Integrated Management Guidelines for Four Habitats and Associated State Endangered Plants and Wildlife Species of Greatest Conservation Need in the Skylands and Pinelands Landscape Conservation Zones of the New Jersey State Wildlife Action Plan



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APPENDICES

Project Summary:

New Jersey is the first state projected to reach build-out, and pressure from competing land use interests and associated threats is high on the remaining open space. Therefore it is imperative to strategically protect and manage these natural areas for resiliency, as it is on these lands where the future of conservation lies for plants, animals and their critical habitats. Strengthening New Jersey's State Wildlife Action Plan (SWAP) will help address the growing need for guided protection and integrated management for species of greatest conservation need (SGCN).

While broad habitat categories based on vegetation communities are referenced in the New Jersey SWAP, plant species of conservation concern are not addressed (NJDEP 2008). The purpose of this project is to develop rare plant conservation strategies that complement conservation actions for animal species in the context of biodiversity protection and climate change in New Jersey. The project focused on two high-priority regions of the state with the development of a spatial framework and conservation strategy prototype that can be used in other regions of the state. Integrated rare plant and wildlife SGCN management guidelines will be incorporated into New Jersey's updated 2015 SWAP and implemented, as practicable, with state and NGO conservation partners.

The outcomes of this project include:

- ✧ Integrated management guidelines were developed for State Endangered plants and wildlife SGCN using a habitat approach. The four habitats include calcareous fens and sinkhole ponds in the Kittatinny Valley of northern New Jersey and coastal plain intermittent ponds and wet savannas in the Pine Barrens of southern New Jersey.
- ✧ Tables with Wildlife Conservation Management Plan (CMP) Threats and Wildlife Tracking and Reporting Actions for the Conservation of Species (TRACS) Conservation Actions were created for all 70 State Endangered plant species and 30 wildlife SGCN.
- ✧ Examples of supplemental sidebars were created for the SWAP featuring integrated management recommendations for relevant rare plant and wildlife SGCN/guilds by habitat within the SWAP Landscape Conservation Zones.
- ✧ The project opened a constructive dialogue between ENSP and NHP on integrated management issues with respect to rare plants, animals and their habitats.
- ✧ A significant outcome of the project was an awareness of the gap that exists in coordinating the management of natural resources in a state reaching build-out with limited areas left for habitat and species protection. We have realized that multiple projects occur on private or NGO lands that are not necessarily coordinated with other state efforts to integrate management of all elements of biodiversity (e.g., bog turtle habitat restoration projects). This understanding underscores the importance of reaching out to landowners involved in incentive programs in the future to educate them about rare plant conservation.

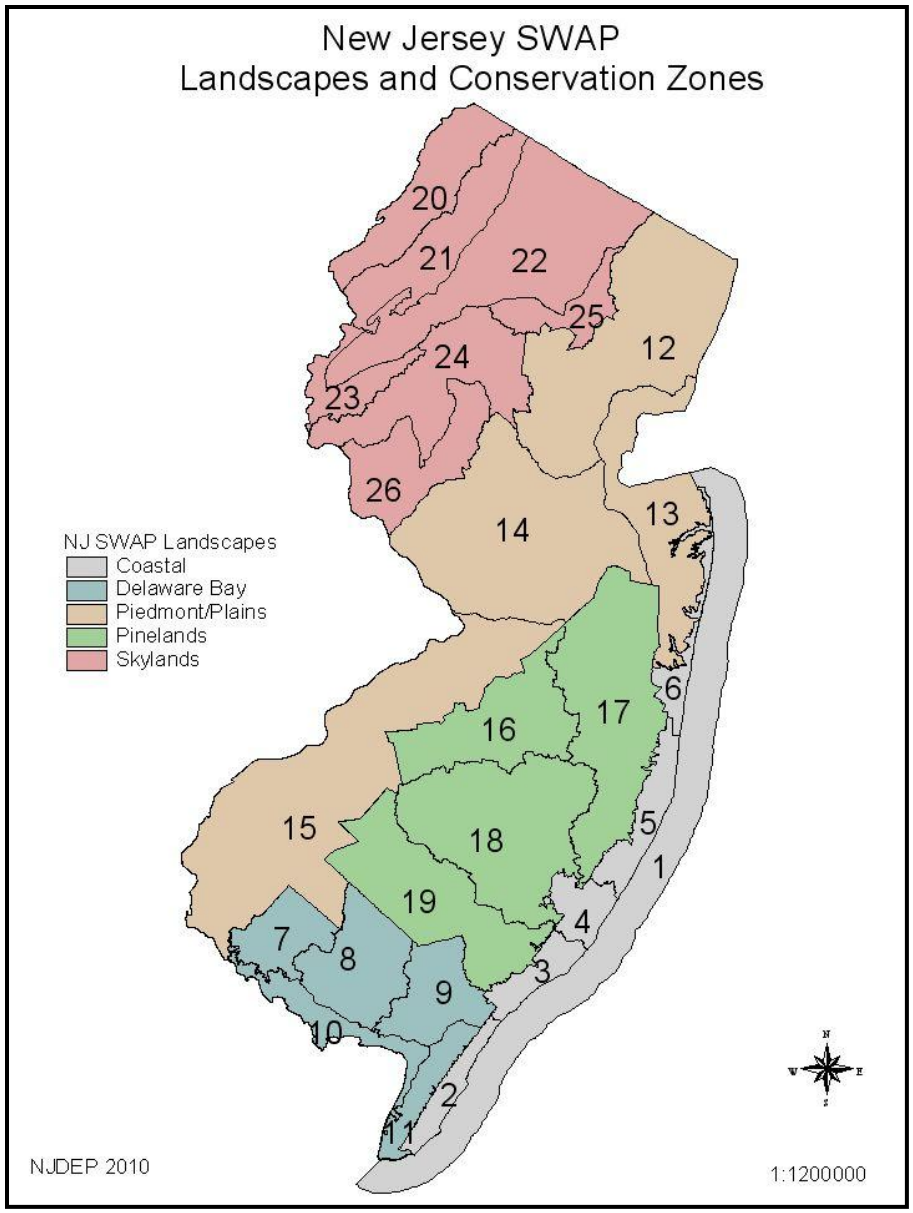
Introduction:

In 2005, as part of a national effort, New Jersey developed a State Wildlife Action Plan (SWAP) that seeks, in part, to identify the threats to wildlife and the conservation actions needed to address them. Since that time, the SWAP was updated in 2008 and has been used as a guiding document for agencies, organizations, and individuals working to conserve New Jersey's wildlife species of greatest conservation need (SGCN). Yet while the focus of the SWAP has been on animal species of conservation concern, many rare plants are also found in the same habitats as the animals. Unfortunately, plants were not included in the definition of "wildlife" provided in the federal guidelines for plan development and as a result, most plans do not address plants in any significant way (Stein and Gravuer 2008). This has led to some management conflicts over the years, where rare plant populations inadvertently were damaged due to incompatible management actions implemented for rare animal conservation.

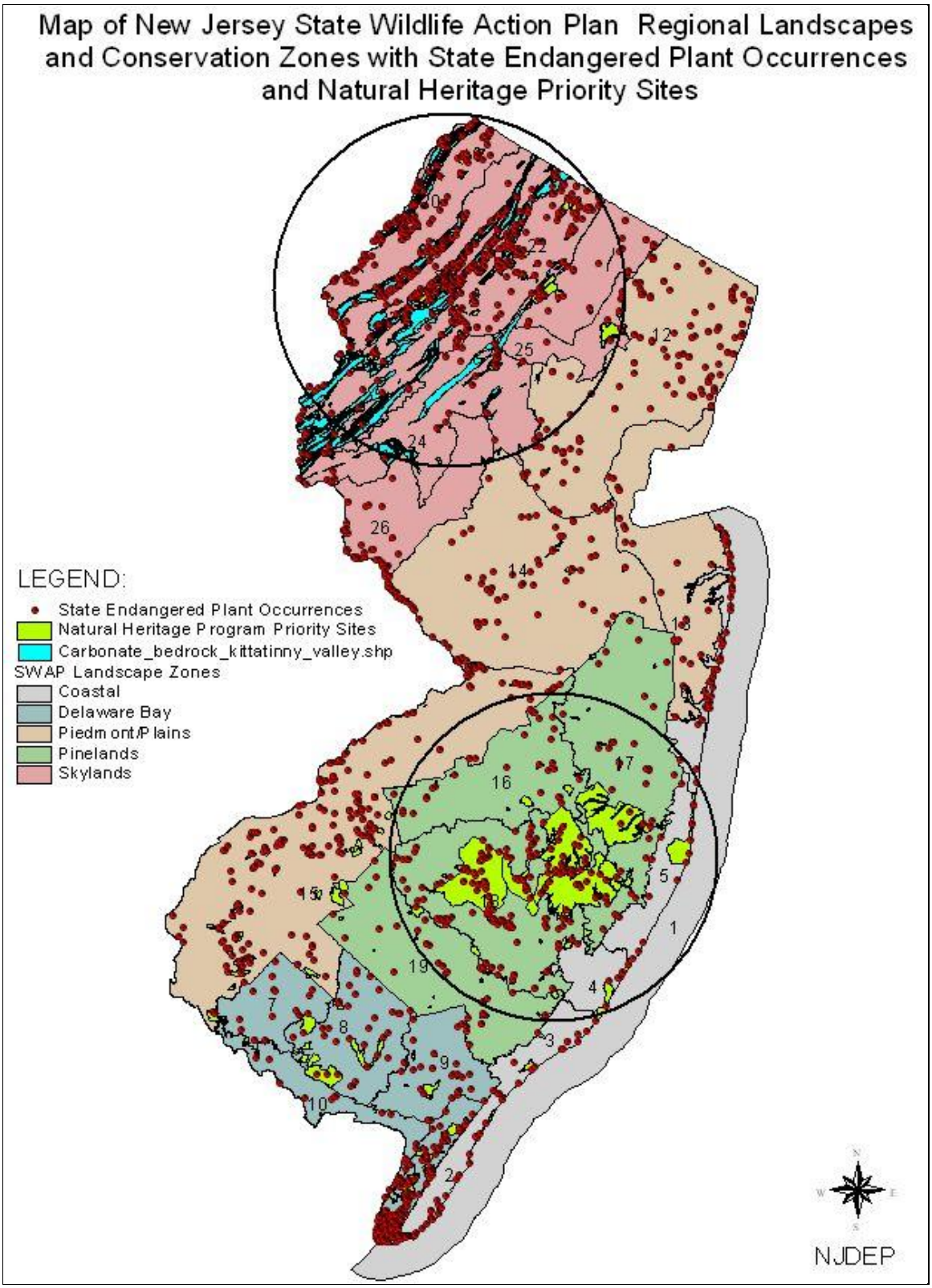
New Jersey is a small state, and predicted to be the first state to reach build-out. For these reasons, there is a very clear limit to the amount of habitat available to support biodiversity, New Jersey's plants and wildlife species, natural communities, and ecological processes. While New Jersey has protected close to 30 percent of its land area (Hasse and Lathrop 2010), many of these protected habitats are fragmented from each other and face significant external stresses. Another complication is the fact that most of New Jersey's endangered plant populations are found outside of state- or federally-protected lands (Breden et al. 2006) where protections for plants and/or their habitats are either non-existent or significantly weaker than for wildlife. Essentially, there are fewer safe habitats for plants than animals in New Jersey. While working with willing landowners to protect species and habitats on private lands are important conservation actions, it may be that the more lasting conservation actions are the ones taken on public lands. The challenge is how to meet the conservation needs of all species, plants and animals, in these remaining protected habitats.

To illustrate how this might be done in New Jersey, we selected four rare wetland habitats (Pine Barrens savannas, coastal plain intermittent ponds, calcareous fens, and calcareous sinkhole ponds). These wetlands support the highest diversity of both rare plants and wildlife SGCN in the state and the habitats themselves are also regionally and globally significant. For details on each of the four wetlands including habitat classification crosswalk, see individual habitat discussions.

For each of these four habitats we compiled a list of state endangered plant species from the 2012 Natural Heritage Program list of Plant Species of Conservation Concern, and a list of the animal species of greatest conservation need (game and nongame) identified from the 2008 New Jersey State Wildlife Action Plan and for which active management is anticipated in the near future. The following maps illustrate the habitat based conservation strategy approach and the tables list the species addresses in this report by habitat.



MAP LEGEND: NJ SWAP Landscape Regions and Conservation Zones		
MAP ID	LANDSCAPE REGION	CONSERVATION ZONE
1	Coastal	The Atlantic Ocean
2	Coastal	Atlantic Coastal Cape May
3	Coastal	Atlantic City Area
4	Coastal	Brigantine - Great Bay
5	Coastal	Barnegat Bay - Little Egg Harbor
6	Coastal	Northern Atlantic Coastal
7	Delaware Bay	Cohansey
8	Delaware Bay	Maurice
9	Delaware Bay	Tuckahoe
10	Delaware Bay	Shoreline
11	Delaware Bay	Peninsula
12	Piedmont/Plains	Northern Piedmont Plains
13	Piedmont/Plains	Raritan Bay
14	Piedmont/Plains	Central Piedmont Plains
15	Piedmont/Plains	Southern Piedmont Plains
16	**Pinelands**	**Western Pinelands**
17	**Pinelands**	**Northern Pinelands**
18	**Pinelands**	**Mullica River Watershed**
19	**Pinelands**	**Southern Pinelands**
20	**Skylands**	**Upper Delaware River Valley & Kittatinny Ridge**
21	**Skylands**	**Kittatinny Valley**
22	**Skylands**	**Northern Highlands**
23	Skylands	Upper Delaware/Musconetcong River Valleys
24	Skylands	Central Highlands
25	Skylands	Urban Highlands
26	Skylands	Southern Highlands


Map of New Jersey State Wildlife Action Plan Regional Landscapes and Conservation Zones with State Endangered Plant Occurrences and Natural Heritage Priority Sites
LEGEND:
State Endangered Plant Occurrences
Natural Heritage Program Priority Sites
Carbonate_bedrock_kittatinny_valley.shp
SWAP Landscape Zones
Coastal
Delaware Bay
Piedmont/Plains
Pinelands
Skylands
NJDEP

State Endangered Plan Species and Animal Species of Greatest Conservation Need by NJ SWAP Landscape Region and Habitat

NJ SWAP LANDSCAPE REGION	HABITAT TYPE	NUMBER OF ENDANGERED PLANT SPECIES	NUMBER OF ANIMAL SPECIES OF GREATEST CONSERVATION NEED
Pinelands	Pine Barren Savannas	14	6
Pinelands	Coastal Plain Intermittent Pond	17	5
Skylands	Calcareous Fen	28	17
Skylands	Calcareous Sinkhole Pond	13	3
2 REGIONS	4 HABITATS	70 PLANTS*	30 ANIMALS*

* Note that 2 plant species and 1 animal species occur in 2 different habitats but are counted only once in the total number of species by habitat

STATE ENDANGERED PLANT SPECIES LIST BY SWAP LANDSCAPE REGION AND HABITAT		
REGION: SKYLANDS	**Common name**	**Scientific name**
Habitat type: Calcareous Fen (28 species)		
	Bog Rosemary	*Andromeda glaucophylla*
	Rush Aster	*Aster borealis*
	Foxtail Sedge	*Carex alopecoidea*
	Water Sedge	*Carex aquatilis*
	Lesser Panicled Sedge	*Carex diandra*
	Handsome Sedge	*Carex formosa*
	Cyperus-like Sedge	*Carex pseudocyperus*
	Tuckerman's Sedge	*Carex tuckermanii*
	Wood's Sedge	*Carex woodii*
	Marsh Cinquefoil	*Comarum palustris*
	Hemlock-parsley	*Conioselinum chinense*
	Small White Lady's-slipper	*Cypripedium candidum*
	Showy Lady's-slipper	*Cypripedium reginae*
	Few-flower Spike-rush	*Eleocharis quinqueflora*
	Variegated Horsetail	*Equisetum variegatum var. variegatum*
	Queen-of-the-prairie	*Filipendula rubra*
	Labrador Marsh Bedstraw	*Galium labradoricum*
	Small Bedstraw	*Galium trifidum var. trifidum*
	Northern Panic Grass	*Panicum boreale*
	Capillary Beaked-rush	*Rhynchospora capillacea*
	Orange Coneflower	*Rudbeckia fulgida var. fulgida*
	Shining Willow	*Salix lucida ssp. lucida*
	Bog Willow	*Salix pedicellaris*
	Strict Blue-eyed Grass	*Sisyrinchium montanum var. crebrum*
	Arborvitae	*Thuja occidentalis*
	Seaside Arrow-grass	*Triglochin maritima*
	Spreading Globe Flower	*Trollius laxus ssp. laxus*
	Sessile Water-speedwell	*Veronica catenata*
Habitat type: Calcareous Sinkhole Pond (13 species)		
	Large Water-plantain	*Alisma triviale*
	Appalachian Mountain Boltonia	*Boltonia montana*
	Cloud Sedge	*Carex haydenii*
	Hop-like Sedge	*Carex lupuliformis*
	Small Floating Manna Grass	*Glyceria borealis*

	Larger Canadian St. John's Wort	*Hypericum majus*
	Water-marigold	*Megalodonta beckii*
	Lake Water-cress	*Neobeckia aquatica*
	Wiry Panic Grass	*Panicum flexile*
	Arum-leaf Arrowhead	*Sagittaria cuneata*
	Torrey's Bulrush *	*Schoenoplectus torreyi*
	Small Burr-reed	*Sparganium natans*
	Lesser Bladderwort	*Utricularia minor*
REGION: PINELANDS	**Common name**	***Scientific name***
Habitat type: Pine Barren Savanna (14 species)		
	Pickering's Reed Grass	*Calamagrostis pickeringii*
	Spreading Pogonia	*Cleistes divaricata*
	Rough Cotton-grass	*Eriophorum tenellum*
	Pine Barren Boneset	*Eupatorium resinosum*
	New Jersey Rush	*Juncus caesariensis*
	Bog Asphodel	*Narthecium americanum*
	Yellow Fringeless Orchid	*Platanthera integra*
	Knieskern's Beaked-rush	*Rhynchospora knieskernii*
	Long's Woolgrass	*Scirpus longii*
	Lace-lip Ladies'-tresses	*Spiranthes laciniata*
	False Asphodel	*Tofieldia racemosa*
	Reversed Bladderwort *	*Utricularia resupinata*
	Fringed Yellow-eyed-grass	*Xyris fimbriata*
	Death-camus	*Zigadenus leimanthoides*
Habitat type: Coastal Plain Intermittent Pond (17 species)		
	Southern Boltonia	*Boltonia asteroides var. glastifolia*
	Wrinkled Jointgrass	*Coelorachis rugosa*
	Marsh Flat Sedge	*Cyperus pseudovegetus*
	Hirst Brothers' Panic Grass	*Dichanthelium hirstii (Panicum hirstii)*
	Larger Buttonweed	*Diodia virginiana var. virginiana*
	Knotted Spike-rush	*Eleocharis equisetoides*
	Featherfoil	*Hottonia inflata*
	Barton's St. John's-wort	*Hypericum adpressum*
	Clasping-leaf St. John's-wort	*Hypericum gymnanthum*
	Boykin's Lobelia	*Lobelia boykinii*
	Narrow-leaf Primrose-willow	*Ludwigia linearis*
	Awned Meadow-beauty	*Rhexia aristosa*
	Small-head Beaked-rush	*Rhynchospora microcephala*
	Slender Arrowhead	*Sagittaria teres*
	Torrey's Bulrush *	*Schoenoplectus torreyi*
	Dwarf White Bladderwort	*Utricularia olivacea*
	Reversed Bladderwort *	*Utricularia resupinata*

WILDLIFE SGCN SPECIES LIST BY SWAP LANDSCAPE REGION AND HABITAT		
REGION: SKYLANDS	**Common name**	**Scientific name**
Habitat type: Calcareous Fen (17 species)		
Bird	Veery	*Catharus fuscescens*
Bird	Sedge wren	*Cistothorus platensis*
Bird	Black-billed cuckoo	*Coccyzus erythropthalmus*
Bird	Least flycatcher	*Empidonax minimus*
Bird	Red-headed woodpecker	*Melanerpes erythrocephalus*
Bird	Northern parula *	*Setophaga (Parula) americana*
Bird	American woodcock	*Scolopax minor*
Bird	Winter wren	*Troglodytes hiemalis*
Bird	Golden-winged warbler	*Vermivora chrysoptera*
Bird	Canada warbler	*Cardellina (Wilsonia) canadensis*
Butterfly	Silver-bordered Fritillary	*Boloria selene myrina*
Butterfly	Mitchell's Satyr	*Neonympha mitchellii mitchellii*
Moth	Schweitzer's buckmoth	*Hemileuca nevadensis ssp. 2*
Dragonfly	Kennedy's Emerald	*Somatochlora kennedyi*
Dragonfly	Brush-tipped Emerald	*Somatochlora walshii*
Reptile	Spotted turtle	*Clemmys guttata*
Reptile	Bog turtle	*Glyptemys (Clemmys) muhlenbergii*
Habitat type: Calcareous Sinkhole Pond (3 species)		
Amphibian	Jefferson salamander	*Ambystoma jeffersonianum*
Amphibian	Marbled salamander	*Ambystoma opacum*
Amphibian	Long-tailed salamander	*Eurycea longicauda longicauda*
REGION: PINELANDS	**Common name**	***Scientific name***
Habitat type: Pine Barren Savanna (6 species)		
Bird	Northern parula*	*Setophaga (Parula) americana*
Butterfly	Arogos skipper	*Atrytone arogos arogos*
Butterfly	Helicta Satyr (Georgia Satyr)	*Neonympha helicta (Neonympha areolata septentrionalis)*
Mammal	Southern bog lemming	*Synaptomys cooperi*
Moth	Moth	*Dichagyris reliqua*
Moth	Carter's noctuid moth	*Photedes (Spartiniphaga) carterae*
Habitat type: Coastal Plain Intermittent Pond (5 species)		
Amphibian	Pine Barrens treefrog	*Hyla andersonii*
Amphibian	Carpenter frog	*Lithobates virgatipes*
Dragonfly	Scarlet Bluet	*Enallagma pictum*
Dragonfly	Pine Barrens Bluet	*Enallagma recurvatum*
Dragonfly	Golden-winged skimmer	*Libellula auripennis*

* Note that 2 plant species (*Schoenoplectus torreyi* and *Utricularia resupinata*) and 1 animal species (*Setophaga americana*) occur in 2 different habitats but are counted only once in the total number of species addressed in this report.

We identified key threats to plants and animals in each habitat using the Conservation Measures Partnership (CMP) THREATS classification (see Salafsky et al. 2008 for the lexicon). The Threats categories are listed below. See Appendix C for the table of CMP Threats for each of the state endangered plant species and wildlife SGCN by habitat addressed in this study.

CMP THREATS Categories:

1. Residential and Commercial Development
2. Agriculture & Aquaculture
3. Energy Production & Mining
4. Transportation & Service Corridors
5. Biological Resource Use
6. Human Intrusions and Disturbance
7. Natural Systems Modifications
8. Invasive and Other Problematic Species & Genes
9. Pollution
10. Geological Events
11. Climate Change & Severe Weather

In future years, the USFWS will be adopting the Wildlife Tracking and Reporting Actions for the Conservation of Species (TRACS) as the reporting framework for tracking conservation actions funded by State Wildlife grants that implement actions identified in SWAPs (USFWS 2013). New Jersey will be adopting the TRACS language in their 2015 SWAP update so we have included a correlation with this report. The 13 TRACS Actions at Level 1 are listed below, are addressed in the integrated management guidelines for the four habitats in this report.

Wildlife TRACS ACTIONS

1. Coordination and Administration
2. Create, Restore, or Enhance Habitat and Natural Processes
3. Data Collection and Analysis
4. Education
5. Facilities and Areas/New Construction
6. Facilities and Areas/Major Renovation
7. Facilities and Areas/Operations and Maintenance
8. Land and Water Rights/Acquisition and Protection
9. Law Enforcement
10. Outreach
11. Planning
12. Species Reintroduction and Stocking
13. Technical Assistance

We then looked at proposed management actions identified in the 2008 SWAP that addressed threats to the habitat and/or SGCN species, to identify possible impacts to the rare plants in the same habitat. We offer suggestions for ways to avoid or mitigate management conflicts for the given suites of species. And finally, we looked at the potential effects of climate change on species and habitats with an emphasis on identifying future management conflicts that might arise from new actions proposed to adapt to projected climate changes. Following are discussion points for each of the four habitats and their rare plant and wildlife SGCN, presented as integrated management guideline, followed by a summary for all.

Integrated Management Guidelines:
CALCAREOUS FEN HABITAT



Spreading globe flower *(Trollius laxus spp. laxus);* Calcareous Fen; Bog turtle *(Glyptemys muhlenbergii)*

Overview

Calcareous fens are distinctive wetlands that depend on a constant supply of cold, oxygen-poor ground water rich in calcium and magnesium bicarbonates. This calcium-rich environment supports a plant community dominated by "calciphiles," or calcium-loving species. These fens typically occur on slight slopes where upwelling ground water surfaces slowly and surface water inputs are minimal. The substrate is peat, muck or marl, and usually saturated to the surface, with seeps and shallow pools of water surrounded by low, tussocky, grass- and sedge-dominated vegetation. The substrate is springy or quaking underfoot (Walz 2006).

In New Jersey, calcareous fens are located predominantly in the Kittatinny Valley of northwestern New Jersey (Sussex and Warren counties) and support numerous rare plant and animal species with diverse management needs. There are eight different calcareous fen ecological community types found in New Jersey, but for the purposes of this report we are addressing fens as a habitat system, not focusing just on one particular fen type.

Calcareous fens are included in the NE Wildlife Habitat Classification System as North-Central Appalachian Seepage; in the New Jersey Landscape Map as Emergent, Forest and Wetland Species-Based Habitat; and mapped in the New Jersey Land Use/Land Cover as Emergent Wetlands, Deciduous Scrub/Shrub Wetlands, Coniferous Scrub/Shrub Wetlands, Mixed Scrub-Shrub Wetlands (Deciduous Dominant), Mixed Scrub-Shrub Wetlands (Coniferous Dominant). See Appendix B for more details on habitat classification.

Twenty-eight (28) state endangered plant species occur in calcareous fens, including Bog Rosemary (*Andromeda glaucophylla*), Rush Aster (*Aster borealis*), Foxtail Sedge (*Carex alopecoidea*), Water Sedge (*Carex aquatilis*), Lesser Panicled Sedge (*Carex diandra*), Handsome Sedge (*Carex formosa*), Cyperus-like Sedge (*Carex pseudocyperus*), Tuckerman's Sedge (*Carex tuckermanii*), Wood's Sedge (*Carex woodii*), Marsh Cinquefoil (*Comarum palustris*), Hemlock-parsley (*Conioselinum chinense*), Small White Lady's-slipper (*Cypripedium candidum*), Showy Lady's-slipper (*Cypripedium reginae*), Few-flower Spike-rush (*Eleocharis quinqueflora*), Variegated Horsetail (*Equisetum variegatum var. variegatum),* Queen-of-the-prairie (*Filipendula rubra),* Labrador Marsh Bedstraw (*Galium*

labradoricum), Small Bedstraw (*Galium trifidum var. trifidum),* Northern Panic Grass (*Panicum boreale),* Capillary Beaked-rush (*Rhynchospora capillacea),* Orange Coneflower(*Rudbeckia fulgida var. fulgida),* Shining Willow (*Salix lucida ssp. Lucida),* Bog Willow (*Salix pedicellaris),* Strict Blue-eyed Grass (*Sisyrinchium montanum var. cerebrum),* Arborvitae (*Thuja occidentalis),* Seaside Arrow-grass (*Triglochin maritime),* Spreading Globe Flower (*Trollius laxus ssp. Laxus),* Sessile Water-speedwell (*Veronica catenata).* See Appendix A for complete list of state endangered plant species with rarity rankings. Seventeen wildlife species identified as Species of Greatest Conservation Need (SGCN) in the 2008 version of the New Jersey State Wildlife Action Plan (SWAP) also occur in fens including: two reptiles (bog turtle [*Glyptemys (Clemmys) muhlenbergii*] and spotted turtle [*Clemmys guttata*]; several Lepidoptera (Mitchell's satyr [*Neonympha mitchellii mitchellii*], Schweitzer's buckmoth [*Hemileuca nevadensis species 2]*, silver-bordered fritillary [*Boloria selene*]); two dragonflies (Kennedy's emerald [*Somatochlora kennedyi*] and brush-tipped emerald [*Somatochlora walshii*]); ten nesting bird species (red-headed woodpecker [*Melanerpes erythrocephalus*], golden-winged warbler [*Vermivora chrysoptera*], Canada warbler [*Cardellina (Wilsonia) canadensis*], sedge wren [*Cistothorus platensis*], winter wren [*Troglodytes hiemalis*], northern parula [*Setophaga* (*Parula) americana*], black–billed cuckoo [*Coccyzus erythropthalmus*], least flycatcher [*Empidonax minimus*], veery [*Catharus fuscescens*] and a game species of regional priority, the American woodcock [*Scolopax minor*]). See Appendix A for list of wildlife SGCN with rarity rankings.

