Swamp Pink
(Helonias bullata)

5-Year Review:
Summary and Evaluation

U.S. Fish and Wildlife Service
New Jersey Field Office
Pleasantville, New Jersey

5-YEAR REVIEW
Swamp pink (*Helonias bullata*)

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1.0 GENERAL INFORMATION

1.1 Reviewers

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1.2 Methodology Used to Complete the Review

This review was prepared as an individual effort by Wendy Walsh of the U.S. Fish and Wildlife Service (USFWS) New Jersey Field Office, with oversight and assistance from Mary Parkin and Anne Hecht of the Region 5 Regional Office and Annette Scherer of the New Jersey Field Office. Further input was obtained from Regional and Field Offices, State agencies, and other species experts. A draft of Sections 2.0 through 2.3 was provided for technical review to all Regional and Field Offices and Natural Heritage Programs in the species' range, the New Jersey Division of Land Use, the Pinelands Commission, Rutgers University, and the former USFWS species coordinator. A threats assessment (Appendix A) was prepared in support of the Five-Factor Analysis (Section 2.3.2) as follows: A draft threats matrix was developed by the New Jersey Field Office, then refined and completed via conference call by staff from the Regional Office, New Jersey Field Office, and Asheville (North Carolina) Field Office. Information that was heavily relied upon for this review includes USFWS (1991), Peterson (1992), Obee (1995), Windham and Breden (1996), Godt *et al.* (1995), Dodds (1996a), L. Torok (pers. comm., 2007), C. Wells (pers. comm., 2007), and Natural Heritage Program data from all states in the species' range.

Several geospatial analyses were performed using Geographic Information Systems (GIS). The GIS software for all analyses was ESRI ArcMap version 9.2. The number of swamp pink occurrences located at least partly on protected land in Virginia was determined using element occurrence locations provided by the Virginia Field Office and a Virginia Conservation Lands layer developed by the Virginia Department of Conservation and Recreation (http://www.dcr.virginia.gov/dnh/conslandindex.htm). The number of swamp pink occurrences located at least partly on protected land in New Jersey was determined using element occurrence locations provided by the New Jersey Natural Heritage Program and layers of local, State, Federal, and private conservation lands obtained directly from the land-owning agencies and organizations. The layer of physiographic divisions shown in Figure 1 was obtained from the U.S. Geologic Survey (http://water.usgs.gov/GIS/metadata/usgswrd/XML/physio.xml). Watershed, land use, and impervious surface cover layers shown in Figure 2 and discussed under Section 2.3.1.6 were obtained from the New Jersey Department of Environmental Protection (NJDEP) (http://www.state.nj.us/dep/gis/). A national layer of impervious surface from Elvidge *et al.* (2002) was used to prepare Figure 3. The NJDEP's 10-meter Digital Elevation Model layers (http://www.state.nj.us/dep/gis/wmalattice.html) were used to map the work of Cooper *et al.* (2005) regarding coastal flooding relative to known swamp pink locations, as discussed in Section 2.3.2.5. A layer of potential tidal marsh retreat zones from the work of Lathrop and Love (2007), also discussed in Section 2.3.2.5, was provided by the Grant F. Walton Center for Remote Sensing and Spatial Analysis at Rutgers University.

1.3 Background

1.3.1 Federal Register (FR) citation announcing initiation of this review: April 21, 2006 (71 FR 20717-20718). Notice of Endangered and Threatened Wildlife and Plants; Initiation of a 5-Year Review of Nine Listed Species

1.3.2 Listing history:

FR citation: 53 FR 35076-35080
Date listed: September 9, 1988
Entity listed: Species (monotypic genus)
Classification: Threatened

1.3.3 Associated rulemakings: None

1.3.4 Review history: The swamp pink was included in a cursory 5-year review of all species listed before 1991 (announced in 56 FR 56882 on November 6, 1991). Although no other 5-year review has been conducted for the species until now, the 1991 recovery plan includes an assessment of the species' status.

1.3.5 Species' Recovery Priority Number at start of 5-year review: 7C. As per the criteria set forth in 48 FR 43098, the 7C ranking is indicative of a moderate degree of threat, high recovery potential, classification as a monotypic genus, and the potential for imminent conflict with economic development activities.

1.3.6 Recovery plan:

Name of plan: Swamp Pink (*Helonias bullata*) Recovery Plan
Date issued: September 8, 1991
Dates of previous plans: 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 recovery 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? No. Since the 1991 recovery plan, intensive survey efforts have revealed many new occurrences[1] of swamp pink, State and Federal regulatory programs have changed, and substantial bodies of literature have been published regarding swamp pink biology, impervious surface, the sensitivity of swamp pink to habitat degradation, and climate change.

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)? No. Although all five listing factors are discussed in the recovery plan, only Factor A (habitat-related threats) is addressed directly by the recovery criteria. Relevant factors that are not addressed include Factor C (predation, *e.g.*, herbivory) and Factor E (other factors, *e.g.*, climate change). In addition, new information has become available regarding the severity of some threats (*e.g.*, indirect habitat degradation from off-site development, herbivory).

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1 An element occurrence is the spatial representation of a species or ecological community at a specific location and represents the geo-referenced biological feature that is of conservation or management interest (NatureServe, 2007). Occurrences may or may not represent biologically distinct populations.

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:

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 in light of current information. Therefore, measuring progress toward these criteria is a useful means to track recovery until such time as a determination is made whether the criteria require revision. According to the recovery plan (USFWS 1991), swamp pink will be considered for delisting when the following three conditions are achieved.

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* [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. Approximately 35 populations occur wholly or partially on public lands at this time; out of these, approximately one-third are A- or B-ranked. Another 45 populations on private lands meet one or more of the above criteria. These populations include the A- and B-ranked sites on private lands in Delaware, Maryland, and New Jersey; additional sites in those States representing habitat diversity or range extension; populations on private lands in Virginia and North Carolina; and the Georgia population. As a preliminary quantitative objective, 80 sites must be permanently protected to achieve condition 1. This figure is subject to change based on new information derived from genetic studies and additional searches. Habitat will be considered permanently protected when: (1)Aadequate 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.*

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(ESA) is withdrawn.*

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

Progress toward meeting Condition 1 – Secure protection for A and B occurrences:

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

About 91 of approximately 227 known extant occurrences of swamp pink (about 40 percent) are at least partly on public or otherwise protected land (Table 1). Of these 91 occurrences, 30 are ranked A or B (12 in New Jersey, 2 in Delaware, 12 in Virginia, 3 in North Carolina, and 1 in South Carolina). Available information is insufficient to assess which, if any, of the 91 occurrences meet the standards of protection specified in the recovery criteria. Preservation efforts continue in several States. New Jersey's active open space preservation program is described under Condition 2, below. The North Carolina Plant Conservation Program and local land trusts are actively pursuing conservation of areas supporting swamp pink, but little progress has been made to date due to a variety of factors, including lack of landowner interest. The most significant population in the southern Appalachians, the Pink Beds in North Carolina, occurs on lands owned by the U.S. Forest Service; however, there is no routine monitoring of this population and no site-specific management plan exists (C. Wells, pers. comm., 2007).

Table 1. Summary of swamp pink occurrences, 1991 and 2007

	1991						2007					
	Historic	Extant	A or B	%	Protected	%	Historic	Extant	A or B	%	Protected	%
NY	1	0	na	na	na	na	1	0	na	na	na	na
NJ	68	71	29	41	14	20	76	140	22	16	46	33
DE	8	15			3	20	16	19	5	26	4	21
MD	2	5			0	0	2	7	1	14	2	29
VA	0	22			14	64	0	43	15	35	33	77
NC	0	8			3	38	2	16	6	38	5	31
SC	0	1	1	100	1	100	0	1	1	100	1	100
GA	0	1			0	0	0	1	0	0	0	0
total	79	123	<56	<45	35	28	97	227	50	22	91	40

Historic = Presumed extirpated based on:
- time of last-observed date (50-150 years ago) AND/OR
- absence of plants and habitat conditions at most recent site visit(s) (usually within the past 5-20 years)

Extant = In existence based on presence of plants at most recent site visit (usually within the past 5-20 years

Protected = Extant occurrences of any rank located at least partly on public or otherwise conserved land

Totals from 2007 do not include 2 occurrences in Georgia that were recently outplanted as a recovery effort

The NJDEP prepared Preserve Designs in 1991, 1993, and 2001 for a total of eight New Jersey occurrences, as well as Conservation Plans (modified Preserve Designs that lack landowner information) in 1994, 1995, and 1996 for a total of 21 New Jersey occurrences. However, it is currently unknown: (1) Which of these 29 occurrences are ranked A or B (or represent important aspects of distribution, habitat, or genetic diversity) and have adequate protected acreage; and (2) the extent to which these management plans have translated into protective measures on the ground and have prevented, halted, or reversed population declines.

In addition, 11 voluntary landowner agreements have been executed with the USFWS for the protection of swamp pink on private lands in New Jersey. Although such agreements may be an important recovery tool to reduce the near-term risk of extirpation, they do not count toward the delisting criteria as they do not confer permanent protection or meet the other criteria listed in the recovery plan.

In addition to A- and B-ranked sites, other swamp pink occurrences may contribute toward meeting Condition 1 because they are representative of the species' range-wide distribution, habitat diversity, or genetic diversity. Information that has become available since the 1991 recovery plan is provided below.

Distribution: Budd Lake Bog in New Jersey is the northernmost occurrence of swamp pink; this site is protected on State preserve land, and is B-ranked. Commissioners Rock Bog, the only naturally occurring site in Georgia, is the southernmost occurrence of swamp pink; this site is C or D-ranked and is under ongoing threat despite continuing conservation efforts (M. Moffett, pers. comm., 2007). Greenhouse-propagated swamp pink has recently been outplanted to two other Georgia sites, both on National Forest lands, one in a county outside the known historic range (M. Moffett, pers. comm., 2007). How these outplanted sites factor into meeting the recovery criteria is not yet clear. An occurrence on the Watson-Cooper State Heritage Preserve represents the only known swamp pink site in South Carolina and is nearly as far south as the Georgia populations; this B-ranked population is well protected, with State biologists conducting annual surveys and habitat management as required (L. Zimmerman, pers. comm., 2007). Further analysis is needed to determine which additional occurrences are important to the range-wide distribution of swamp pink.

Habitat Diversity: About 85 percent of extant swamp pink occurrences are located within the Atlantic Coastal Plain; therefore, occurrences in the Appalachian Highlands can generally be considered important representatives of habitat diversity, as stated in the recovery plan. Of the two montane occurrences in New Jersey, both are protected, including Budd Lake Bog. Twenty-two Virginia occurrences are in the Appalachians, 18 of which are at least partly on conserved lands. All 18 occurrences in the Carolinas and Georgia are Appalachian; of these, 5 sites in North Carolina and the one in South Carolina are at least partly protected. Further analysis is needed to determine which Coastal Plain occurrences (in New Jersey, Delaware, Maryland, and Virginia) are important representatives of habitat diversity (*e.g.*, high-quality examples of Atlantic white cedar (*Chamaecyparis thyoides*) and red maple (*Acer rubrum*) swamps).

Genetic Diversity: Godt *et al.* (1995) found that two disjunct populations at the southern end of the swamp pink range (one in southern North Carolina and the one in Georgia) are particularly genetically variable. When data were pooled by region, Godt *et al.* (1995) observed a significant latitudinal trend in genetic diversity, despite considerable variation among populations within regions. The highest level of genetic diversity was observed in the Southern Appalachians. New Jersey exhibited the lowest level of diversity, and Virginia was intermediate. Populations in Delaware and Maryland were not sampled. These results suggest that the more northerly areas, which almost certainly did not support swamp pink during the last glacial period, might still be subject to founder effects associated with post-glacial colonization. The Southern Appalachian occurrences may be relict populations from the last glacial epoch and may have been the source of founders for the more northerly populations (Godt *et al.*, 1995). Based on this study, the 18 occurrences in the Carolinas and Georgia can generally be considered important representatives of genetic diversity; 6 of them are at least partly protected as discussed above. Despite the latitudinal trend, Godt *et al.* (1995) did find some populations in New Jersey and Virginia with relatively high genetic diversity for this species. Further analysis is needed to determine which additional occurrences from New Jersey to Virginia are important to the species' genetic diversity, based on the work of Godt *et al.* (1995) and other genetic investigations (see Section 2.3.1.3).

Progress toward meeting Condition 2 – Ensure sufficient regulatory protection:

Although notable progress has been made toward meeting this recovery criterion, the necessary level of regulatory protection has not been fully achieved. Significant protections are in place in parts of the species' range, and some level of regulatory protection would continue even if the species was to be delisted. It is also likely, however, that one or more States would remove the plant from their species lists, with varying consequences in those states. Relevant regulations and their effect on swamp pink conservation are discussed below on a State-by-State basis.

