of 53 (42%) extant swamp pink colonies on the installation (Applegate and Josey 2020). Twenty-two beaver dams were identified, with some dams potentially impacting multiple swamp pink colonies, and some colonies potentially impacted by multiple dams. In response, Fort A.P. Hill provided maps of beaver activity to participants in its 2019 recreational trapping program and ultimately removed 75 beavers from the areas where impacts were greatest (Applegate and Josey 2020). Even with beaver control and

temporary hydrologic stabilization practices, three swamp pink colonies at Fort A.P. Hill continue to be threatened by inundation from persistent beaver activity (Stanhope pers. comm. 2021). Staff from Fort A.P. Hill and the USFWS completed a trial salvage and translocation effort in February 2021; two of four remaining swamp pink rosettes at an impacted colony were moved to new locations (within the same wetland) that are less likely to be subject to continuous inundation when beavers return. Fort A.P. Hill will monitor the survival and growth of the transplanted rosettes for three years (Stanhope pers. comm. 2021). Outside of Virginia, inundation of swamp pink habitat by beavers is less common.

Climate Change: As discussed in USFWS (2008), climate change was not considered in the Swamp Pink Recovery Plan but the predicted changes in temperature, carbon dioxide concentrations, precipitation patterns, water quality, human demand for water supplies, and sea-level rise are likely to affect swamp pink across its range in complex ways.

In the southeastern United States, climate model simulations of future conditions project increases in temperature and extreme precipitation for both lower and higher emission scenarios (Carter et al. 2018). In the southern Appalachian Mountains, sphagnum bogs are projected to experience increases in evapotranspiration coupled with elevated nitrogen deposition, which are ultimately predicted to cause drying, community succession, and localized extinction of bog species (Schultheis et al. 2010).

The Intergovernmental Panel on Climate Change's (IPCC) Assessment Report 5 (Climate Change 2014) continues to agree that climate change adversely affects freshwater ecosystems through alteration of streamflow and water quality (Jiménez Cisneros et al. 2014). Water resources are already stressed in many parts of North America; additional degradation of surface waterbodies could lead to localized increases in groundwater extraction to meet human needs (Jiménez Cisneros et al. 2014, Romero-Lankao et al. 2014). Groundwater extraction near wetlands and depletion of groundwater in water table aquifers are associated with degradation of swamp pink habitat; however, existing regulatory mechanisms are inadequate to address the threat, as described in Section 2.3.2.1 "Groundwater Extraction".

Intense storm events with heavy rainfall (DuBois pers. comm. 2020, Torok pers. comm. 2020) and resulting flooding (Smith pers. comm. 2020, Turner pers. comm. 2020) were identified as major threats to swamp pink populations in New Jersey. The Northeastern U.S. has experienced significant increases in both the frequency and intensity of heavy rain events over the last century (Dupigny-Giroux et al. 2018, Hoerling et al. 2016) and this trend is expected to continue into the future (Thibeault and Seth 2014). Under a high-end climate change scenario (i.e., high emissions, high concentrations, large temperature increase), monthly precipitation in the Northeast is projected to be up to one inch greater by the end of the century (2070 – 2100) (Dupigny-Giroux et al. 2018, Lynch et al. 2016). Storms that release large volumes of precipitation over a short period of time (i.e., high-intensity storms) often overwhelm stormwater infrastructure and can cause scour and sedimentation issues within swamp pink habitat. Additionally, high-intensity storms are likely to increase nitrogen and phosphorus pollution in wetlands and waterways (Jeznach and Granato 2020, Sinha et al. 2017), which may facilitate the invasion of non-native species into swamp pink habitat (Hernández et al. 2016). These changing precipitation patterns are likely to exacerbate swamp pink declines within developed watersheds.

Existing state-level stormwater regulations are inadequate to address this threat, as described in Section 2.3.2.1 “Storm Water Modifications”.