Threats

Altered hydrology and degraded water quality associated with development (whether residential or industrial) or adjacent agricultural practices are the main threats to calcareous fens. For example, groundwater withdrawals that lower the water table or drainage ditches that divert water out of the wetlands change the habitat significantly and affect associated rare species.

Water laden with fertilizers from adjacent farmland or homeowners' lawns as well road runoff can negatively impact plants in wetlands downslope due to changes in water chemistry. Calcareous fens are characterized by high pH with high levels of calcium and magnesium in the water and the plant community in particular is adapted to this water chemistry.

Flooding from beaver activity, while a natural process, can threaten fen habitats that support rare plants, rare Lepidoptera and bog turtles. Vegetation succession (e.g., from open herbaceous vegetation to shrub swamp) can also be a threat, despite the fact that vegetation change through time is a natural process. Typically, as some fen wetlands become shrubbier, others open up on the landscape due to beaver activity or other disturbance processes. Wetland connectivity among sites enables plants and animals to disperse to more suitable habitats as these changes occur. However, today few calcareous wetland habitats remain intact and most are separated from each other by roads, development or other unsuitable habitat, so plants and animals are unable to find new suitable habitat when the vegetation structure and hydrology in a fen changes.

Invasive species, such as purple loosestrife (*Lythrum salicaria*) and common reed (*Phragmites australis*) also threaten the integrity of fen habitats, crowding out native vegetation and altering site characteristics required by plants like spreading globe flower and animals like the bog turtle (Snyder and Kaufman 2004). The use of pesticides for insect pest control (e.g., gypsy moth or mosquito control) can threaten butterfly and moth populations (Schweitzer et al. 2011). Overabundant animals like white-tailed deer may over-browse sensitive fen vegetation (NJDEP 2008). Off Road Vehicle (ORV) use and other intensive recreational activities compact soil, destroy vegetation, and can harm wetland-dependent species such as dragonflies and bog turtles (Switalski and Jones 2012). Individual taxa (e.g., orchids, some Lepidoptera, and both turtle species) are also threatened by illegal collecting (NJDEP 2008).

A summary of CMP Threats to state endangered plants and wildlife SGCN in calcareous fen habitat is found in Appendix C.

Species Ecology

Calcareous fens are wetlands characterized by sedges, grasses and brown mosses (non-*Sphagnum*), a relatively high water table, nutrient-poor, mineral-rich (calcium and/or magnesium) alkaline waters, with shallow rivulets and groundwater seepage areas among hummocky herbaceous vegetation. Each plant and animal species that occurs in calcareous fens has specific habitat and/or management needs, as each requires slightly different microclimate and vegetation zones within the fen. In fact, most calcareous fen plants have evolved with adaptations to tolerate high calcium and magnesium concentrations, which cause neutral to alkaline pH, as well as hydrology adaptations to such conditions as perpetual exposure to groundwater seepage (Bedford and Godwin 2003).

Plants:

Calcareous fens are extraordinarily diverse wetlands that support approximately 275 plant species, of which 55 are rare including 28 listed as state endangered that are addressed in this report. Many of them are northern species that reach their southern limit in or near New Jersey. Examples include arborvitae, bog rosemary, bog willow and many of the carices. A few have a wider distribution but are considered rare due mainly to the restricted distribution of calcareous fen habitat in the state. These include marsh cinquefoil (*Potentilla palustris),* variegated horsetail (*Equisetum variegatum*), orange coneflower (*Rudbeckia fulgida*), queen-of-the-prairie (*Filipendula rubra*), and Labrador marsh bedstraw *(Galium labradoricum)*.

The following two tables provide a list of state endangered species that can found in calcareous fens in New Jersey with their phenology, or timing of vegetative, flowering and fruiting, and comments on their habitat/niche. The phenology and habitat information can be used to help avoid negative impacts to these state endangered plant species during wildlife surveys and management activities.

FL = Flowering; FR = Fruiting; V = Vegetative

Phenology of State Endangered Plant Species in Calcareous Fen Habitat		**APRIL**		**MAY**		**JUNE**		**JULY**		**AUG**		**SEPT**		**OCT**		**NOV**	
Scientific Name	**Common Name**	**1-15**	**16-30**	**1-15**	**16-31**	**1-15**	**16-30**	**1-15**	**16-31**	**1-15**	**16-31**	**1-15**	**16-30**	**1-15**	**16-31**	**1-15**	**16-30**
Andromeda glaucophylla	Bog Rosemary	V	FL	FL	FL	FL, FR	FR	FR	FR	V	V	V	V	V	V	V	V
Aster borealis	Rush Aster								FL	FL	FL	FL, FR	FL, FR	FL, FR	FR	FR	
Carex alopecoidea	Foxtail Sedge				FL, FR	FL, FR	FR	FR									
Carex aquatilis	Water Sedge				FL, FR	FL, FR	FL, FR	FR	FR	FR	FR						
Carex diandra	Lesser Panicled Sedge				FL, FR	FL, FR											
Carex formosa	Handsome Sedge					FR	FR										
Carex pseudocyperus	Cyperus-like Sedge				FL	FL, FR	FR	FR	FR	FR	FR						
Carex tuckermanii	Tuckerman's Sedge					FL, FR	FL, FR	FR									
Carex woodii	Wood's Sedge		FL	FL	FL, FR	FR	FR										
Comarum palustre	Marsh Cinquefoil					FL	FL	FL, FR	FR	FR							
Conioselinum chinense	Hemlock-parsley										FL	FL, FR	FL, FR	FR			
Cypripedium candidum	Small White Lady's-slipper				FL	FL											
Cypripedium reginae	Showy Lady's-slipper					FL	FL	FR	FR	FR	FR	FR	FR				
Eleocharis quinqueflora	Few-flower Spike-rush						FL, FR	FR	FR	FR	FR	FR	FR	FR			
Equisetum variegatum var. variegatum	Variegated Horsetail	V	V	V	V	V	V	V	V	FR	FR	FR	FR	FR	FR	V	V
Filipendula rubra	Queen-of-the-prairie					*FL*	FL	FL	*FL*	FL, FR	FL, FR	FR	FR				
Galium labradoricum	Labrador Marsh Bedstraw						FL	FL	FL, FR	FR	FR	FR					

Phenology of State Endangered Plant Species in Calcareous Fen Habitat (continued)		**APRIL**		**MAY**		**JUNE**		**JULY**		**AUG**		**SEPT**		**OCT**		**NOV**	
Scientific Name	**Common Name**	**1-15**	**16-30**	**1-15**	**16-31**	**1-15**	**16-30**	**1-15**	**16-31**	**1-15**	**16-31**	**1-15**	**16-30**	**1-15**	**16-31**	**1-15**	**16-30**
Galium trifidum var. trifidum	Small Bedstraw							FL	FL	FL, FR	FR	FR	FR				
Panicum boreale	Northern Panic Grass				FL	FL, FR	FL, FR	FL, FR	FR								
Rhynchospora capillacea	Capillary Beaked-rush								FL	FL, FR	FL, FR	FL, FR	FR	FR			
Rudbeckia fulgida var. fulgida	Orange Coneflower											FL	FL	FL, FR	FR		
Salix lucida ssp. Lucida	Shining Willow				FL, FR	FR	FR										
Salix pedicellaris	Bog Willow		FL	FL	FL	FL, FR	FR	FR	FR	FR							
Sisyrinchium montanum var. cerebrum	Strict Blue-eyed Grass				FL	FL	FL, FR	FR	FR								
Thuja occidentalis	Arborvitae	V	V	V	V	V	V	V	V	V	V	V	FR	FR	FR	FR	FR
Triglochin maritima	Seaside Arrow-grass				FL	FL, FR	FL, FR	FL, FR	FR	FR	FR	FR	FR	FR			
Trollius laxus ssp. Laxus	Spreading Globe Flower		FL	FL	FL	FL	FR	FR	FR	FR	FR	FR	FR				
Veronica catenata	Sessile Water-speedwell						FL	FL, FR	FL, FR	FL, FR	FR						

SOURCE: New Jersey Natural Heritage Program, Biotics Database

SOURCE: New Jersey Natural Heritage Program, Biotics Database

Calcareous Fen Habitat -- State Endangered Plant Habitat/Niche Comments

Scientific Name	**Common Name**	**Calcareous Fen Habitat/Niche Comments**
Andromeda glaucophylla	Bog Rosemary	Restricted to thickets and openings in sphagnous bogs, and more rarely in calcareous fens that have well developed sphagnous hummocks
Aster borealis	Rush Aster	Grows in open, peaty limestone fens, marl fens, and other limestone wetlands
Carex alopecoidea	Foxtail Sedge	Grows in swampy calcareous meadow, low woods at edge of pond, swampy meadows, in NJ this species apparently is restricted to calcareous wetlands
Carex aquatilis	Water Sedge	Grows in open calcareous seepage fens
Carex diandra	Lesser Panicled Sedge	Swampy, marshy, or boggy areas, especially wet meadows, fens, floating mats, and peaty or marly shores of lakes and ponds
Carex formosa	Handsome Sedge	Typically occurs in or at the edge of limey swamps, seeps, or bottomland forests
Carex pseudocyperus	Cyperus-like Sedge	Grows in open calcareous marsh and open areas of a calcareous swamp
Carex tuckermanii	Tuckerman's Sedge	Found in rich or calcareous open wetlands
Carex woodii	Wood's Sedge	Grows in black, mucky peaty soil on sedge hummocks in shrubby calcareous fen habitat
Comarum palustre	Marsh Cinquefoil	Grows in floating turf of sedge and sphaghum moss in shallow water, sphagnous or peaty seepage areas in calcareous marshes and wooded swamps
Conioselinum chinense	Hemlock-parsley	Grows in wooded seepage areas along small streams or brooks in calcareous or basic soils
Cypripedium candidum	Small White Lady's-slipper	Grows in light to fairly heavy shade of overgrown portion of calcareous fen, reportedly associated with larch
Cypripedium reginae	Showy Lady's-slipper	Grows in shrub borders or open thickets in calcareous fens and wooded swamps; prefers constant moisture and full sun to semi-shaded conditions
Eleocharis quinqueflora	Few-flower Spike-rush	Restricted to wet, marl of ponds margins and fens
Equisetum variegatum var. variegatum	Variegated Horsetail	Occurs in seepage areas on marl deposits at edge of water

Scientific Name	**Common Name**	**Calcareous Fen Habitat/Niche Comments**
Filipendula rubra	Queen-of-the-prairie	Grows in brushy calcareous fens along edge of wooded swamps
Galium labradoricum	Labrador Marsh Bedstraw	Grows in wet sphagnum or peat of calcareous pond shores, sedge mats, and fens.
Galium trifidum var. trifidum	Small Bedstraw	Grows in sphagnum or mosses of calcareous fens and along edge of marl pond shores
Panicum boreale	Northern Panic Grass	Grows in open, wet swales of calcareous fens
Rhynchospora capillacea	Capillary Beaked-rush	Restricted to seepage areas in marl and calcareous fens.
Rudbeckia fulgida var. fulgida	Orange Coneflower	Grows in calcareous fens
Salix lucida ssp. lucida	Shining Willow	Grows in sedge meadows; vernal pools, alvars, open calcareous fens, marl bogs
Salix pedicellaris	Bog Willow	Grows in open to shrubby calcareous fens and swamps; occassionally in more sphagnous habitats with a calcareous substrate
Sisyrinchium montanum var. cerebrum	Strict Blue-eyed Grass	Grows in among calcareous rocks in seepage areas on river shores and in moist grassy places and calcareous fens
Thuja occidentalis	Arborvitae	Grows in peaty and sphagnous calcareous seepage fens
Triglochin maritima	Seaside Arrow-grass	Grows in open, calcareous seepage fens
Trollius laxus ssp. laxus	Spreading Globe Flower	Grows in wetlands influenced by cold, highly alkaline groundwater seepage; open fens, along swamp margins, and in partly sunny, wet openings in seepage swamps; sloping fens on sedge tussocks somewhat above the saturated soils, or on seepy mineral soil.
Veronica catenata	Sessile Water-speedwell	Grows in shallow water of small brooks in calcareous seepage fens

SOURCE: New Jersey Natural Heritage Program, Biotics Database

The rarest are Wood's sedge (*Carex woodii*) and handsome sedge (*Carex formosa*), which are found in only one location statewide, spreading globe flower (*Trollius laxus* ssp*. laxus*) which is globally rare, and arborvitae (*Thuja occidentalis*) which is at the southern limit of its range. *Trollius* has a very limited distribution, being found in only four states (NY, NJ, CT, and PA), with New Jersey supporting the largest population worldwide. Calcareous fens in New Jersey also are characterized by the presence of eastern red cedar (*Juniperus virginiana*), which is found more typically in upland habitats. Both woody plants, *Thuja* and

Juniperus, are particularly vulnerable to deer browsing as they provide succulent winter forage. Other rare plants especially targeted by deer include orchids.

All species rely on fen hydrology characterized by rich, perennial, and groundwater seepage. The groundwater dominant hydrology helps form a hummock and hollow microtopography where plant distribution is based on elevation above water level – those that need less water live on the hummocks and those tolerant of more water live in the hollows. Some plants such as few-flowered spikerush (*Eleocharis pauciflora*) need patches of bare soil without competition from other rhizomatous species to survive.

Calcareous fens are patchy habitats, often characterized by a mosaic of open sunny areas with herbaceous plants and dense shrubby areas. Plants and animals each find their own niche in this mosaic, with animals often moving between these areas at different times of the day or year.

There are a number of rare orchids that live in calcareous fen habitat and nowhere else. Orchids in particular have a complex life history. They do not bloom in every year and seed germination is highly dependent on a number of environmental factors, hence they are very sensitive to disturbance. They are also particularly sensitive to browsing by deer. In fact, the exact management needs for many of the calcareous fen-dependent species are not known. Therefore, maintaining the site hydrology and water chemistry, in part by maintaining sufficient buffers around wetlands to prevent runoff with road salt, fertilizers or other pollutants from entering the fen, minimizing deer herbivory, and preventing trampling of the vegetation and soil are all critical.

Animals:

Bog turtles live in spring fed sphagnum bogs, fens, and wet meadows with clear slow moving rivulets and a soft organic substrate that support low grasses and sedges. Active April through September, they will estivate in moist mud in rivulets or hide under sedge tussocks during extended periods of heat in summer. Bog turtles prefer nesting in raised hummocks, such as moss beds, in sunny open areas of the wetland. They hibernate from late September to March/April in soft-bottomed waterways, tree stumps, or beneath sedge tussocks (Ernst et al. 1994, Liguori and Tesauro 2003, B. Zarate, personal communication, 2013).

Spotted turtles use a variety of shallow water habitats such as bogs, wet pastures and marshes, with fens also providing important habitat. In New Jersey they are active from March through September. They nest in late May/June in grass tussocks, or hummocks of moist sphagnum moss and spend the winter in soft muddy stream bottoms (Ernst et al. 1994).

Habitat fragmentation that eliminates connectivity between wetlands, shrub encroachment that eliminates open herbaceous openings, as well as illegal collecting for the pet trade are the major threats to both turtle species.

The **Kennedy's emerald** dragonfly is a northern species that reaches its southern limit in New Jersey. It inhabits cold-water calcareous fens, often with small streams flowing through them. Adult emerald dragonflies emerge in May and are active through June, with females laying eggs in open water portions of the fen. Larvae may spend a number of years as aquatic naiads (larval stage) before emerging as adults (Nikula et al. 2003, Barlow et al. 2009).

The **brush-tipped emerald** dragonfly is active from early June through early August and is found in fens and open swamps with clear slow moving rivulets. A northern species, this emerald also reaches its southern limit in New Jersey. Females lay their eggs in open water near emergent vegetation and have an aquatic larval stage that may last more than one year. Adults forage along forest edges around the fen (Nikula et al. 2003, Barlow et al. 2009).

The main threats to these dragonflies are altered hydrology and degradation of water quality.

Mitchell's satyr butterfly was presumed extirpated from New Jersey in the mid-1980s. Satyr numbers had declined significantly prior to that time due to the loss of its wetland habitat, however over-collecting of the last remaining population may have been a contributing factor in its extirpation from the state. It is rare throughout its range, which includes isolated populations in Alabama, Indiana, Michigan, Mississippi, North Carolina, and Virginia (Hamm et al. 2013, NatureServe 2013a). Mitchell's satyr relies on open, wet meadows, as their larvae feed on sedges. They overwinter as fourth instar larvae. These butterflies may have a limited ability to colonize new fens by following narrow watercourses (Gochfeld and Burger 1997).

Schweitzer's buckmoth is only found in the limestone region of Sussex and Warren County, New Jersey. Adults fly during the day in late September and early October. Eggs are laid in a ring around the lower stem of the food plant and remain until spring, when the larvae emerge. Caterpillars feed on willow (*Salix* spp.), bog birch (*Betula pumila*), and shrubby cinquefoil (*Dasiflora fruticosa* ssp. *floribunda*), pupate in July in *Sphagnum* moss, and emerge as adults in the fall (NatureServe 2013b).

The **silver-bordered fritillary** ranges across southern Canada south to New Jersey in the East. Originally found statewide, it declined dramatically over the past 40 years, most likely due to a combination of habitat loss and pesticide use for gypsy moth and mosquito control. These fritillaries prefer open, wet meadows, rarely entering woodlands and are double-brooded (triple-brooded in the south). Larvae feed on a variety of *Viola* species and overwinter as partially grown caterpillars, likely in the litter at the base of the foodplant (Golden 2003; D. Schweitzer, personal communication, 2013).

Ten bird species listed as SGCN breed in shrubby or emergent wetlands in the Skylands region and will use fen habitats. Of these, the **Canada warbler**, **golden-winged warbler**, **winter wren**, and **least flycatcher** are more northern species that reach their southern limit for breeding in northwestern New Jersey. The golden-winged warbler is a fen nester,

preferring shrubbier sections with overgrown openings, although it will use other habitats (S. Petzinger, personal communication, 2013). Least flycatchers nest in open woodlands and shrubby areas at edges of ponds, streams, and bogs. They will use a fen edge (e.g. Hyperhumus and fens along the Wallkill River), although they are not dependent on them. Canada warblers nest on or near the ground in or along the brushy edges of wetlands with low herbaceous cover (Walsh et al. 1999). They would breed in the shrubby edge of fens (S. Petzinger, personal communication, 2013). Winter wren is a forest interior nesting species that prefers old growth forests or moist coniferous forests (Walsh et al. 1999) with snags and downed logs, typically near water. Although there are not many records in New Jersey, they also would breed in the shrubby edge of fens (S. Petzinger, personal communication, 2013).

Of all the birds listed as SGCN, the **sedge wren**, although very rare and can occur in any part of the state, is most dependent on fens in northern New Jersey. Sedge wrens nest in high marsh ecotones along the coast and in fens, bogs, and wet meadows or grasslands away from the coast. They breed in calcareous fens along the Wallkill and Black Creek and have also been observed breeding in a fen in the Paulinskill River watershed (S. Petzinger, personal communication, 2013).

The **veery** nests throughout northern New Jersey and prefers shrubby habitats in or near damp, moist habitats. They are known to breed in the fens at HyperHumus and at Wallkill (S. Petzinger, personal communication, 2013).

Black-billed cuckoo and **northern parula warbler** are found locally throughout the state. Cuckoos nest along forest edges in thickets, especially in the shrubby edges of wet areas and, while not fen-dependent, they might use the shrubby edge of a fen for nesting particularly in the Wallkill and Paulinskill areas (S. Petzinger, personal communication, 2013). Northern parula warblers typically nest in trees over water, especially in riverside floodplain forests (W. and S. Wander, personal communication, 2013) but they are known to use the edges of fens in the Paulinskill drainage as well as the Flatbrook River and other isolated fens in the Delaware Water Gap (S. Petzinger, personal communication, 2013).

Also found locally state-wide, **red-headed woodpeckers** prefer to nest in standing dead trees with an open understory. They will also use standing timber in swamps and are known breeders in fens at Johnsonburg Swamp, Whittingham Wildlife Management Area, and other larger sites with open water (S. Petzinger, personal communication, 2013).

Although not dependent on fen habitats**, American woodcock** is a game species of regional concern that may nest in early successional sedge meadows and shrub fens and/or use them during migration in the spring and fall. These birds rely on different habitat types in close proximity, requiring open fields or meadows for courtship display, second growth hardwood stands for nesting and rearing of young, and large fields as night roosting sites (Kelley et al. 2008).

Integrated Conservation Management Guidelines:

An important goal of the SWAP is to protect, maintain, and restore critical wetland habitat for wildlife SGCN. Due to the fact that there are a number of rare taxa with varying habitat preferences that use fen habitats, there is significant potential for conflicts between conservation management actions proposed for SGCN animals and rare plants at individual sites. For this reason, it is recommended that there be a thorough survey and mapping of all rare species found at a site, including population location, status and condition, such that any proposed management can avoid or minimize impacts. Ideally, fen management must be holistic, maintaining not only the core open meadow areas but also the shrubby matrix in which the grassy areas occur.

The following integrated conservation management guidelines address broad categories linked to conservation actions identified in the SWAP and correlated with the TRACS ACTIONS Level 1. We have specifically targeted discussion around the actions where there may be potential for management incompatibility between state endangered plants and wildlife SGCN.

TRACS ACTIONS

1. Coordination and Administration
2. **Create, Restore, or Enhance Habitat and Natural Processes**
3. **Data Collection and Analysis**
4. Education
5. Facilities and Areas/New Construction
6. Facilities and Areas/Major Renovation
7. Facilities and Areas/Operations and Maintenance
8. Land and Water Rights/Acquisition and Protection
9. Law Enforcement
10. Outreach
11. Planning
12. Species Reintroduction and Stocking
13. Technical Assistance

TRACS ACTION #2:
CREATE, RESTORE, OR ENHANCE HABITAT AND NATURAL PROCESSES

Hydrology and Water Quality Management
Maintaining the integrity of important and unique natural communities is a conservation goal of the SWAP and increasing the effective size and connectivity of wetlands an important conservation action. Accomplishing these will help maintain site hydrology, which will be the key to fen longevity. Additionally, research proposed in the SWAP to identify groundwater recharge areas for calcareous wetlands habitats would be of great benefit to the rare plants and SGCN animals using these fens.

Vegetation Management

Managing succession: Rare plants, bog turtles, the emerald dragonflies, above mentioned Lepidoptera and some birds require an early successional vegetation stage characterized by low herbaceous cover. Preventing shrub or sapling encroachment or canopy closure is critical. Maintaining open habitat can be done in a variety of ways; by selective cutting of red maples or other shrubs, with the targeted use of herbicides, or the addition of grazing animals such as goats.. These management methods are typically used, in New Jersey fens to date or have been recommended in the SWAP. In addition, the SWAP recommends researching different management techniques for maintaining early successional habitats, which would be of value to the suite of species using fens.

> Manual vegetation removal: Hand-pruning or selective cutting of woody vegetation can be used to set back succession and open the canopy for those plant and animal species that require it. If done in the winter months, there will be little impact to fen vegetation or other animal species that use the habitat.
>
> Use of Herbicides: Extreme care must be taken if herbicides are used in fen habitats as most are broad spectrum. Only direct hand application (e.g., hand painting stump cuts) should be considered for vegetation control adjacent to rare plant populations.
>
> Grazing: For degraded habitats where grazing might be used to remove common reed (*Phragmites australis*) and other invasive vegetation and restore fen-like habitat structure, a determination of which rare plants and animals remain at the site should be made and those sensitive areas fenced off from grazing and subsequent trampling. Fencing usually requires clearing of a 10-foot wide fence path and the installation of posts (B. Zarate, personal communication, 2012). Although fence construction typically occurs outside the growing season, some trampling could occur, which might affect plants, overwintering Lepidoptera larvae or odonate larvae in rivulets. Another consideration is the number of animals applied per acre. The U.S. Fish and Wildlife Service recovery plan for bog turtles (USFWS 2001) recommends one animal/acre but consultation with botanists to see if this density should be modified on a site-by-site basis, is warranted. Many plants, such as rare orchids, are particularly vulnerable to grazing pressure. (Grazers such as goats introduced to a site for bog turtle vegetation management can be in direct conflict with Schweitzer's buckmoth survival, as the goats may inadvertently consume eggs laid on stems of plants they browse or can eat so many leaves when they first emerge in the spring that there is insufficient food to support caterpillar development [D. Schweitzer, personal communication, 2012].)

Silvicultural practices on adjacent uplands: The improvement of silvicultural practices by encouraging landowners to use ecologically appropriate techniques has been identified in the SWAP as an important conservation action. Such practices would benefit both rare plants and animals in fen habitats in part by reducing erosion from surrounding uplands and protecting water quality.

Utility rights-of-way management: The SWAP recommends the development of BMPs for Rights-of-Way (ROW) management for scrub-shrub and animal species that may use them. As ROWs cut through calcareous fen habitats, the development of management guidelines should be coordinated such that all rare plants as well as wildlife SGCN using ROWs are incorporated into BMPs. This will assist the landowner in making appropriate management decisions and to avoid potentially conflicting recommendations.

Note: Maintaining appropriate wetland scrub-shrub habitat in the region has been identified in the SWAP as a priority for many breeding birds. Fens can provide this wetland scrub-shrub habitat, as there are often shrub zones in the fens and some fens are characterized by their dominance of shrubs (e.g., calcareous shrub fen and rich shrub carr). For this reason, any vegetation management plan should take into consideration the rare habitat itself and the needs of all species at a site, when possible. Some birds, like the golden-winged warbler, rely on both patches of herbaceous cover for nesting and shrub cover for foraging. In addition, Schweitzer's buckmoth larvae feed on low shrub vegetation. Maintaining shrub fens as well as both open herbaceous areas and shrub zones in other fen habitats is important to meet the habitat needs of the entire suite of plant and animal species that may occur in these habitats.

Invasive, Over-abundant, and Pest Species Management

Invasive plant species: Management and control of invasive plant species is an important conservation goal identified in the SWAP, as it is critical to maintaining the integrity of the fen habitat upon which so many rare plant and animal species depend. In particular, common reed (*Phragmites australis*), purple loosestrife (*Lythrum spicata*), and multiflora rose (*Rosa multiflora*) are often targets for removal and control. As mentioned in the vegetation management section above, control should begin with the least harmful process (hand pulling or seedhead removal) before moving toward use of chemicals or other less targeted techniques. Biocontrol may be an option for some invasive species, however consultation with experts, both botanists and zoologists is always warranted when considering the use of chemicals and/or biocontrol. Decisions should be made on a site-by-site basis to prevent (or minimize) negative impacts to non-target rare plant or animal species.