New Jersey: Swamp pink is State-listed as endangered under the New Jersey Endangered Plant Species List Act (N.J.A.S. 13:1B-15.151), which merely establishes a list. Actual protections for State-listed plants are conferred through a variety of other State laws. In addition to providing habitat for over 60 percent of all extant swamp pink occurrences within the nation's most densely populated State, New Jersey is distinct for its State-assumed wetland permitting program and for its State-wide regulation of flood plains and stormwater management. Nearly 40 percent of New Jersey's swamp pink sites are further protected by regional land-use regulations (*e.g.*, Highlands, Pinelands, Coastal Zone). Summarized below, these regulatory programs protect swamp pink against not only most direct habitat losses (*e.g.*, filling, clearing, draining) but also against some of the more immediate and severe aspects of habitat degradation caused by adjacent development. These regulatory programs continue to evolve, and several proposed rule changes are discussed below[2].

Collectively, New Jersey regulations have likely begun to curtail habitat degradation from adjacent development, although they are probably insufficient to halt habitat degradation over the long term at all sites. Many occurrences continue to be degraded by adjacent development that was constructed prior to more recent and stringent rules. In addition, even the largest (300-foot) upland buffers required by these regulatory programs are not certain to provide sufficient long-term habitat protection in all cases, and for more than 60 percent of New Jersey's known sites, these large buffers are afforded only due to the status of swamp pink as a Federally listed species.

[2] The proposed rule changes are included for informational purposes only and were not considered in the Service's listing recommendation (Section 3.0 of this review) because they are not yet in effect. The efficacy of any new regulations will be considered during the next 5-year review.

Regulation of Wetlands: In 1993, New Jersey became the only State in the species' range to assume regulation of freshwater wetlands under Section 404 of the Clean Water Act (33 U.S.C. 1344 *et seq.*) (CWA). Regulatory jurisdiction for all wetlands supporting swamp pink was assumed by the State, eliminating Federal authorization by the U.S. Army Corps of Engineers (Corps) and thereby also removing the protections afforded by Section 7 of the ESA (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*). To avoid the loss of USFWS review under the ESA, a Memorandum of Agreement (MOA) was signed by the USFWS, the NJDEP, and the U.S. Environmental Protection Agency (EPA) concurrent with State assumption; this MOA serves as a functional equivalent of Section 7 consultation. Under the MOA, the USFWS reviews State wetland applications in municipalities with known occurrences of swamp pink and works with the NJDEP and applicants to avoid adverse effects. Any application that has the potential to affect Federally listed species is elevated to Federal oversight by the EPA for further consultation with the USFWS.

The Freshwater Wetlands Protection Act (N.J.S.A. 13:9B-1 *et seq.*) (FWPA) and implementing regulations (N.J.A.C. 7:7A) are the basis for State assumption and must therefore be at least as protective as the Federal 404 program. The FWPA includes several provisions that are more restrictive than the CWA. For example, the FWPA regulates essentially all activities in wetlands (*e.g.*, disturbances to soils, vegetation, or the water table) while the CWA only regulates the placement of fill material. The FWPA also regulates "transition areas," or upland buffers, either 50 or 150 feet wide, while the CWA provides no regulation of uplands. As a State law, the FWPA retains full jurisdiction over isolated and non-navigable waters and wetlands, while Federal jurisdiction over these areas under the CWA has been curtailed by recent court decisions.

The FWPA requires the larger, 150-foot buffer on wetlands that support Federally listed species or State-listed animals (not State-listed plants). Under current regulations, removal of ESA protection for swamp pink would limit the State-mandated buffer to a maximum of 50 feet (or 150 feet if a State-listed animal also occupies the same habitat). In contrast, with the current protection of the ESA, 300-foot buffers on wetlands supporting swamp pink are often negotiated through the MOA process. These 300-foot buffers are considered the minimum necessary to protect swamp pink's sensitive habitats and may not afford sufficient protection in all cases (Dodds, 1996a; L.P. Arroyo, pers. comm., 2007). The MOA also provides for presence/absence surveys in suitable but undocumented habitats, which would be outside the authority of the FWPA absent the ESA protection of swamp pink (L. Torok, pers. comm., 2007). Such surveys have documented several new occurrences of swamp pink. Regardless of the species' status under ESA, activities more than 150 feet from a wetland supporting swamp pink are not regulated under the FWPA if the project does not also entail work within the actual wetland or regulated transition area.

Regional Land-Use Laws: Fifty-three extant swamp pink occurrences are located in New Jersey's Highlands Preservation Area, Pinelands Area, or Coastal Zone. State laws and regulations for these geographic regions provide explicit protection for State-listed plants that would remain in place absent ESA protections. The Coastal Zone Management rules (covering 27 swamp pink occurrences) prohibit development of habitat for Federally or State-listed species unless such habitat would not be adversely affected either directly or through secondary impacts; habitat for listed species is defined to include a sufficient buffer area to ensure continued survival of the population (N.J.A.C. 7:7E-3.38). The Pinelands Comprehensive Management Plan (covering 25 swamp pink occurrences) prohibits development unless designed to avoid irreversible adverse impacts upon the survival of any local populations of Federal- or State-listed species (N.J.A.C. 7:50-6.27 and 6.33). The Highlands Water Protection and Planning Act rules (covering one swamp pink occurrence, Budd Lake Bog) require 300-foot 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, Federal- or State-listed species (N.J.A.C. 7:38-3.11).

<u>Regulation of Flood Plains</u>: Applicable State-wide, the Flood Hazard Area Control Act (N.J.S.A. 58A:16A-50 *et seq.*) regulates activities in flood plains. Implementing regulations state that the NJDEP will not approve any regulated activity that is likely to significantly and adversely affect listed species or their current or documented historic habitats (N.J.A.C. 7:13-3.1(b)3). These protections apply to State-listed plants regardless of a species' ESA status. The Flood Hazard Area Control Act regulations recently underwent major revisions, adopted in November 2007. Benefits to swamp pink from the revised rules include standard 150-foot buffers from the top of bank on waterways determined to feature documented habitat for certain listed aquatic species including swamp pink; these buffers extend 1 mile upstream from the documented habitat. These new permitting criteria strengthen the protection provided to the habitat for threatened and endangered species within the Act's jurisdiction (L.Torok, pers. comm., 2007). These changes bring the State regulation of riparian areas up to the protective standards recommended by Dodds (1996a), specifically 150-foot buffers around streams and tributaries that feed directly into the wetlands supporting swamp pink. However, Dodds (1996a) also recommends larger stream buffers when adjacent land use includes activities that pose a high risk for siltation or sedimentation. Effects of these newly adopted regulatory changes will be assessed during the next 5-year review.

<u>Regulation of Stormwater Management</u>: In 2004, the NJDEP adopted a new set of State-wide stormwater rules (N.J.A.C. 7:8 and 7:14A). The primary focus of these rules is to steer management practices away from stormwater collection and point discharge and encourage groundwater recharge and less concentrated discharges. To the extent that these rules are implemented, they should reduce localized groundwater or water table modifications and stormwater surges – factors known to severely degrade swamp pink habitat. However, for those swamp pink populations already in urban and suburban landscapes where past stormwater practices dominate, the rules offer little help. Although retrofitting and improving old systems is encouraged, little to no funding for major overhauls of existing systems is provided. As a result, the revised rules will greatly assist in the long-term maintenance of those swamp pink populations subject to development pressure in the future but will do little to ease the degradation of existing populations already experiencing stormwater impacts (L.Torok, pers. comm., 2007).

Regulation of Water Withdrawals: In 2002, the NJDEP began to focus on the potential impacts of water withdrawals on environmentally sensitive areas. Since this time, impacts to wetlands and endangered and threatened species have been more routinely evaluated during water allocation reviews. The NJDEP is currently revising water allocation regulations to expressly state that permitted activities shall not adversely affect endangered or threatened species' habitat. Once adopted, these regulations will codify current NJDEP procedural practices (L.Torok, pers. comm., 2007), which will benefit swamp pink provided plants are included. Any effects of these proposed regulatory changes will be considered during the next 5-year review.

Surface Water Quality Standards: In May 2007, the NJDEP proposed changes to the State's Surface Water Quality Standards (N.J.A.C. 7:9B-1.4 and 1.15). Among other changes, the NJDEP proposes to classify as Category One anti-degradation status those waters that support certain Federal- and State-listed aquatic wildlife species. In commenting on the proposed changes, the USFWS has recommended that the NJDEP consider adding swamp pink to the list of aquatic species for which Category One status will be conferred. Category One waters are protected from measurable changes in water quality. Among the protections afforded to Category One waters are 300-foot buffers on these waters and their immediate tributaries, which are required under the State's stormwater regulations.

The proposed changes would also classify as Category One those waters in subwatersheds below certain thresholds of impervious surface cover. The highest-quality swamp pink populations generally occur in relatively pristine watersheds with minimal impervious surface, and may therefore benefit from the proposed upgrades of certain waters to Category One. However, many swamp pink populations are located in watersheds that are already extensively developed, and are therefore excluded from the pending definition change and upgrades. Any effects of these proposed regulatory changes will be considered during the next 5-year review.

Land Use Planning: Although not necessarily regulatory in nature, land use planning in New Jersey has progressed considerably since the 1991 recovery plan. The State Development and Redevelopment Plan, last updated in 2001, encourages development in some areas and discourages it in others, in part by promoting consistent planning and zoning by county and municipal governments. State land use regulations are also evolving to reflect consistency with the State Plan (*i.e.*, different requirements for different Planning Areas.) The Metropolitan, Suburban, and Fringe Planning Areas, where development is generally encouraged, include 45 extant swamp pink occurrences. The Rural, Environmentally Sensitive, and Park Planning Areas, where development is generally discouraged, include 70 occurrences. The Pinelands Planning Area, which is governed by the Pinelands Comprehensive Management Plan, includes 25 occurrences.

New Jersey also supports planning for 20 Watershed Management Areas (WMAs). Planning progress varies considerably among the different WMAs, and the extent to which swamp pink has been considered is unknown.

In addition, New Jersey has developed a State-wide Wildlife Action Plan, which is largely based on extensive mapping of habitats for Federal- and State-listed wildlife. The NJDEP is also working on new regulations that would provide protections for habitats supporting listed wildlife regardless of where they occur (*i.e.*, closing gaps in the patchwork of State land use laws described above). However, none of these efforts includes Federal- or State-listed plants thus far. Recently, individuals and groups have formed an umbrella organization called Partnerships for New Jersey Plant Conservation that is working for conservation of native plants. In 2007, the Pinelands Preservation Alliance and over 35 additional stakeholders, including prominent conservation groups, wrote to the NJDEP seeking greater protection for plants and ecological communities. The letter called for more surveys, research (both basic and applied in areas such as climate change, wildfire, deer, invasive species, and off-road vehicles), regulatory protections, management on public lands, and funding for the New Jersey Natural Heritage Program. The NJDEP responded with a letter affirming the State's commitment to biodiversity conservation and vowing to give the group's recommendations strong consideration.

New Jersey's land use planning is supported by an ambitious open space preservation effort. From 1961 through 1995, New Jersey voters approved nine bond issues, earmarking over $1.4 billion for land acquisition and park development (Green Acres Program, 2007). In 1999, the Garden State Preservation Trust Act (P.L. 1999 c. 152) committed nearly $2 billion for land preservation and park development over 10 years – the second largest land preservation program in the country. From 1999 to 2006, New Jersey's Green Acres preservation totaled 192,729 acres of State and local parks, wildlife areas, watershed lands, and forests (Garden State Preservation Trust, 2007).

Other States: Throughout the other six States in the range, wetlands supporting swamp pink continue to be regulated primarily by the Corps and the EPA under Section 404 of the CWA. Prior to issuing permits, the Corps consults with the USFWS pursuant to Section 7 of the ESA. Through State-wide or regional conditions, some Corps Districts (*e.g.*, Philadelphia, Wilmington) also ensure that applicants have consulted with the USFWS prior to conducting activities under a Nationwide Permit or State Program General Permit, sometimes specifically referencing swamp pink in the Special Public Notice. Since 2001, Federal jurisdiction to regulate wetlands has been the subject of litigation. Further analysis is needed to determine which, if any, swamp pink occurrences have likely lost Federal jurisdiction in light of these recent court decisions, but a preliminary assessment is presented below.

The Supreme Court's 2001 decision in the case of *Solid Waste Agency of Northern Cook County v. U.S. Army Corps of Engineers* (commonly referred to as to "SWANCC") overturned the Corps' assertion of Federal jurisdiction over isolated wetlands when based only on the presence of migratory birds. The SWANCC decision likely had little effect on the Corps' regulation of swamp pink habitats in the headwaters of streams, but may have removed Federal jurisdiction from certain isolated mountain bogs supporting this species (Buhlmann *et al.*, 1999, cited in Tiner *et al.*, 2002).