2.4 Synthesis

The total number of known extant occurrences of swamp pink (235 in 2020) has decreased for the first time since listing (from 249 in 2011), though the extent of the species’ distribution has not changed appreciably. The number of known extant occurrences of swamp pink in 2020 is almost double the number of known extant occurrences in 1991 (123 occurrences) and has increased the species’ representation and redundancy since ESA listing. There are 114 extant swamp pink occurrences (49% of total extant occurrences) located at least partially on protected lands, which is more than a three-fold increase compared to the number of known occurrences at least partially protected in 1991 (approximately 35). Of the 114 occurrences that are at least partially protected, 38 are robust A- or B- ranked occurrences that are well distributed across the species’ range. However, a significant number of swamp pink occurrences throughout the range, including some occurrences located at least partially on protected land, are clearly declining. In most cases, the declines are gradual and may only become evident over long periods of time, which affords some time for intervention. Cryopreservation of swamp pink seeds has been demonstrated to be possible for the first time and long-term storage of seeds from one swamp pink population was initiated at the Atlanta Botanical Garden (Perullo et al. 2015). Additional collections of marginal and highly imperiled genotypes will be needed to preserve the adaptive capacity of the species long-term.

The direct loss or alteration of wetland habitat was identified as the most significant threat to swamp pink in the 1988 ESA listing (USFWS 1988). Because of the regulatory mechanisms of the ESA, habitat destruction resulting from draining or filling of wetlands is no longer a significant threat to swamp pink. If the species were no longer federally listed, only Maryland and possibly Virginia have adequate regulatory mechanisms to continue to consider the impact of wetland fill on swamp pink during permit application reviews; protection in other states would be reduced to that which is incidentally provided by the CWA Section 404 program or state-level wetland regulatory programs. Additionally, revisions to the CWA, which went into effect June 20, 2020, may have reduced the number of swamp pink wetlands that would be considered jurisdictional under Section 404, but the consequences of the changes for swamp pink may not become apparent for several years. The destruction of swamp pink habitat from fill is largely irreversible once it occurs and can’t be offset by the creation of new wetland area given the species’ particular hydrologic requirements. Significant wetland fill is unlikely to occur on public or otherwise preserved lands, so the 114 swamp pink occurrences that are located at least partially on protected lands are at a reduced risk of being impacted by this threat if swamp pink were no longer federally listed.

Habitat degradation was identified in the 1991 recovery plan as the most important threat to swamp pink following implementation of the ESA protections; this threat remains persistent and pervasive today. Development of uplands and associated stormwater modification, erosion and sedimentation, groundwater extraction, vegetative succession, invasive species, and the past effects of wetland ditching and fill continue to contribute to the degradation of swamp pink’s wetland habitat throughout the range. Existing regulatory mechanisms are inadequate to prevent

development and other human activities like groundwater extraction from encroaching on wetlands and degrading swamp pink habitat. Where degradation is driven by extensive development within watersheds supporting swamp pink, there also tend to be few opportunities to mitigate or reverse its effects on the species and its habitat. As a result, acquisition or easement of swamp pink occurrences and adequate upland buffer areas remains a high priority action for the recovery of the species.

USFWS (2008) identified deer herbivory and climate change as potentially significant threats to swamp pink. These threats are suspected to have synergistic interactions with other co-occurring threats (e.g., groundwater drawdown, development of uplands, stormwater modification), exacerbating the cumulative threat to swamp pink over time. Habitat disturbance from beaver and feral hogs have also become severe, but localized, threats to roughly ten percent of extant swamp pink sites, primarily in the southern portion of the range. Targeted habitat management (e.g., herbivore exclusion, dam breaking, hog deterrents) has been shown to be effective at mitigating some of these threats, but sources of funding outside of the ESA are inadequate to allow continuation of this work long-term if swamp pink were no longer federally listed.

As noted in USFWS (2008), the status of swamp pink hinges on the balance between the discovery of additional extant occurrences across a relatively wide geographic range and the level of threat currently facing the species range-wide. The pace of discovery has begun to taper off while threats to the species have remained the same or increased (particularly in developed watersheds), resulting in the first observed decline in the total number of extant swamp pink occurrences. The criteria for delisting have not been met, and threats to the species have not been abated to an extent that eliminates the likelihood that the species may become endangered across all or a significant portion of its range in the foreseeable future. These factors lead to the conclusion that swamp pink continues to meet the definition of a threatened species throughout its range (i.e., swamp pink is likely to become an endangered species in the foreseeable future).