Insect pests and/or disease pathogens: A number of insect pests may be targeted for control in and around fen wetlands (e.g., mosquitoes, gypsy moths). Control measures often include application of pesticides, many of which are broad spectrum or are applied at times of the year when other invertebrates are vulnerable or are applied in a manner harmful to the rare plant community (e.g., trampling). Any proposed control measures should be site specific and the use of integrated pest management and committed, ongoing coordination among agencies and with fen managers to reduce non-target impacts is critical. In all cases, botanists and zoologists should be included in the discussion to avoid any potential harm to rare plant or SGCN animal populations or the habitat during treatment.

Note: Proper protocols should be put into place to prevent the spread of invasive species and/or disease pathogens (e.g., Chytrid fungus, Ranavirus) among wetland sites. It is best

to follow these or similar recommendations between site visits: 1) wash boots and field equipment with soap and water; 2) rinse in clean water; and 3) disinfect with a 10% bleach solution and allow to air dry (Dodd 2010; B. Zarate, personal communication, 2013).
Deer control: Management of deer populations is an important conservation goal identified in the SWAP to promote forest health and biodiversity. Deer consume rare plants, larval foodplants and nectar sources for adult Lepidoptera, alter habitat structure for nesting birds, among other impacts (Côté et al. 2004, Rawinski 2008, Schweitzer et al. 2011). Management measures may include increased hunting efforts or fencing of vulnerable habitat against deer. Managing the size of local deer herds would benefit both rare plants and animals, and any trampling of vegetation by hunters would occur when most plants are dormant.

Beaver control: Beaver control may be needed on occasion and has also been identified as a conservation action in the SWAP. Typically, this could include trapping and removing beaver from a site to prevent dam construction (or partial dam removal), and/or the installation of a water level control device. Since the rare plants and the SGCN animals all rely on a similar site hydrology, beaver control should benefit both.

Recreational Use Management

Regulating ORV and other recreational vehicle use is a goal of the SWAP and ORVs are a threat to some calcareous fen wetlands (Walz 2006). Implementation of conservation actions to either prohibit this activity or restrict use of ORVs to less sensitive areas, coupled with adequate enforcement, would benefit rare plants and animals as well as habitat integrity.

The SWAP also includes a goal to promote public education and awareness, wildlife conservation, and viewing opportunities, all worthwhile actions. However, if wildlife viewing structures or trails are planned in or near calcareous fens, care must be taken to avoid altering site hydrology, permitting unguided access into vulnerable habitat to avoid trampling, introducing invasive plant seeds, and harming sensitive plants and animals during construction.

SPECIES MANAGEMENT (= TRACS ACTION TARGETS)

Species–Specific Management Actions highlighted in the SWAP:

Silver-bordered fritillary – The SWAP identifies conservation actions for this species that include identifying critical habitat, managing for violets (the larval foodplant), and retarding succession where appropriate (see above caveats for vegetation management, although to date no active management has been implemented). Although this fritillary is not generally a fen species (D. Schweitzer, personal communication, 2013), maintaining an intact fen community should benefit this butterfly if or when present, as well as other fen-dependent Lepidoptera species.

Red-headed woodpecker – There are two conservation actions included in the SWAP for these woodpeckers, one that recommends the use of GIS to identify wetlands with standing dead wood and the other to develop BMPs to maintain trees for nesting. Conservation actions to maintain standing dead trees in fens with the woodpeckers (e.g., in Johnsonburg Swamp) can be incorporated into ongoing vegetation management without conflict to other rare plants and animals.

Bog turtle – A number of habitat management actions are proposed in the SWAP to maintain or enhance turtle populations that could potentially conflict with other rare plant and animal species. See the earlier vegetation management discussion for details and recommendations. Other SWAP conservation actions for the bog turtle include conducting research on water quality parameters and protecting turtles from illegal collecting, neither of which would conflict with other rare plant or other animal species.

Scrub-shrub species – In addition to survey and monitoring, the SWAP recommends actions for rights-of-way (ROW) management, as many ROWs provide critical habitat for early successional bird species. If such ROWs cut through fen wetlands, care must be taken with any vegetation management measures that are applied (see vegetation management section above). Collaboration on management techniques used within ROWs may be necessary to avoid incompatibilities when managing for different species occupying the same area.

American Woodcock –The SWAP recommends increasing the number of forests that are managed to contain a mix of seral stages to benefit forest-dwelling species, including American woodcock. As long as the silvicultural practices on forests adjacent to fens are ecologically appropriate and compatible with fen conservation, this management recommendation should not be in conflict with fen plants and other SGCN animals.

TRACKS ACTION #3:
ATA COLLECTION AND ANALYSIS
RESEARCH, SURVEY OR MONITORING

Inventory and Long-term Monitoring

Inventory of all animal SGCN and long-term monitoring have been identified as priorities in the SWAP, however care must be taken when implementing survey and monitoring of fen species. Survey and monitoring for all animal and plant species requires some movement through the fens at various times throughout the season. Trampling of vegetation is a major threat to rare plant species and also to certain SGCN animals. Tramping may alter site hydrology by filling in rivulets with sediment; may crush odonate larva or newly emerged (teneral) adults and Lepidoptera larva or pupa; or harm nests of ground-nesting birds. For these reasons, plant and animal population monitoring efforts at a site should be coordinated to prevent situations where multiple monitoring initiatives are occurring, potentially creating frequent, extensive, long-term disturbance without sufficient recovery periods. As mentioned previously, it is also recommended that there be a thorough survey

and mapping of all rare species found at a site, including population location, status and condition, such that any proposed management can avoid or minimize impacts.

Animal survey and monitoring techniques – minimizing harm to rare plants:
Turtle surveys: Survey and monitoring for spotted and bog turtles would include multiple site visits between March and June, with later season visits also conducted. Substantial trampling may occur as bog turtle monitoring can be intensive, especially if radio telemetry or active trapping with drift fences are components. See above recommendation for coordination of survey work. Consult the plant phenology tables in this report and any rare species maps that are prepared for additional guidance when planning the location and timing of survey work.

Breeding bird surveys: Assessing the status of the ten bird species in these habitats would generally require multiple site visits in May and June during the breeding season, so may affect rare plants. Furthermore, if golden-winged warblers are breeding in an area, a single mist-net may be temporarily set up to capture and band them. Setting up this net may involve trampling and removing tall vegetation and branches near the net. If this is to be done in a fen, the net will most likely be set up along the edge where there are shrubs and trees to provide shade (S. Petzinger, personal communication, 2013). As above, prior to conducting bird surveys in fen habitats, consult the plant phenology tables in this report and any rare species maps that are prepared for additional guidance when planning the location and timing of survey work.

Lepidoptera surveys: Surveys for silver-bordered fritillary would typically occur during the peak flight periods of late June and August. The buckmoth flies in late September when turtles are entering overwintering sites so should not conflict with these animals, however, some rare plants may still be present into November. Planning for any Lepidoptera survey work should include consultation with plant phenology information in this report and any additional rare species maps that are available. The SWAP recommends expanding volunteer citizen scientist recruitment to conduct surveys at particular sites. It is important that reputable groups are chosen and that survey methodology be developed upfront, so that citizen scientists can avoid harming any rare plant species that might be present at the survey site.

Odonate surveys: Surveys would be conducted from May through August as Kennedy's emerald flies early in the season, in May and June while the brush-tipped emerald flies during the summer. Dragonfly and damselfly survey and monitoring at a fen could include netting of adults for identification in the hand, searching for larvae in rivulets and/or exuviae along the water's edge, and specimen collection if deemed necessary. Such activities may trample the plant community so care must be taken during survey work to avoid rare plant locations. Consultation with the plant phenology tables in this report and any rare species maps that are prepared will help avoid harm to rare plants and other sensitive species.

Plant survey and monitoring techniques- ways to minimize harm to animals:

Plant surveys: Plant surveys and rare plant monitoring activities can occur throughout the growing season as phenology differs among species, and over multiple years since growing conditions vary from year to year. Such activities may include random searches through habitat, use of parallel transects, and/or the establishment of long-term vegetation monitoring plots.

Recommendations for plant surveys:

Impacts on ground-nesting birds can be minimized when doing plant surveys the following ways: If possible, conduct the surveys before May or after July to avoid the nesting season altogether. If surveys must be done during that time, care should be taken to stay on trails (paths, wildlife trails, etc.) whenever possible, avoid stepping on any tussock sedges (where some birds may be nesting) and try to walk through areas where vegetation is less dense (where you can see the ground when walking). If going off trail in dense grasses or forbs, use a walking stick to brush the vegetation in front of where you are walking. Doing this may make you aware of a nest in your path (flush a bird off the nest) as well as help you see the ground you are stepping on before you take the step (S. Petzinger, personal communication, 2013).

Impacts to turtles: Avoid stepping atop of raised hummocks and moss beds, particularly between May and September, where fen turtles tend to nest.

Climate Change Vulnerability Assessment

The year 2012 was the warmest on record nation-wide (NOAA 2013) and in the garden state (Robinson 2013), with more changes forecast to come. In New Jersey the effects of climate change are projected to include: an increase in average temperature (minimum 2-6 °F. increase by 2050) and precipitation (although the exact nature of the change in precipitation may vary across the state); more extreme weather events such as storms and droughts; and sea level rise. Generally we can expect more prolonged summer heat waves with temperatures above 90° F., and fewer cold days and nights during the winter, which may be of import for those species requiring cold dormancy. Rainfall, especially in the northern part of the state, may increase in amount mainly in the winter moths (Faass et al. 2012, NJ Climate Adaptation Alliance 2013a).

Fen Habitats and Climate Change:

According to Faass et al. (2012) there are a number of stressors that should be looked at to determine whether or not a particular plant community in a habitat is vulnerable to climate change. These stressors include: 1) exacerbation of other non-climate stressors; 2) specific hydrologic conditions; 3) vulnerability to human response; 4) sensitivity to extreme climate events; 5) intrinsic adaptive capacity; 6) species vulnerability; 7) latitudinal constraints; 8) management feasibility; 9) degree of cold adaptation; and 10) location in geographical range. (For a detailed discussion of each of these stressors, see Faass et al. 2012.)

Fen wetlands are susceptible to a number of these stressors. Fens are maintained by specific hydrologic conditions that require a fairly even distribution of precipitation throughout the year. The significant alteration to precipitation patterns anticipated with a changing climate (e.g., greater flood events, increased drought during the summer months) may alter groundwater flow and seepage. This in turn will affect plant and animal species composition, favoring species adapted to drier conditions and possibly permitting greater invasive species incursion (non-climate stressor) (NJ Climate Adaptation Alliance 2013b). Although fen communities are found wherever there is karst topography, the type of fens found in New Jersey are of northern affiliation and many plant and animal species within them are also at the southern edge of their range, making them more vulnerable to changing climate. Responses of these species to predicted warming trends may include a range contraction or shift northward.

Species and Climate Change:

Plants: Using the NatureServe Climate Change Vulnerability Assessment (CCVA) model (NatureServe 2011), state endangered plants in New Jersey calcareous fen habitat were assessed for climate vulnerability (Ring and Spencer 2013). Two sedges, Tuckerman's sedge (*Carex tuckermanii*) and cyperus-like sedge (*Carex pseudocyperus*) were considered highly vulnerable to a changing climate (both are at the extreme southern edge of their range). Most calcareous fen state endangered plant species (21 species, 75%) were considered moderately vulnerable, with the main factors being their location at the southern edge of their range and their inability to tolerate warmer conditions and altered hydrologic regime. In addition, calcareous wetland connectivity may not be sufficient to allow movement in response to climate changes. Only five plant species were presumed stable. See Ring and Spencer (2013) for more detailed discussion.

Animals: New Jersey's SGCN animals have not yet been assessed for vulnerability to climate change. However, some predictions can be made about how they would fare in future years given a warming climate by consultation with experts and other species assessments.

Although no CCVAs were conducted for these particular rare **butterflies and moths**, Lepidoptera depend on the presence of their larval food plants for survival. Climate-induced alterations to fen wetlands that change hydrology and species composition could affect persistence of these insects. A key threat to Mitchell's satyr (should any undiscovered populations persist in New Jersey) might be succession of wetland habitat such that the sedges that the larvae feed on are no longer available.

In contrast, buckmoth larvae feed on shrubby cinquefoil, bog birch, and willow, all of which have been determined to be 'presumed stable' by Ring and Spencer (2013). As long as other critical habitat characteristics remain in place (site hydrology, presence of *Sphagnum* pupation sites, etc.) the buckmoth may persist, although a more thorough assessment is needed before any stronger predictions can be made.

Silver-bordered fritillary have been declining in recent years, particularly at the southernmost edge of their range in the Washington D.C. area, and in southern New Jersey, and it is likely that the climate change that is already occurring and its associated erratic hydrologic regimes have been contributing factors (D. Schweitzer, personal communication, 2013). Silver-bordered fritillary feed on violets, although it is unknown if they require a particular species of *Viola*. CCVAs were not conducted on *Violas*. Given that New Jersey is located at the southeastern-most extent of the fritillary's range and that its range has contracted dramatically in recent years, it is possible that this species will disappear from the state in the future regardless of species management efforts and future climate change impacts.

There are other fen Lepidoptera that may be affected by climate change that were not included in the SWAP when originally written. These include northern populations of Dion skipper (*Euphyes dion*) that rely on calcareous wetlands, the eyed brown (*Satyrodes eurydice*) found at one or two fen sites in this region, (D. Schweitzer, personal communication, 2013), and the Acadian hairstreak (*Satyrium acadica*) (W. & S. Wander, personal communication, 2013). Future updates to the SWAP may want to consider these species for inclusion.

Both **dragonflies** also rely on a specific site hydrology. Although no CCVAs were prepared for these two species, it is likely that their ranges will also contract northward with a warming climate as they are at their southern limit and dependent on cold water habitats (A. Barlow, personal communication, 2013).

Bog and spotted turtles: CCVAs were conducted for bog turtles and spotted turtles by both New York State and Pennsylvania. Bog turtles are considered by both states to be extremely vulnerable to climate change. The key factors contributing to this extreme vulnerability include their specialized habitat requirements (site hydrology), spotty distribution on the landscape, excessive collecting pressure, and poor dispersal ability (Furedi et al. 2011, Schlesinger et al. 2011). It is likely that New Jersey bog turtle populations also would be considered extremely vulnerable as the same factors apply. Spotted turtles were considered moderately vulnerable in Pennsylvania and presumed stable in New York, their lower level of vulnerability likely due in part to the fact that they are not restricted to calcareous wetlands and can use a variety of wetland habitats and that the NY/PA/NJ populations are at the center of the species' range. Although is it not known how sex is determined in bog turtles, many other turtles like the spotted turtle have temperature-dependent sex ratios, which might be altered with a changing climate. Creating and maintaining wetland connectivity in the future is vital to the persistence of viable populations of these turtle species.

Scrub-shrub nesting birds: No CCVAs were prepared for these species in New Jersey. Over time, the more northern affiliate species will likely disappear as breeders in the state as their ranges contract northward. However, a CCVA prepared in Pennsylvania for golden-winged warblers considered them not vulnerable, and likely to increase in that state (Furedi et al. 2011). Since most birds are more mobile and can move longer distances (in contrast to plants and other animals like salamanders), are not overly sensitive to

temperature, and have a more generalized diet, some species may be less affected by climate change so long as sufficient habitat exists and they are not negatively affected by other competing species expanding their ranges northward into New Jersey (Furedi et al. 2011). However, a phenological mismatch, where the arrival of some migratory birds to their breeding habitat earlier in the season may put them out of synch with their invertebrate food supply, could be a problem. Generalized predictions for all scrub-shrub nesting birds are difficult to make, especially when the entire range of the species is not included in the CCVA (Furedi et al. 2011).

Climate Change Summary

Fen habitats, as well as the species most closely tied to site hydrology (i.e., bog turtles, some butterflies, and plants) are highly vulnerable to climate change. Due in part to their mobility, most of the SGCN birds covered in this report may be less vulnerable and able to find and use other early successional wetland habitats in northern New Jersey.

Maintaining site hydrology and providing calcareous wetland connectivity are the most important conservation actions in light of climate change. Maintaining wetland landscape connectivity will be crucial so that movement can occur among wetland habitats as the fen landscape changes. Typically, mobile animal fen species such as turtles and some butterflies move among habitats and colonize new habitats via stream corridors or other wetland linkages. Rare plants also move among wetlands, their propagules dispersed by water or by animals (e.g., carried as seeds or other propagules on feet or fur). Such networks of wetlands are necessary to allow movement and gene flow among populations of rare plants, bog turtles, or other species and must extend across state boundaries. Of import is linking geophysical settings, enhancing connectivity of wetlands on calcareous bedrock and following these geologic corridors into nearby New York and Pennsylvania (Anderson and Ferree 2010). Regional conservation assessments and collaboration will be essential, as species and habitat ranges shift.

No species-focused SGCN animal management actions have been identified in the 2008 SWAP to address climate change. Calcareous fen habitat and species management actions currently outlined in the SWAP should continue, modified as needed by the recommendations in this report.

Addressing existing hydrology and water quality issues, invasive species, recreational overuse, and other threats as necessary to maintain or restore existing habitat will be key to resiliency. The ability of fen habitats to withstand change over time while retaining their basic structure and function will enable them to support viable populations of rare plants and wildlife SGCN into the future (Anderson and Ferree 2010).

Overall Conclusions

While there are some areas of potential conflict in fen species management, generally it appears that with regular communication and coordination among land managers,

botanists, and zoologists, calcareous fen habitats can be successfully managed for wildlife SGCN and the rare plants.

In addition, we recommend that an assessment of species and threats to calcareous fens in New Jersey on both public and private lands be conducted as there are many landowners actively managing their fens for single species (e.g., bog turtles) who may be unaware of the rare plants that may also be found in those habitats. Ultimately, some fens might be best managed for a single species, such as for bog turtles, while others could be successfully managed for a suite of fen-dependent species but a full review of all sites is critical before such determinations can be made.

Integrated Management Guidelines:
Calcareous Sinkhole Pond Habitat

Appalachian Mountain Boltonia *(Boltonia montana);* Calcareous Sinkhole Pond*;* Long-tailed Salamander *(Eurycea longicauda longicauda)*

Overview

Calcareous sinkhole ponds and their associated rare plant communities are wetlands that occur on calcareous bedrock at the ground-water interface (Walz et al. 2000). In New Jersey, these ponds are found predominantly in the northwestern part of the state in the Appalachian valley and ridge province (Sussex and Warren counties). Typically, these ponds fill with water in winter and early spring. During the summer, as the water table drops, a diverse plant community develops on the pond shore, supporting numerous rare species. In addition, these pondshore habitats themselves are rare throughout their range and in fact, there are several types that are found only in New Jersey and nowhere else in the world (Walz et al. 2000). There are six different calcareous sinkhole pond ecological community types found in New Jersey, but for the purposes of this report we are addressing sinkhole ponds as a habitat system, not focusing just on one particular pond type.

They are included in the NE Wildlife habitat classification system as Central Interior Highlands and Appalachian Sinkhole and Depression Pond; in the New Jersey Landscape Map as Forest and Wetland Species-Based Habitat, and Vernal Habitat; and mapped in the New Jersey Land Use/Land Cover as Herbaceous Wetlands, Deciduous Wooded Wetlands and Mixed Forest Wetlands (Deciduous Dominant).. See Appendix B for more details on habitat classification.

Thirteen (13) state endangered plant species occur in calcareous sinkhole ponds, including Large Water-plantain (*Alisma triviale*), Appalachian Mountain Boltonia (*Boltonia montana*), Cloud Sedge (*Carex haydenii*), Hop-like Sedge (*Carex lupuliformis*), Small Floating Manna Grass (*Glyceria borealis*), Larger Canadian St. John's Wort (*Hypericum majus*), Water-marigold *(Megalodonta beckii*), Lake Water-cress (*Neobeckia aquatic*), Wiry Panic Grass (Panicum flexile), Arum-leaf Arrowhead (*Sagittaria cuneata*), Torrey's Bulrush (*Schoenoplectus torreyi*), Small Burr-reed (*Sparganium natans*), Lesser Bladderwort (*Utricularia minor*). See Appendix A for a complete list of state endangered plant species with rarity rankings.

The ponds also provide important breeding habitat for three rare salamanders identified as Species of Greatest Conservation Need (SGCN) in the 2008 New Jersey State Wildlife Action Plan (SWAP). They include Jefferson (*Ambystoma jeffersonianum*), marbled (*Ambystoma opacum*), and long-tailed (*Eurycea longicauda longicauda*) salamanders.

Threats:
General threats to the calcareous sinkhole pond habitats include changes to hydrology and to water quality and chemistry due to adjacent residential and commercial development or agriculture. These ponds rely on groundwater connection and this region of karst is very susceptible to changes in groundwater flow if development or agriculture intentionally or unintentionally diverts underground flow away from a wetland. (Karst systems are complex, and wetlands may be linked hydrologically underground even if no surface connection is evident.)

Ponds require significant habitat buffer around them to ensure water quality. In ponds adjacent to roads, the use of deicing salts and ensuing runoff alters pond chemistry. This not only affects rare plants adapted to the calcareous water chemistry of the ponds but also adversely affects amphibian development. Road traffic is also a source of significant mortality for mole salamanders and other amphibians as they cross roads to reach the ponds during the breeding season.

Other threats include invasive species, in particular nonnative plants such as purple loosestrife (*Lythrum salicaria*), Japanese stiltgrass (*Microstigium vimineum*), common reed (*Phragmites australis)*, Japanese knotweed (*Polygonum persicaria)*, garlic mustard (*Alliaria petiolata),* and Japanese barberry (*Berberis thunbergii*), which affect the integrity of the sinkhole pond habitat or its calcareous upland buffer. In larger ponds, recreational activities such as shoreline fishing or boating access that tramples sensitive pondshore vegetation can be a problem. The use of off-road vehicles (ORVs) and 4WD access in some ponds crushes plants and compacts the soil, while hiking trails placed adjacent to a pond edge with sensitive vegetation also can threaten the rare plant community and inadvertently introduce invasive species carried on shoes from other nearby sites. Onsite and offsite use of herbicides and pesticides also may harm nontarget plants or animals (Walz et al. 2000).

A summary of CMP Threats to state endangered plants and wildlife SGCN in calcareous sinkhole pond habitat is found in Appendix C.

Species Ecology

Plants:

Calcareous sinkhole ponds support a distinctive flora with significant populations of rare plants species that prefer calm shallow waters. Many are calcicoles found only in calcareous habitats, such as *Chara* spp.*, Carex cryptolepis, Carex viridula*, and hop-like sedge (*Carex lupuliformis)* (Walz et al. 2000). Most are adapted to seasonal flooding and drying, even requiring a seasonal natural drawdown for reproduction and/or seed germination.

For example, many Carex species require exposed mud for seed germination and bare, moist mud also facilitates rooting of the stem and leaf fragments of lake water-cress (*N. lacustris*).

Boltonia montana has a very restricted range, found only in New Jersey and Delaware and likely extirpated from Pennsylvania. Of the twelve rare plants identified from sinkhole ponds and that are covered in this report, seven reach their southern limit in New Jersey. These include arum-leaf arrowhead (*Sagittaria cuneata*), large water-plantain (*Alisma triviale*), water-marigold (*Megalodonta beckii*), small floating manna grass (*Glyceria borealis*), cloud sedge (*Carex haydenii*), small burr-read (*Spharganium natans*), and lesser bladderwort (*Utricularia minor*). Others are found at mid-range for the species overall (e.g. wiry panic grass [*Panicum flexile*], Torrey's bulrush [*Schoenoplectus torreyi*], lake water-cress [*Neobeckia lacustris*], hop-like sedge [*Carex lupuliformis*]), but are rare due to the limited distribution of the calcareous sinkhole pond habitat in New Jersey.

The following two tables provide a list of state endangered species that can found in calcareous sinkhole ponds in New Jersey with their phenology, or timing of vegetative, flowering and fruiting, and comments on their habitat/niche. The phenology and habitat information can be used to help avoid negative impacts to these state endangered plant species during wildlife surveys and management activities.

FL = Flowering; FR = Fruiting; V = Vegetative

Phenology of State Endangered Plant Species in Calcareous Sinkhole Pond Habitat

		APRIL		MAY		JUNE		JULY		AUG		SEPT		OCT		NOV	
Scientific Name	**Common Name**	**1-15**	**16-30**	**1-15**	**16-31**	**1-15**	**16-30**	**1-15**	**16-31**	**1-15**	**16-31**	**1-15**	**16-30**	**1-15**	**16-31**	**1-15**	**16-30**
Alisma triviale	Large Water-plantain								FL	FL	FL, FR	FL, FR	FL, FR	FR	FR		
Boltonia montana	Appalachian Mountain Boltonia									FL	FL	FL, FR	FL, FR				
Carex haydenii	Cloud Sedge			FL	FL, FR	FR	FR										
Carex lupuliformis	Hop-like Sedge						FL	FL	FR	FR	FR	FR	FR	FR			
Glyceria borealis	Small Floating Manna Grass					FL	FL, FR	FR									
Hypericum majus	Larger Canadian St. John's Wort								FL	FL	FL, FR	FL, FR	FL, FR	FR			
Megalodonta beckii	Water-marigold								FL	FL	FL, FR	FL, FR	FL, FR	FL, FR	FR		
Neobeckia aquatic	Lake Water-cress								FL, FR	FL, FR	FL, FR	FR					
Panicum flexile	Wiry Panic Grass									FL	FL, FR	FR	FR	FR			
Sagittaria cuneata	Arum-leaf Arrowhead						FL	FL	FL, FR	FL, FR	FL, FR	FL, FR	FR	FR			
Schoenoplectus torreyi	Torrey's Bulrush								FL	FL, FR	FL, FR	FR	FR	FR			
Sparganium natans	Small Burr-reed									FR	FR	FR					
Utricularia minor	Lesser Bladderwort					FL	FL	FL	FL	FL							

SOURCE: New Jersey Natural Heritage Program, Biotics Database

Calcareous Sinkhole Pond -- State Endangered Plant Habitat/Niche Comments

Scientific Name	Common Name	Habitat/Niche Comments
Alisma triviale	Large Water-plantain	Shallow water of limestone sinkhole pond, often dominant in patchy mosaic, muddy substrate.
Boltonia montana	Appalachian Mountain Boltonia	Upper pondshores of calcareous sinkhole ponds, on silt over dolomite or rarely on marly peat.
Carex haydenii	Cloud Sedge	Upper pondshores of calcareous sinkhole ponds, on silt over dolomite, often stony.
Carex lupuliformis	Hop-like Sedge	Upper pondshores of calcareous sinkhole ponds in shallow water; open to partial shade (often under trees at edge of pond).
Glyceria borealis	Small Floating Manna Grass	Shallow water of calcareous sinkhole ponds, often in wet mote around edge of ponds.
Hypericum majus	Larger Canadian St. John's Wort	Wet marl or calcareous soils of fens and sinkhole ponds.
Megalodonta beckii	Water-marigold	Shallow water of calcareous sinkhole ponds, usually growing in mucky substrate.
Neobeckia aquatica	Lake Water-cress	Open water in marl ponds and calcareous lakes.
Panicum flexile	Wiry Panic Grass	Upper pondshores of calcareous sinkhole ponds, on marl or rocky dolomitic silt.
Sagittaria cuneata	Arum-leaf Arrowhead	Shallow water of limestone sinkhole pond, often dominant in patchy mosaic, mucky substrate.
Schoenoplectus torreyi	Torrey's Bulrush	Shallow water of limestone sink hole ponds, mucky substrate.
Sparganium natans	Small Burr-reed	Grows on muddy bottom or in shallow water of a calcareous sinkhole pond.
Utricularia minor	Lesser Bladderwort	Grows in shallow, calcareous water of marshes, pond shores, and marl fens.