The Supreme Court's 2006 decision in the consolidated cases *Rapanos v. United States* and *Carabell v. United States* (commonly called "Rapanos") addressed where the Federal government can apply the CWA, specifically by determining whether a wetland or tributary is a "water of the United States." In June 2007, the Corps and the EPA issued a memorandum implementing the Rapanos decision. The effect of the Rapanos decision and implementing memorandum is to generally preserve Federal jurisdiction (and therefore the applicability of Section 7 of the ESA) over those wetlands supporting swamp pink that are immediately adjacent to permanent streams. Federal jurisdiction over those swamp pink populations in wetlands further removed from permanent streams, or along intermittent streams, will be determined case-by-case, based on the Corps' determination of whether the flow characteristics and functions (including hydrologic and ecologic factors) of a stream and adjacent wetlands significantly affect the integrity of downstream traditional navigable waters.

Delaware: Delaware's endangered species law (Delaware Code Annotated Title 7 §§601 to 605) does not include any legal protections for plants or their habitats (George, 1998; W. McAvoy, pers. comm., 2007). There have been no new formal consultations or significant informal consultations on swamp pink in Delaware in the last 5 years. A development called Spring Breeze is underway adjacent to a known swamp pink population. The USFWS discussed issues such as hydrology and buffers with the consultant, but these discussions ended upon the Corps' determination that no jurisdictional wetlands would be affected. The potential remains for degradation of this swamp pink site (A. Moser, pers. comm., 2007).

Maryland: Swamp pink is State-listed as endangered under the Maryland Nongame and Endangered Species Conservation Act (Annotated Code of Maryland 10-2A-01 to -09) and implementing regulations (Code of Maryland Regulations 08.03.08). The law prohibits take of listed animals only (George, 1998). There have been no new formal consultations or significant informal consultations on swamp pink in Maryland in the last 5 years (A. Moser, pers. comm., 2007).

Virginia: Swamp pink is State-listed as endangered under the Virginia Endangered Plant and Insect Species Act (Chapter 39 §3.1-1020 through 1030, as amended). The law prohibits take of listed plants from public lands and carries criminal penalties as a misdemeanor (George, 1998).

Section 7 of the ESA is effective in protecting swamp pink from Corps-permitted wetland impacts in Virginia when the plants occur directly in the wetlands being regulated, but it is less effective if the plants are located outside the immediate project area under Corps jurisdiction (*i.e.*, would not be impacted "but for" the Corps-permitted activity.) Even when wetlands supporting swamp pink are afforded protection through Section 7 consultation, upland buffers are usually limited to the widths agreed to by the applicant (K. Smith, pers. comm., 2007).

Virginia has no land-use regulations that apply to endangered or threatened species, and neither State nor local regulation of stormwater or groundwater is sufficient to protect swamp pink (K. Smith, pers. comm., 2007). Although some protections would remain if the species were listed solely under Virginia State statute, the limited protections afforded to swamp pink from the destruction of plants or habitat associated with otherwise legal activities would be lost if delisted under the ESA.

North Carolina: Swamp pink is State-listed as threatened under the North Carolina Plant Protection and Conservation Act (§§ 106-202.12 to .20), which prohibits take without consent of the owner with penalties up to $2,000 (George, 1998). The law primarily regulates commercial trade in listed plants and is not intended to prohibit destruction of plants or habitat associated with otherwise legal activities including development (C. Wells, pers. comm., 2007).

Under Section 7 of the ESA, the USFWS makes protective and mitigative recommendations to the Corps on a case-by-case basis for those individual CWA permit applications that the Corps has determined "may affect" swamp pink. In 2007, the Corps' Asheville Field Office agreed to also provide the USFWS Asheville Field Office with notification of activities proposed under Nationwide permits in watersheds containing Federally listed species. This may assist the USFWS in minimizing indirect impacts from projects occurring elsewhere in the watersheds where swamp pink is present (C. Wells, pers. comm., 2007). Non-permitted wetland impacts are a primary threat to swamp pink occurrences in Transylvania County (E. Schwartzman, pers. comm., 2007). State or local regulation of stormwater or groundwater offers minimal protection for swamp pink, either through limitations on the State statutes or lack of adequate enforcement (C. Wells, pers. comm., 2007). Although some protections listed above for North Carolina would remain if the species were listed solely under State statute, the limited protections afforded to swamp pink from the destruction of plants or habitat associated with otherwise legal activities would be lost if delisted under the ESA.

South Carolina: Swamp pink is State-listed as threatened under the South Carolina Nongame and Endangered Species Conservation Act (S.C. Code Ann. §§ 50-15-10 to -90) (George, 1998). Current regulations prohibit collection of any plant from State-owned land without written permission. The only population of swamp pink in South Carolina is on South Carolina Department of Natural Resources Heritage Preserve land. Because it is on State preservation land, regulatory mechanisms such as Section 7 review for wetland fill are unnecessary because there will not be any development on the Preserve. The South Carolina swamp pink population would continue to be protected by State ownership and regulation regardless of its status under the ESA (L. Zimmerman, pers. comm., 2007).

Georgia: Swamp pink is listed as threatened under the Georgia Wildflower Preservation Act (Georgia Code Ann. § 12-6-170 -176), which prohibits unauthorized take of plants from public lands and carries criminal penalties as a misdemeanor (George, 1998). The one naturally occurring population of swamp pink in Georgia is located on private land, while two outplanted populations are on Federal land.

Progress toward meeting Condition 3 – Ensure *ex situ* maintenance of representative genotypes:

Significant strides have been made in the greenhouse propagation of swamp pink from fresh seed, and survival rates of outplanted propagules are generally high. However, long-term seed storage is limited by the rapid decrease of seed viability. Cryogenic seed preservation and clonal propagation techniques need to be investigated before this condition can be met. Accomplishments and challenges in meeting Condition 3 are discussed below.

In 2000, the USFWS signed a Memorandum of Understanding with the Center for Plant Conservation (CPC) to advance the conservation of North American plants. The CPC is a network of major botanical institutions. The CPC oversees the National Collection of Endangered Plants, which stores plant material in case a species becomes extinct or no longer reproduces in the wild.

The designated CPC member institution for swamp pink is the New York Botanical Garden, which has swamp pink under propagation that originated from a salvage effort in New Jersey. Seeds from these propagated plants were tested in 2006 and found to have good viability. Nonetheless, the New York Botanical Garden does not have any swamp pink seeds in long-term storage because viability decreases rapidly (plants normally germinate from fresh seed). The CPC would consider experimenting with cryogenically freezing seeds, but has not attempted this to date (S. Carter, pers. comm., 2007).

Swamp pink is also being cultivated at the Atlanta Botanical Garden, another CPC member. Seeds have been collected for about six years from Commissioners Rock Bog, the only naturally occurring swamp pink occurrence in Georgia, which is degraded and remains under imminent threat. About 600 individual propagules have been germinated from these seeds. Approximately half of these propagules were outplanted to two sites in Chattahoochee National Forest: Keener Creek Bog (consisting of two planting areas in Rabun County) in 2005 and 2007 and Cooper Creek Bog (consisting of two planting areas in Union County) in 2006. Monitoring in 2007 found that survival rates to date are high, except in one area of Cooper Creek that has experienced drought conditions (C. Denhof, pers. comm., 2007; M. Moffett, pers. comm., 2007). Survival rates were 47 and 75 percent after one year at Cooper Creek Bog, and 56 and 100 percent after one year at Keener Creek Bog. Plans are in place for additional outplantings at Cooper Creek Bog, Keener Creek Bog, and a third site called Hale Ridge Bog (Denhof, 2007).

The Atlanta Botanical Garden and the New England Wildflower Society have both developed propagation techniques for swamp pink. Propagation is relatively easy with good, fresh seed (Cullina, 2000; C. Denhof, pers. comm., 2007).

Rutgers University maintains an active interest in studying propagation of swamp pink. Although funding was not available to pursue a 2007 proposal to clonally propagate swamp pink using organogenesis by culture of leaf tissues, Rutgers remains interested in propagation research and, possibly, future experimental reintroduction (A. Novy, pers.

comm., 2007). Rutgers was also involved in the propagation of swamp pink for a salvage and reintroduction effort in Salem County (1988) and for studies of seedling establishment (1992) and flooding stress (2007) (Hartman and Wagner, 1993; Hartman and Dodds, 1995; J.M. Hartman, pers. comm., 2007; A. Novy, pers. comm., 2007).

While at Rutgers, Dodds (1996b) conducted a series of experimental outplantings to a southern New Jersey site that had been restored following a severe impact. On-site propagation from seed was wholly unsuccessful, regardless of planting location. Success of germination and seedling establishment in the greenhouse was influenced by substrate, moisture, and light levels; it was difficult to find the appropriate combination of these factors in the field. In contrast, success of outplanting from the greenhouse to the field was higher, with 66 percent of outplanted seedlings and 95 percent of outplanted mature plants alive one year later. Differences due to planting sites were apparent in survival, clonal reproduction, leaf number, and leaf length. Plants at the restored site were smaller than those planted at shaded sites and faced greater stress from increased light levels and competition with other herbaceous species.

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:

Utech (1978)[3] compared the vascular floral anatomy and carpel morphology of swamp pink to a close relative, the Asian *Heloniopsis orientalis*, and found that the vasculature of swamp pink represents a peculiar type found among the primitive Liliaceae. The difference in floral vasculature between swamp pink and *Heloniopsis* is insignificant when it is analyzed from an overall reproductive (sexual) point of view.

Tanaka (1997) investigated the taxonomic significance of some floral characters in swamp pink and *Ypsilandra* (Liliaceae) and found that: (1) Swamp pink has often been described to possess three separate styles, but they are often fused to form a very short column at the base; (2) the anthers of swamp pink have been reported to be bilocular, but they are in fact unilocular; (3) both genera possess the same character on the basal part of the filament; (*i.e.*, the basal part of the inner filament is joined to the basal part of the ovary, while the same part of the outer filament is free from the ovary, in anthesis); and (4) contrary to previous reports, swamp pink has nectaries (glandlike organs that secrete nectar).

A field study by Hartman and Wagner (1993) found that seedlings and adult plants were distributed differently among microsites. For example, adults were most often in leaf litter while seedlings were most likely to occur on moss and were completely absent in patches of leaf litter. In the greenhouse portion of the same study, seeds germinated with greater success in muck than in moss or leaf litter, probably due to somewhat wetter conditions at the surface of the muck. Under greenhouse conditions, germination rates

[3] Although this information was available at the time, it was not referenced in the recovery plan.

are high, but successful germination and establishment in the field is low (Hartman and Wagner 1993, cited in Liloia 1994).

In a greenhouse study, Liloia (1994) monitored swamp pink seedlings for changes in leaf number and color across three substrates (muck, moss, and leaf litter), three water levels, and two light levels. All of these factors proved significant. Shaded seedlings lost fewer leaves and retained a greener color than unshaded plants. Consistent with the greenhouse germination tests of Hartman and Wagner (1993), Liloia (1994) found that seedling leaf loss was lowest in muck, higher in leaf litter, and highest in moss. However, these findings are inconsistent with the field tests of Hartman and Wagner (1993) that found seedlings were most likely to occur on moss and were completely absent in patches of leaf litter. Liloia's (1994) medium water level treatment produced the most successful seedlings, followed by dry and then wet. Soil in the medium treatment remained moist at all times and was saturated only at the base of the pots, so soil remained aerobic. This author suggests that the effects of substrate on seedling establishment may be solely a result of the way in which different substrates affect water availability. Leaf loss within the muck treatment varied little across water levels, while leaf litter and moss substrates showed greater variability with different water levels. Likewise, leaf loss varied considerably across different substrates in the dry and wet treatments, but the medium water level was fairly constant across substrates. The most successful seedlings were produced in dry leaf litter, where plants actually gained leaves, possibly due to the ability of the leaf layer to reduce water loss. Considering all factors, Liloia (1994) found that swamp pink seedlings do well when shaded and planted in a muck substrate with a medium water level.

Dodds (1996b) found that swamp pink did not respond to experimental changes in water level and concluded that the conditions tested were within the species' range of short-term tolerance. This investigator found that many species respond slowly (over many years) to changes in water regime. In contrast, plants responded quickly to changes in light level. Plants at the highest light levels showed the greatest increase in size and number of rosettes and incidence of flowering; however, the range of light conditions tested was lower than those often measured in the field in areas of canopy disturbance. Changes in leaf color under high light conditions were observed due to both photoprotection and photodestruction, and are considered field indicators of disturbed habitat and poor plant health. Addition of nutrients increased the number of leaves per rosette, but not leaf length or clonal reproduction.

Novy *et al.* (2007) investigated physiological factors involved in swamp pink's adaptation to wetland habitats by exposing plants to three soil water regimes: control (moist), waterlogged, and submerged. After 12 days of stress due to flooding, plants exhibited visual leaf senescence and after 20 days plants showed stunted growth of roots and shoots. The results suggest that although swamp pink may survive in wet soils by increasing ethylene production and root aerenchyma (intercellular tissue with air spaces for buoyancy and gas circulation) formation, growth is reduced when plants are waterlogged or submerged for an extended period.

Maddox (1990)[4] states that local dispersion of swamp pink is strongly correlated with mean water availability (*i.e.*, plants tend to be found in saturated but not inundated sites), and that wetness is also correlated with community type. This author suggested that it may be possible to monitor changes in soil water, plant community, or key plant associates that presage potential damage to a swamp pink population.