3.0 RESULTS

3.1 Recommended Classification:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist (Indicate reasons for delisting per 50 CFR 424.11):
____ *Extinction*
____ *Recovery*
____ *Original data for classification in error*
_X__ No change is needed

3.2 New Recovery Priority Number: 7C (no change)

Brief Rationale: The overall magnitude of threat to the continued existence of swamp pink is moderate based on the relatively high number of known populations spread across a large geographic area weighed against the pervasive

nature of virtually all categories of threats, which have brought about documented populations declines and local extirpations. All known threats are imminent, and, in fact, ongoing; however, many threats bring about population declines slowly, affording time for intervention. Despite ongoing taxonomic controversy, swamp pink is still described by taxonomic authorities as a monotypic genus, and the species continues to be in conflict with construction or other development projects.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

Identify Priority Sites

- Investigate the genetic diversity of swamp pink occurrences range-wide (especially in states that are under-represented in existing genetic studies, including North Carolina, Virginia, Delaware, Maryland, and New Jersey). Smaller, less vigorous swamp pink occurrences can harbor significant genetic diversity (Godt et al. 1995) and must not be overlooked during sampling. Develop guidance or criteria to identify occurrences that are representative of the species' genetic diversity and designate those occurrences as priority sites for protection. (Section 2.2.3, Priority 2 action)

- Develop guidance or criteria to identify the swamp pink occurrences that are representative of the species' range and habitat. Designate the occurrences that meet the criteria as priority sites for protection. (Section 2.2.3, Priority 2 action)

- Develop a swamp pink-specific protocol for delimiting element occurrences and pursue uniform implementation across the species' range. Consider implementing 'parent and child' structure for element occurrences to delineate populations and their corresponding sub-populations/occurrences. (Section 2.3.1.2, Priority 3 action)

Research to Inform Management

- Conduct a study to look for correlations between buffer widths, level of watershed development, and changes in swamp pink population size and vigor over time. Use this information to develop guidance on adequate buffer size/acreage for swamp pink sites to be considered permanently protected. Investigate whether buffer enhancement activities can be implemented to achieve adequate buffer protection at swamp pink occurrences that already have development in the buffer zone. (Section 2.2.3, Priority 2 action)

- Investigate the impacts of herbivory (at different frequencies and intensities) on the growth and survival of swamp pink in the short- and long-term, as well as potential synergistic interactions with other co-occurring threats (e.g., groundwater drawdown). Investigate alternate management strategies (e.g., habitat management to increase light availability) to mitigate the effect of herbivory in situations where deer cannot effectively be excluded. (Section 2.3.2.3, Priority 2 action)

- Based on the results of research, create guidance that describes the minimum protections and management stipulations (to be tailored to the site-specific conditions) required for a swamp pink occurrence to be considered permanently protected. (Section 2.2.3, Priority 3 action)

Safeguarding Actions

- Develop a captive propagation plan for swamp pink that clarifies objectives of ongoing *in-situ* and *ex-situ* safeguarding efforts and their significance for swamp pink recovery. (Section 2.2.3, Priority 2 action)

- Pursue long-term storage (*ex-situ* safeguarding) of swamp pink seed and/or tissue at Center for Plant Conservation member institutions. Prioritize collection and preservation of occurrences that are known or suspected to be representative of the species' genetic diversity and are currently imperiled, or may become imperiled in the future. (Section 2.2.3, Priority 2 action)

- Investigate the need, methods, and opportunities for the establishment of *in-situ* swamp pink safeguarding sites and/or reintroductions to sites that have become extirpated. (Section 2.2.3, Priority 3 action)

Land Preservation and Management

- Work with public and private land trusts to acquire and manage swamp pink priority sites and buffer areas. Continue to seek landowner agreements to protect swamp pink on private lands where outright acquisition is a low priority or is not feasible. (Section 2.2.3, Priority 3 action)

- Work with restoration groups to halt or reverse declines at impacted sites. Seek out new funding sources, such as those for non-point source pollution control or preservation of lands important to water supplies. (Section 2.3.2.1, Priority 2 action)

- Incorporate swamp pink in watershed planning, especially where multiple occurrences are clustered in small watersheds. Examples of watershed planning activities may include identifying priority areas for acquisition or conservation easements; mapping groundwater recharge areas; mapping up-gradient areas of steep slopes or highly erodible soils; and seeking protections through surface water quality standards, development design standards, or regulation of flood plains or stormwater management. (Section 2.3.2.1, Priority 3 action)

Continue Survey Efforts

- Continue surveying swamp pink occurrences, especially sites which haven't been surveyed in 20+ years and are nearing historic status. New Jersey and Delaware in particular have a significant number of sites that have not been visited for several decades

but are still believed to be extant. Build relationships with private landowners and secure property access for swamp pink surveys. (Section 2.3.1.2, Priority 3 action)