SOURCE: New Jersey Natural Heritage Program, Biotics Database

Animals:

The three animal species of greatest conservation need identified in the 2008 State Wildlife Action Plan that use sinkhole ponds are amphibians, specifically salamanders (Jefferson, marbled, and the long-tailed salamander). Both Jefferson and marbled salamanders are mole salamanders, so named as they spend most of the year in underground retreats in forested uplands surrounding their breeding ponds (Petranka 1998). Mole salamanders breed in sinkhole ponds, taking advantage of the ephemeral nature of these wetlands and the fact that ponds typically dry out during the summer months. This drying out period reduces predation pressure from fish and other predators that require permanent water (Colburn 2004). **Jefferson salamanders** migrate to these sinkhole ponds in late winter/early spring, mate, and deposit their eggs in small clusters attached to vegetation in the water. In contrast, **marbled salamanders** migrate to the ponds in the fall. Females deposit their eggs under leaves, moss, or fallen woody debris in the dry pond basin. The females typically guard the clutch from predators until the ponds refill with water later in the season (Kenney and Burne 2000). Regardless of when the adults arrive at the ponds, once the larvae of either salamander species hatch they must complete metamorphosis before the ponds dry out in early summer.

Long-tailed salamanders are less dependent on the ephemeral hydrology of sinkhole ponds, overwintering in connected seepages and underground crevices and caves. Adults emerge from these overwintering sites in late April/early May. During the summer, they also depend on wooded buffer around breeding ponds (and in certain areas they use adjacent rocky seepage areas) but typically do not venture far from water. They return to underground aquatic retreats in the fall, and mate and lay eggs overwinter. Larvae metamorphose in June and July (Kenney and Burne 2000).

Integrated Conservation Management Guidelines

The following integrated conservation management guidelines address broad categories linked to conservation actions identified in the SWAP for SGCN animals that use calcareous sinkhole pond habitats. They are also correlated the TRACS ACTIONS Level 1. We have specifically targeted discussion around the actions where there may be potential for management incompatibility between rare plants and SGCN animals. An important first step in the planning process would be to conduct a thorough survey and mapping of all rare plant and animals species found at a site, including population location, status and condition, such that any proposed management can avoid or minimize impacts.

TRACS ACTIONS
1. Coordination and Administration
2. Create, Restore, or Enhance Habitat and Natural Processes
3. Data Collection and Analysis
4. Education
5. Facilities and Areas/New Construction
6. Facilities and Areas/Major Renovation
7. Facilities and Areas/Operations and Maintenance
8. Land and Water Rights/Acquisition and Protection
9. Law Enforcement
10. Outreach
11. Planning
12. Species Reintroduction and Stocking
13. Technical Assistance

TRACS ACTION #2:
CREATE, RESTORE, OR ENHANCE HABITAT AND NATURAL PROCESSES

Hydrology and Water Quality Management

The protection of water quality in critical wetlands and other aquatic habits for target animal species is an overarching goal identified in the 2008 SWAP in particular, preserving the ecological quality and integrity of vernal pool communities. Management that ensures maintenance of pond hydroperiod and water quality (e.g., limiting development near the ponds and regulating use of road salts) would benefit all taxa. The Jefferson salamander is particularly vulnerable to habitat acidification (Sadinski and Duncan 1992), as are the rare plants in sinkhole pond habitats.

Research to identify groundwater recharge areas (recommended in the SWAP) also would benefit both rare plants and animals at these sites.

Vegetation Management:

Managing succession: Shrub or sapling encroachment has not been identified as a significant threat to the rare plant community in New Jersey's calcareous sinkhole ponds to date (Walz et al. 2000), or to salamander SGCN although targeted invasive plant species control may be necessary at some sites (see below). So long as the site hydrology remains intact, there should be minimal woody vegetation management needed in calcareous ponds.

> Manual vegetation removal: Hand-pruning or selective cutting of woody vegetation can be used to set back succession and open the canopy for those plant and animal species that require it. If done in the winter months, there will be little impact to pond vegetation or other animal species that use the habitat.
>
> Use of herbicides: Extreme care must be taken if herbicides, especially broad spectrum are used in calcareous sinkhole pond habitats. Only direct hand application (e.g., hand painting stump cuts) should be considered for vegetation control adjacent to rare plant populations.

Silvicultural practices on adjacent uplands: The SWAP includes recommendations to promote ecologically sound silvicultural practices on critical upland habitats and wetland buffers. This would certainly be of benefit to rare plant and animal species that rely on pristine pond water quality and appropriate pond chemistry. In addition, the quality of the surrounding forest habitat is critically important to mole salamanders, which spend 11 months of the year there.

Utility rights-of-way management: The SWAP recommends the development of BMPs for Rights-of-Way (ROW) management for scrub-shrub and other species that may use them. As ROWs occasionally cut through calcareous sinkhole pond habitats, the development of management guidelines should be coordinated such that all rare plants as well as wildlife SGCN using ROWs are incorporated into BMPs. This will assist the landowner in making appropriate management decisions and to avoid potentially conflicting recommendations.

Invasive, Over-abundant, and Pest Species Management:

Invasive plant species: Management and control of invasive plant species is an important conservation goal identified in the SWAP and a priority in the Skylands zone, although there were no specific invasive plant species control actions proposed to improve habitat for salamanders. However, a number of invasive plant species, in particular purple loosestrife (*Lythrum spicata*), reed canary grass (*Phalaris arundinacea*), common reed (*Phragmites australis*) and Eurasian water-milfoil (*Myriophyllum spicatum*)pose significant threat to the habitat itself (e.g., Spring Lake at Swartswood State Park), as well as to rare plant populations. Should new invasive plant populations become established, control should begin with the least harmful process (hand pulling or seedhead removal) before

moving toward use of chemicals or other less targeted techniques. Biocontrol may be an option for some invasive species, however consultation with experts, both botanists and zoologists is always warranted when considering the use of chemicals and/or biocontrol. Decisions should be made on a site-by-site basis to prevent (or minimize) negative impacts to non-target rare plant or animal species.

Deer control: The management of deer populations is a major conservation action identified in the SWAP to promote forest health and biodiversity. Management measures may include increased hunting efforts or fencing of vulnerable habitat against deer. Managing the size of local deer herds would benefit both rare plants and SGCN animals in ponds and upland forest buffer areas, and any trampling of vegetation by hunters would occur when most plants are dormant. Although deer have not yet been identified as a significant problem in calcareous sinkhole pond habitats for either plants or SGCN animals, browsing activity should be regularly monitored.

Beaver control may be needed on occasion and has also been identified as a conservation action in the SWAP. Typically this could include trapping and removing beaver from a site to prevent dam construction (or partial dam removal), and/or the installation of a water level control device. Since the rare plants and the salamanders in sinkhole pond habitats all rely on a similar pond hydrology, beaver control should benefit both.

Insect pests and/or disease pathogens: Insect pests may be targeted for control in and around calcareous sinkhole ponds (e.g., mosquitoes, gypsy moths). Control measures often include application of pesticides, many of which are broad spectrum or are applied at times of the year when other invertebrates are vulnerable or are applied in a manner harmful to the rare plant community (e.g., trampling). Any proposed control measures should be site specific and the use of integrated pest management and committed, ongoing coordination among agencies and with pond managers to reduce non-target impacts is critical. In all cases, botanists and zoologists should be included in the discussion to avoid any potential harm to rare plant or SGCN animal populations or the habitat.

Note: Proper protocols should be put into place for all field biologists to prevent the spread of invasive species propagules and/or disease pathogens (e.g. Chytrid fungus, Ranavirus) among wetland sites. It is best to follow these or similar recommendations between site visits: 1) wash boots and field equipment with soap and water; 2) rinse in clean water; and 3) disinfect with a 10% bleach solution and allow to air dry (Dodd 2010; B. Zarate, personal communication, 2013).

Recreational Use Management

Although most calcareous sinkhole ponds are small and fishless, boating and shoreline fishing are popular activities at the larger sinkhole ponds in New Jersey such as Swartswood Lake (Walz et al. 2000). Without safeguards, these activities can inadvertently harm sensitive rare plants such as Appalachian Mountain Boltonia (*Boltonia montana*) and contribute to the spread of invasive species or pathogens from one pond to another. Use of ORVs and other recreational vehicles also threaten certain sinkhole pond wetlands and

regulating their use is a goal of the SWAP. Implementation of conservation actions to manage and/or restrict such activities in sensitive areas as appropriate, coupled with adequate enforcement, would benefit rare plants and wildlife SGCN.

Promoting public education and awareness, wildlife conservation, and viewing opportunities is an important goal of the SWAP. However, if wildlife viewing structures or trails are planned for construction in or near calcareous sinkhole ponds, care must be taken to avoid altering site hydrology, permitting unguided access into vulnerable habitat to avoid trampling and introducing invasive plant seeds, and harming sensitive plants and animals during construction.

SPECIES MANAGEMENT (= TRACS ACTION TARGETS)

Species-Specific Management Actions (Highlighted in the SWAP):

Salamanders: SWAP recommendations for the rare salamanders are general, addressing the need to protect critical habitat for these species. Salamanders require significant forested habitat around breeding ponds. Protection of this intact woodland buffer also benefits pond vegetation by reducing runoff and maintaining water quality. Onsite management for salamanders might entail allowing woody debris to accumulate on the forest floor (with perhaps the addition of cover boards), which would not negatively affect pond vegetation.

Active management for mole salamanders (and other herps) identified in the SWAP also includes monitoring road crossings during salamander migration to the breeding ponds. This typically occurs during rainy evenings in late winter/early spring, which should not affect the plant community at the pond. [Note: there is a Conserve Wildlife Foundation of New Jersey proposal to construct a road crossing culvert at one salamander breeding population at Swartswood State Park. Care must be taken to survey and map any locations of rare plants to avoid tramping and to prevent runoff from entering the wetland during and after construction.]

The SWAP also recommends conducting research that looks at the effects of various water quality parameters on salamanders identified as SGCN. Perhaps any proposed research initiatives could be broadened to include rare plants that are a significant part of the sinkhole pond community.

TRACS ACTION #3:
DATA COLLECTION AND ANALYSIS (TRACS Action Level 1)
***Research, Survey, or Monitoring* (TRACS Action Level 2)**

Inventory and Long-term Monitoring
Inventory and long-term monitoring of all animal SGCN have been identified as priorities in the SWAP. A good first step should be a vegetation assessment that maps the locations of rare plants such that future amphibian or other animal surveys can avoid locations of sensitive plant populations. In addition, plant and animal population monitoring efforts at a

site should be coordinated to prevent situations where multiple monitoring initiatives are occurring, potentially creating frequent, extensive, long-term disturbance without sufficient recovery periods.

Animal survey and monitoring techniques – minimizing harm to rare plants:

Vernal pool habitat surveys: Surveying for vernal pools has been identified in the SWAP as a priority. While this habitat is classified as "Eastern Woodland Vernal Pool Sparse Vegetation" in the National Vegetation Classification, in NJ calcareous sinkhole ponds are considered to be vernal pool habitat by the Division of Fish and Wildlife. "Vernal habitat" is defined in the NJDEP Freshwater Wetlands Protection Act as a wetland or State open water that meets four criteria including 1) confined basin depression without permanent flowing outlet, 2) evidence of breeding by one or more species of obligate and/or facultative fauna adapted to reproduce in ephemeral aquatic conditions, 3) maintains ponded water for at least two continuous months between March and September of a normal rainfall year, and 4) is free of reproducing fish populations throughout the year, or dries up at some time during a normal rainfall year. See Appendix E for more details and a list of vernal habitat obligate and facultative species. More information can also be found at. Much work has already been done with the use of remote sensing, followed by site visits to verify pond presence (see http://www.nj.gov/dep/fgw/ensp/vernalpool.htm). Typically, site visits to ground-truth remotely-sensed data are easiest to do in the winter when ponds are full of water (or frozen) and there is no ground cover so generally there would be little or no impact to the rare plant community. Site visits in the spring to confirm the presence of obligate wetland species (e.g., wood frogs, fairy shrimp) should also occur early enough in the season to avoid trampling rare plants.

Mole salamander surveys: Typically, survey and monitoring of mole salamander breeding at ponds occurs in the early spring and care is taken to minimize tramping in the pond to not harm salamander eggs (Heyer et al. 1994). This is well before any of the target rare plant species would have emerged so should not conflict. Follow-up survey for larvae (dip-netting) may occur later in the spring when plants may have begun growth. Adult salamanders are surveyed by searching under logs or cover boards adjacent to the pond edge and in the upland forest. When surveying for mole salamanders, avoid trampling areas of exposed vegetation or uprooting plants if using dip nets. When placing cover boards, avoid covering rare plants at pond edge or in upland areas. Consult the plant phenology tables in this report and any rare species maps that are prepared for additional guidance when planning the location and timing of survey work.

Long-tailed salamander surveys: Surveys for long-tailed salamanders usually occur later in the season when plants might be actively growing. Dip-netting for larvae, searching for adults under logs or cover boards adjacent to the pond edge, or searching seepage areas in outcrops away from the pond are all standard techniques. When conducting surveys for long-tailed salamanders, avoid trampling areas of exposed vegetation or uprooting plants if using dip nets. When placing cover boards to avoid rare plants at pond edge or in upland areas. Consult the plant phenology tables in this report and any rare species maps that are prepared for additional guidance when planning the location and timing of survey work.

Plant survey and monitoring techniques- ways to minimize harm to animals:

Plant surveys: Plant surveys and rare plant monitoring activities can occur throughout the growing season as phenology differs among species, and over multiple years since growing conditions vary from year to year. Such activities may include random searches through habitat, use of parallel transects, and/or the establishment of long-term vegetation monitoring plots. There are no anticipated impacts to SGCN salamanders by plant surveying in calcareous sinkhole ponds.

Climate Change Vulnerability Assessment

The year 2012 was the warmest on record nation-wide (NOAA 2013) and in the garden state (Robinson 2013), with more changes forecast to come. In New Jersey the effects of climate change are projected to include: an increase in average temperature (minimum 2-6 °F. increase by 2050) and precipitation (although the exact nature of the change in precipitation may vary across the state); more extreme weather events such as storms and droughts; and sea level rise. Generally we can expect more prolonged summer heat waves with temperatures above 90° F., and fewer cold days and nights during the winter, which may be of import for those species requiring cold dormancy. Rainfall, especially in the northern part of the state may increase in amount mainly in the winter months (Faass 2012, NJ Climate Adaptation Alliance 2013a).

Calcareous Sinkhole Ponds and Climate Change:

According to Faass et al. (2012) there are a number of stressors that should be looked at to determine whether or not a particular plant community is vulnerable to climate change. These stressors include: 1) exacerbation of other non-climate stressors; 2) specific hydrologic conditions; 3) vulnerability to human response; 4) sensitivity to extreme climate events; 5) intrinsic adaptive capacity; 6) species vulnerability; 7) latitudinal constraints; 8) management feasibility; 9) degree of cold adaptation; and 10) location in geographical range. (For a detailed discussion of each of these stressors, see Faass et al. 2012.)

Calcareous sinkhole ponds are susceptible to a number of these stressors. These ponds are maintained by specific hydrologic conditions that require a fairly even (predictable) distribution of precipitation throughout the year. The significant alteration to precipitation patterns anticipated with a changing climate (e.g., greater flood events, increased drought during the summer months) may alter groundwater flow and seepage. This in turn will affect plant and animal species composition, favoring species adapted to drier conditions and possibly permitting greater invasive species incursion (non-climate stressor) (NJ Climate Adaptation Alliance 2013b).

Species and Climate Change:

Plants: All thirteen state endangered plant species present at calcareous ponds were assessed for vulnerability to climate change (see Ring and Spencer 2013), using the NatureServe Climate Change Vulnerability Assessment (CCVA) model (NatureServe 2011). Three species of rare plants (cloud sedge [*Carex haydenii*], small floating manna grass [*Glyceria borealis*] and Torrey's bulrush [*Schoenoplectus torreyi*]) were considered highly vulnerable, six (46%) were determined to be moderately vulnerable, two were presumed stable, and for two others there was not enough data to make an assessment. Although there are some exceptions based on individual life history characteristics, many of the most vulnerable are the plant species that are currently at the southern edge of their range. See Ring and Spencer (2013) for detailed discussion.

Animals: New Jersey's SGCN animals have not yet been assessed for vulnerability to climate change. However, some predictions can be made about how they would fare in future years given a warming climate by consultation with experts and species assessments from other states.

Salamanders: Climate change vulnerability analyses (CCVAs) were not conducted for New Jersey populations of the amphibian species. However, we did consult with both the long-tailed and marbled salamander CCVAs completed by the New York Natural Heritage Program and the Jefferson salamander CCVA completed by the Pennsylvania Natural Heritage Program. Long-tailed salamanders were presumed stable in New York, perhaps as they are more tied to ground water habitats that are potentially less likely to dry out. They can also use a wider array of habitats including some swamps and stream seepages in addition to sinkhole ponds. Their status in New Jersey would likely be similar to New York's vulnerability assessment.

In contrast, marbled salamander was listed as highly vulnerable in New York, due to its lack of mobility and specific habitat needs (Schlesinger et al. 2011). Because marbled salamanders are found statewide in New Jersey, a CCVA model might have come out differently, with them being only moderately vulnerable. They still would have limited dispersal capability and dependence on specific hydrology in their habitat, making them sensitive to any climate-linked alterations to site hydrology.

In the Pennsylvania assessment, Jefferson salamander was found to be highly vulnerable in that state mainly due to its limited dispersal capacity and its physical habitat requirements (e.g., vernal pools of specific pH range) (Furedi et al. 2011). It is likely that Jefferson salamander would also be ranked highly vulnerable in New Jersey for similar reasons and due to the fact they have a limited distribution in New Jersey, being restricted to the northern part of the state.

The key unifying threat exacerbated by a changing climate for the most vulnerable plant and animal species is altered hydrology and lowering of water table such that ponds no longer retain sufficient (or any) water. Preventing further drawdown from nearby wells is important, yet remains a challenge in the fractured limestone belt where sinks and springs appear and disappear. Limestone sinkhole ponds that become disconnected from groundwater are most likely to change hydrology, to the detriment of wetland-dependent

plants and mole salamanders. Although the larval period has some plasticity, there is a limit to how shortened it could be for successful transformation to the adult stage.

Climate Change Summary

Calcareous pond habitats as well as the species most closely tied to site hydrology and water chemistry (i.e., certain rare plants and mole salamanders) are highly vulnerable to climate change. Maintaining site hydrology and providing calcareous wetland connectivity are the most important conservation actions in light of climate change. Maintaining or enhancing landscape connectivity among pond sites will allow dispersing salamander juveniles to colonize other suitable pond habitats. Similarly, such connectivity of calcareous wetland habitat could allow for plant population movement via seed or other dispersal mechanisms to new or more suitable habitat as the climate changes. These landscape connections must also link geophysical settings, following limestone corridors across state boundaries to allow for northward migration of habitat or species (Anderson and Ferree 2010). Regional conservation assessments and collaboration will be essential, as species and habitat ranges shift.

Apart from this, no specific wildlife SGCN management actions have been identified in the 2008 SWAP to address climate change. The wildlife SGCN management actions currently outlined in the SWAP should continue, modified as needed by the recommendations in this report. Addressing existing hydrology and water quality issues, invasive species, recreational overuse, and other threats as necessary to maintain or restore existing habitat will be key to resiliency. The ability of calcareous sinkhole ponds habitats to withstand change over time while retaining their basic structure and function will enable them to support viable populations of rare plants and wildlife SGCN into the future (Anderson and Ferree 2010).

Overall Conclusions:
Overall, there appears to be relatively little conflict between conservation management actions proposed for rare salamanders in the 2008 SWAP and rare plant survival in calcareous sinkhole pond habitats. These ponds and their associated plant and animal species share similar threats and have similar management needs.

Integrated Management Guidelines:
Pine Barren Savanna Habitat



Bog asphodel (*Narthecium americanum*); Pine Barren Riverside Savanna; Bog lemming (*Synaptomys cooperi*

Overview

There are two main wetland savanna habitats in the New Jersey Pine Barrens. Pine Barren riverside savannas are sedge and grass dominated wetlands found along stream edges and in floodplains on the coastal plain of New Jersey. They are permanently saturated by groundwater seepage but can be seasonally inundated by stream flooding after storm events (Walz et al. 2006). Often bordered by Atlantic white cedar (*Chamaecyparis thyoides*) or pitch pine lowland swamps, these savannas support many carnivorous plants as well as numerous globally rare plants species such as Knieskerns beaked-rush (*Rhyncospera knieskernii*) and bog asphodel (*Narthecium americanum*). In fact, *Rhynchospora kneiskernii* is listed as Threatened by the U.S. Fish and Wildlife Service, and *Narthecium americanum* is a Candidate species under consideration for listing (Walz et al. 2006a). Pitch pine reedgrass savannas are also found on moist soil but are predominantly maintained by fire. Depending on moisture levels, they share many rare plants species in common with the riverside savanna habitats. The majority of the pine barren riverside savanna habitats are found in natural areas within the Wharton State Forest (Walz et al. 2006a). Pitch pine reedgrass savannas are found within state protected lands including Bass River State Forest, Penn State Forest, Stafford Forge Wildlife Management Area, and federal military Joint Base McGuire-Dix-Lakehurst. There are six different Pine Barren riverside savanna ecological community types and one pitch pine reedgrass savanna type found in New Jersey, but for the purposes of this report we are addressing savanna as habitat systems, not focusing just on one particular savanna type.

Savannas are included in the NE Wildlife Habitat Classification System as Northern Atlantic Coastal Plain Stream and River (Pine Barren riverside savannas) and Northern Atlantic Coastal Plain Pitch Pine Lowland (pitch pine reedgrass savanna); in the New Jersey Landscape Map as Emergent, Forest and Wetland Species-Based Habitat; and mapped in the New Jersey Land Use/Land Cover as Herbaceous Wetlands, Coniferous Scrub/Shrub Weltands, Mixed Scrub/Shrub Wetlands (Coniferous Dominant), and Coniferous Wooded Wetlands. See Appendix B for more details on habitat classification.

Fourteen (14) state endangered plant species occur in pine barren savanas, including Pickering's Reed Grass (*Calamagrostis pickeringii*), Spreading Pogonia (*Cleistes divaricata*), Rough Cotton-grass (*Eriophorum tenellum*), Pine Barren Boneset (*Eupatorium resinosum*), New Jersey Rush (*Juncus caesariensis*), Bog Asphodel (*Narthecium americanum*), Yellow Fringeless Orchid (*Platanthera integra*), Knieskern's Beaked-rush (*Rhynchospora knieskernii*), Long's Woolgrass (*Scirpus longii*), Lace-lip Ladies'-tresses (*Spiranthes laciniata*), False Asphodel (*Tofieldia racemosa),* Reversed Bladderwort (*Utricularia resupinata),* Fringed Yellow-eyed-grass (*Xyris fimbriata*), Death-camus (*Zigadenus leimanthoides*). See Appendix A for complete species list with rarity rankings.

Animals identified as Species of Greatest Conservation Need (SGCN) in the 2008 State Wildlife Action Plan (SWAP) that rely on Pine Barren savannas include southern bog lemming (*Synaptomys cooperi*), four Lepidoptera species including *Dichagyris reliqua*, Arogos skipper (*Atrytone arogos*), Carter's noctuid moth [*Photedes* (*Spartiniphaga) carterae*], and Georgia satyr (*Neonympha areolata*) and one bird species, the northern parula warbler [*Setophaga (Parula) americana*]. See Table A fora list of wildlife SGCN with rarity ranks. [note: The New Jersey and coastal plain populations of Georgia satyr are now considered a separate species, Helicta satyr (*Neonympha helicta*) (D. Schweitzer, personal communication, 2013; see NatureServe 2013).

Threats

Savannas have been present in the Pine Barrens landscape for at least 8000 years (Walz et al. 2006b). In New Jersey, savannas are maintained as open habitat by groundwater seepage and persistent soil saturation, or by fire (pitch pine reedgrass savanna), although past land use may have been a factor in some cases. Past human disturbances have included peat removal, bog iron mining, cedar logging, and cranberry farming (Walz et al. 2006b).

Any significant alteration of these processes will change the plant community composition and vegetation structure, and affect dependent wildlife. For this reason, changes in hydrology, whether a lowering of the water table due to groundwater withdrawal or, conversely, long term flooding by beaver activity, as well as changes to the fire regime can threaten these habitats. In addition, groundwater contamination from agricultural and residential land use or expansion of cranberry bogs into existing savannas on unprotected lands may also be a threat.

While fire is an important element in maintaining pitch pine reedgrass savannas, more frequent, hotter fires that burn through the duff could harm wildlife, especially Lepidoptera. Recreational overuse by ORVs harms vegetation and compacts soils and even exploring canoeists and botanical field trip participants can trample sensitive vegetation. In addition, collecting of orchids and other rare plants also threatens Pine Barrens savanna habitats (Walz et al. 2006a).

A summary of CMP Threats to state endangered plants and wildlife SGCN in pine barren savanna habitat is found in Appendix C.

Species Ecology

Plants:

The rare plants of the riverside savannas are well-adapted to the wet, acidic, nutrient-poor soils of these open savannas, with their particular hydrology. The seeds of some plants such as cotton-grass (*Eriophorum tenellum*) disperse via water, although the plant can also reproduce via spreading rhizomes (Hays 2001).

All of the plant species considered rare are perennials. One, Kneiskern's beaked-rush, is a Pine Barren endemic, found in New Jersey and nowhere else. Seven of the listed plant species are at the northern edge of their range, including the false asphodel (*Tofieldia racemosa*), bog asphodel (*Narthecium americanum*), spreading pogonia (*Cleistes divaricata),* fringed yellow-eyed grass *(Xyris fimbriata),* lace-lip ladies'-tresses *(Spiranthes laciniata*), pine barren boneset (*Eupatorium resinosum*), and the yellow fringeless orchid (*Platanthera integra*). In contrast, other species like rough cotton-grass (*Eriophorum tenellum*), Long's woolgrass (*Scirpus longii*), Pickering's reed grass (*Calamagrostis pickeringii*), and larger St. John's wort (*Hypericum majus*), are at the southern edge of their range.

While predominantly a wetland community, fire may occasionally (drought conditions) pass through riverside savannas. In contrast, pitch pine reedgrass savannas are fire-maintained, where periodic fires are needed to keep the habitat open and promote the persistence of reedgrass and other fire-dependent species. Some plants like Long's woolgrass are considered "pyrophytes", they gain competitive advantage from fire (Rawinski 2001). These species require some periodic disturbance, such as fire, flooding, or herbivory to stimulate flowering.

The following two tables provide a list of state endangered species that can found in Pine Barren Savannas in New Jersey with their phenology, or timing of vegetative, flowering and fruiting, and comments on their habitat/niche. The phenology and habitat information can be used to help avoid negative impacts to these state endangered plant species during wildlife surveys and management activities.