Peterson (1992) found that swamp pink seeds possess an eliasome (ridge of soft tissue) that fosters dispersal by ants (myrmecochory). The eliasome is composed of lipids and is readily consumed by ants. Experimental study showed that swamp pink seeds may be dispersed by water and ants, a dispersal mechanism that had not been previously described for this species. In his three-year study, Peterson (1992) also found that detachment of rosettes from others in a connected clone did not reduce the incidence of flowering, nor did it increase mortality among the detached rosettes. Competitive effects among rosettes appeared to have little influence on growth or flowering. From his findings, Peterson (1992) suggested that populations along stream banks seem to be more vulnerable to plant loss by water scour than those in swampy areas.

The New Jersey Pinelands Commission is collecting hydrologic and ecological information needed to determine how current and future water-supply needs will affect the Kirkwood-Cohansey aquifer system. The aquifer study is being implemented in cooperation with the NJDEP, Rutgers University, the USFWS, and the U.S. Geological Survey. The purpose of the study is to determine: (1) the probable hydrologic effects of groundwater diversions from the Kirkwood-Cohansey aquifer on stream flows and wetland water levels; and (2) the probable ecological effects of induced streamflow and groundwater-level changes on aquatic and wetland communities. Participation of USFWS in the study involved collecting data on the distribution and relative abundance of swamp pink at two Pinelands sites in 2004 and 2005 to determine the hydrologic regimes associated with swamp pink colonies, and to assess the distribution and abundance of swamp pink plants along hydrologic gradients. Data collected include water levels over time, information on tree canopy, distance of swamp pink plants to water, and detailed parameters of individual swamp pink plants. Study results will be used to develop regression models describing potential changes in swamp pink distribution in response to modifications of the hydrologic regime (Popolizio, 2004).

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

Abundance and Trends: As shown in Table 1, the number of known extant occurrences of swamp pink increased from 123 in 1991 (as described in the recovery plan) to 227 in 2007, due to intensive survey efforts. Although a volunteer monitoring program was established in New Jersey in 2004, available information to date is insufficient to look for any trends in plant numbers over time in New Jersey or range-wide. However, some occurrences of swamp pink are clearly declining and disappearing. Table 1 shows that the number of occurrences considered historic has increased from 79 to 97 since 1991, a loss of this species at 18 sites (8 in New Jersey, 8 in Delaware, and 2 in North Carolina).

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[4] Although available at the time, this information was not referenced in the recovery plan.

Although intensive survey efforts have resulted in a near doubling of the total number of known occurrences in New Jersey since 1991, the number of occurrences ranked A or B has decreased by 7. The NJDEP conducted extensive monitoring of swamp pink populations between 1998 and 2001 (Johnson, 1998a, 1998b, 1999, 2000, 2001), which is reflected in the occurrence ranks recorded in the New Jersey Natural Heritage database. Comparing ranks from snapshots of the New Jersey database taken in 1997 and 2004, only 6 occurrences of swamp pink were upgraded while 20 were downgraded, including 8 that are presumed extirpated. Of the 27 occurrences of swamp pink discovered in Delaware between 1983 and 1999, 16 showed substantial declines in plant numbers during the most recent site visits, including 8 populations that are presumed extirpated (W. McAvoy, pers. comm., 2007). Declines in swamp pink populations may only be evident over long periods of time (Dodds, 1996a); L. Torok (pers. comm., 2007) notes that even highly disturbed swamp pink populations can continue to persist for years before eventually going extinct.

L. Torok (pers. comm., 2007) and J.R. Arsenault (pers. comm., 2007) suspect there are as yet undiscovered occurrences of swamp pink in New Jersey's less-developed southern counties, including Salem, Cumberland, and Cape May. L. Torok (pers. comm., 2007) foresees less potential for new populations in the more urbanized areas of Monmouth, Ocean, Atlantic, Gloucester, and Camden counties. Moreover, the number of new locations discovered during the State wetland regulatory process has declined sharply over the last 5 to 7 years, suggesting that most populations outside of the Pinelands have already been found (L. Torok, pers. comm., 2007). K. Smith (pers. comm., 2007) does not believe there are many undiscovered occurrences in Virginia. Both E. Schwartzman (pers. comm., 2007) and C. Wells (pers. comm., 2007) suspect that there are undiscovered subpopulations in the vicinity of known sites in North Carolina, particularly near Cedar Mountain, which is facing high development pressure. C. Wells (pers. comm., 2007) finds it less probable that distinct new populations exist in North Carolina. L. Zimmerman (pers. comm., 2007) notes that surveys for swamp pink have been conducted through much of the southern Blue Ridge and infers that appropriate habitat for additional populations is not present.

Demographic Features: Studying three swamp pink populations in Maryland, Maddox (1990) found that probability of flowering was not correlated with plant size or any apparent features of micro-habitat. Seedlings were rare and apparently suffer extremely high mortality (over 95 percent of experimental seedlings in the greenhouse and field died within 30 days). This author concluded that adult survivorship is critical to the maintenance of existing populations.

Observing six swamp pink populations in New Jersey over 3 years, Peterson (1992) found that the percent of rosettes that flowered ranged from 0 to 27.5. The proportion of plants flowering was not reduced by simulated above or below ground herbivory. In contrast to the findings of Maddox (1990), flowering occurred in rosettes larger than the mean rosette sizes for a population. Individual rosettes seldom flowered in successive years. Flowering plants produced an average of nearly 1,500 seeds in 25 to 60 flowers. The number of flowers produced per inflorescence increased with total leaf area, and seed production increased with rosette size. Seeds generally have both high viability (above 90 percent) and high germination under ideal conditions. However, the number of seedlings observed in the field was very small. Seed germination and survival of young seedlings appear to be the prime factors limiting population growth, as adult survival is often greater than 90 percent annually. For all populations pooled, the species appeared to have low mortality of established individuals relative to other rare or endangered species. Mortality was concentrated in the smaller size classes; in fact, no rosette larger than 400 centimeters died or was lost during the study. Size class distributions showed a rapid decrease in plant numbers from the smallest to the largest size classes. Half-lives (the time required for the number of rosettes to decline by half assuming no recruitment) ranged from 8 years to 60 years.

Dodds (1996b) concluded that a low percentage of flowering, limited seed dispersal, and poor establishment combine to make reproduction from seed a weak link in the life history of swamp pink. Considering demographic and genetic findings, this author suggests that sexual reproduction has not played an important role in the survival of swamp pink, with population growth and the species' persistence primarily dependent on the vegetative reproduction of mature plants. Dodds's (1996b) conclusions are consistent with those of Maddox (1990).

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

Utech *et al.* (1980)[5] conducted a somatic karyotype analysis of swamp pink, and a comparison to *Heloniopsis orientalis*. This author found that the somatic karyotype of swamp pink has 34 chromosomes that range in size from 2.0 to 5.0 μ. A decreasing size gradient within the complement was found to be gradual, with the longer pairs being subtelocentric and the shorter pairs tending to be submetacentric to metacentric. Subtelocentric chromosomes dominate the karyotype; pairs 1 to 9 are subtelocentric with pairs 1, 2, and 7 further distinguished by a secondary constriction on their long arms. Most of the remaining pairs are submetacentric. The smallest pair (17) is the only pair within the complement that is metacentric. Utech *et al.* (1980) found similarities between swamp pink and *Heloniopsis orientalis* (*e.g.*, base number x=17 for both, similarities in karyotype size and morphology), and concluded these species are a vicariad pair (*i.e.*, geographical counterparts).

In addition to the general north-south trend in genetic diversity discussed in Section 2.2.3, Godt *et al.* (1995) found low overall genetic diversity of swamp pink both within the species and within populations. This study included 15 populations in five States (New Jersey, Virginia, North Carolina, South Carolina, and Georgia). For every genetic parameter calculated, variation was lower than that typically found for narrowly distributed plant species. Of the 33 allozyme loci examined, 33 percent (n = 11) were polymorphic, while on average only 12.8 percent (n = 4) of the loci were polymorphic within populations. The number of alleles per polymorphic locus was 2.36 for the

[5] Although this information was available at the time, it was not referenced in the recovery plan.

species and averaged 2.09 within populations. The number of genotypes detected per population ranged from three to 21, with a mean of 13. The authors found a relatively high proportion of total genetic diversity (30.6 percent) among populations and a significant correlation between genetic distance and geographic distance. Genetic drift phenomena appear to play a major role in the population genetics of this species. Anomalously, several populations that appeared most limited in size and vigor were most variable genetically, perhaps because they represent older, relict populations.

Bersch (1996) estimated the genetic diversity of three swamp pink populations at five sites in southern New Jersey using allozyme electrophoresis and likewise found low genetic diversity. Citing Huenneke (1991), Dodds (1996b) noted that species restricted to patches of specific habitat have likely survived in isolated populations for a long time, and may be relatively tolerant of inbreeding and of increasing distance between populations. Osaloo *et al.* (1999) used swamp pink as an outgroup in their study of comparative DNA sequencing of the chloroplast gene mafK for 41 *Trillium* taxa.

A. Novy (pers. comm., 2007) is planning to use leaf material to conduct a detailed genetic analysis of swamp pink using Amplified Fragment Length Polymorphism, a DNA fingerprinting technique. The study will test hypotheses regarding overall genetic variability of swamp pink within and among populations and the relationship between genetic diversity and a population's latitude, size, and vigor. The results are expected to reveal new insights about population structure and bottleneck and founder effects, thereby contributing to propagation and conservation efforts.

2.3.1.4 Taxonomic classification or changes in nomenclature:

There have been no changes in the taxonomic classification or nomenclature of swamp pink. However, Utech (1978, 1980) concluded that floral and somatic karyotype similarities between swamp pink and *Heloniopsis orientalis* support the position that both species should be maintained in the same tribe. Utech (1980) goes further to state, "*One might even argue for congeneric status.*" Tanaka (1997) found that floral similarities confirm the close relationship between *Helonias* and *Ypsilandra*. This author concluded that regarding these as congeneric seems appropriate, but noted that comparison of many other characters is necessary to clarify fully the relationship among *Helonias*, *Ypsilandra*, and *Heloniopsis* (Tanaka, 1997). Combination of *Helonias* with any other genus could affect the recovery priority assigned to swamp pink (using the criteria in 48 FR 43099).

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

Since the 1991 recovery plan, swamp pink has been identified in one additional county, Ashe County, North Carolina, within its historic range. In addition, the species has been outplanted to Union County, Georgia, which is outside the known historic range. See Figure 1 (page 44) and Table 2 below for an updated map and list of counties with extant occurrences of swamp pink.

Table 2. Counties with extant occurrences of swamp pink

	County	Number of Extant Occurences
New Jersey	Atlantic	5
	Burlington	10
	Camden	28
	Cape May	13
	Cumberland	14
	Gloucester	13
	Middlesex	1
	Monmouth	10
	Morris	2
	Ocean	24
	Salem	20
Delaware	Kent	4
	New Castle	1
	Sussex	14
Maryland	Anne Arundel	4
	Cecil	2
	Dorchester	1
Virginia	Augusta	21
	Caroline	16
	Henrico	5
	Nelson	1
North Carolina	Ashe	1
	Henderson	2
	Jackson	1
	Transylvania	12
South Carolina	Greenville	1
Georgia*	Rabun	2
	Union	1
Total		**229**

*1 each in Rabun and Union Counties due to outplanting.

2.3.1.6 Habitat or ecosystem conditions:

Habitat Loss: Wetlands within the range of swamp pink continue to be lost, but at a slowing rate. Dahl (1990) reports that the seven states in the range lost over 11 million acres of wetlands from the 1780s to the 1980s, an average decline of 37 percent per State. According to Dahl (2006) the average net loss of wetlands nationwide slowed dramatically from the 1950s through the 1990s, and restoration efforts between 1998 and 2004 resulted in an average nationwide net increase of 32,000 wetland acres/year; however, these gains are not likely being realized for forested wetlands, given the very low success rates of restoring or creating these sensitive habitats (National Research Council, 2001; Balzano *et al.*, 2002; Minkin and Ladd, 2003).

As a prime example of these trends, from 1972 to 2001 New Jersey lost about 190,000 acres of wetlands, a decline of about 20 percent. Wetland loss averaged about 11,000 acres/year between 1972 and 1984 (Lathrop, 2004a). More recently, the rate of wetland conversion to developed areas has slowed dramatically, from about 2,000 acres/year between 1986 and 1995 to about 1,000 acres/year from 1995 to 2000. Rates of wetland conversion to agriculture have likewise dropped significantly (Lathrop, 2004b). The NJDEP (2002) estimates a total (not annual) permitted net loss (*i.e.*, acres of permitted impacts minus acres of compensatory mitigation) of 718 acres of freshwater wetlands from 1989 to 1999, suggesting that additional losses over this time period, as reported by Lathrop (2004a), were of coastal wetlands and/or from unpermitted activities.