- Conduct *de novo* surveys for swamp pink in suitable habitat on public and private lands, especially in remote or otherwise undisturbed areas. Public lands have continued to yield new A- or B- ranked swamp pink occurrences in New Jersey, and discovery of new populations (or subpopulations) is also possible in the southern portion of the range (e.g., North Carolina). (Section 2.3.1.2, Priority 3 action)

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The report was developed using New Jersey Department of Environmental Protection Natural Heritage Program Geographic Information System digital data. As such, this is a secondary product and has not been verified or authorized by the NJDEP Natural Heritage Program.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Helonias bullata*

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: 7C (no change)

Review Conducted By: Alicia Protus, Fish and Wildlife Biologist, New Jersey Field Office

LEAD REGIONAL OFFICE APPROVAL:

Assistant Regional Director, Fish and Wildlife Service

Approve SHARON MARINO Digitally signed by SHARON MARINO Date: 2021.10.05 14:40:27 -04'00' Date _____

Appendix A: Summary of Identified Swamp Pink Priority Sites

Budd Lake Bog, New Jersey: This northern-most population in the range (B-ranked) is protected on State preserve land, although some of the buffer areas for the population occurs on privately owned parcels. A utility powerline right-of-way also crosses part of the wetland and swamp pink buffer area. The site has a permanent 350-foot by 10-foot monitoring transect that was installed in 2005 and is monitored by volunteers. The observers conducting the counts have remained consistent across all sampling years, resulting in a reliable data set with minimal observer bias. The population is considered to be stable, with the number of swamp pink plants within the transect area fluctuating only slightly between years (typical gains or losses of < 30 plants). During the most recent survey in May 2019, the swamp pink plants and wetland habitat were noted to be in good condition but the black spruce trees in the wetland appeared stressed (Newgard pers. comm. 2019). Black spruce is primarily a northern tree species that is sensitive to high temperatures and moisture availability (Sullivan et al. 2017). The condition of this wetland will continue to be monitored during the biennial swamp pink surveys.

Pink Beds, North Carolina: This A-ranked population is by far the largest in the southern Appalachians, and is located on lands owned by the U.S. Forest Service. A complete re-inventory of swamp pink in the Pink Beds was completed in 2020, except for one site that was last surveyed in 2019 (Fruchey pers. comm. 2020). Swamp pink monitoring includes counts of rosettes (ramets) instead of plant clumps (genets) because discerning between genets is difficult in dense aggregations of swamp pink. The Pink Beds are now estimated to consist of at least 20 discrete subpopulations that collectively contain an estimated 118,770 - 270,770 rosettes (NCNHP 2020). The largest subpopulation is estimated to contain between 100,000 and 250,000 rosettes and the 19 smaller subpopulations are estimated to collectively contain between 18,770 and 20,770 rosettes. At least 11 of the subpopulations were noted to have recently germinated fruits and/or swamp pink seedlings present during the 2020 surveys (NCNHP 2020). The estimated number of rosettes in the Pink Beds population has increased as survey efforts shifted focus from distribution mapping to counting/estimating rosette abundance. Known threats to the Pink Beds subpopulations are varied and include localized flooding from a road culvert, disturbance associated with a powerline right-of-way, impacts from trails, stormwater runoff from park facilities, shading by shrubs, and competition from invasive species (Fruchey pers. comm. 2020). The Pink Beds population is largely regarded to be stable overall, though trends at individual subpopulations likely vary (Fruchey pers. comm. 2020).

Watson-Cooper Heritage Preserve, South Carolina: This site is the only known swamp pink population in South Carolina and is nearly as far south as the Georgia population. This B-ranked population is well protected on a large tract of preserved land, and is managed by the South Carolina Department of Natural Resources (SCDNR 2020). Deer herbivory of racemes, feral hog activity, and shading from tree and shrub species may be impacting the swamp pink to varying degrees (Fowler pers. comm. 2020). The South Carolina Department of Natural Resources has conducted mechanical and chemical treatments to control the invasion of hardwood species and habitat succession at the site, maintaining the total area and quality of the swamp pink habitat (Bradley pers. comm. 2021). Similar to the Pink Beds population, swamp pink monitoring includes counts of rosettes instead of plant clumps. Census count efforts in 2018 documented 5,140 swamp pink rosettes and 398 flowering stalks across five subpopulations (Fowler pers.