Phenology of State Endangered Plants in Pine Barrens Savanna Habitat

FL = Flowering; FR = Fruiting; V = Vegetative

		APRIL		MAY		JUNE		JULY		AUG		SEPT		OCT		NOV	
SCIENTIFIC NAME	**COMMON NAME**	**1-15**	**16-30**	**1-15**	**16-31**	**1-15**	**16-30**	**1-15**	**16-31**	**1-15**	**16-31**	**1-15**	**16-30**	**1-15**	**16-31**	**1-15**	**16-30**
Calamagrostis pickeringii	Pickering's Reed Grass					FL	FL, FR	FR	FR	FR	FR	FR	FR	FR			
Cleistes divaricata	Spreading Pogonia						FL	FL	FR	FR	FR	FR					
Eriophorum tenellum	Rough Cotton-grass				FL, FR	FL, FR	FL, FR	FR	FR								
Eupatorium resinosum	Pine Barren Boneset								FL	FL	FL, FR	FL, FR	FL, FR	FL, FR	FL, FR	FR	
Juncus caesariensis	New Jersey Rush					FL	FL	FR	FR	FR	FR	FR	FR	FR	FR		
Narthecium americanum	Bog Asphodel						FL	FL, FR	FL, FR	FL, FR	FR	FR	FR	FR	FR	FR	FR
Platanthera integra	Yellow Fringeless Orchid								FL	FL	FL	FL, FR	FL, FR	FR	FR		
Rhynchospora knieskernii	Knieskern's Beaked-rush							FL	FL, FR	FR	FR	FR	FR	FR	FR	FR	
Scirpus longii	Long's Woolgrass				FL	FL	FL, FR	FL, FR	FL, FR	FL, FR	FL, FR	FR	FR				
Spiranthes laciniata	Lace-lip Ladies'-tresses									FL	FL	FL, FR	FL, FR	V			
Tofieldia racemosa	False Asphodel						FL	FL	FL, FR	FR	FR	FR	FR	FR	FR		
Xyris fimbriata	Fringed Yellow-eyed-grass								FL	FL, FR	FL, FR	FL, FR	FR	FR			
Zigadenus leimanthoides	Death-camus							FL	FL	FL, FR	FR	FR	FR	FR	FR		

PINE BARRENS SAVANNAS – State Endangered Plant Habitat/Niche Comments

SCIENTIFIC NAME	COMMON NAME	Habitat/Niche Comments
Calamagrostis pickeringii	Pickering's Reed Grass	Most occurrences are in open, pine barren savannas, also in open, herbaceous swale under a powerline through pine-oak woodland. One of the few grasses that can be found in open Sphagnum mats.
Cleistes divaricata	Spreading Pogonia	Pine barren savannas and margin of Coastal Plain intermittent pond.
Eriophorum tenellum	Rough Cotton-grass	Frows in sedge and grass dominated pine barren savanna. Historically also collected from Atlantic white cedar swamps and various other sphagnous wetlands.
Eupatorium resinosum	Pine Barren Boneset	Saturated to seasonally-saturated sand, such as in pinelands shrub bogs, streambanks and disturbed wet openings. Full or mostly full sun; post-fire sprouting suspected; seedlings thought to require full sun and mineral soil for germination/growth; disturbance creates and maintains habitat.
Juncus caesariensis	New Jersey Rush	Typically found in open sphagnous bogs and seepage areas adjacent to Atlantic white cedar swamps and stream corridors. Also occurs in disturbed areas like roadside ditches and railroad and powerline rights-of way.
Narthecium americanum	Bog Asphodel	A wetland species restricted to sphagnous or peaty sedge and grass dominated savannas and seepage areas adjacent to Atlantic white cedar swamps in the Pine Barrens.
Platanthera integra	Yellow Fringeless Orchid	Grows in open or thicket seepage areas of sedge and grass dominated savannas along pine barren rivers. Historically collected from pitch pine lowland forests.
Rhynchospora knieskernii	Knieskern's Beaked-rush	Grows in saturated to seasonally-saturated fine sand and clay, in open moist areas of pinelands with exposed mineral soil; such as early successional habitats in pitch pine lowlands, riverside savannas, bog iron deposits or flood scoured areas along streams; also in disturbed roadsides, scrapes, gravel pits in wetlands.
Scirpus longii	Long's Woolgrass	Grows in moist to saturated sandy or peaty soils in swales, pond margins, and stream sides. Mostly in pitch pine lowland forest, especially areas with frequent fire history. This species has been observed most often in open shallow-water habitats, described as wet soggy meadows or swales, sedge meadows, sandy-peat bogs, though Sphagnum is usually absent, or depressions, associated with river-stream floodplains, or resulting from human excavations. The shallow water of these habitats is often seasonally fluctuating, subject to summer drought.

Spiranthes laciniata	Lace-lip Ladies'-tresses	Grows in wet, peaty or sphagnous seepage areas of open pine barren savannas and intermittent Coastal Plain ponds.
Tofieldia racemosa	False Asphodel	Grows in open, sphagnous seepage areas of pine barren river savannas.
Xyris fimbriata	Fringed Yellow-eyed-grass	Grows in sphagnous seepage areas of pine barren savannas.
Zigadenus leimanthoides	Death-camus	Grows in peaty thickets, swales, riverside savannas, streamsides, and occasionally open wet woods.

Animals:

The **southern bog lemming** is highly localized, preferring moist grassy areas with hummocks and sphagnum mats, and abundant vegetative cover (although they can use upland habitats (Whittaker and Hamilton 1998). They feed on leaves, stems, and seeds of wetland vegetation with small piles of grass cuttings found in burrows or along runways (Whittaker and Hamilton 1998). Lemmings appear to be most active in May, primarily nocturnal, and move to the wetter areas of the riverside savanna as the summer progresses and other sections dry out. They travel throughout these wetter areas via underground tunnels and surface runways (Buchanan 2006). Sociable animals, they usually occur in small colonies (Whittaker and Hamilton 1998).

The **northern parula warbler** nests in conifers such as Atlantic white cedar. When it is available, they will use old man's beard lichen (*Usnea barbata*) for nest construction (Leck 1979), however they also use other vegetation. Parula warblers forage for insects in the open areas of the savannas but are not restricted to this habitat. They are considered a rare breeder in the Pine Barrens region.

There are four **Lepidopera** species found in Pine Barrens savannas and three of them (*Dichargyris reliqua*, Arogos skipper, and Carter's noctuid moth depend on the presence of Pine Barrens reedgrass (*Calamovilfa brevipilis*). Reedgrass typically is found in patches around the edges of many of the wetter riverside savannas (Walz et al. 2006a). However, it is dominant in a similar community, the pitch pine reedgrass savanna that occurs in broader seepage areas in upper watersheds particularly in the pine plains. These pitch pine reedgrass habitats support the largest populations of these Lepidopteran species.

Arogos skipper prefers a moist savanna habitat in this part of its range, which extends from northern New Jersey south to Georgia. In Pine Barren populations, Arogos larvae feed on the leaves of pitch pine reedgrass. In contrast to the *Dichargyris*, which requires high intensity fire to stimulate production of its food supply, a similar fire regime could destroy populations of this skipper. The larvae overwinter on the food plant wrapped in a leaf and then resume feeding and development the following spring (Schweitzer et al. 2011).
The main threats to Arogos skippers in the Pine Barrens are loss and fragmentation of habitat due to altered hydrology and/or fire regimes, depending on the habitat in which the butterfly is located (e.g., riverside savannas or pitch pine reedgrass savannas). The skipper

often occurs in metapopulations and must be able to readily move among suitable habitat patches (Schweitzer et al. 2011).

Carter's noctuid moth (aka reed grass borer moth) also relies on the persistence of *Calamovilfa brevipilis*. The moth lays its eggs on the leaves and upon hatching, the larvae crawl inside the plant stem to feed, and burrow into rhizomes over the winter. For this reason, they are more tolerant of surface fires. Carter's noctuid moth is generally found in moist pine savannas that burn only rarely (Schweitzer et al. 2011).

Although ***Dichagyris reliqua*** has not been seen in New Jersey since 1995 further survey is warranted (D. Schweitzer, personal communication, 2012). The larvae of this moth feed on the seeds of *Calamovilfa brevipilis* and were typically found in recently burned pitch pine reedgrass savannas. If present, adults fly in late July/early August and the larvae overwinter in the soil. Management for this species would entail frequent, intense growing season burns that promote flowering and seed set (Schweitzer et al. 2011). This moth could be expected in riverside savannas if the foodplant were in flower. Otherwise, it would be underground in diapause.

The fourth Lepidoptera, **Georgia satyr** (*Neonympha areolata*) (now helicta satyr, (*Neonympha helicta*) is also found in open bogs and wet pine savannas in New Jersey as well as in grassy openings in upland pinelands (Cech and Tudor 2005). The Pine Barrens populations are at the northern edge of the species' range and disjunct from the southern core coastal population (NatureServe 2013c). Larvae feed on sedges, and overwinter when partially grown.

Integrated Conservation Management Guidelines

The following integrated conservation management guidelines address broad categories linked to conservation actions identified in the SWAP and correlated with the TRACS ACTIONS Level 1. We have specifically targeted discussion around the actions where there may be potential for management incompatibility between rare plants and SGCN animals. An important first step in the planning process would be to conduct a thorough survey and mapping of all rare plant and animals species found at a site, including population location, status and condition, such that any proposed management can avoid or minimize impacts.

TRACS ACTIONS

1. Coordination and Administration
2. **Create, Restore, or Enhance Habitat and Natural Processes**
3. **Data Collection and Analysis**
4. Education
5. Facilities and Areas/New Construction
6. Facilities and Areas/Major Renovation
7. Facilities and Areas/Operations and Maintenance
8. Land and Water Rights/Acquisition and Protection
9. Law Enforcement
10. Outreach

11. Planning
12. Species Reintroduction and Stocking
13. Technical Assistance

TRACS ACTION #2:
CREATE, RESTORE, OR ENHANCE HABITAT AND NATURAL PROCESSES

Hydrology and Water Quality Management

Protecting critical riverine and riparian habitat in the Pine Barrens along with establishing and maintaining wetland connectivity are key conservation measures identified in the four Pine Barrens zones of the 2008 SWAP. Actions associated with these goals include land protection, work with public and private landowners, and development of sufficient habitat buffers and landscape connectivity. Each of these actions, if implemented, would benefit rare plants and animals found in these Pine Barren savannas, especially riverside savannas. If the hydrology is maintained in these systems, these habitats should remain open and suitable for rare plants and SGCN.

Vegetation Management

Managing succession: In addition to maintaining critical ecological processes, woody vegetation management is a major component of the SWAP, especially for maintaining early successional wetlands like savannas and shrub-scrub habitats. Techniques may include manual removal (e.g., selective cutting and tree removal, mowing or brushhogging), targeted use of herbicides, and/or application of prescribed fire (see fire management section below). Currently no vegetation management has been proposed for SGCN animals in Pine Barren riverside savannas or reedgrass savannas in the core Pine Barrens. However, any future plans for woody vegetation control or management should keep in mind the life history and habitat needs of rare plants and other SGCN animals that occur at individual sites to avoid non-target impacts.

> Manual vegetation removal: Hand-pruning or selective cutting of woody vegetation can be used to set back succession and open the canopy for those plant and animal species that require it. If done in the winter months, there will be little impact to savanna vegetation or other animal species that use the habitat.
>
> Use of herbicides: Extreme care must be taken if herbicides are used in savannas as most are broad spectrum. Only direct hand application (e.g. hand painting stump cuts) should be considered for shrub control adjacent to rare plant populations.

Silvicultural practices on adjacent uplands: The SWAP recommends working with landowners to promote the use of ecologically appropriate forestry practices as a conservation action. Maintaining upland buffers around savannas and implementing such practices in these upland buffers would benefit both rare plants and SGCN animals in savannas in part by reducing erosion and protecting water quality.

Utility rights-of-way management: The SWAP recommends the development of BMPs for Rights-of-Way (ROW) management for scrub-shrub and animal species that may use them. As ROWs may cut through Pine Barren savannas, the development of management guidelines should be coordinated such that all rare plants as well as wildlife SGCN using ROWs are incorporated into BMPs. This will assist the landowner in making appropriate management decisions and to avoid potentially conflicting recommendations.
Fire Management: Most New Jersey Pine Barrens habitats have been shaped by and are maintained by fire. For this reason, fire management is an ongoing activity, whether by application of prescribed fire for fuel reduction during the winter months or by suppression of hotter growing season burns or wildfires that might affect surrounding development. The way in which fire is managed has a major effect on the persistence and quality of Pine Barrens habitats, including these savannas and their associated rare plants and SGCN wildlife, especially during times of extreme drought.

When considering the use of fire as a management tool, it is necessary to thoroughly assess what rare plant and SGCN animals are present in the habitat, their tolerances to fire, and their distribution on the landscape before developing a plan for when and if to burn, what to burn and how intensely, or whether fire prevention is warranted. In short, the needs of all species, plant and animal, at a site must be considered. This assessment and evaluation does occur on state lands during the NJDEP internal Land Management Review process. But any burn activities considered for private lands do not require this level of assessment as part of the permit application. For this reason, pitch pine reedgrass savannas on private land may be burned by private landowners (e.g., cranberry bog owners that regularly use prescribed fire to clear land and reduce fuel loads; military activity on Ft. Dix that may cause fires) that may affect rare plants and/or SGCN animals.

Without fire, other vegetation management techniques such as mowing are sometimes applied. The ecological and species-specific effects of such management practices must be assessed for each rare species as to whether the results are beneficial, harmful, or benign. Conducting research on fire and its effects on habitats and SGCN animals is another priority goal of the SWAP. A better understanding of landscape effects of fire will be of benefit to long-term viability of plant and animal populations in the Pine Barrens.

Invasive, Over-abundant, and Pest Species Management

Invasive plant species: Management and control of invasive plant species is a conservation goal for all Pine Barrens SWAP zones. To date, there are no known invasive or nonnative plants present in core riverside or pitch pine reedgrass savannas. Should new populations become established, control should begin with the least harmful process (hand pulling or seedhead removal) before moving toward use of chemicals or other less targeted techniques. Biocontrol may be an option for some invasive species, however consultation with experts, both botanists and zoologists is always warranted when considering the use of chemicals and/or biocontrol. Decisions should be made on a site-by-site basis to prevent or minimize negative impacts to non-target rare plant or animal species, or to the habitat.

Insect pests and/or disease pathogens: A number of insect pests may be targeted for control in and around Pine Barren savannas (e.g., mosquitoes, southern pine beetle). Control measures often include application of pesticides, many of which are broad spectrum or are applied at times of the year when other invertebrates may be vulnerable or are applied in a manner harmful to the rare plant community (e.g., trampling). In the case of the southern pine beetle (*Dendroctonus frontalis*), removal of infested trees and a 50 – 100 foot buffer of uninfested trees to prevent the spread of the outbreak has been recommended. Tree cutting during the breeding season may affect northern parula warblers, skidding of trees during removal may harm rare plants and habitat.
Any proposed control measures should be site specific and the use of integrated pest management and committed ongoing coordination among agencies and with savanna managers to reduce non-target impacts is critical. In all cases, botanists and zoologists should be included in the discussion to avoid any potential harm to rare plants or SGCN populations or the habitat.

Deer control: Management of deer populations is an important conservation action identified in the SWAP to promote forest health and biodiversity. Deer consume rare plants and larval food plants and nectar sources for Lepidoptera, among other impacts (Côté et al. 2004, Rawinski 2008, Schweitzer et al. 2011). Management measures may include increased hunting efforts or fencing of vulnerable habitat against deer. Managing the size of local deer herds would benefit both rare plants and SGCN animals, and any trampling of vegetation by hunters would occur when most plants are dormant. To date, deer herbivory has not been identified as a major threat in these savannas but their presence and browsing activity should be regularly monitored.

Beaver control may be needed on occasion in Pine Barrens savannas and has also been identified as a conservation action in the SWAP. Typically this could include trapping and removing beaver from a site to prevent dam construction (or partial dam removal), and/or the installation of a water level control device. Since the rare plants and the SGCN all rely on a similar site hydrology, beaver control should benefit both in riverside savanna habitats.

Note: Proper protocols should be put in place to minimize spread of invasive species propagules and/or disease (e.g. Chytrid fungus, Ranavirus) among wetland sites. It is best to follow these or similar recommendations between site visits: 1) wash boots and field equipment with soap and water; 2) rinse in clean water; and 3) disinfect with a 10% bleach solution and allow to air dry (Dodd 2010; B. Zarate, personal communication, 2013). Pinelands Commission scientists have also adopted a disinfection procedure to use between sites, similar to the above (J. Bunnell, personal communication, 2013).

Recreational Use Management

Use of ORVs and 4WD vehicles is a popular pastime in the Pine Barrens, whether by individuals or as part of large-scale organized enduro events. Regulating this use is a priority of the SWAP and conservation actions identified in the SWAP that protect this

habitat from encroachment by vehicles, coupled with adequate enforcement, would be of benefit to rare plants and SGCN animals.

Passive recreation can sometimes also threaten the integrity of the savanna vegetation, for example, when canoeists stop to explore stream banks and adjacent wetlands, trampling sensitive vegetation or disturbing wildlife. Public education is an important tool for ongoing conservation of these rare habitats and their associated species and the SWAP includes conservation actions encouraging public outreach and education.

In addition, the SWAP recommends enhancing public access opportunities, also an important goal. However, if wildlife viewing structures or trails are planned in or near riverside or reedgrass savannas, care must be taken to avoid altering site hydrology, permitting unguided access into vulnerable habitat to avoid trampling and introducing invasive plant seeds, and harming sensitive plants and animals during construction.

SPECIES MANAGEMENT (=TRACS ACTION TARGETS)

Species-Specific Management Actions identified in the SWAP:

Arogos skipper: The SWAP recommends surveying suitable habitats in the Mullica River zone to identify new populations of this skipper. Such survey will have no impact on pine barren riverside savannas or pitch pine reedgrass savannas if sensitive vegetation is not trampled (see guidelines for survey and monitoring). The SWAP also calls for development of a management plan to maintain and enhance habitat for Arogos skipper using controlled burns. Development of this plan must be done in consultation with other experts to avoid impacts to non-target species in the same habitat.

TRACS ACTION #3:
DATA COLLECTION AND ANALYSIS (TRACS Level 1)
Research, Survey, or Monitoring (TRACS Level 2)

Inventory and Long-term Monitoring

Conducting baseline survey and long-term monitoring for all SGCN animals is a conservation priority in all Pinelands landscape zones. In particular, forest passerines (e.g., northern parula) have been mentioned as targets for this work. Plant and animal population monitoring efforts at a site should be coordinated to prevent situations where multiple monitoring initiatives are occurring, potentially creating frequent, extensive, long-term disturbance without sufficient recovery periods. As mentioned previously, it is also recommended that there be a thorough survey and mapping of all rare species found at a site, including population location, status and condition, such that any proposed management can avoid or minimize impacts.

Animal survey and monitoring techniques –minimizing harm to plants:
Breeding bird surveys: Assessing the status of the northern parula warbler or other passerines in these habitats would generally require multiple site visits in May and June

during the breeding season. Surveys for the parula warbler should have minimal impact on rare plants in the savanna as these bird surveys are typically conducted as roadside point counts (S. Petzinger, personal communication, 2013).

Lepidoptera surveys: Moth surveys generally consist of evening visits with light traps throughout the flight season for each species but with minimal vegetation trampling as lights are typically placed at the edge of the wetland (D. Schweitzer, personal communication, 2012). The helicta satyr flies from late June through July in these Pine Barrens locations and would best be surveyed during the day during this flight period. Consult the plant phenology tables in this report and any rare species maps that are prepared for additional guidance when planning the location and timing of helicta satyr survey work.

The SWAP recommends working with qualified groups or citizen scientists to conduct surveys at particular sites, depending on the level of expertise needed. It is important that survey methodology be developed upfront, to be sure that there is no conflict in recommended techniques and that volunteers are made aware of the need to avoid rare plant populations at specific sites.

Mammal surveys: Survey and monitoring of the southern bog lemming may entail extensive walking through the site. If live traps are used, they are typically placed along runways within the habitat, as the animals are faithful to them. Pitfall traps may also be used, however avoid digging up any rare plants when installing traps (M. Valent, personal communication, 2013). As bog lemmings are often difficult to trap, an analysis of owl pellets can be useful in certain locales (Whittaker and Hamilton 1998). In all cases, consult the plant phenology tables in this report and any rare species maps that are prepared for additional guidance when planning the location and timing of survey work.

Rare plant survey and monitoring techniques –minimizing harm to animals:

Plant surveys: Plant surveys and rare plant monitoring activities can occur throughout the growing season as phenology differs among species, and over multiple years since growing conditions vary from year to year. Such activities may include random searches through habitat, use of parallel transects, and/or the establishment of long-term vegetation monitoring plots.

Rare plant populations in savannas are regularly monitored. However, there should be no impact to northern parula warblers or bog lemmings for any transect or other ground plant survey work (S. Petzinger, personal communication, 2013; M. Valent, personal communication, 2013).

Climate Change Vulnerability Assessment

The year 2012 was the warmest on record nation-wide (NOAA 2013) and in the garden state (Robinson 2013), with more changes forecast to come. In New Jersey the effects of climate change are projected to include: an increase in average temperature (minimum 2-6

°F. increase by 2050) and precipitation (although the exact nature of the change in precipitation may vary across the state); more extreme weather events such as storms and droughts; and sea level rise. Generally we can expect more prolonged summer heat waves with temperatures above 90° F., and fewer cold days and nights during the winter, which may be of import for those species requiring cold dormancy. Rainfall, especially in the northern part of the state may increase in amount mainly in the winter months (Faass et al. 2012, NJ Climate Adaptation Alliance 2013a).

Savanna Habitats and Climate Change:

According to Faass et al. (2012) there are a number of stressors that should be looked at to determine whether or not a particular plant community is vulnerable to climate change. These stressors include: 1) exacerbation of other non-climate stressors; 2) specific hydrologic conditions; 3) vulnerability to human response; 4) sensitivity to extreme climate events; 5) intrinsic adaptive capacity; 6) species vulnerability; 7) latitudinal constraints; 8) management feasibility; 9) degree of cold adaptation; and 10) location in geographical range. (For a detailed discussion of each of these stressors, see Faass et al. 2012.)

Pine Barrens savannas are susceptible to a number of these stressors. Riverside savannas are maintained by specific hydrologic conditions that require constant groundwater seepage. The significant alteration to precipitation patterns anticipated with a changing climate (e.g., greater flood events, increased drought the summer months) may alter groundwater flow and seepage. This may be compounded by increased development at the periphery of the Pine Barrens in future years, putting more pressure on underlying aquifers. This in turn will affect plant and animal species composition, favoring species adapted to drier conditions and possibly permitting greater invasive species incursion (non-climate stressor).

Reedgrass savannas are maintained fire. Although some studies in the western U.S. have shown a predicted increase in wildlife fire frequency with changing climate, recent research in New Jersey indicates that fire size and intensity here may not change appreciably in the coming years (Clark et al. in press). In New Jersey, wildfire is currently constrained by habitat fragmentation and ongoing fuel management activities. However, it is difficult to predict future scenarios as there are many additional confounding factors to consider with changing climate, such as the introduction of new forest pests and changes in tree and plant species composition and subsequent effects on fuels. Also, the increase in other disturbances to the landscape such as more storm and wind events may play a role.

Species and Climate Change:

Plants: Using the NatureServe Climate Change Vulnerability Assessment (CCVA) model (NatureServe 2011), state endangered plant species of Pine Barren savannas were assessed for climate vulnerability (see Ring and Spencer 2013). Six species (43%) including Rough Cotton-grass (*Eriophorum tenellum*), Pine Barren Boneset (*Eupatorium resinosum*), New

Jersey Rush (*Juncus caesariensis*), Bog Asphodel (*Narthecium americanum*), Knieskern's Beak-rush (*Rhynchospora knieskernii*), Death Camas (*Zigadenus leimanthoides*), were considered moderately vulnerable to a changing climate. Of these, one (*Eriophorum tenellum*, rough cotton-grass) is at the southern edge of its range while the others are considered vulnerable for specific life history traits. Eight (57%) of the rare plants species were presumed stable, likely because in general core pine barren habitats are largely intact and relatively protected from human disturbance. For more detailed discussion, see Ring and Spencer (2013).

Animals:

Southern Bog Lemming – A CCVA for southern bog lemmings has not been completed in New Jersey as not enough is known about their status and life history in the state to populate the model. However, a CCVA was prepared for Illinois populations that found the lemming to be "presumed stable" in light of climate change based on similar life history factors (Hollingshead 2011). Unless Pine Barrens riverside savanna habitats change significantly with a changing climate, it is likely that lemming populations will remain relatively stable. No additional habitat management actions are proposed to address climate change needs for this species.

The rare **moths and butterfly** depend on the presence of their food plants for survival. Three of the four species rely on Pine Barrens reed grass. Although a CCVA was not conducted for it, reed grass is widespread in the Pine Barrens and the habitat in the core Pine Barrens remains relatively intact, so it may persist. Georgia satyr (= helicta satyr) is a southern species, although New Jersey populations are disjunct from the core southern populations. Depending on how its habitat migrates, this satyr may actually do well with a warming climate. A warmer New Jersey climate may enable them to become bivoltine, completing two life cycles in a summer instead of the single generation it currently completes (D. Schweitzer, personal communication, 2012). Arogos skipper may also benefit for similar reasons. A warming climate could extend the growing season in turn enabling the skipper, which is currently at the extreme northern edge of its range in New Jersey, to produce more generations per season. It is unclear how climate change will affect the other moth species. In any case, no new habitat management practices have been proposed for these Lepidoptera species to account for climate changes impacts.

Northern parula warblers are at the northern edge of their breeding range. Their numbers declined during the early- to mid-1900s in New Jersey, possibly due to the decline of *Usnea* lichen with which they built their nests. However, their numbers have increased in recent years in the state, perhaps due to their ability to use alternate nest materials (Walsh et al. 1999) and habitats (riverside floodplain forest over swamps in other regions) (W. & S. Wander, personal communication, 2012). It is unclear how a changing climate will affect them although the U.S. Forest Service climate bird atlas projections indicate that their numbers will likely increase in New Jersey in future years (Matthews et al. 2007).

Climate Change Summary

There are no specific management recommendations proposed to address climate change for Pine Barrens savannas or any of the savanna species highlighted in this report other than maintaining appropriate ecological processes: site hydrology and wetland connectivity on the landscape for riverside savannas and fire frequency and type of burn (growing season) for reedgrass savannas. For these reasons, no additional habitat management conflicts are anticipated in the near term due to plant and animal species management activities. As riverside savannas have persisted on the landscape for thousands of years and are intimately associated with riverine habitats, they may remain relatively stable in light of future climate change. Although current projections are for wildfire frequency and severity to remain relatively constant (Clark et al. in press), the need for ongoing fire management for fire-dependent habitats remains.

Therefore, the Pine Barren species management actions currently outlined in the SWAP should continue (modified as needed by the recommendations in this report). Addressing existing hydrology and water quality issues, invasive species, recreational overuse, and other threats as necessary to maintain or restore existing habitat will be key to resiliency. The ability of Pine Barrens savannas to withstand change over time while retaining their basic structure and function will enable them to support viable populations of rare plants and wildlife SGCN into the future (Anderson and Ferree 2010).

Overall Conclusions:

Pine Barrens savannas support significant populations of rare plants and SGCN animals. Based on the information presented in the 2008 SWAP, there are few management actions proposed for the SGCN in these habitats that would potentially affect the rare plants also occurring in these habitats. In part, this is a result of the fact that the savannas occur within the Pine Barrens in a relatively well protected and intact matrix landscape. Intensive survey and monitoring of multiple species at individual sites would cause harm, and therefore regular communication among organizations and others working in these habitats is critical to minimize impact.