In those New Jersey subwatersheds supporting swamp pink, the acreage of forested wetlands actually increased by about 9 percent from 1986 to 2002 (Table 3), primarily as a result of succession of herbaceous, agricultural, and managed (*e.g.*, rights of way) wetlands and artificial lakes, as well as some deliberate restoration efforts (*e.g.*, conversion of old fields) (NJDEP, 2007a). Due to the narrow hydrologic, soil, and other requirements of swamp pink (Maddox, 1990; USFWS, 1991; Dodds, 1996b), it is unlikely that such young forested wetlands provide suitable habitat yet and unclear how much of this succeeding acreage is located in landscape positions (*e.g.*, along headwaters) conducive to swamp pink.

Table 3. Acreage of forested wetlands in New Jersey subwatersheds with extant occurrences of swamp pink (NJDEP, 2007a)

forested wetland acres 1986	70,899
forested wetland acres 1995	70,180
forested wetland acres 2002	77,344
% change 1986-1995	*-1.0*
% change 1995-2002	*10.2*
% change 1986-2002	*9.1*

Habitat Degradation: Despite a slowing of direct habitat losses, evidence of habitat degradation from the effects of surrounding development continues to mount, as does documentation of the sensitivity of swamp pink to these indirect and sometimes subtle impacts to its habitat. The extent and severity of swamp pink habitat degradation caused by changing land uses in surrounding watersheds is likely worsening as development trends have continued and in some areas accelerated. J.R. Arsenault, J.M. Hartman, M. Moffett, A. Moser, A. Novy, E. Schwartzman, K. Smith, L. Torok, and C. Wells (pers. comm., 2007) all report continued development pressure in the vicinity of swamp pink populations and/or continued habitat degradation from existing developments in New Jersey, Delaware, Virginia, North Carolina, and Georgia. Lathrop (2004a) found that New Jersey added almost 600,000 acres of developed land from 1972 to 2001, a 67 percent increase. Table 4 compares all subwatersheds in New Jersey with those that support swamp pink; swamp pink watersheds went from slightly less developed (about 20 percent) than the State as a whole in 1986 to slightly more developed (about 27 percent) in 2002.

Table 4. Comparison of all subwatersheds in New Jersey with those that currently support swamp pink (NJDEP, 2007a)

	New Jersey	Swamp Pink
number	933	89
% of total		*9.5*
cumulative square miles	9,023.7	781.3
% of total		*8.7*
Minimum square miles	2.4	4.8
Maximum square miles	145.5	21.1
Average square miles	9.7	8.8
% developed area 1986	22.0	20.2
difference from NJ		*-1.8*
% developed area 1995	24.3	23.7
difference from NJ		*-0.7*
% developed area 2002	26.3	26.5
difference from NJ		*0.3*
change 1986 to 2002	4.2	6.3

Wright *et al.* (2006) reviewed more than 100 scientific studies on the direct and indirect impacts of urbanization on wetlands. Although the national rate of wetland loss has dropped sharply in recent years, these authors found the goal of no net loss in wetland quality is not being achieved. Development in both urban and rural areas now is the source of more than 60 percent of national wetland loss. Several national assessments have noted gaps in current Federal and State regulatory programs that allow direct and indirect impacts to continue, reducing wetland function and quality (Wright *et al.*, 2006).

Although their studies were not specific to swamp pink wetlands, Ehrenfeld and Schneider (1990, 1991, 1993) sampled environmental parameters to assess the impact of nearby development on Atlantic white cedar swamps in New Jersey, including some that support swamp pink. They found that site hydrology was affected by the proximity of dams, ditches, and direct road runoff, but that nearby roads and housing had little effect alone. These authors also found changes in pH and elevated levels of ammonia, phosphate, chloride, lead, and exotic and upland species in wetlands near development. Native herbaceous species and *Sphagnum* ground cover decreased near development. Woody plant composition and structure showed little change over the gradient of adjacent development and were more strongly correlated with changes in water quality than hydrology. As cited in Obee (1995), the negative effects of urbanization on species composition were thought to be due to increased variability in environmental quality and the number of altered factors rather than degradation of any key environmental factor. Ehrenfeld (2005) found that red maple swamps (another important habitat type for swamp pink) are more resilient to the effects of surrounding urban development, showing an ability to maintain community composition and structure similar to those in undeveloped landscapes. However, this study did not focus on rare or sensitive species that may be more prone to declines from subtle changes in hydrology or other effects of adjacent development. Wright *et al.* (2006) list several key habitat types for swamp pink (bogs, headwater riparian wetlands, Atlantic white cedar wetlands) as particularly sensitive to development in the watershed.

Forested wetlands in close proximity to developed areas are often degraded by poor water quality, invasive or exotic species (Ehrenfeld, 2004; Wright *et al.*, 2006), trash, all terrain vehicles, overabundant deer populations, general disturbances both along and off trails (Ehrenfeld, 2004), and canopy disturbance (Peterson, 1992; Windisch, 1993; Obee, 1995; Dodds, 1996b). Increased human presence in urban wetlands can also lead to increased trampling and collection of sensitive species. All of these impacts are known and ongoing threats to swamp pink (USFWS, 1991; C. Wells, pers. comm., 2007; J.R. Arsenault, pers. comm., 2007). However, the most pervasive element of habitat degradation from surrounding development comes from changes to the hydrologic regime, including sedimentation. More than 50 studies reviewed by Wright *et al.* (2006) document indirect impacts to wetlands caused by land alteration in the supporting watershed. Upland development decreases groundwater and increases stormwater runoff to wetlands, and downstream crossings create flow constrictions. Together these changes lead to increased ponding, greater water level fluctuation, and/or hydrologic drought in urban wetlands (Wright *et al.*, 2006). Hydrologic change is emerging as the primary threat to swamp pink (Peterson, 1992; Obee, 1995; Dodds, 1996a; L. Torok, pers. comm., 2007; J.R. Arsenault, pers. comm., 2007; J.M. Hartman, pers. comm., 2007; A. Novy, pers. comm., 2007; C. Wells, pers. comm., 2007; M. Moffett, pers. comm., 2007).

While hydrologic changes can result from water withdrawals or from direct ditching, draining, damming, or channelizing of wetlands or waters, the most widespread hydrologic effects are from the introduction of impervious surfaces in the watershed. Even with the detention and treatment of stormwater before release, impervious surfaces alter the fundamental hydrologic characteristics of a drainage area. Even areas of maintained lawn can show reduced perviousness as a result of soil compaction (Ocean County Soil Conservation District, 2001; Wright *et al.*, 2006; L. Torok, pers. comm., 2007) or the use of fill materials. The relationship among impervious surface cover, non-point source runoff, and the concomitant adverse impacts on water quality, aquatic communities, habitat, and water quantity has been well documented in the literature (Kaplan and Ayers, 2000; NJDEP, 2007b), much of which was published after the 1991 recovery plan. The findings of some key publications on impervious surface are summarized below and compared to conditions in those New Jersey subwatersheds that support swamp pink.

Impervious Surface: Although impervious surfaces themselves do not generate pollution, they do induce hydrologic change in a watershed that promotes many of the physical and biological changes affecting urban streams. In natural settings, very little annual rainfall is converted to runoff and about half is infiltrated into the underlying soils and water table. This infiltrated water supplies aquifers and supports adjacent surface waters during dry periods (base flow). In urbanized areas, less annual rainfall is infiltrated and more volume is converted to runoff on a more frequent basis. The shift away from infiltration reduces groundwater recharge, threatening aquifer supplies and impacting groundwater base flow to streams, especially during periods of low rainfall (Schueler, 1994; Arnold and Gibbons, 1996; Kaplan and Ayers, 2000). Reductions in the volume of groundwater available to sustain dry weather flows (base flow) as a result of urbanization have been documented for small headwater streams in particular (Wright *et al.*, 2006).

Disruption of natural runoff processes by increases in impervious cover results from the loss of the water-retaining function of the soil in the urban landscape. As impervious cover increases, surface runoff increases in volume and velocity while infiltration and soil percolation decrease. Stream channels are often highly modified in urban areas (*e.g.*, enclosed with storm drains or lined with stone), further increasing the conveyance of runoff. Increases in runoff volume, coupled with increased water conveyance efficiency (*e.g.*, through pipes, gutters, and artificially straightened channels), results in more severe flooding. The annual volume of stormwater runoff can increase by 2 to 16 times its predevelopment level, with proportional reductions in groundwater recharge (Schueler, 1994; Arnold and Gibbons, 1996; Kaplan and Ayers, 2000; Wright *et al.*, 2006).

Development in the watersheds of headwater streams has been strongly linked to active channel enlargement by widening of the stream banks or lowering of the streambed. Urban stream channels may incise over time (Wright *et al.*, 2006). Cross-sectional areas of urban streams increase from increased flow; streams can widen by a factor of 2 to 5 (Kaplan and Ayers, 2002). As the channel deepens, the local water table drops, often to a point where it is below the rooting depth of riparian plants. A second consequence of stream incision is that riparian wetlands become disconnected from the stream. Riparian wetlands that depend on occasional flooding and baseflow to sustain their hydroperiod can face a condition termed hydrologic drought as urbanization increases in the watershed. Hydrologic drought occurs when a riparian wetland does not receive adequate water to sustain its hydric soils and vegetation (Wright *et al.*, 2006).

Increases in runoff result in erosion not only from construction sites, but also from incising streambanks (Kaplan and Ayers, 2002). Headwater floodplains may have particularly high sedimentation rates, and plant species that are intolerant of sediment deposition can show significant decreases in germination with as little as 0.2 inch of sediment accumulation (Wright *et al.*, 2006). Other changes associated with increasing impervious surface include increases in the number of road crossings (bridges and culverts) and stormwater outfalls, increases in summer stream temperatures, and worsening water quality from transmission of stormwater pollutants including nutrients, heavy metals, and toxic organic pollutants such as pesticides (Schueler, 1994; Arnold and Gibbons, 1996; Kaplan and Ayers, 2000). Pollutant concentrations in urban stormwater are typically one to two orders of magnitude greater than predevelopment conditions (Wright *et al.*, 2006).

Numerous studies show that about 10 percent impervious surface in a watershed tends to be a threshold above which aquatic resources start to degrade (Booth and Jackson, 1997 Schueler, 1994; Arnold and Gibbons, 1996; Kaplan and Ayers, 2000; NJDEP, 2007b), although there is disagreement whether thresholds can be applied uniformly to all watersheds (Wright *et al.*, 2006). A second threshold appears to exist at around 25 to 30 percent impervious cover, above which most indicators of stream quality tend to shift to poor conditions (Kaplan and Ayers, 2000). The NJDEP (2007b) finds that small subwatersheds (less than 5 square miles) that support headwater streams, an important habitat for swamp pink, are even more sensitive, showing adverse impacts to aquatic resources above 2 percent impervious surface. Recent research has also shown that the amount of impervious cover in a subwatershed can be used to project the current and future quality of many headwater streams (Kaplan and Ayers, 2000). Studies suggest that a 10 percent impervious surface threshold may apply to wetland communities as well as streams. Annual wetland fluctuations have been reported consistently when upstream watersheds exceed 10 to 15 percent imperviousness (Kaplan and Ayers, 2000).

As shown in Table 4, those New Jersey subwatersheds supporting swamp pink tend to be smaller than average. The smallest of these subwatersheds (under about 5 square miles) may begin to experience declines with as little as 2 percent impervious surface, while the larger swamp pink subwatersheds can be expected to show degradation by around 10 percent. Those New Jersey subwatersheds that support swamp pink collectively had about 7.3 percent impervious surface in 1995 and about 8.1 percent impervious surface in 2002, an increase of over 4,000 acres (NJDEP, 2007a). Clearly, some swamp pink watersheds already have exceeded important thresholds for maintaining the health of the species' habitat, and as a group these swamp pink watersheds are approaching a tipping point. Figures 2 and 3 (pages 45 and 46) present impervious surface maps for New Jersey and the entire range of swamp pink.

Taken together, Figures 1, 2, and 3 show that New Jersey's Ocean, Gloucester, and Camden Counties contain the highest densities of swamp pink and among the highest levels of impervious surface in the range. In Gloucester and Camden Counties, most swamp pink occurrences lie outside the Pinelands Area and the Coastal Zone. Although most of Ocean County's swamp pink populations are in either the Pinelands Area or the Coastal Zone, this county contains seven of the state's 20 occurrences known to have declined or become extirpated.

<u>Sensitivity and Response of Swamp Pink</u>: Habitat specificity, rather than limited geographic range or small local population sizes, is the critical factor in defining swamp pink as a rare species. Its habitats on the Coastal Plain, forested headwater wetlands, were not always rare but have been severely reduced and degraded by continuous development (Dodds, 1996b). Historically, mountain bogs were always uncommon, but were disproportionately impacted by agricultural development (M. Moffett, pers. comm., 2007). Although habitat availability may be a limiting factor across much of the range, the New Jersey Pine Barrens support an abundance of high-quality forested wetlands, many of which are not occupied (K. Laidig, pers. comm., 2007), suggesting that subtle, unknown habitat requirements are not provided by these wetlands and/or low dispersal rates limit the colonization of these wetlands by swamp pink.