comm. 2020). Plans are underway to collect material from this occurrence and begin propagating an *ex-situ* safeguarding collection at the Atlanta Botanical Garden (Radcliffe pers. comm. 2020). The headwaters of this creek system were restored in 2019 which should help to improve downstream habitat quality and resilience (Bradley pers. comm. 2021)

Commissioner's Rock Bog (aka James Bog, Scaly Mountain Bog), Georgia: Commissioner's Rock Bog is the only naturally occurring swamp pink population in Georgia, and the southern-most in the species range. This CD-ranked population occurs on private land and has been critically imperiled for years due to hydrology changes associated with ditching efforts in 1946 (GADNR 2020). Swamp pink has maintained itself vegetatively on dry hummocks surrounded by sunken areas that used to be flowing water and bog habitat (Radcliffe pers. comm. 2020). The site was last visited in April 2015 and all ten patches of swamp pink were noted to be intact but rosettes were not counted (GADNR 2020). Small numbers of flowering plants were observed in 2014 and 2015; however, late frost prevented seed set in 2015. Flowering and seed production were plentiful during surveys in 2013 and seed was collected (≤10% of the seeds from ≤10% of parent plants) for propagation at the Atlanta Botanical Garden (GADNR 2020). The population of swamp pink plants at Commissioner's Rock Bog is presumed to be declining slowly in response to the habitat degradation that has occurred at the site.

Using material sourced from the Commissioner's Rock Bog occurrence, four *in-situ* swamp pink safeguard sites (containing 13 subpopulations) have been established on protected lands in Georgia, including one new site established in White County in 2012 (Radcliffe pers. comm. 2020). The establishment of *in-situ* safeguard sites supplements the ex-situ propagation work ongoing at Georgia Plant Conservation Alliance member facilities and is considered a conservation effort of last resort to prevent the extinction of the Commissioner's Rock Bog genotype. Since 2011, approximately 332 swamp pink individuals have been planted across the four sites (Radcliffe pers. comm. 2020). Evidence of swamp pink sexual reproduction and seedling recruitment was observed at a safeguarding site for the first time in 2011. A large swamp pink plant outplanted in 1995 in Chattahoochee National Forest flowered in 2010 after habitat management activities increased light levels at the site. During monitoring the year following flowering, several swamp pink seedlings were observed adjacent to the same plant. Seedling recruitment has since been documented at two additional safeguarding sites in 2014. Overall the swamp pink safeguarding sites are believed to be stable, with increasing viability as restoration efforts are fine-tuned (Radcliffe pers. comm. 2020). The role of these safeguarding sites in the context of swamp pink recovery is uncertain at this time; the USFWS is collaborating with Georgia Plant Conservation Alliance institutions to set goals and evaluate measures of success for the *in-situ* safeguard sites (Elmore pers. comm. 2020).

Habitat disturbance from feral hogs is a major threat to the swamp pink at the safeguarding sites. Feral hog activity in mountain fens and bogs has increased dramatically since 2010, with visitation expanding from summer months to nearly year-round, as well as into remote areas where they had not been seen previously (Radcliffe pers. comm. 2020). Frequent damage at multiple bog sites has been observed since 2017, including one event which uprooted swamp pink at a safeguarding site in Rabun County (Radcliffe pers. comm. 2020).

Other Southern Appalachian Occurrences: Excluding the previously discussed priority sites in North Carolina, South Carolina, and Georgia, there are 17 extant swamp pink occurrences in North Carolina which are important representatives of swamp pink genetic diversity; 13 of which occur at least partly on protected lands. Of the 17 populations, 9 appear to be stable or increasing, 1 population appears to be declining, and another 7 populations did not have clear trends (NCNHP 2020). One site (Cedar Mountain Bog, element occurrence 21.004) is believed to have declined to extirpation between 2003 and 2007 and may represent a loss of genetic diversity for swamp pink. Cedar Mountain Bog is part of a population that has two remaining subpopulations which may harbor individuals genetically similar to the extirpated plants. The North Carolina Plant Conservation Program recently acquired and restored Cedar Mountain Bog and reintroduced swamp pink to the site in 2018 using plant material sourced from another occurrence and propagated at the Atlanta Botanical Garden (Radcliffe pers. comm. 2020).