Integrated Management Guidelines:
Coastal Plain Intermittent Pond Habitat



Hirst brothers' panic grass (*Dichanthelium hirstii*); Coastal plain intermittent pond; Pine Barren treefrog (*Hyla andersonii*)

Overview

New Jersey's Coastal Plain Intermittent Ponds (CPIP) are found on the state's Inner and Outer Coastal Plain, and were formed in Wisconsin periglacial depressions. Plant and animal inhabitants of these ponds rely on their seasonal hydrology, typically filling and drying annually. Foremost among these is Hirst brothers' panic grass (*Dichanthelium hirstii* or *Panicum hirstii*), one of the rarest grass species in the world and listed as a federal candidate species (Walz et al. 2006b). The ponds themselves are also considered rare throughout their range. There are 11 different coastal plain intermittent pond ecological community types found in New Jersey, but for the purposes of this report we are addressing these ponds as habitat systems, not focusing just on one particular type.

Coastal plain intermittent ponds are included in the NE Wildlife Habitat Classification System as Northern Atlantic Coastal Plain Pond; in the New Jersey Landscape Map Emergent and Wetland Species-Based Habitat and Vernal Habitat; and mapped in the New Jersey Land Use/Land Cover as Herbaceous Wetlands See Appendix B for more details on habitat classification.

Seventeen (17) state endangered plant species occur in coastal plain intermittent ponds, including Southern Boltonia (*Boltonia asteroides var. glastifolia),* Wrinkled Jointgrass (*Coelorachis rugosa),* Marsh Flat Sedge (*Cyperus pseudovegetus),* Hirst Brothers' Panic Grass (*Dichanthelium hirstii or Panicum hirstii),* Larger Buttonweed (*Diodia virginiana var. virginiana),* Knotted Spike-rush (*Eleocharis equisetoides),* Featherfoil (*Hottonia inflata),* Barton's St. John's-wort (*Hypericum adpressum),* Clasping-leaf St. John's-wort (*Hypericum gymnanthum),* Boykin's Lobelia (*Lobelia boykinii),* Narrow-leaf Primrose-willow(*Ludwigia linearis),* Awned Meadow-beauty (*Rhexia aristosa),* Small-head Beaked-rush (*Rhynchospora microcephala),* Slender Arrowhead (*Sagittaria teres),* Torrey's Bulrush (*Schoenoplectus torreyi),* Dwarf White Bladderwort (*Utricularia olivacea),* Reversed Bladderwort (*Utricularia resupinata*). See Appendix A for complete species list with rarity rankings.

Animal Species of Greatest Conservation Need (SGCN) identified in the 2008 State Wildlife Action Plan (SWAP) include Pine Barrens treefrog (*Hyla andersonii*), carpenter frog

(*Lithobates virgatipes*), and two damselflies and one dragonfly (Pine Barrens bluet [*Enallagma recurvatum*], scarlet bluet [*Enallagma pictum*], and golden-winged skimmer [*Libellula auripennis*]). Other SGCN have been documented from coastal plain intermittent ponds (e.g., Fowler's toad (*Anaxyrus fowleri*), southern gray treefrog (*Hyla chrysoscelis*), etc.) (Walz et al. 2006b) but for the purposes of this report they were not included, rather we chose representative species of core Pinelands ponds. The presence of any of these animals at a particular pond depends upon pond hydrology, particularly the length of time ponds retain standing water during the season.

For the purposes of this assessment we are focusing on the CPIP natural community found in the four New Jersey Pine Barrens SWAP zones (Western, Mullica drainage, northern, and southern), although there are other significant coastal plain intermittent ponds found on the inner and outer coastal plain in Cape May, Cumberland, Gloucester, and Salem counties).

Threats

Threats to Coastal Plain Intermittent Ponds range-wide include altered hydrology that modifies the annual cycle of filling and drying, and runoff with nutrients and other pollutants that alter water quality and change the water chemistry of the acid Pine Barrens waters. Changes in pond chemistry have significant impacts to breeding amphibians and to rare plant species. Groundwater depletion due to agricultural use or due to surrounding development also threatens pond hydrology (Walz et al. 2006b), with implications for those species, such as treefrogs that rely on ponds holding water for certain lengths of time during the season.

Ponds are also threatened by Off Road Vehicle (ORV) use that crushes rare plants, compacts soil, alters site hydrology, and causes direct mortality of animals in their path (Switalski and Jones 2012). Invasive species like nonnative fish or bullfrogs (*Lithobates catesbeiana*) outcompete and/or consume native pond amphibians (J. Bunnell, personal communication, 2013) while over-browsing by white-tailed deer in some ponds alters the habitat structure and destroys rare plants. Suppression of natural fire regimes is also a concern in Pine Barrens landscapes that have evolved in the presence of fire. Although most ponds are maintained primarily by site hydrology, some coastal plain intermittent ponds have been and are affected by periodic wildfires especially during times of extreme drought, which helps shape their vegetation and structure (Little 1979, Laidig 2010). Other threats to coastal plain intermittent ponds in New Jersey have included ditching and draining of these wetlands, sand and gravel mining, and past conversion to cranberry bog operations (Walz et al. 2006b).

A summary of CMP Threats to state endangered plants and wildlife SGCN in coastal plain intermittent pond habitat is found in Appendix C.

Species Ecology

Plants:

Rare plants of coastal plain intermittent ponds are well-adapted to the changing hydrology of these ponds. The seeds of grasses and forbs become part of the seed bank, germinating and flowering as conditions become suitable. In fact, some seeds can remain viable for decades. In contrast, during periods of either extended flood or drought, some perennial plants such as grasses and orchids survive by storing energy underground in their rhizomes or tubers (Walz et al. 2006b).

Of the seventeen rare species found in these ponds, nine are at the northern limit of their range, six are mid-range, and two are at the eastern edge of their range (e.g., southern boltonia and marsh flat sedge). See Ring and Spencer (2013) for more detailed information.

The following two tables provide a list of state endangered species that can found in Coastal Plain Intermittent Ponds in New Jersey with their phenology, or timing of vegetative, flowering and fruiting, and comments on their habitat/niche. The phenology and habitat information can be used to help avoid negative impacts to these state endangered plant species during wildlife surveys and management activities.

FL = Flowering; FR = Fruiting; V = Vegetative

Phenology of State Endangered Plant Species in Coastal Plain Intermittent Pond Habitat		**APRIL**		**MAY**		**JUNE**		**JULY**		**AUG**		**SEPT**		**OCT**		**NOV**	
SCIENTIFIC NAME	**COMMON NAME**	**1-15**	**16-30**	**1-15**	**16-31**	**1-15**	**16-30**	**1-15**	**16-31**	**1-15**	**16-31**	**1-15**	**16-30**	**1-15**	**16-31**	**1-15**	**16-30**
Boltonia asteroides var. glastifolia	Southern Boltonia					V	V	V	V	V	FL	FL	FL				
Coelorachis rugosa	Wrinkled Jointgrass									FL	FL	FL, FR	FL, FR	FR	FR	FR	
Cyperus pseudovegetus	Marsh Flat Sedge							FL	FL	FL, FR	FR	FR	FR	FR			
Panicum hirstii (Dichanthelium hirstii)	Hirst Brothers' Panic Grass					FL	FL, FR	FR	FR	FR	FR	FL, FR	FL, FR	FR	FR	FR	
Diodia virginiana var. virginiana	Larger Buttonweed						FL	FL	FL, FR	FL, FR	FL, FR	FL, FR	FR	FR			
Eleocharis equisetoides	Knotted Spike-rush					FL	FL, FR	FL, FR	FR	FR	FR	FR	FR	FR	FR	FR	
Hottonia inflata	Featherfoil			FL	FL, FR	FL, FR	FL, FR	FL, FR	FR	FR							
Hypericum adpressum	Barton's St. John's-wort								FL, FR	FL, FR	FL, FR	FR	FR				
Hypericum gymnanthum	Clasping-leaf St. John's-wort						FL	FL	FL, FR	FL, FR	FL, FR	FL, FR					
Lobelia boykinii	Boykin's Lobelia						FL	FL, FR	FL, FR	FL, FR	FR	FR					
Ludwigia linearis	Narrow-leaf Primrose-willow							FL	FL, FR	FL, FR	FL, FR	FR	FR	FR			
Rhexia aristosa	Awned Meadow-beauty								FL	FL	FL, FR	FL, FR	FL, FR	FL, FR	FR	FR	
Rhynchospora microcephala	Small-head Beaked-rush								FL	FL, FR	FR	FR	FR				
Sagittaria teres	Slender Arrowhead							FL	FL, FR	FL, FR	FL, FR	FL, FR	FR				
Utricularia olivacea	Dwarf White Bladderwort								FL	FL	FL						

Coastal Plain Intermittent Pond - Rare Plant Habitat/Niche Comments

SCIENTIFIC NAME	COMMON NAME	Habitat/Niche Comments
Boltonia asteroides var. glastifolia	Southern Boltonia	Herbaceous dominated clay bottomed vernal ponds.
Coelorachis rugosa	Wrinkled Jointgrass	Restricted sedge and grass dominated turfy zones in intermittent Coastal Plain ponds.
Cyperus pseudovegetus	Marsh Flat Sedge	Upper shoreline edge of intermittent Coastal Plain pond.
Dichanthelium hirstii (Panicum hirstii)	Hirst Brothers' Panic Grass	Restricted to dry bottoms or in shallow water of intermittent Coastal Plain ponds.
Diodia virginiana var. virginiana	Larger Buttonweed	Grows in shallow water filled depressions in open areas of wet woods, open, wet, grassy swales, and intermittent pond shores.
Eleocharis equisetoides	Knotted Spike-rush	Grows in shallow water of intermittent Coastal Plain ponds.
Hottonia inflata	Featherfoil	Grows in open, usually shallow, water of intermittent ponds, sluggish streams, and wet depressions in wooded swamps.
Hypericum adpressum	Barton's St. John's-wort	Seasonally saturated to flooded acidic sands and peat of shores/margins of freshwater ponds, swales, wet meadows, and depressions.
Hypericum gymnanthum	Clasping-leaf St. John's-wort	Edge of wet woods, boggy meadows, peaty pond shores, and borrow pits, growing in wet, sandy soil of shallow depressions.
Lobelia boykinii	Boykin's Lobelia	Restricted to Coastal Plain Intermittent Ponds.
Ludwigia linearis	Narrow-leaf Primrose-willow	Typically occurring in intermittantly wet habitats such as pond shores, ditches and inactive sand and gravel pits.
Rhexia aristosa	Awned Meadow-beauty	Grows in sandy bottomed Coastal Plain intermittent ponds and shallow warter of abandoned sand and gravel pits.
Rhynchospora microcephala	Small-head Beaked-rush	Grows in moist to wet sand in powerline ROW's through pitch pine lowland forests and sphagnous hummocks in overgrown boggy borrow pits.
Sagittaria teres	Slender Arrowhead	Restricted to shallow water or exposed sandy or muddy bottoms of Coastal Plain intermittent ponds.
Utricularia olivacea	Dwarf White Bladderwort	Grows in shallow, acid water of a large Coastal Plain intermittent pond in the Pine Barrens.

Animals:

Pine Barrens treefrogs are found from New Jersey south along the coastal plain in three disjunct populations; the New Jersey Pine Barrens, the Carolina Sandhills, and the Florida panhandle. (They have recently been confirmed from southern Alabama near the Florida panhandle [J. Bunnell, personal communication, February 2013.] In New Jersey, treefrogs begin calling in mid-to-late April with peak calling in May and part of June, when ponds still hold sufficient water. Coastal plain intermittent ponds provide important breeding habitat, although treefrogs will use a range of wetlands including other natural and excavated ponds and the edges of some high-quality on-stream impoundments (Zampella and Bunnell 2000). Up to one thousand eggs are scattered on the pond bottom or attached to vegetation. Larvae transform in 80 – 100 days, beginning in late June and disperse into adjacent upland habitat (Bunnell and Ciraolo 2010).

Carpenter frogs are found on the coastal plain from New Jersey south to the Florida/Georgia border in Okefenokee Swamp. Their distribution in New Jersey is somewhat restricted in that they are only found in more forested landscapes in the Pine Barrens. Carpenter frogs use a variety of aquatic habitats including coastal plain intermittent ponds, other natural as well as excavated ponds, and other acidic wetlands (Zampella and Bunnell 2000, Bunnell and Zampella 2008). Usually found in or near water, they rarely venture into upland habitats. Carpenter frogs begin calling in April, their breeding period extending into August. They lay eggs in masses with 200 – 600 eggs/mass and may mate more than once each season. Because the larval period may last up to a year, it is critical that ponds retain sufficient water in at least some sections to ensure tadpole survival.

Major threats to these frog species include altered wetland hydrology and water quality, especially changes to water chemistry that elevate pH. The stocking of nonnative predatory fish such as bluegill, black crappie, and largemouth bass in impoundments is also a concern. Raising the pH of acidic Pinelands waters provides an opportunity for these nonnative species to become established (J. Bunnell, personal communication, 2013).

Similarly, two damselflies, the **scarlet bluet** and the **Pine Barrens bluet** also rely on coastal plain ponds for breeding, if the ponds have deeper sections that retain water throughout the year. (The aquatic larval period for odonates typically lasts longer than a year.) The **Pine Barrens bluet** inhabits shallow acidic coastal plain ponds and has a short, early flight season (May and June). They are endemic to the Northeastern U.S. with a limited range, New Jersey being at the southern edge.

The **scarlet bluet** prefers acidic sand-bottomed coastal plain ponds with floating vegetation. It is most abundant from late June through July. Like the Pine Barrens bluet, it is a regional endemic and ranges from New Jersey up the coast to southern Maine (Barlow et al. 2009).

The **golden-winged skimmer** dragonfly is rare in New Jersey and found in sand bottomed ponds. Adults are active from mid May through early October (most commonly seen in July

and August). It is near the northern limit of its range, which extends from southern Massachusetts along the coastal plain south to Florida and west to Texas (Barlow et al. 2009).

The main threats to the odonates include altered hydrology, pollution, and removal of emergent aquatic vegetation that provides critical oviposition and larval habitat (Barlow et al. 2009).

Integrated Conservation Management Guidelines

An important goal of the SWAP is to protect, maintain, and restore critical wetland habitat for SGCN animals. Due to the fact that there are a number of rare taxa with varying habitat preferences that use coastal plain intermittent pond habitats, there is potential for conflicts between conservation management actions proposed for SGCN animals and rare plants at individual sites. For this reason, it is recommended that there be a thorough survey and mapping of all rare species found at a site, including population location, status and condition such that any proposed management can avoid or minimize impacts.
The following integrated conservation management guidelines address broad categories linked to conservation actions identified in the SWAP and correlated with the TRACS ACTIONS Level 1. We have specifically targeted discussion around the actions where there may be potential for management incompatibility between rare plants and SGCN animals.

TRACS ACTIONS

1. Coordination and Administration
2. **Create, Restore, or Enhance Habitat and Natural Processes**
3. **Data Collection and Analysis**
4. Education
5. Facilities and Areas/New Construction
6. Facilities and Areas/Major Renovation
7. Facilities and Areas/Operations and Maintenance
8. Land and Water Rights/Acquisition and Protection
9. Law Enforcement
10. Outreach
11. Planning
12. Species Reintroduction and Stocking
13. Technical Assistance

TRACS ACTION #2:
CREATE, RESTORE, OR ENHANCE NATURAL HABITATS OR PROCESSES

Hydrology and Water Quality Management

An over-arching conservation goal in the SWAP is to maintain hydrology and water chemistry of Pine Barrens wetlands and aquatic habitats. Actions proposed in the SWAP are general, and include land protection, work with public and private landowners, and development of sufficient habitat buffers and landscape connectivity (see SWAP zones –

western Pinelands, Mullica river drainage, southern Pine Barrens, northern Pine Barrens). Each of these action items, if implemented, would benefit to rare plants and wildlife SCGN by maintaining site hydrology of coastal plain intermittent ponds.

Vegetation Management

Managing succession: Active vegetation management is a key component of the SWAP, especially for maintaining early successional wetlands and scrub-shrub habitats. Recommended techniques may include manual removal (e.g., selective cutting and tree removal or mowing), targeted use of herbicides, and/or application of prescribed fire (see below). Currently no woody vegetation management for animal SGCN has been proposed for Pine Barren coastal plain intermittent ponds in the core Pine Barrens. However, any future plans for woody vegetation control or management should keep in mind the life history and habitats needs of the rare plants and other animal SGCN that occur at individual sites to avoid non-target impacts.

> Manual vegetation removal: Hand-pruning or selective cutting of woody vegetation can be used to set back succession and open the canopy for those plant and animal species that require it. If done in the winter months, there will be little impact to coastal plain intermittent pond vegetation or other animal species that use the habitat.
>
> Use of herbicides: Extreme care must be taken if herbicides are used in coastal plain intermittent ponds, as most are broad spectrum. Only direct hand application (e.g. hand painting stump cuts) should be considered for vegetation control adjacent to rare plant populations.

Silvicultural practices on adjacent uplands: Certain forestry practices on lands adjacent to coastal plain intermittent ponds can have a negative effect on pond water quality by increasing soil erosion. Maintaining sufficient uncut buffer at some distance away from the ponds will prevent erosion into the water (which may affect the rare plant community and larval amphibians and odonates). Such buffer will also protect upland habitats used by amphibians like Pine Barrens treefrogs, which move away from the pond to some distance after the breeding season. For example, a 100-foot "no activity" buffer is recommended for forests adjacent to ponds that support Pine Barrens treefrogs and activities such as drum chopping that disturb soil are recommended against (Bunnell, no date). The SWAP recommends working with landowners to promote ecological forestry practices, which would be of benefit to all plants and SGCN animals using coastal plain intermittent pond habitats.

Utility rights-of-way management: The SWAP recommends the development of BMPs for Rights-of-Way (ROW) management for scrub-shrub and animal species that may use them. As ROWs may cross through coastal plain intermittent pond habitats, the development of management guidelines should be coordinated such that all rare plants as well as wildlife SGCN using ROWs are incorporated into BMPs at the same time. This will assist the

landowner in making appropriate management decisions and avoid potentially conflicting recommendations.

Fire Management: Most New Jersey Pine Barrens habitats have been shaped by and are maintained by fire. For this reason, fire management is an ongoing activity, whether by application of prescribed fire for fuel reduction during the winter months or by suppression of hotter growing season burns or wildfires that might affect surrounding development. The way in which fire is managed has a major effect on the persistence and quality of Pine Barrens habitats, including the coastal plain intermittent ponds and their associated rare plants and wildlife SGCN, particularly during times of extreme drought. When considering the use of fire as a management tool in forested landscapes that contain coastal plain intermittent ponds, it is necessary to thoroughly assess what rare plant and animal SGCN are present in the habitat, their tolerances to fire, and their distribution on the landscape before developing a plan for when and if to burn, what to burn and how intensely, or whether fire prevention is warranted. In short, the needs of all species, plant and animal, at a site must be considered. Although hydrology, not fire, is the dominant force shaping coastal plain intermittent pond communities, a better understanding of the historical role of fire in the formation and maintenance of these ponds and their associated rare vegetation is an important research need. Conducting research on fire and its effects on habitats and SGCN animals is another priority goal of the SWAP.

Invasive, Over-abundant, and Pest Species Management

Invasive plant species: Control of invasive species is a conservation goal for all Pine Barrens SWAP landscapes. To date, few invasive or nonnative plant species have been found in core Pine Barrens ponds, although this is a concern in outer Pine Barrens locations such as Bennett Bogs and other coastal plain intermittent ponds in Cape May and Cumberland counties. Should new populations become established, control should begin with the least harmful process (hand pulling or seedhead removal) before moving toward use of chemicals or other less targeted techniques. Biocontrol may be an option for some invasive species, however consultation with experts, both botanists and zoologists is always warranted when considering the use of chemicals and/or biocontrol. Decisions should be made on a site-by-site basis to prevent (or minimize) negative impacts to non-target rare plant or animal species, or to the habitat.

Insect pests and/or disease pathogens: A number of insect pests may be targeted for control in and around coastal plain intermittent ponds (e.g., mosquitoes, southern pine beetle). Control measures often include application of pesticides, many of which are broad spectrum or are applied at times of the year when other invertebrates are vulnerable or are applied in a manner harmful to the rare plant community (e.g., trampling). In the case of the southern pine beetle (*Dendroctonus frontalis*), removal of infested trees and a 50 – 100 foot buffer of uninfested trees to prevent the spread of the outbreak has been recommended. Skidding of trees during removal may harm rare plants and habitats and may increase the possibility of erosion into pond habitats.

Any proposed control measures should be site-specific and the use of integrated pest management and committed, ongoing coordination among agencies and with CPIP managers to reduce non-target impacts is critical. In all cases, botanists and zoologists should be included in the discussion to avoid any potential harm to rare plants or animal SGCN populations or the habitat.

Deer control: Management of deer populations is an important conservation action identified in the SWAP to promote forest health and biodiversity. Deer may consume rare plants and track invasive weed seeds into new habitats (Côté et al. 2004, Rawinski 2008). Management measures may include increased hunting efforts or fencing of vulnerable habitat against deer. Managing the size of local deer herds would benefit both rare plants and animals, and any trampling of vegetation by hunters would occur when most plants are dormant. To date, deer herbivory has not been identified as a major threat in these core coastal plain intermittent ponds but their presence and browsing activity should be regularly monitored.

Beaver control may be needed on occasion in coastal plain intermittent ponds and has also been identified as a conservation action in the SWAP. Typically this could include trapping and removing beaver from a site to prevent dam construction (or partial dam removal), and/or the installation of a water level control device. Since the rare plants and wildlife SGCN using CPIPs all rely on a similar hydrologic regime, beaver control should benefit each. However, keep in mind that beaver impoundments provide good habitat for carpenter frogs. In addition, beaver also maintain the dams when old wooden sluice gates rot away in abandoned cranberry farms that dot the region, also maintaining important habitat for carpenter frogs (J. Bunnell, personal communication, 2013). The need for beaver control should be addressed on a case-by-case basis.

Note: Proper protocols should be put in place for all field biologists to prevent the spread of invasive species propagules and/or disease (e.g., Chytrid fungus, Ranavirus) among wetland sites. It is best to follow these or similar recommendations between site visits: 1) wash boots and field equipment with soap and water; 2) rinse in clean water; and 3) disinfect with a 10% bleach solution and allow to air dry (Dodd 2010; B. Zarate, personal communication, 2013). Note: Pinelands Commission scientists have also adopted a disinfection procedure to use between sites, similar to the above (J. Bunnell, personal communication, 2013). Ranavirus has been confirmed from a number of sites in the Pine Barrens, however to date Chytrid has not been found (K. Monsen, personal communication, 2013).

Recreational Use Management

Regulating ORV and other recreational vehicle use is a goal of the SWAP and ORVs are a threat to some CPIPs (Walz et al. 2006b, Pinelands Preservation Alliance 2013) and associated species (MA Endangered Species Program 2008). Implementation of conservation actions to prohibit or restrict this activity to less sensitive areas, coupled with adequate enforcement, would benefit both rare plants and animals.

The SWAP includes conservation actions encouraging public outreach and education with enhanced public access opportunities. This is an important goal. However, if wildlife viewing structures or trails will be planned for placement near coastal plain intermittent ponds, care must be taken to avoid altering site hydrology, permitting unguided access into vulnerable habitat to avoid trampling and introducing invasive plant seeds, and harming sensitive plants and animals during construction.

SPECIES MANAGEMENT (= TRACS ACTION TARGETS)

Species-Specific Management Actions identified in the SWAP:

Pine Barrens treefrog – The SWAP recommends the development of habitat management and a conservation plan for this species. Development of this plan would not conflict with rare plant management. In fact, it could ensure that any actions for the frog would not inadvertently harm rare plants. Other recommendations for amphibians include monitoring amphibian road crossings to breeding ponds. If roads are located adjacent to coastal plain ponds with breeding amphibians, monitoring and managing amphibian road crossings on rainy nights would not conflict with rare plants at the site.

TRACS ACTION #3:
DATA COLLECTION AND ANALYSIS (TRACS ACTIONS Level 1)
***Research, Survey, or Monitoring* (TRACS ACTIONS Level 2)**

Inventory and Long-term Monitoring

Conducting baseline survey and long term monitoring for all SGCN is a conservation priority in all Pinelands landscape zones. In particular, the Pine Barrens treefrog has been mentioned as a target for this work. Individually, these activities should have minimal impact to the rare plant community (see below for details), but survey and monitoring of multiple species at a site should be coordinated to lessen trampling or other impacts to coastal plain intermittent pond species. In addition, a good first step should be a vegetation assessment that maps the locations of rare plants such that future amphibian or other animal surveys can avoid locations of sensitive plant populations.

Animal survey and monitoring techniques –minimizing harm to plants:

Frog surveys: These surveys are typically conducted at the shoreline by counting calling frogs so there is little, if any trampling of pond vegetation. If other more intensive amphibian population monitoring is required at some future time (e.g., egg mass counts, larval dip net sampling) avoid trampling vegetation or uprooting plants during dip net sampling. If cover boards are used to monitor amphibians in adjacent upland habitats, they should be placed to avoid rare plants that may be growing in those forest openings (J. Bunnell, personal communication, 2013). Consult the plant phenology tables in this report and any rare species maps that are prepared for additional guidance when planning the location and timing of survey work.

Odonate surveys: Dragonfly and damselfly survey and monitoring at a pond could include netting of adults for identification in the hand, searching for larvae in the water and/or exuviae along the pond edge, and specimen collection when deemed necessary. Such activities may trample the plant community so care must be taken during survey work to avoid rare plant locations. Consultation with the plant phenology tables in this report and any rare species maps that are prepared will help avoid harm to rare plants and other sensitive species.

Vernal pool habitat surveys: Surveying for vernal pools has been identified in the SWAP as a priority. While this habitat is classified as "Eastern Woodland Vernal Pool Sparse Vegetation" in the National Vegetation Classification, in NJ calcareous sinkhole ponds are considered to be vernal pool habitat by the Division of Fish and Wildlife. "Vernal habitat" is defined in the NJDEP Freshwater Wetlands Protection Act as a wetland or State open water that meets four criteria including 1) confined basin depression without permanent flowing outlet, 2) evidence of breeding by one or more species of obligate and/or facultative fauna adapted to reproduce in ephemeral aquatic conditions, 3) maintains ponded water for at least two continuous months between March and September of a normal rainfall year, and 4) is free of reproducing fish populations throughout the year, or dries up at some time during a normal rainfall year. See Appendix E for more details and a list of vernal habitat obligate and facultative species. More information can also be found at. Much work has already been done with the use of remote sensing, followed by site visits to verify pond presence (see http://www.nj.gov/dep/fgw/ensp/vernalpool.htm). Typically, site visits to ground-truth remotely-sensed data are easiest to do in the winter when ponds are full of water (or frozen) and there is no ground cover so generally there would be little or no impact to the rare plant community. Site visits in the spring to confirm the presence of obligate wetland species (e.g., wood frogs, fairy shrimp) should also occur early enough in the season to avoid trampling rare plants.

Rare plant survey and monitoring techniques –minimizing harm to animals:

Plant surveys – Plant surveys and rare plant monitoring activities can occur throughout the growing season as phenology differs among species, and over multiple years since growing conditions vary from year to year. Such activities may include random searches through habitat, use of parallel transects, and/or the establishment of long-term vegetation monitoring plots. Rare plant monitoring is an ongoing activity in many of these coastal plain intermittent ponds. Vegetation surveys should be done in a manner that minimizes impacts to frogs or odonates (e.g., avoid stepping on or silting up egg masses or nymphs).

Climate Change Vulnerability Analysis

The year 2012 was the warmest on record nation-wide (NOAA 2013) and in the garden state (Robinson 2013), with more changes forecast to come. In New Jersey the effects of climate change are projected to include: an increase in average temperature (minimum 2-6 °F. increase by 2050) and precipitation (although the exact nature of the change in precipitation may vary across the state); more extreme weather events such as storms and droughts; and sea level rise. Generally we can expect more prolonged summer heat waves

with temperatures above 90° F., and fewer cold days and nights during the winter, which may be of import for those species requiring cold dormancy. Rainfall, especially in the northern part of the state may increase in amount mainly in the winter months (Faass et al. 2012, NJ Climate Adaptation Alliance 2013a).