Where it occurs, swamp pink requires stable conditions. Adapted to habitats that combine a number of specialized conditions (*e.g.*, low light, limited nutrients, and saturated soils), swamp pink has few competitors and appears to compete poorly when change in one or more habitat parameters creates an opportunity for the establishment of other species (Dodds, 1996b).

Peterson (1992) compared "impacted" with "non-impacted" swamp pink populations (*i.e.*, local watersheds dominated by development versus natural cover) in New Jersey over 3 years and concluded that anthropogenic effects on the hydrological regime pose the most direct threat. Mean plant sizes in the impacted sites were smaller, and mortality was generally higher. The number of new seedlings was highest in the non-impacted sites. Seedling and mortality data combined suggested that the populations at the non-impacted sites were maintaining themselves, while those in impacted sites were likely to experience steady declines. In fact, with no recruitment of mature rosettes, Peterson (1992) expected the impacted populations to decline by half (half life) within 8 to 17 years. Impacted populations had the shortest half lives, while those of the undisturbed populations were often several-fold greater.

Obee (1995) resumed monitoring 2 years later at the same six populations studied by Peterson (1992). Impacted populations were found to have significantly fewer rosettes, smaller population sizes, less flowering, fewer leaves, shorter leaves, narrower leaves, shorter scapes, and shorter racemes than non-impacted populations. Principal components analysis indicated some differentiation of flowering rosettes between impacted and non-impacted populations based on both plant size and reproductive characteristics. A lack of elevated nutrient levels in the water and observations of increased sedimentation and water flow at impacted populations suggested that changes in hydrology were the primary cause of the negative effects on these populations.

Windham and Breden (1996) used GIS to compare subwatersheds that support swamp pink with those that do not. Land use/land cover proportions were found to differ between subwatersheds with and without swamp pink. Specifically, the presence of swamp pink was negatively associated with the percent of urban land within a subwatershed, while the percent of forested land in a subwatershed was positively associated with both the presence and quality of swamp pink populations. A less clear but positive association was found between the presence of swamp pink and the percent of barren land. Despite the potential for barren lands to generate sediments and nutrients, these areas may retain groundwater recharge that helps maintain consistently saturated soils within swamp pink habitats. (In contrast, see the preceding discussion of impervious surface effects.) The density of wells was not correlated with the presence of swamp pink, probably because the study did not account for wide variations in the volume of water drawn from each well. This study also found swamp pink concentrated in the upper reaches of the larger watershed, a distribution pattern that continues to be borne out by current GIS mapping and that is consistent with the species' tendency to occur in headwater habitats.

Dodds (1996a) examined Natural Heritage Program records for 31 swamp pink occurrences in New Jersey in which the species' decline was documented or projected based on observed habitat degradation. The analysis of the site records showed that direct human impacts, sedimentation, pollution, and changes in hydrology all contribute to the decline of populations. At the majority of sites, detrimental changes were attributed to multiple impacts that fell into two or more of these categories, emphasizing the need to provide a buffer to act as a functional barrier to all of these disturbance types. Sedimentation and siltation due to offsite activities were cited as having eliminated swamp pink from sites where it was previously known to occur.

Canopy clearing or disturbance is a more direct, if less pervasive, form of habitat degradation. Windisch (1993) conducted a demographic study of three swamp pink populations in Atlantic white cedar swamps in southern New Jersey, each of which had a portion of the occupied habitat disturbed by a canopy-removing clear-cut or wildfire. The short term response to clear-cutting was an increase in flowering but a drastic decrease (to zero) in seedling germination and survival. Long-term effects of clear-cutting appeared to be decreases in the number of rosettes per genet, large rosettes, flowering genets, and seedling recruitments. Peterson (1992) also found an increase in flowering at an otherwise non-impacted site that experienced partial removal of the woody canopy; Obee (1995) found that this same population had some of the properties of impacted populations. Dodds (1996b) found no difference in swamp pink survival or growth between cleared and wooded sites, but found clear differences in plant color (pale green, yellow, red, or brown instead of dark green). In contrast to these studies from New Jersey, tree canopies at some southern swamp pink sites may be becoming too dense, possibly inhibiting flowering (M. Moffett, pers. comm., 2007; C. Wells, pers. comm., 2007). Likewise, at least one botanist familiar with this species believes tree canopies in New Jersey may have become too dense to allow flowering.

2.3.2 Five-factor analysis:

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

Although 91 swamp pink occurrences (approximately 40 percent of known extant occurrences) are located at least partly on protected land, the level of protection for these sites varies, and it is not known how many sites are protected to the level specified in the recovery plan. Threats to habitat quality, particularly threats posed by off-site activities, remain a primary factor in the species' current status, as discussed below.

New information summarized above bears out the recovery plan's identification of indirect habitat degradation caused by development in the supporting watersheds as the primary threat to swamp pink. Studies are now available showing the extent of land use change over recent decades and the degradation of wetlands caused by adjacent development through a variety of impacts: water quality degradation, trash, invasive or exotic species, all terrain vehicles, overabundant deer populations, general disturbances along and off trails, canopy disturbance, and hydrologic change including sedimentation. Hydrologic change can be direct (*e.g.*, ditching, damming, draining, channelizing) or indirect (*i.e.*, from the cumulative impacts of development in a watershed). As evidenced in a broad body of literature, the percent of impervious surface cover in a watershed has emerged as both a cause and an indicator of declining aquatic resource conditions. Those

New Jersey subwatersheds that support swamp pink appear to be collectively approaching a threshold of 10 percent impervious cover. The primary effects of impervious surface are to reduce infiltration (and therefore groundwater inputs) and to increase overland flow of stormwater (runoff), which in turn increase stream erosion, wetland sedimentation, flood volumes and velocities, water level fluctuations, and hydrologic drought. All of these effects are detrimental to the maintenance of habitat for swamp pink, which requires stable, narrow (saturated but not inundated), and largely ground-water supported hydrologic conditions. Several studies have documented the sensitivity and response of swamp pink to these kinds of indirect effects, and Federal and State agency personnel involved in swamp pink recovery across the range cite indirect habitat degradation (especially hydrologic change and sedimentation) as the primary threat to this species. Although numerous occurrences of swamp pink have been discovered due to intensive survey efforts, overall trends of local population declines and extirpations are beginning to emerge. These changes may only be evident over long periods of time.

Since the species was listed, upland buffers have been recognized as a key recovery tool to minimize indirect degradation of swamp pink habitat, with the weight of evidence suggesting that 300-foot buffers are the minimum necessary to prevent habitat degradation (Dodds, 1996a). L. Torok (per. comm., 2007) has been involved with the regulatory protection of swamp pink in New Jersey since 1989 and concludes, "Current buffer requirements [in New Jersey] are not sufficient to protect the species from long-term declines because: (a) They are not uniformly applied to all populations; (b) buffers in and of themselves do not protect against other factors that may adversely impact the species (*i.e.* water withdrawals, stormwater discharges); and (c) no species-specific study relating habitat quality to buffer size has been conducted. As a result, there is no qualitative data establishing a suitable buffer size. Based on limited field observations, it would appear a 300-foot buffer is sufficient to protect the species habitat from various types of secondary disturbance. If such a buffer could be applied to all habitats, it would greatly reduce impacts and encourage the long-term survival of the species. However, as noted above, currently regulatory protection does not allow for comprehensive application of maximum buffer widths and even large buffers may not mitigate for all habitat-degrading factors."

Further, based on nine years of experience with the species, L.P. Arroyo (pers. comm., 2007) concludes that even 300-foot buffers may not be not sufficient for the long-term survival of swamp pink, stating, "In certain situations, a 300-foot buffer is adequate, but for most populations I believe that a 300-foot [buffer] will minimize impacts, but not avoid impacts to wetlands containing swamp pink. As a result, swamp pink will decline, albeit at a slower rate than if a smaller buffer [were] implemented."

In New Jersey, swamp pink habitat in developing areas has more protection from indirect impacts than in the past, due to the 2004 stormwater regulations and buffers negotiated under the 1993 MOA. However, the level of threat to populations in already developed areas is at best stable and likely increasing as impacts accumulate (*e.g.*, as stream channels incise, floodplain hydrologic conditions change) (L. Torok, pers. comm., 2007).

Other States in the range appear to lack similar land-use regulations that might protect swamp pink habitat from indirect degradation (M. Moffett, pers. comm., 2007; K. Smith, pers. comm., 2007; C. Wells, pers. comm., 2007), as described in sections 2.2.3 above and 2.3.2.4 below.

Direct habitat losses have slowed, but historical losses were substantial and are generally irreversible, as efforts to create or restore highly impacted forested wetlands have shown limited success (National Research Council, 2001; Balzano *et al.*, 2002; Minkin and Ladd, 2003). The potential to recreate forested wetlands capable of supporting swamp pink may be particularly limited due to the specific habitat requirements of this species (Maddox, 1990; USFWS, 1991; Liloia, 1994; Dodds 1996b).

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

Evidence of collection or trade of swamp pink as a garden plant remains patchy and anecdotal. The true magnitude of the threat is unknown, as is the extent and provenance of swamp pink in cultivation or trade. As recently as 2000, Cullina (2000) noted that cultivation is "easy and rewarding," and that swamp pink makes "a lovely ground cover." The New England Wild Flower Society has been propagating and distributing swamp pink for many years, and the species is beginning to become more available in the trade (Cullina, 2000). However, Gargiullo (2007) cautions, "Plant [swamp pink] only in cooperation with recognized conservation organization advice and direction."

2.3.2.3 Disease or predation:

Herbivory pressure on swamp pink from white-tailed deer (*Odocoileus virginianus*) is likely increasing, in part as a result of the changing land use patterns described above (*i.e.*, herbivory can be considered another symptom of habitat degradation caused by surrounding development). The New Jersey Audubon Society (2005) reports that deer are more abundant in New Jersey than ever before. In many regions of the state, deer are driving rapid ecosystem alterations resulting in local extirpation of native plants and a subsequent takeover by invasive species. Deer densities range from 5 to 30 per square kilometer (km^2) and locally can be as high as 78 per km^2. Suburban encroachment can bring about a highly fragmented environment with reduced deer predation, abundant food sources, and limited hunting pressure, allowing exponential deer population growth. Deer selectively browse flowering plants of the forest understory. Even in southern New Jersey, where deer densities are the lowest in the State, Atlantic white cedar regeneration projects are greatly inhibited by deer (New Jersey Audubon Society, 2005).

J.R. Arsenault (pers. comm., 2007) reports deer as an important threat at some New Jersey swamp pink sites. Johnson (1998a, 1998b, 1999, 2000, 2001) noted herbivory at many sites throughout New Jersey. Little is known about the impacts of herbivory on swamp pink in other states; species experts outside New Jersey did not cite herbivory as a major threat in the course of this review.

No new information has become available about impacts to swamp pink from canopy changes caused by factors such as gypsy moth (*Lymantria dispar*) defoliation or oak decline. No diseases have been reported as affecting swamp pink.

2.3.2.4 Inadequacy of existing regulatory mechanisms:

As described under Section 2.2.3, regulatory mechanisms in New Jersey have improved but are still inadequate to protect swamp pink from its primary threat of gradual habitat degradation from development of surrounding uplands. Further protections for swamp pink that may be afforded by proposed regulatory changes in New Jersey will be considered during the next 5-year review. In other states, the primary protection for swamp pink, especially on private lands, is through consultation on Section 404 wetland permits under Section 7 of the ESA. This Federal regulatory mechanism offers limited protection to swamp pink (*e.g.*, does not guarantee buffers or protection of off-site plants), and its effectiveness may be decreasing due to new limits on Federal jurisdiction over wetlands from recent court decisions.

No State laws prohibit the collection or destruction of Federal- or State-listed plants on private lands with permission of the landowner, although some restrict possession, commercial trade, or collection of State-listed plants from public land. Although it offers no special protections for State-listed plants, New Jersey's FWPA regulates "destruction of plant life which would alter the existing pattern of vegetation" within freshwater wetlands.

Outside of New Jersey, State laws do not prohibit destruction of swamp pink or its habitat incidental to an otherwise lawful activity. In New Jersey, prohibition against such "incidental take" is afforded to State-listed plants in certain geographic areas (*e.g.*, Highlands, Pinelands, Coastal Zone). However, over 60 percent of New Jersey's swamp pink occurrences are outside these areas and are afforded incidental take protection under the FWPA solely due to the species' status as a Federally listed species (*i.e.*, through the interagency MOA discussed above in section 2.2.3).

2.3.2.5 Other natural or manmade factors affecting its continued existence:

Climate change was not considered in the recovery plan, and a more thorough investigation would be necessary to begin assessing the potential effects of climate change on swamp pink. However, a preliminary review of available literature, summarized below, suggests that potential effects could include changes in drought, temperature, carbon dioxide concentrations, precipitation, stream flow, water quality, human demand for water supplies, and sea level rise.