Coastal Plain Intermittent Ponds and Climate Change:

According to Faass et al. (2012) there are a number of stressors that should be looked at to determine whether or not a particular plant community is vulnerable to climate change. These stressors include: 1) exacerbation of other non-climate stressors; 2) specific hydrologic conditions; 3) vulnerability to human response; 4) sensitivity to extreme climate events; 5) intrinsic adaptive capacity; 6) species vulnerability; 7) latitudinal constraints; 8) management feasibility; 9) degree of cold adaptation; and 10) location in geographical range. (For a detailed discussion of each of these stressors, see Faass et al. 2012.)

Coastal plain intermittent ponds are susceptible to a number of these stressors. These ponds are maintained by specific hydrologic conditions that require a fairly even distribution of precipitation throughout the year. The significant alteration to precipitation patterns anticipated with a changing climate (e.g., greater flood events, increased drought the summer months) may alter groundwater flow and seepage. This may be compounded by increased development at the periphery of the Pine Barrens in future years, putting more pressure on underlying aquifers. This in turn will affect plant and animal species composition, favoring species adapted to drier conditions and possibly permitting greater invasive species incursion (non-climate stressor). Additionally, some coastal plain ponds are maintained in part by periodic fire. Although recent research indicates that in the New Jersey Pine Barrens, wildlife fire spread and severity are not anticipated to change, there are many other factors not included in the models that may come into play, so some uncertainty remains (Clark et al. in press).

Species and Climate Change

Plants: Rare plants of coastal plain intermittent ponds were also assessed for climate vulnerability (see Ring and Spencer 2013) using the NatureServe Climate Change Vulnerability model (NatureServe 2011). One species, slender arrowhead (*Sagittaria teres*), was considered extremely vulnerable. Four species (24%) including Southern boltonia (*Boltonia asteroids* var. *glastifolia*), Boykin's lobelia (*Lobelia boykinii*), awned meadow beauty (*Rhexia aristosa*), and Torrey's bulrush (*Schoenoplectus torreyi*) were considered highly vulnerable. Slender arrowhead is found only in a few counties in New Jersey, extreme eastern Long Island and a few locations in Massachusetts and Rhode Island, and is highly dependent on these coastal plain pond habitats. The other highly vulnerable plants are considered vulnerable for specific life history traits. Eight species (47%) were considered moderately vulnerable to a changing climate including marsh flat sedge (*Cyperus pseudovegetus*), Hirst brothers' panic grass (*Dichanthelium hirstii*), larger buttonweed (*Diodia virginiana*), knotted spike-rush (*Eleocharis equisetoides*), Barton's St. John's-wort (*Hypericum adpressum*), clasping-leaf St. John's-wort (*Hypericum gymnanthum*),

narrow-leaf primrose-willow (*Ludwigia linearis*), and small-head beaked-rush (*Rhynchospora microcephala*). Four (24%) of the state endangered plant species were presumed stable, likely because core pine barren habitats are largely intact and relatively protected from human disturbance. For a more detailed discussion, see Ring and Spencer (2013).

Animals: No CCVAs were completed for the New Jersey SGCN anurans or odonates of coastal plain intermittent ponds and it is unclear how Pine Barrens wetlands will fare in future years. However, the following are some predictions based on life history and consultation with state species experts.

Pine Barrens treefrogs and **carpenter frogs** - Pine Barrens treefrog and carpenter frog populations may remain stable into the near future, as they will breed in a variety of wetland habitats so long as water chemistry is suitable and nonnative frogs and/or fish are not present. Treefrogs would be most sensitive to any changes to the annual cycle of filling and drying, or that alter the length of time that ponds retain water. Treefrogs require predator-free habitat, which the annual drying provides, yet need ponds to retain water long enough for larvae to complete metamorphosis.

Dragonflies and damselflies – All three species of odonates are at the southern edge of their range. Depending on changes to precipitation patterns, and whether Pine Barrens aquifers are significantly lowered due to increased development pressure in the coming years, odonates may not continue to use coastal plain intermittent ponds if they do not retain sufficient water to maintain larval habitat. Although they may be lost from these pond communities, there are likely sufficient remaining permanent wetlands and ponds that can still support these odonates into the future.

Climate Change Summary

There are no specific management recommendations currently proposed in the 2008 SWAP to address climate change for the coastal plain intermittent pond wildlife SGCN highlighted in this report other than maintaining appropriate ecological processes, i.e., site hydrology and wetland connectivity on the landscape and current fire regime. For these reasons, no additional habitat management conflicts are anticipated due to plant and animal species management activities. The coastal plain intermittent pond animal species management actions currently outlined in the SWAP should continue (modified as needed by the recommendations in this report). Addressing existing hydrology and water quality issues, invasive species, recreational overuse, and other threats as necessary to maintain or restore existing habitat will be key to resiliency. The ability of coastal plain intermittent ponds to withstand change over time while retaining their basic structure and function will enable them to support viable populations of rare plants and wildlife SGCN into the future (Anderson and Ferree 2010).

Overall Conclusions:

Based on the information presented in the 2008 SWAP and consultation with species biologists, there are few, if any management actions proposed for SGCN animals in these coastal plain intermittent ponds that would potentially affect the rare plants also occurring in these habitats. In part, this is a result of the fact that many of these ponds occur within a matrix of core Pine Barrens and are relatively well-protected and surrounded by an intact landscape with minimal threats. Intensive survey and monitoring of multiple species at individual sites would cause harm to rare species and habitat, and therefore regular communication and coordination of activities among organizations and others working in these habitats is critical.

CONCLUSIONS

In this report, we have provided guidelines for how to comprehensively manage for rare plants and SGCN animals in four rare wetland habitats; Pine Barrens savannas, coastal plain intermittent ponds, calcareous fens, and calcareous sinkhole ponds. These management guidelines are intended to serve as a model for how the needs of both rare plants and animals can be incorporated into more comprehensive management planning. Robust natural habitats (ecological communities) are vital to thriving animal populations hence compatible management is the key to habitat and population resilience. It is important that both plants and animals be considered when developing management plans for wildlife species of conservation concern as the plant community is an integral component of the required habitat.

In many cases, as long as broad threats are addressed such that the systems that shape the habitat type remain in place (hydrologic or fire regimes, for example) then plant and animal management at sites may be compatible as all benefit from actions that maintain the landscape, key features, and ecological processes.

In some cases, the methods of management may need to be modified to meet specific challenges (e.g., not use chemicals near rare plants or sensitive amphibian species), or the timing of activities will need to be modified (e.g., coordinating survey and monitoring activities at a site to avoid tramping of habitat).

Occasionally, decisions will have to be made on case by case basis for what a site will be "best" managed for, where management needs of two or more species are diametrically opposed (e.g., golden-winged warbler and Schweitzer's buckmoth require shrubby vegetation whereas the bog turtle and queen-of-the-prairie require open habitats). To accomplish this, a thorough assessment (of species and threats) in all rare habitats of a certain type in the state (all calcareous fens, for example) and an understanding of the scope of proposed management activities on both public *and private* lands is recommended. Climate change adds an extra layer of complexity to the development of long-term management plans. Although no species-specific management actions have been proposed to date for SGCN animals, this may change in the 2015 revision. Ultimately, decisions may need to be made as to how to prioritize and select species for active conservation and management, based on climate change prediction models.

In preparing this report, a number of other issues came to light.

1. For any species and habitats on state-owned property, there is an agency internal management review committee (the Natural and Historic Resources Land Management Review, Policy Directive 2008-1) that coordinates proposed management actions to minimize negative impacts to non-target species. However, some of these habitats (especially calcareous fens) are owned privately and managed by homeowners in consultation with NGOs or agencies such as the NRCS. In such cases, site management may be focused on single species management with little or no coordination or consultation so that rare plants may be overlooked in the

planning process, or conflicts with other animals using the sites may occur (shrub-nesting birds vs. bog turtles, for example). Landowners and other organizations should be strongly encouraged to refer to the SWAP for management guidelines. In addition, for these and other rare habitats it may be beneficial to establish a group of experts to review the status of particular habitats on both public and private land to ensure that the needs of endangered plants and wildlife SGCN are being adequately addressed among all sites.

2. In this report we are only looking at state wildlife species of conservation need or state endangered (S1) plant species. There are other species that although they may not be "rare," are considered to have exemplary populations or are key elements of a particular natural community (e.g., bog birch and other shrubs in calcareous fens). Ideally, these other species should also be considered with planning for management at sites.

3. It is interesting to note that the most potential conflict was observed in the Skylands region in the calcareous fens, not in the core Pine Barrens habitats. Strong landscape-level protection coupled with the work of watchdog groups over the years has resulted in a relatively natural system with many fewer stresses than in areas without such comprehensive land use policies. Outside the Pine Barrens or core areas of the Highlands Region, most New Jersey habitats are fragmented and/or degraded, and species there face multiple threats, necessitating ongoing site-specific management for population persistence rather than broad landscape level or systems management.

4. Ongoing communication and coordination is critical. The DEP Natural and Historic Resources Land Management Review process is an excellent tool for this within the Department. Extending such collaboration and coordination outside the Department with other agencies and organizations, as noted in the SWAP, is also recommended as is continued collaboration between the New Jersey Endangered and Nongame Species Program and the Natural Heritage Program/Office of Natural Lands Management as the SWAP is revised in the coming months.

5. Development of Best Management Plans for landowners and others as part of the SWAP, should address both wildlife SGCN and rare plants, to the extent possible. This will ensure that conflicting management recommendations are not inadvertently presented.

6. The New Jersey habitat-based approach worked well for incorporating rare plants into WAPs, as well as linking rare plants and wildlife SGCN by habitat for protection and integrated management. Habitat became an essential component of conducting the CCVI for 70 state endangered plant species – many assessments of species could not be done without an understanding of specific habitat responses to projected climate change. This worked mainly because the state endangered species chosen for the study had a high fidelity to the rare habitats chosen (calcareous fen, calcareous sinkhole pond, coastal plain intermittent pond, Pine Barren savanna). In

fact, the habitat focus for integrated management was crucial for more than climate change – it drove the entire assessment in the context of Wildlife CMP Threats and TRACS Actions frameworks (unified lexicon being used in WAPs).

In addition to coordinating management activities at sites with wildlife SGCN animals and rare plants, public education is an important tool. For all the actions included in the SWAP, whether small backyard habitat projects or larger-scale landowner incentive programs enhanced public education about species and habitats is critical. Providing a greater awareness about New Jersey's biodiversity to strengthen environmental literacy would greatly benefit all New Jersey's species. An additional goal should be to also include information about plants in any public outreach. In the same manner that invertebrates have been overlooked, so, too have plants. Public education and outreach about New Jersey's species of greatest conservation need should also include information about the state's unique and rare plants. People often suffer from "plant blindness", where plants are considered just a green backdrop to the landscape rather than accorded the importance they deserve.

Because New Jersey's landscapes have been so significantly altered and protected habitats are limited, for the most part we must meet the conservation needs of plants and animals (in fact, all biodiversity) at the same locations. While recognizing that there may be individual species management actions that must be undertaken, depending on the species, managing for habitat resilience is the most important management action we can take. To succeed, we need to take into consideration all habitat components; the ecological processes that create and maintain the habitat and the plants and animals that occur there. Managing for one apart from the whole will not work in today's New Jersey.

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Appendix A

- ✧ List of Rare Plants with Protection Status and Rarity Rank
- ✧ Special Plants of NJ Categories & Definitions
- ✧ List of Wildlife Species of Conservation Need (SGCN) with Protection Status and Rarity Rank
- ✧ NJ Endangered and Nongame Species Program Special Concern Species Status Listing Status Definitions:

List of Selected State Endangered Plant Species with Protection Status and Rarity Rank

SCIENTIFIC NAME	COMMON NAME	Fed Status	State Prot Status	Global Rarity Rank	State Rarity Rank
Alisma triviale	Large Water-plantain		E	G5	S1
Andromeda glaucophylla	Bog Rosemary		E	G5T5	S1
Aster borealis	Rush Aster		E	G5	S1
Boltonia asteroides var. glastifolia	Southern Boltonia		E	G5TNR	S1
Boltonia montana	Appalachian Mountain Boltonia			G1G2	S1S2
Calamagrostis pickeringii	Pickering's Reed Grass		E	G4	S1
Carex alopecoidea	Foxtail Sedge		E	G5	S1
Carex aquatilis	Water Sedge		E	G5	S1
Carex diandra	Lesser Panicled Sedge			G5	S1
Carex formosa	Handsome Sedge		E	G4	S1.1
Carex haydenii	Cloud Sedge		E	G5	S1
Carex lupuliformis	Hop-like Sedge		E	G4	S1
Carex pseudocyperus	Cyperus-like Sedge		E	G5	S1
Carex tuckermanii	Tuckerman's Sedge		E	G4	S1
Carex woodii	Wood's Sedge			G4	S1.1
Cleistes divaricata	Spreading Pogonia		E	G4	S1
Coelorachis rugosa	Wrinkled Jointgrass		E	G5	S1
Comarum palustris	Marsh Cinquefoil		E	G5	SH
Conioselinum chinense	Hemlock-parsley		E	G5	S1
Cyperus pseudovegetus	Marsh Flat Sedge		E	G5	S1
Cypripedium candidum	Small White Lady's-slipper		E	G4	S1
Cypripedium reginae	Showy Lady's-slipper		E	G4	S1
Diodia virginiana	Larger Buttonweed		E	G5T5	S1
Eleocharis equisetoides	Knotted Spike-rush		E	G4	S1
Eleocharis quinquefolia	Few-flower Spike-rush		E	G5	S1
Equisetum variegatum	Variegated Horsetail		E	G5T5	S1
Eriophorum tenellum	Rough Cotton-grass		E	G5	S1
Eupatorium resinosum	Pine Barren Boneset		E	G3	S2
Filipendula rubra	Queen-of-the-prairie		E	G4G5	SX
Galium labradoricum	Labrador Marsh Bedstraw		E	G5	S1
Galium trifidum	Small Bedstraw		E	G5T5	S2
Glyceria borealis	Small Floating Manna Grass		E	G5	SH.1
Hottonia inflata	Featherfoil		E	G4	S1
Hypericum adpressum	Barton's St. John's-wort		E	G3	S2
Hypericum gymnanthum	Clasping-leaf St. John's-wort			G4	S1
Hypericum majus	Larger Canadian St. John's Wort		E	G5	S1
Juncus caesariensis	New Jersey Rush		E	G2	S2
Lobelia boykinii	Boykin's Lobelia		E	G2G3	S1
Ludwigia linearis	Narrow-leaf Primrose-willow			G5	S1

SCIENTIFIC NAME	COMMON NAME	Fed Status	State Prot Status	Global Rarity Rank	State Rarity Rank
Megalodonta beckii	Water-marigold		E	G4G5	S1
Narthecium americanum	Bog Asphodel	C	E	G2	S2
Neobeckia lacustris	Lake Water-cress		E	G4?	SH
Panicum boreale	Northern Panic Grass		E	G5	S1
Panicum flexile	Wiry Panic Grass		E	G5	S1
Panicum hirstii	Hirst Brothers' Panic Grass	C	E	G1	S1
Platanthera integra	Yellow Fringeless Orchid		E	G3G4	S1
Rhexia aristosa	Awned Meadow-beauty		E	G3	S1
Rhynchospora capillacea	Capillary Beaked-rush		E	G4	S1
Rhynchospora knieskernii	Knieskern's Beaked-rush	LT	E	G2	S2
Rhynchospora microcephala	Small-head Beaked-rush		E	G5T5	S1
Rudbeckia fulgida	Orange Coneflower		E	G5T4?	S1
Sagittaria cuneata	Arum-leaf Arrowhead		E	G5	S1
Sagittaria teres	Slender Arrowhead		E	G3	S1
Salix lucida ssp. lucida	Shining Willow			G5T5	S1
Salix pedicellaris	Bog Willow		E	G5	S1
Schoenoplectus torreyi	Torrey's Bulrush		E	G5?	S1
Scirpus longii	Long's Woolgrass		E	G2G3	S2
Sisyrinchium montanum	Strict Blue-eyed Grass		E	G5T4T5	S2
Sparganium natans	Small Burr-reed		E	G5	S1
Spiranthes laciniata	Lace-lip Ladies'-tresses		E	G4G5	S1
Thuja occidentalis	Arborvitae		E	G5	S1
Tofieldia racemosa	False Asphodel		E	G5	S1
Triglochin maritima	Seaside Arrow-grass		E	G5	S1
Trollius laxus ssp. laxus	Spreading Globe Flower		E	G4T3	S1
Utricularia minor	Lesser Bladderwort		E	G5	S1
Utricularia olivacea	Dwarf White Bladderwort		E	G4	S1.1
Utricularia resupinata	Reversed Bladderwort		E	G4	S1
Veronica catenata	Sessile Water-speedwell		E	G5	S1
Xyris fimbriata	Fringed Yellow-eyed-grass		E	G5	S1
Zigadenus leimanthoides	Death-camus		E	G4Q	S1

SOURCE: New Jersey Natural Heritage Program, Biotics Database

Special Plants of NJ - - Categories & Definitions

http://www.nj.gov/dep/parksandforests/natural/heritage/spplant_ap1.html

Plants:

Plant taxa listed as endangered are from New Jersey's official Endangered Plant Species List (N.J.A.C. 7:5C – 5.1).

E Native New Jersey plant species whose survival in the State or nation is in jeopardy.

REGIONAL STATUS CODES FOR PLANTS AND ECOLOGICAL COMMUNITIES

LP Indicates taxa listed by the Pinelands Commission as endangered or threatened within their legal jurisdiction. Not all species currently tracked by the Pinelands Commission are tracked by the Natural Heritage Program. A complete list of endangered and threatened Pineland species is included in the New Jersey Pinelands Comprehensive Management Plan.

HL Indicates taxa or ecological communities protected by the Highlands Water Protection and Planning Act within the jurisdiction of the Highlands Preservation Area.

EXPLANATION OF GLOBAL AND STATE ELEMENT RANKS

The Nature Conservancy developed a ranking system for use in identifying elements (rare species and ecological com-munities) of natural diversity most endangered with extinction. Each element is ranked according to its global, national, and state (or subnational in other countries) rarity. These ranks are used to prioritize conservation work so that the most endangered elements receive atten-tion first. Definitions for element ranks are after The Nature Conservancy (1982: Chapter 4, 4.1-1 through 4.4.1.3-3).

GLOBAL ELEMENT RANKS

G1 Critically imperiled globally because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especial-ly vulnerable to extinction.

G2 Imperiled globally because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.

G3 Either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g., a single western state, a physiogra-phic region in the East) or because of other factors making it vulnerable to extinction throughout its range; with the number of occurrences in the range of 21 to 100.

G4 Apparently secure globally; although it may be quite rare in parts of its range, especially at the periphery.

G5 Demonstrably secure globally; although it may be quite rare in parts of its range, especia-lly at the periphery.

GH Of historical occurrence throughout its range i.e., formerly part of the established biota, with the expectation that it may be rediscovered.

GU Possibly in peril range-wide but status uncertain; more information needed.

GX Believed to be extinct throughout range (e.g., passenger pigeon) with virtually no likelihood that it will be rediscovered.

G? Species has not yet been ranked.

GNR Species has not yet been ranked.

STATE ELEMENT RANKS

S1 Critically imperiled in New Jersey because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres). Elements so ranked are often restricted to very specialized conditions or habitats and/or restricted to an extremely small geographical area of the state. Also included are elements which were formerly more abundant, but because of habitat destruction or some other critical factor of its biology, they have been demonstrably reduced in abundance. In essence, these are elements for which, even with intensive searching, sizable additional occurrences are unlikely to be discovered.

S2 Imperiled in New Jersey because of rarity (6 to 20 occurrences). Historically many of these elements may have been more frequent but are now known from very few extant occurrences, primarily because of habitat destruction. Diligent searching may yield additional occurrences.

S3 Rare in state with 21 to 100 occurrences (plant species and ecological communities in this category have only 21 to 50 occurrences). Includes elements which are widely distributed in the state but with small populations/acreage or elements with restricted distribution, but locally abun-dant. Not yet imperiled in state but may soon be if current trends continue. Searching often yields additional occurrences.

S4 Apparently secure in state, with many occurrences.

S5 Demonstrably secure in state and essentially ineradicable under present conditions.

SA Accidental in state, including species (usually birds or butterflies) recorded once or twice or only at very great intervals, hundreds or even thousands of miles outside their usual range; a few of these species may even have bred on the one or two occasions they were recorded; examples include European strays or western birds on the East Coast and vice-versa.

SE Elements that are clearly exotic in New Jersey including those taxa not native to North America (introduced taxa) or taxa deliberately or accidentally introduced into the State from other parts of North America (adventive taxa). Taxa ranked SE are not a conservation priority (viable introduced occurrences of G1 or G2 elements may be exceptions).

SH Elements of historical occurrence in New Jersey. Despite some searching of historical occurrences and/or potential habitat, no extant occurrences are known. Since not all of the historical occurrences have been field surveyed, and unsearched potential habitat remains,

historically ranked taxa are considered possibly extant, and remain a conservation priority for continued field work with the expectation they may be rediscovered.

SP Element has potential to occur in New Jersey, but no occurrences have been reported.

SR Elements reported from New Jersey, but without per-suasive documentation which would provide a basis for either accepting or rejecting the report. In some instances documentation may exist, but as of yet, its source or location has not been determined.

SRF Elements erroneously reported from New Jersey, but this error persists in the literature.

SU Elements believed to be in peril but the degree of rarity uncertain. Also included are rare taxa of uncertain taxonomical standing. More information is needed to resolve rank.

SX Elements that have been determined or are presumed to be extirpated from New Jersey. All historical occurrences have been searched and a reasonable search of potential habitat has been completed. Extirpated taxa are not a current conservation priority.

SXC Elements presumed extirpated from New Jersey, but native populations collected from the wild exist in cultivation.

SZ Not of practical conservation concern in New Jersey, because there are no definable occurrences, although the taxon is native and appears regularly in the state. An SZ rank will generally be used for long distance migrants whose occurrences during their migrations are too irregular (in terms of repeated visitation to the same locations), transitory, and dispersed to be reliably identified, mapped and protected. In other words, the migrant regularly passes through the state, but enduring, mappable element occurrences cannot be defined.

Typically, the SZ rank applies to a non-breeding population (N) in the state - for example, birds on migration. An SZ rank may in a few instances also apply to a breeding population (B), for example certain lepidoptera which regularly die out every year with no significant return migration.

Although the SZ rank typically applies to migrants, it should not be used indiscriminately. Just because a species is on migration does not mean it receives an SZ rank. SZ will only apply when the migrants occur in an irregular, transitory and dispersed manner.

B Refers to the breeding population of the element in the state.

N Refers to the non-breeding population of the element in the state.

T Element ranks containing a "T" indicate that the infraspecific taxon is being ranked differently than the full species. For example Stachys palustris var. homotricha is ranked

"G5T? SH" meaning the full species is globally secure but the global rarity of the var. homotricha has not been determined; in New Jersey the variety is ranked historic.

Q Elements containing a "Q" in the global portion of its rank indicates that the taxon is of questionable, or uncertain taxonomical standing, e.g., some authors regard it as a full species, while others treat it at the subspecific level.

.1 Elements only, ever documented from a single location.
Note: To express uncertainty, the most likely rank is assigned and a question mark added (e.g., G2?). A range is indicated by combining two ranks (e.g., G1G2, S1S3).

IDENTIFICATION CODES
These codes refer to whether the identification of the species or community has been checked by a reliable individual and is indicative of significant habitat. These codes are not included on all Natural Heritage Reports.

Y Identification has been verified and is indicative of significant habitat.

BLANK Identification has not been verified but there is no reason to believe it is not indicative of significant habitat.
? Either it has not been determined if the record is indicative of significant habitat or the identification of the species or community may be confusing or disputed.

List of selected Wildlife Species of Conservation Need with Protection Status and Rarity Rank

Animal Type	Common name	*Scientific name*	Fed Status	State Status (ENSP)	Global Rarity Rank	State Rarity Rank
Amphibian	Pine barrens treefrog	*Hyla andersonii*		**T**	G4	S2
Amphibian	Jefferson salamander	*Ambystoma jeffersonianum*		SC	G4	S3
Amphibian	Marbled salamander	*Ambystoma opacum*		SC	G5	S3
Amphibian	Long-tailed salamander	*Eurycea longicauda longicauda*		**T**	G5	S2
Amphibian	Carpenter frog	*Lithobates virgatipes*		SC	G4	S3
Bird	Winter wren	*Troglodytes hiemalis*		SC	G5	S3B,S4N
Bird	Veery	*Catharus fuscescens*		SC	G5	S3B
Bird	Sedge wren	*Cistothorus platensis*		**E**	G5	S1B, S1N
Bird	Black-billed cuckoo	*Coccyzus erythropthalmus*		SC	G5	S3B
Bird	Least flycatcher	*Empidonax minimus*		SC	G5	S3B
Bird	Red-headed woodpecker	*Melanerpes erythrocephalus*		**T**	G5	S2B, S2N
Bird	Northern parula *	*Setophaga (Parula) americana*		SC	G5	S3B
Bird	American woodcock	*Scolopax minor*			G5	S5
Bird	Golden-winged warbler	*Vermivora chrysoptera*		**E**	G4	S3B, S3N
Bird	Canada warbler	*Cardellina (Wilsonia) canadensis*		SC	G5	S3B
Butterfly	Arogos skipper	*Atrytone arogos arogos*		**E**	G3T1T2	S1
Butterfly	Silver-bordered Fritillary	*Boloria selene myrina*		**T**	G5	S2
Butterfly	Georgia Satyr = Helicta Satyr	*Neonympha areolata septentrionalis (=Neonympha helicta)*		SC	G3G4	S3
Butterfly	Mitchell's Satyr	*Neonympha mitchellii mitchellii*	**E**	**E**	G2T2	S1
Dragonfly	Scarlet Bluet	*Enallagma pictum*		SC	G3	S3
Dragonfly	Pine Barrens Bluet	*Enallagma recurvatum*		SC	G3	S3
Dragonfly	Golden-winged skimmer	*Libellula auripennis*		SC	G5	S3
Dragonfly	Kennedy's Emerald	*Somatochlora kennedyi*		**T**	G5	S3
Dragonfly	Brush-tipped Emerald	*Somatochlora walshii*		SC	G5	S3
Mammal	Southern bog lemming	*Synaptomys cooperi*			G5	S2
Moth	Moth	*Dichagyris reliqua*			G2G3	S1
Moth	Schweitzer's buckmoth	*Hemileuca nevadensis ssp. 2*			G5T1	S1
Moth	Carter's noctuid moth	*Photedes (Spartiniphaga) carterae*			G2G3	S2
Reptile	Spotted turtle	*Clemmys guttata*		**T**	G5	S3

Animal Type	Common name	*Scientific name*	Fed Status	State Status (ENSP)	Global Rarity Rank	State Rarity Rank
Reptile	Bog turtle	*Glyptemys (Clemmys) muhlenbergii*	**T**	**E**	G3	S1

SOURCE: Endangered Non-Game Species Program. T= Threatened; E = Endangered; SC = Special Concern

NJ Endangered and Nongame Species Program Special Concern Species Status Listing

Status Definitions:

Endangered: Applies to a species whose prospects for survival within the state are in immediate danger due to one or several factors, such as loss or degradation of habitat, over-exploitation, predation, competition, disease or environmental pollution, etc. An endangered species likely requires immediate action to avoid extinction within NJ.

Threatened: Applies to species that may become Endangered if conditions surrounding it begin to or continue to deteriorate. Thus, a Threatened species is one that is already vulnerable as a result of, for example, small population size, restricted range, narrow habitat affinities, significant population decline, etc.