Some evidence exists that global or continental climatic change could be contributing to the alteration of mountain bogs, such as those that support swamp pink. Summer droughts are expected to increase over central North America during the next century. Increasing drought may have serious implications for the few remaining mountain wetlands, many of which have already undergone substantial hydrologic alterations (Murdock, 1994).

In a recent report, the Intergovernmental Panel on Climate Change (IPCC) found that the impacts of climate change on inland aquatic ecosystems will range from the direct effects of the rise in temperature and carbon dioxide concentration to indirect effects through alterations in hydrology resulting from changes in the regional or global precipitation regimes and the melting of glaciers and ice cover. Small increases in the variability of precipitation regimes will significantly affect wetland plants and animals at different stages of their life cycle. Changes in climate and land use will place additional pressures on already-stressed riparian ecosystems along many rivers in the world. An increase or decrease in freshwater flows will also affect coastal wetlands by altering salinity, sediment inputs, and nutrient loadings (Parry *et al.*, 2007).

In a 1997 assessment of climate change impacts in North America (Watson *et al.*, 1997), the IPCC found that important vulnerabilities of water resources to potential scenarios of climate change involve changes in runoff and stream flow regimes, reductions in water quality associated with changes in runoff, and human demands for water supplies. Specific findings of this assessment relevant to swamp pink include:

- Seasonal and annual runoff may change over large regions as a result of changes in precipitation or evapotranspiration.

- Seasonal patterns in the hydrology of mid- and high-latitude regions could be altered substantially, with runoff and stream flows generally increasing in winter and declining in summer.

- Altered precipitation and temperature regimes will affect the seasonal pattern and variability of water levels of wetlands, thereby affecting their functioning including flood protection, carbon storage, water cleansing, and waterfowl/wildlife habitat.

- Increases in the frequency or magnitude of extreme hydrological events could result in water quality deterioration and water management problems.

- Increases in competition for limited water under a warmer climate could lead to supply shortfalls and water-quality problems, particularly in regions experiencing declines in runoff.

Increasing rates of sea level rise caused by global warming are expected to lead to permanent inundation, episodic flooding, beach erosion, and saline intrusion in low-lying coastal areas of New Jersey (Cooper *et al.*, 2005). A preliminary mapping effort based on the work of Cooper *et al.* (2005) found that about 20 swamp pink occurrences in Atlantic, Cumberland, and Cape May counties in New Jersey lie at elevations with increased vulnerability to episodic coastal flooding over the next 50 to 100 years due to sea level rise. These 20 occurrences include all 13 known swamp pink sites in Cape May County. Eleven of these 20 low-lying South Jersey swamp pink occurrences are also located within or adjacent to the potential tidal marsh retreat zones as mapped by Lathrop and Love (2007), although at several sites the true potential for marsh retreat is currently limited by intervening development. Swamp pink occurrences in Cape May County appear particularly vulnerable to sea level rise, with seven sites located in or near the potential marsh retreat zone. The analysis conducted by Lathrop and Love (2007) used a high-end elevation threshold, which could substantially overestimate the projected Year 2100 sea level rise and was conducted for planning purposes rather than to accurately gauge future conditions. Nonetheless, taken together these two studies suggest that sea level rise may represent an additional threat to swamp pink populations located at low elevations and in close proximity to tidal systems through indirect influences such as increased coastal flooding and intrusion of estuarine or tidal conditions.

With respect to other threats, new evidence tends to support the problem of foot traffic as identified in the recovery plan. Repeated disturbance from frequent, long-term monitoring along transects at two southern New Jersey sites is one suspected cause of observed declines in plant numbers and vigor at these A- and B-ranked sites; however, a planned investigation has not yet begun to determine if trampling is in fact a cause of the declines (J.S. Dodds, pers. comm., 2007).

Finally, J.R. Arsenault (pers. comm., 2007) reports all terrain vehicle use as an important threat at some New Jersey sites.

2.3.2.6 Threats assessment:

Sections 2.3.2.1 through 2.3.2.5, above, present only new information regarding the five listing factors that has become available since publication of the recovery plan in 1991. To further integrate all relevant information into a comprehensive summary of our current understanding of the species' status, a threats assessment was conducted as part of this review, as noted in section 1.2. The resulting threats assessment matrix is provided in Appendix A and shows that the highest threats to swamp pink are: (1) the legacy effects of past wetland destruction; (2) habitat degradation, especially through changes to hydrology and sedimentation; and (3) climate change, especially through changes in drought and the atmosphere. Of these, habitat degradation shows some potential to be mitigated or reversed, while wetland destruction that has already occurred and climate change are deemed essentially irreversible within the scope of the swamp pink recovery effort.

2.4 Synthesis

Since the 1991 recovery plan, intensive survey efforts have revealed many new occurrences of swamp pink, with nearly twice the number of sites known as of 2007. However, some occurrences of swamp pink are clearly declining, and local extirpations have been documented at 18 sites in three states. New Jersey and Delaware alone have 20 additional occurrences with documented declines in population size or health. Declines in swamp pink populations may only be evident over long periods of time. Although monitoring is excellent at some sites (and a volunteer monitoring program was launched in New Jersey in 2004), to date monitoring has been generally insufficient to track range-wide population trends in a meaningful way.

Since 1991, State and Federal regulatory programs have changed, and substantial bodies of literature have been published regarding swamp pink biology, impervious surface effects, the sensitivity of swamp pink to habitat degradation, and climate change. However, the general nature of threats to swamp pink described in the recovery plan has not changed significantly in light of new information, so the 1991 recovery criteria (*i.e.*, recovery conditions) remain relevant. Progress toward the three conditions required for recovery is uneven. About 91 of approximately 227 known extant occurrences of swamp pink are at least partially on public or otherwise protected land, but available information is insufficient to assess if any of these 91 occurrences meet the recovery plan's definition of "protected." Regulatory protections for swamp pink vary across the range but are generally inadequate for long-term protection against habitat degradation from off-site development, particularly if the species were to be delisted. Although swamp pink is in cultivation at two recognized botanical institutions, long-term storage of plant material has not been undertaken.

Studies conducted since 1991 have confirmed that swamp pink requires narrow and stable habitat conditions, especially water and light levels, and that a low incidence of flowering, limited seed dispersal, and poor seedling establishment combine to make reproduction from seed a weak link in the life history of swamp pink. However, optimal habitat parameters, such as specific hydrologic, soil, and canopy conditions, are still not fully understood.

As ranked through a threats assessment, the highest threats to swamp pink are: (1) The legacy effects of past wetland destruction; (2) habitat degradation, especially through changes to hydrology and sedimentation; and (3) climate change, especially through changes in drought and the atmosphere. Of these, habitat degradation shows some potential to be mitigated or reversed, while wetland destruction and climate change are deemed essentially irreversible. Overall, habitat degradation continues to be considered the primary threat because: (1) Degradation can occur through many different aspects of habitat (*e.g.*, vegetation, hydrology, substrate), often in subtle and complex ways; and (2) degradation is occurring now while wetland destruction generally occurred in the past and significant effects of climate change have only recently begun. Habitat degradation from off-site development is an appropriate focus for recovery efforts, especially considering that these impacts to habitat quality have some potential to be prevented, mitigated or reversed.

In sum, the status of swamp pink hinges on the balance between the discovery of numerous additional extant occurrences across a relatively wide geographic range and the level of threat currently facing the species range-wide. The primary concern at the time of this review is the difficulty of addressing (either through land protection or regulatory mechanisms) off-site land uses that have the potential to cause pervasive long-term population declines and eventual extirpation. Within this context the potential effects of global climate change must also be considered. 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 within the foreseeable future).

3.0 RESULTS

3.1 **Recommended Classification:** Retain as threatened; no change is needed.

Rationale: Although more abundant than previously known, swamp pink remains threatened with habitat degradation stemming from off-site land uses. This primary threat is compounded by other stresses on swamp pink populations, including herbivory, trampling, and potentially global climate change. Regulatory protections, which (along with landowner education) may be key to ensuring the long-term viability of swamp pink populations, would be substantially reduced if ESA prohibitions were to be removed.

3.2 **Recommended Recovery Priority Number**: Retain as 7C; no change is needed.

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. Swamp pink continues to constitute a monotypic genus and to be in conflict with construction or other development projects.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

Revaluate Recovery Criteria in Light of New Information

- Conduct a population viability analysis (PVA) with cautious assumptions about collection, herbivory, and climate change.

- Use the results of the PVA to determine the importance and viability of C and D-ranked sites, and to determine if the recovery criteria need revision (particularly the number, type, and conditions for "protected" sites).

Monitor and Track Recovery

- Develop criteria to determine which populations are representative of the species' range, habitat, or genetic diversity, and identify those specific occurrences.

- Develop a rapid assessment protocol to map and rank occurrences with minimal effort, expense, and disturbance in a consistent way across the range. Use the protocol to rank and map 20 percent of sites each year (*e.g.*, a 5-year cycle), using volunteers where possible. Make sure the information is entered in Natural Heritage Program databases. Track element occurrence ranks and plant numbers over time.

Site-Specific Protection

- Work with public and private land trusts to acquire and manage important sites and buffers, prioritizing A and B-ranked sites and sites identified as representative of the species' range, habitat, or genetic diversity.

- Continue to seek landowner agreements to protect swamp pink on private lands where outright acquisition is a low priority or is not feasible.

- 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.

- Continue to protect swamp pink sites through various regulatory processes as necessary and appropriate.

Watershed-Level Protection

- Conduct a study to look for correlations between buffer width and changes in population size and vigor.

- Develop Best Management Practices to protect swamp pink habitat and encourage their adoption by Federal and State regulatory agencies, local governments, and public and private landowners.

- Incorporate swamp pink in watershed planning, especially where multiple sites are clustered in small watersheds. 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.

Propagation

- Pursue long-term seed storage at CPC member institutions.

- Investigate the need, feasibility, methods, and opportunities for reintroduction of plants. Support research on propagation and genetics. Investigate how swamp pink colonizes new habitat under natural conditions to determine where natural dispersal is precluded and could be augmented by reintroductions consistent with the USFWS propagation policy.

- Develop partnerships with horticultural groups to learn more about the amount and origin of swamp pink in cultivation and trade for ornamental gardens. Work cooperatively with these partners to develop a statement of principals for responsible cultivation and trade of swamp pink.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of SWAMP PINK (*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: Not applicable

Review Conducted By: Wendy Walsh, New Jersey Field Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve ______________________ Date 16 Nov 07
Field Supervisor, New Jersey Field Office, Fish and Wildlife Service

REGIONAL OFFICE APPROVAL:

Lead Regional Director, Fish and Wildlife Service

Approve ______________________ Date 10-28-08
Acting Regional Director, Region 5, Fish and Wildlife Service

Cooperating Regional Director, Fish and Wildlife Service

_X_ Concur ____ Do Not Concur

Signature ______________________ Date 1/8/08
Regional Director, Region 4, Fish and Wildlife Service

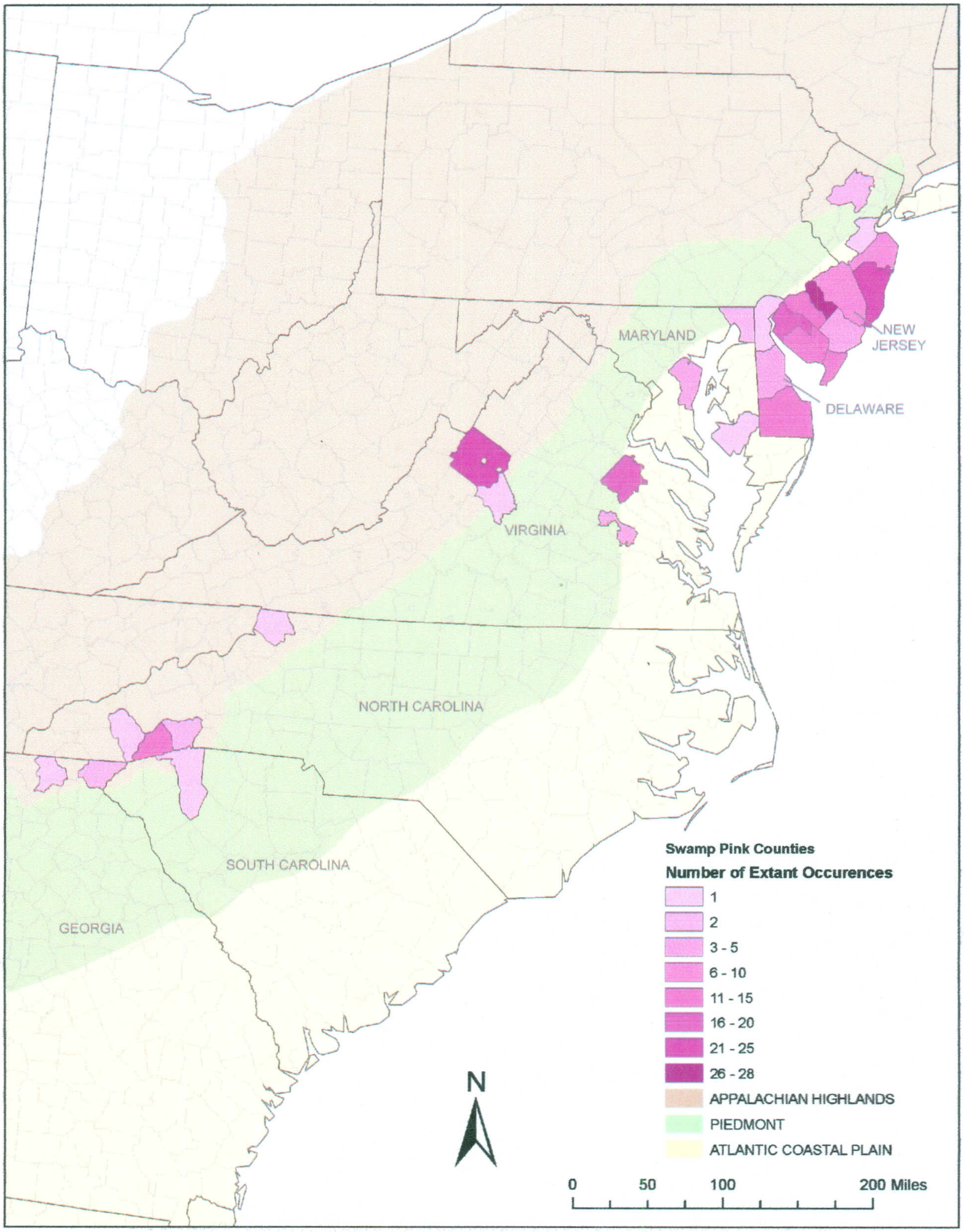

Figure 1. Counties with extant occurrences of swamp pink

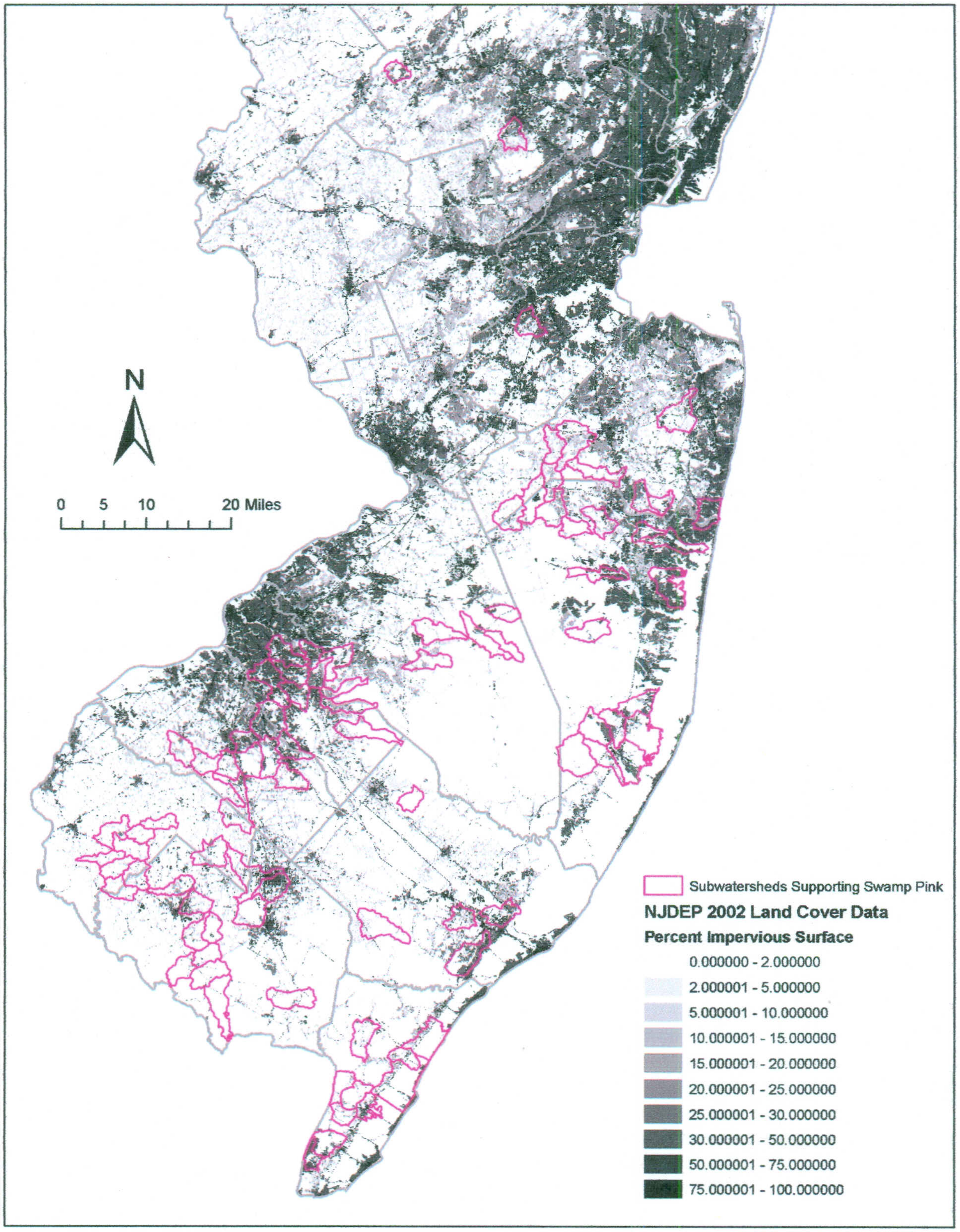

Figure 2. Impervious surface cover in New Jersey subwatersheds supporting swamp pink

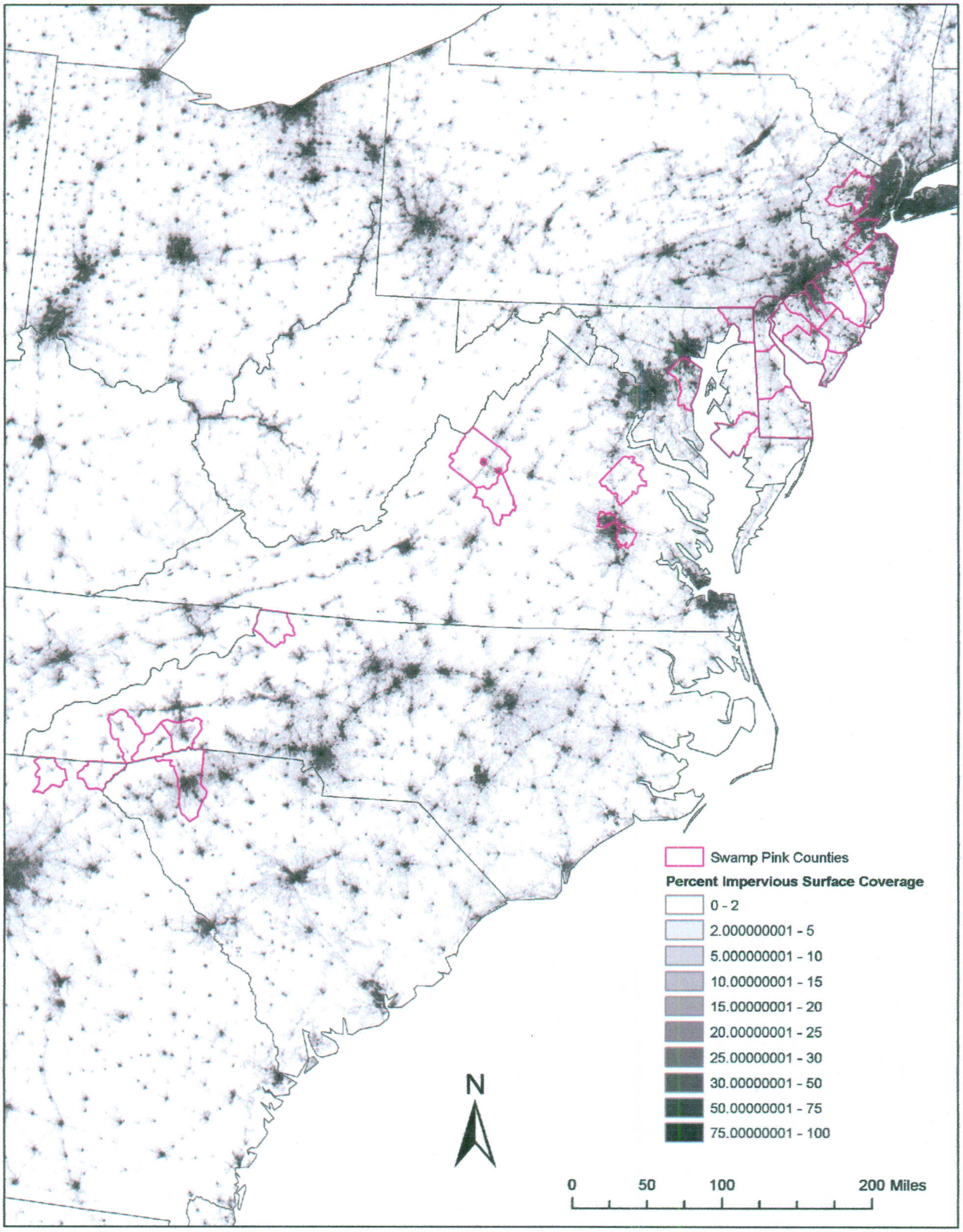

Figure 3. Impervious surface cover in counties supporting swamp pink, rangewide (Elvidge *et al.*, 2002)

Appendix A:
Threats Assessment

Habitat Loss					
Wetland destruction (3)	4	2	4	10	4
Habitat Degradation (4)					
Canopy disturbance	2	2	2	6	2
Sedimentation	4	3	2	9	3
Groundwater changes	3	4	3	10	4
Surface water changes (5)	4	3	2	9	3
Vegetative changes (6)	3	3	1	7	2
Plant removal	1	2	2	5	1
Plant crushing/trampling	1	3	1	5	1
Herbivory	3	4	1	8	1
Increasing drought	4	4	3	11	4
Changing atmosphere (7)	4	4	1	9	4
Increased coastal flooding	1	1	3	5	4
Estuarine/tidal intrusion	1	1	4	6	4
	1 = localized	1 = future	1 = reduced growth/reproduction	Sum of scope,	1 = highly reversible
	2 = scattered	2 = ongoing & slowing	2 = limited mortality (individuals)	immediacy, and	2 = somewhat reversible
	3 = regional/widespread	3 = ongoing & steady	3 = widespread mortality within population	response	3 = minimally reversible
	4 = ~rangewide	4 = ongoing & accelerating	4 = population decline/extirpation		4 = ~irreversible

(1) Average or typical response of populations across the range where the stressor occurs. Note that response times can be long, often many years.

(2) Potential to reverse or mitigate the effects of a stressor, even if reversal or species response may occur slowly.

(3) Disturbance to soils, hydrology, and/or vegetation such that forested wetland conditions no longer exist, usually from activity in the wetland.

(4) Reduction or elimination of the ability of forested wetlands to support swamp pink, usually from activity in surrounding uplands.

(5) *e.g.*, volumes, velocities, or timing of sheetflow or channel flow inputs

(6) *e.g.*, competition, physical habitat characteristics shaped primarily by vegetation

(7) *e.g.*, temperatures, carbon dioxide concentrations

Habitat Loss		
Wetland destruction (3)	Wetland fill/draining, clear cutting	
Habitat Degradation (4)		
Canopy disturbance	Significant tree cutting (not selective cutting undertaken for restoration purposes)	
Sedimentation	Ground disturbance, vegetation clearing, road/rail crossings, stormwater discharges, incised streams, trails/ATVs	Highly variable in severity
Groundwater changes	Soil compaction, impervious surface, incised streams, road/rail crossings, dams, water withdrawls, climate change	Variable in severity
Surface water changes (5)	Ground disturbance, vegetation clearing, soil compaction, impervous surface, channelization/ditching, road/rail crossings, stormwater discharges, incised streams, dams, water withdrawals, climate change, natural factors (*e.g.* , beavers, stream migration)	Highly variable in severity
Vegetative changes (6)	Invasive species, succession, deer, degraded water quality, fire, natural factors (*e.g.* , storms)	Variable in severity
Plant removal	Collection, monitoring/surveys/research	High degree of uncertaint
Plant crushing/trampling	Collection, Trails/ATVs, monitoring/surveys/research	High degree of uncertaint
Herbivory	Deer	Variable in severity
Increasing drought	Climate change	High degree of uncertaint
Changing atmosphere (7)	Climate change	High degree of uncertaint
Increased coastal flooding	Climate change through sea level rise	High degree of uncertaint
Estuarine/tidal intrusion	Climate change through sea level rise	High degree of uncertaint

(1) Average or typical response of populations across the range where the stressor occurs. Note that response times can be long, often many years.

(2) Potential to reverse or mitigate the effects of a stressor, even if reversal or species response may occur slowly.

(3) Disturbance to soils, hydrology, and/or vegetation such that forested wetland conditions no longer exist, usually from activity in the wetland.

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