Special Concern: Applies to species that warrant special attention because of inherent vulnerability to environmental deterioration or habitat modification that would result in its becoming threatened if conditions surrounding the species begin or continue to deteriorate. Factors that can lead to classification as special concern include, but are not limited to, species rarity in the State, highly specialized food and/or habitat requirements, low reproductive rate, isolated populations of the species within the State and/or other characteristics that make the species particularly susceptible to environmental or habitat changes. This category includes a species that meets the foregoing criteria and for which there is little understanding of its current population status in the state.

Stable: Applies to species that appear to be secure in NJ and not in danger of falling into any of the preceding the categories in the near future.

Undetermined: A species about which there is not enough information available to determine the status.

The lists of New Jersey's endangered and nongame wildlife species are maintained by the DEP's Division of Fish and Wildlife's Endangered and Nongame Species Program. These lists are used to determine protection and management actions necessary to ensure the survival of the state's endangered and nongame wildlife.

This work is made possible through voluntary contributions received through check-off donations to the Endangered Wildlife Conservation Fund on the New Jersey State Income Tax Form, the sale of Conserve Wildlife License Plates, and donations. For more information about the Endangered and Nongame Species Program or to report a sighting of endangered or threatened wildlife, contact the Endangered and Nongame Species, NJ Division of Fish and Wildlife, Mail Code 501-03, PO Box 420, Trenton, NJ 08625-0420.
2/21/2012

APPENDIX B

- **HABITAT CLASSIFICATION**
  - **Calcareous Fen**
  - **Calcareous Sinkhole Pond**
  - **Pine Barren Savanna**
    - Pine Barren Riverside Savanna
    - Pitch Pine Reedgrass Savanna
  - **Coastal Plain Intermittent Pond**

The habitat classification used in this report is based on the following documents:

Anderson, James R., Ernest E. Hardy, John T. Roach, and Richard E. Witmer. 1976. A Land Use and Land Cover Classification System for Use with Remote Sensor Data, U. S. Geological Survey Professional Paper 964, A revision of the land use classification system as presented in U.S. Geological Survey Circular 671. United States Department of the Interior, Washington, DC. 41 p.

Federal GeographicData Committee. 2008. National Vegetation Classification Standard, Version 2. FGDC Document number FGDC-STD-005-2008 (Version 2). http://usnvc.org/wp-content/uploads/2011/02/NVCS_V2_FINAL_2008-02.pdf

Gawler, S.C. 2008. Northeast terrestrial wildlife habitat classification: The Northeast habitat classification and mapping project: report to the Virginia Department of Game and Inland Fisheries on behalf of the Northeast Association of Fish and Wildlife Agencies for the National Fish and Wildlife Foundation (NFWF Project 2006-0181-003). NatureServe, Boston, MA.

New Jersey Department of Environmental Protection. 2010. NJDEP 2007 Land Use/Land Cover. http://www.state.nj.us/dep/gis/lulc07cshp.html

New Jersey Division of Fish and Wildlife. 2012. New Jersey Landscape Project, Version 3.1. New Jersey Department of Environmental Protection, Division of Fish and Wildlife, Endangered and Nongame Species Program. pp. 33. http://www.state.nj.us/dep/fgw/ensp/landscape/lp_report_3_1.pdf

United States National Vegetation Classification System (USNVC). 2012. The U.S. National Vegetation Classification System: Your guide to inventorying natural and cultural plant communities. http://usnvc.org/

Walz, K.S., K. Anderson, L. Kelly, A.Windisch, and M. Wong. 2012. Draft New Jersey ecological community crosswalk: A tool for the identification of habitats across jurisdictional boundaries. New Jersey Department of Environmental Protection, Division of Parks and Forestry, Office of Natural Lands Management, Natural Heritage Program, Trenton, NJ.

1. CALCAREOUS FEN CLASSIFICATION

NORTHEAST TERRESTRIAL WILDLIFE HABITAT/ECOLOGICAL SYSTEM:
North-Central Appalachian Seepage Fen
"This rare small-patch system occurs in scattered locations in the central Appalachians and eastern Great Lakes regions. Mostly non-forested, these open fens develop on shallow to deep peat over a sloping substrate, where seepage waters provide nutrients. Conditions are often circumneutral to alkaline. Sedges are the major dominants. Skunk cabbage is a characteristic forb. Some of these areas are kept open by grazing, and succession to shrublands may occur in the absence of disturbance." (Gawler 2008)

NATIONAL VEGETATION CLASSIFICATION SYSTEM (USNVC 2012):
Class: Shrubland & Grassland
Formation: Temperate & Boreal Bog & Fen
Division: North American Bog & Fen
MacroGroup: Appalachian, Interior Plateau & Prairie Fen
Group: North-Central Appalachian, Interior & Prairie Fen Group
NJ Associations / Ecological Community Types:
Calcareous Shrub Fen
Intermediate Graminoid Fen
Northern Piedmont Rich Fen
Pasture Fen
Prairie Fen
Rich Shrub Carr
Twig-rush Fen
Lakeshore Marl Fen *(note that this type of fen occurs on pond and lakeshores and is therefore included in the calcareous sinkhole pond classification below)*

LANDSCAPE MAP HABITAT CLASSIFICATION (NJDFW 2010)
Emergent Habitat
Forest Habitat
Wetland Habitat

LAND USE / LAND COVER TYPES (NJDEP 2010, NJDFW 2012)
Herbaceous Wetlands
Deciduous Scrub/Shrub Wetlands
Coniferous Scrub/Shrub Wetlands
Mixed Scrub/Shrub Wetlands (Deciduous Dominant)
Mixed Scrub/Shrub Wetlands (Coniferous Dominant)

2. CALCAREOUS SINKHOLE POND CLASSIFICATION

NORTHEAST TERRESTRIAL WILDLIFE HABITAT/ECOLOGICAL SYSTEM:
Central Interior Highlands and Appalachian Sinkhole and Depression Pond

"This system of ponds and wetlands ranges from the Ozarks east to the northern Piedmont of Pennsylvania and New Jersey. It is found in basins of sinkholes or other isolated depressions on uplands. Soils are very poorly drained, and surface water may be present for extended periods of time, rarely becoming dry. Water depth may vary greatly on a seasonal basis and may be a meter deep or more in the winter. Some examples become dry in the summer. Soils may be deep (1 m or more), consisting of peat or muck, with parent material of peat, muck or alluvium. Ponds vary from open water to herb-, shrub-, or tree-dominated. Tree-dominated examples typically contain oaks, sycamore, green ash, silver maple, and/or black gum. Buttonbush is a typical shrub component." (Gawler, 2008)

NATIONAL VEGETATION CLASSIFICATION SYSTEM (USNVC 2012):
Class: Shrubland & Grassland
Formation: Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland
Division: Eastern North American Freshwater Wet Meadow, Riparian & Marsh
MacroGroup: Eastern North American Wet Meadow & Marsh
Group: Eastern North American Wet Meadow Group
NJ Associations / Ecological Community Types:
Calcareous Sinkhole Boltonia Pondshore
Calcareous Sinkhole Mote Marsh

NATIONAL VEGETATION CLASSIFICATION SYSTEM (USNVC 2012):
Class: Shrubland & Grassland
Formation: Temperate & Boreal Bog & Fen
Division: North American Bog & Fen
MacroGroup: Appalachian, Interior Plateau & Prairie Fen
Group: North-Central Appalachian, Interior & Prairie Fen
NJ Associations / Ecological Community Types:
Lakeshore Marl Fen *(note that this is a calcareous fen that occurs on pond and lakeshores and is therefore included in the calcareous sinkhole pond classification section)*

NATIONAL VEGETATION CLASSIFICATION SYSTEM (USNVC 2012):
Class: Forest to Open Woodland
Formation: Temperate Flooded & Swamp Forest
Division: Eastern North American Flooded & Swamp Forest
MacroGroup: Northern & Central Floodplain Forest & Scrub
Group: Silver Maple - Green Ash - Sycamore - Hackberry Floodplain Forest
NJ Associations / Ecological Community Types:
Sinkhole Pond Floodplain Forest
Pond or Lakeside Ash - Maple Swamp
Northeastern Maple - Ash Swamp

LANDSCAPE MAP HABITAT CLASSIFICATION (NJDFW 2010)
Forest Habitat
Wetland Habitat
Vernal Habitat

LAND USE / LAND COVER TYPES (NJDEP 2010, NJDFW 2012)

Herbaceous Wetlands
Deciduous Wooded Wetlands
Mixed Forested Wetlands (Deciduous Dominant)

3. PINE BARREN SAVANNA CLASSIFICATION

NORTHEAST TERRESTRIAL WILDLIFE HABITAT/ECOLOGICAL SYSTEM:
Northern Atlantic Coastal Plain Stream and River

"This system is found throughout the northern Atlantic Coastal Plain from Virginia to New Jersey along low-gradient small streams and rivers with little to moderate floodplain development. This system is influenced by overbank flooding, groundwater seepage and occasional beaver impoundments. The vegetation is a mosaic of forests, woodlands, shrublands, and herbaceous communities. Canopy composition and cover can vary within examples of this system, but typical tree species may include bottomland oaks, Atlantic white cedar, red maple, green ash, black gum, black birch, sweetgum, and sycamore. Shrubs and herbaceous layers can vary in richness and cover. Some characteristic shrubs include alder, musclewood, and spicebush. Seepage forests dominated by red maple sweet bay can often be found within this system, especially at the headwaters and terraces of streams." (Gawler, 2008)

NATIONAL VEGETATION CLASSIFICATION SYSTEM (USNVC 2012):

Class: Forest to Open Woodland
Formation: Temperate Flooded & Swamp Forest
Division: Eastern North American Flooded & Swamp Forest
MacroGroup: Northern & Central Swamp Forest
Group: Northern Atlantic White-cedar-(Pitch Pine) Swamp Group

NJ Associations / Ecological Community Types:

Pine Barren Riverside Bog Asphodel Savanna
Pine Barren Riverside Muhly Savanna
Pine Barren Riverside Sedge Savanna
Pine Barren Riverside Shrub Savanna
Pine Barren Riverside Wet Depression Savanna

NORTHEAST TERRESTRIAL WILDLIFE HABITAT/ECOLOGICAL SYSTEM:
Northern Atlantic Coastal Plain Pitch Pine Lowland

"This system is comprised of wetland pine barrens, best developed in the New Jersey Pine Barrens. Although it can be extensive, components often co-occur as a mosaic with upland pine barrens vegetation as well. Substrates range from saturated deep peats to seasonally saturated mineral soils. The range of hydroperiods is reflected in the vegetation, which ranges from wet grasslands dominated by pine barren sandreed to seasonally saturated pine forests. Fire frequency also has a profound influence on the vegetation. Where fire frequency is high, woody vegetation is impeded, favoring the development of large wet grasslands." (Gawler, 2008)

NATIONAL VEGETATION CLASSIFICATION SYSTEM (USNVC 2012):

Class: Forest to Open Woodland
Formation: Temperate Flooded & Swamp Forest
Division: Eastern North American Flooded & Swamp Forest
MacroGroup: Northern Swamp Forest
Group: Northern Atlantic Coastal Conifer Swamp
NJ Associations / Ecological Community Types:
Pitch Pine / Sandreed Savanna

LANDSCAPE MAP HABITAT CLASSIFICATION (NJDFW 2010)

Emergent Habitat
Forest Habitat
Wetland Habitat

LAND USE / LAND COVER TYPES (NJDEP 2010, NJDFW 2012)

Herbaceous Wetlands
Coniferous Scrub/Shrub Wetlands
Mixed Scrub/Shrub Wetlands (Coniferous Dominant)
Coniferous Wooded Wetlands

4. COASTAL PLAIN INTERMITTENT POND CLASSIFICATION

NORTHEAST TERRESTRIAL WILDLIFE HABITAT/ECOLOGICAL SYSTEM:
Northern Atlantic Coastal Plain Pond

'This system includes groundwater-flooded depressions characterized by a flora characteristic of the coastal plain from the Delmarva Peninsula to Cape Cod. It occurs on sandy deposits such as outwash plains of the glaciated region (Long Island and Cape Cod), on the deep sands of the New Jersey Pine Barrens, or on finer sediments of the Coastal Plain of Cape May, the Delmarva peninsula, and the Chesapeake Bay region. Ponds may contain permanent water, such as the deep glacial kettleholes of Cape Cod and Long Island, or may be shallow basins where groundwater drops below the surface late in the growing season. The vegetation is characterized by strong zonation, with a border of tall shrubs, such as highbush blueberry, and several essentially concentric bands dominated by progressively lower vegetation with strong coastal plain affinities. In shallower basins, such strong zonation is generally lacking but still remains evident in some cases. On Cape Cod, Long Island, and New Jersey, this system most often occurs within the pitch pine barrens. From Cape May and south, it occurs within an upland matrix of mixed hardwood forests and generally supports a seasonally flooded swamp forest characterized by sweet gum, red maple, and wetland oaks such as willow oak. Buttonbush often occurs as scattered individuals or forms a shrub swamp in areas with lower diversity and cover of coastal plain flora. (Gawler, 2008)

NATIONAL VEGETATION CLASSIFICATION SYSTEM (USNVC 2012):

Class: Shrubland & Grassland
Formation: Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland
Division: Eastern North American Freshwater Wet Meadow, Riparian & Marsh
MacroGroup: Atlantic & Gulf Coastal Plain Pondshore and Wet Meadow
Group: Atlantic & Gulf Coastal Plain Pondshore & Wet Prairie Group

NJ Associations / Ecological Community Types:

Bulblet Flatsedge Coastal Plain Sandy Pondshore
Buttonbush Coastal Plain Pond
Cape May - Delmarva Depression Meadow
Coastal Plain Horsetail Spikerush Peatland
Coastal Plain Muck Pondshore
Coastal Plain Pondshore
Deep Muck Coastal Plain Pond
Delmarva Bay Tall Grassland
Northern Peatland Sedge Coastal Plain Pond
Panicgrass Pondshore
Swamp-loosestrife Coastal Plain Pond

LANDSCAPE MAP HABITAT CLASSIFICATION (NJDFW 2010)

Emergent Habitat
Wetland Habitat
Vernal Habitat

LAND USE / LAND COVER TYPES (NJDEP 2010, NJDFW 2012)

Herbaceous Wetlands

Appendix C

CMP THREATS AND STRESSES Tables for State Endangered Plant Species and Wildlife SGCN

- ✧ Calcareous Fen Habitat
  - State Endangered Plant Species
  - Wildlife SGCN
- ✧ Calcareous Sinkhole Pond Habitat
  - State Endangered Plant Species
  - Wildlife SGCN
- ✧ Pine Barren Savanna Habitat
  - State Endangered Plant Species
  - Wildlife SGCN
- ✧ Coastal Plain Intermittent Pond Habitat
  - State Endangered Plant Species
  - Wildlife SGCN

CMP THREATS & STRESSES TO STATE ENDANGERED PLANT SPECIES IN CALCAREOUS FEN HABITAT		Bog Rosemary	Rush Aster	Foxtail Sedge	Water Sedge	Lesser Panicled Sedge	Handsome Sedge	Cyperus-like Sedge	Wood's Sedge	Marsh Cinquefoil	Hemlock-parsley	Small White Lady's-	Showy Lady's-slipper	Few-flower Spike-rush	Variegated Horsetail	Queen-of-the-prairie	Labrador Marsh	Small Bedstraw	Northern Panic Grass	Capillary Beaked-rush	Orange Coneflower	Shining Willow	Bog Willow	Strict Blue-eyed Grass	Arborvitae	Seaside Arrow-grass	Spreading Globe Flower	Sessile Water-speedwell
		Andromeda glaucophylla	*Aster borealis*	*Carex alopecoidea*	*Carex aquatilis*	*Carex diandra*	*Carex formosa*	*Carex pseudocyperus*	*Carex woodii*	*Comarum palustris*	*Coniioselinum chinense*	*Cypripedium candidum*	*Cypripedium reginae*	*Eleocharis quinquefolia*	*Equisetum variegatum*	*Filipendula rubra*	*Galium labradoricum*	*Galium trifidum*	*Panicum boreale*	*Rhynchospora capillacea*	*Rudbeckia fulgida*	*Salix lucida ssp. lucida*	*Salix pedicellaris*	*Sisyrinchium montanum*	*Thuja occidentalis*	*Triglochin maritima*	*Trollius laxus ssp. laxus*	*Veronica catenata*
CMP THREATS																												
1	**Residential and Commercial Development**																											
1.1	Housing and Urban Areas	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y
1.2	Commercial and Industrial Areas	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y
1.3	Tourism and Recreation Areas																			Y								
2	**Agriculture and Aquaculture**																											
2.1	Annual and Perennial Non-timber Crops	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2.2	Wood and Pulp Plantations																											
2.3	Livestock Farming and Ranching	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y

CMP THREATS & STRESSES TO STATE ENDANGERED PLANT SPECIES IN CALCAREOUS FEN HABITAT		Bog Rosemary	Rush Aster	Foxtail Sedge	Water Sedge	Lesser Panicled Sedge	Handsome Sedge	Cyperus-like Sedge	Wood's Sedge	Marsh Cinquefoil	Hemlock-parsley	Small White Lady's-	Showy Lady's-slipper	Few-flower Spike-rush	Variegated Horsetail	Queen-of-the-prairie	Labrador Marsh	Small Bedstraw	Northern Panic Grass	Capillary Beaked-rush	Orange Coneflower	Shining Willow	Bog Willow	Strict Blue-eyed Grass	Arborvitae	Seaside Arrow-grass	Spreading Globe Flower	Sessile Water-speedwell
		Andromeda glaucophylla	*Aster borealis*	*Carex alopecoidea*	*Carex aquatilis*	*Carex diandra*	*Carex formosa*	*Carex pseudocyperus*	*Carex woodii*	*Comarum palustris*	*Conioselinum chinense*	*Cypripedium candidum*	*Cypripedium reginae*	*Eleocharis quinquefolia*	*Equisetum variegatum*	*Filipendula rubra*	*Galium labradoricum*	*Galium trifidum*	*Panicum boreale*	*Rhynchospora capillacea*	*Rudbeckia fulgida*	*Salix lucida ssp. lucida*	*Salix pedicellaris*	*Sisyrinchium montanum*	*Thuja occidentalis*	*Triglochin maritima*	*Trollius laxus ssp. laxus*	*Veronica catenata*
2.4	Marine and Freshwater Aquaculture																											
3	**Energy production and mining**																											
3.1	Oil and Gas Drilling																											
3.2	Mining and Quarrying																											
3.3	Renewable Energy																											
4	**Transportation and service corridors**																											
4.1	Roads and Railroads	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y
4.2	Utility and Service Lines	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
4.3	Shipping Lanes																											
4.4	Flight Paths																											

CMP THREATS & STRESSES TO STATE ENDANGERED PLANT SPECIES IN CALCAREOUS FEN HABITAT		Bog Rosemary	Rush Aster	Foxtail Sedge	Water Sedge	Lesser Panicled Sedge	Handsome Sedge	Cyperus-like Sedge	Wood's Sedge	Marsh Cinquefoil	Hemlock-parsley	Small White Lady's-	Showy Lady's-slipper	Few-flower Spike-rush	Variegated Horsetail	Queen-of-the-prairie	Labrador Marsh	Small Bedstraw	Northern Panic Grass	Capillary Beaked-rush	Orange Coneflower	Shining Willow	Bog Willow	Strict Blue-eyed Grass	Arborvitae	Seaside Arrow-grass	Spreading Globe Flower	Sessile Water-speedwell
		Andromeda glaucophylla	*Aster borealis*	*Carex alopecoidea*	*Carex aquatilis*	*Carex diandra*	*Carex formosa*	*Carex pseudocyperus*	*Carex woodii*	*Comarum palustris*	*Conioselinum chinense*	*Cypripedium candidum*	*Cypripedium reginae*	*Eleocharis quinquefolia*	*Equisetum variegatum*	*Filipendula rubra*	*Galium labradoricum*	*Galium trifidum*	*Panicum boreale*	*Rhynchospora capillacea*	*Rudbeckia fulgida*	*Salix lucida ssp. lucida*	*Salix pedicellaris*	*Sisyrinchium montanum*	*Thuja occidentalis*	*Triglochin maritima*	*Trollius laxus ssp. laxus*	*Veronica catenata*
5	**Biological Resource Use**																											
5.1	Hunting and Collecting Terrestrial Animals	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
5.2	Gathering Terrestrial Plants	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
5.3	Logging and Wood Harvesting																											
5.4	Fishing and Harvesting Aquatic Resources																											
6	**Human Intrusions and Disturbance**																											
6.1	Recreational Activities	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
6.2	War, Civil Unrest and Military Exercises																											
6.3	Work and Other Activities	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
7	**Natural System Modifications**																											

CMP THREATS & STRESSES TO STATE ENDANGERED PLANT SPECIES IN CALCAREOUS FEN HABITAT		Bog Rosemary	Rush Aster	Foxtail Sedge	Water Sedge	Lesser Panicled Sedge	Handsome Sedge	Cyperus-like Sedge	Wood's Sedge	Marsh Cinquefoil	Hemlock-parsley	Small White Lady's-	Showy Lady's-slipper	Few-flower Spike-rush	Variegated Horsetail	Queen-of-the-prairie	Labrador Marsh	Small Bedstraw	Northern Panic Grass	Capillary Beaked-rush	Orange Coneflower	Shining Willow	Bog Willow	Strict Blue-eyed Grass	Arborvitae	Seaside Arrow-grass	Spreading Globe Flower	Sessile Water-speedwell
		Andromeda glaucophylla	*Aster borealis*	*Carex alopecoidea*	*Carex aquatilis*	*Carex diandra*	*Carex formosa*	*Carex pseudocyperus*	*Carex woodii*	*Comarum palustris*	*Conioselinum chinense*	*Cypripedium candidum*	*Cypripedium reginae*	*Eleocharis quinquefolia*	*Equisetum variegatum*	*Filipendula rubra*	*Galium labradoricum*	*Galium trifidum*	*Panicum boreale*	*Rhynchospora capillacea*	*Rudbeckia fulgida*	*Salix lucida ssp. lucida*	*Salix pedicellaris*	*Sisyrinchium montanum*	*Thuja occidentalis*	*Triglochin maritima*	*Trollius laxus ssp. laxus*	*Veronica catenata*
7.1	Fire and Fire Suppression																											
7.2	Dams and Water Management/Use	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
7.3	Other Ecosystem Modifications																											
8	**Invasive and other problematic species and genes**																											
8.1	Invasive Non-native/Alien species	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y
8.2	Problematic Native Species	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
8.3	Introduced Genetic Material																											
9	**Pollution**																											
9.1	Household Sewage and Urban Waste Water	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y

CMP THREATS & STRESSES TO STATE ENDANGERED PLANT SPECIES IN CALCAREOUS FEN HABITAT		Bog Rosemary	Rush Aster	Foxtail Sedge	Water Sedge	Lesser Panicled Sedge	Handsome Sedge	Cyperus-like Sedge	Wood's Sedge	Marsh Cinquefoil	Hemlock-parsley	Small White Lady's-	Showy Lady's-slipper	Few-flower Spike-rush	Variegated Horsetail	Queen-of-the-prairie	Labrador Marsh	Small Bedstraw	Northern Panic Grass	Capillary Beaked-rush	Orange Coneflower	Shining Willow	Bog Willow	Strict Blue-eyed Grass	Arborvitae	Seaside Arrow-grass	Spreading Globe Flower	Sessile Water-speedwell
		Andromeda glaucophylla	*Aster borealis*	*Carex alopecoidea*	*Carex aquatilis*	*Carex diandra*	*Carex formosa*	*Carex pseudocyperus*	*Carex woodii*	*Comarum palustris*	*Conioselinum chinense*	*Cypripedium candidum*	*Cypripedium reginae*	*Eleocharis quinquefolia*	*Equisetum variegatum*	*Filipendula rubra*	*Galium labradoricum*	*Galium trifidum*	*Panicum boreale*	*Rhynchospora capillacea*	*Rudbeckia fulgida*	*Salix lucida ssp. lucida*	*Salix pedicellaris*	*Sisyrinchium montanum*	*Thuja occidentalis*	*Triglochin maritima*	*Trollius laxus ssp. laxus*	*Veronica catenata*
9.2	Industrial and Military Effluents	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
9.3	Agricultural and Forestry Effluents	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y
9.4	Garbage and Solid Waste	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
9.5	Airborne Pollutants																											
9.6	Excess Energy																											
10	**Geological Events**																											
10.1	Volcanoes																											
10.2	Earthquakes/Tsunamis																											
10.3	Avalanches/Landslides																											
11	**Climage Change and Severe Weather**																											
11.1	Habitat Shifting and Alteration	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

CMP THREATS & STRESSES TO STATE ENDANGERED PLANT SPECIES IN CALCAREOUS FEN HABITAT		Bog Rosemary	Rush Aster	Foxtail Sedge	Water Sedge	Lesser Panicled Sedge	Handsome Sedge	Cyperus-like Sedge	Wood's Sedge	Marsh Cinquefoil	Hemlock-parsley	Small White Lady's-	Showy Lady's-slipper	Few-flower Spike-rush	Variegated Horsetail	Queen-of-the-prairie	Labrador Marsh	Small Bedstraw	Northern Panic Grass	Capillary Beaked-rush	Orange Coneflower	Shining Willow	Bog Willow	Strict Blue-eyed Grass	Arborvitae	Seaside Arrow-grass	Spreading Globe Flower	Sessile Water-speedwell
		Andromeda glaucophylla	*Aster borealis*	*Carex alopecoidea*	*Carex aquatilis*	*Carex diandra*	*Carex formosa*	*Carex pseudocyperus*	*Carex woodii*	*Comarum palustris*	*Conioselinum chinense*	*Cypripedium candidum*	*Cypripedium reginae*	*Eleocharis quinquefolia*	*Equisetum variegatum*	*Filipendula rubra*	*Galium labradoricum*	*Galium trifidum*	*Panicum boreale*	*Rhynchospora capillacea*	*Rudbeckia fulgida*	*Salix lucida ssp. lucida*	*Salix pedicellaris*	*Sisyrinchium montanum*	*Thuja occidentalis*	*Triglochin maritima*	*Trollius laxus ssp. laxus*	*Veronica catenata*
11.2	Droughts	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
11.3	Temperature Extremes																											
11.4	Storms and Flooding	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
11.5	*Phenology and Pollination/Pollinators*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
CMP STRESSES																												
1	**Ecosystem/Community Stresses**																											
1.1	Ecosystem Conversion	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
1.2	Ecosystem Degradation	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
1.3	Indirect Ecosystem Effects																											
2	**Species stresses**																											

CMP THREATS & STRESSES TO <u>STATE ENDANGERED PLANT SPECIES IN CALCAREOUS FEN HABITAT</u>		Bog Rosemary	Rush Aster	Foxtail Sedge	Water Sedge	Lesser Panicled Sedge	Handsome Sedge	Cyperus-like Sedge	Wood's Sedge	Marsh Cinquefoil	Hemlock-parsley	Small White Lady's-	Showy Lady's-slipper	Few-flower Spike-rush	Variegated Horsetail	Queen-of-the-prairie	Labrador Marsh	Small Bedstraw	Northern Panic Grass	Capillary Beaked-rush	Orange Coneflower	Shining Willow	Bog Willow	Strict Blue-eyed Grass	Arborvitae	Seaside Arrow-grass	Spreading Globe Flower	Sessile Water-speedwell
		Andromeda glaucophylla	*Aster borealis*	*Carex alopecoidea*	*Carex aquatilis*	*Carex diandra*	*Carex formosa*	*Carex pseudocyperus*	*Carex woodii*	*Comarum palustris*	*Conioselinum chinense*	*Cypripedium candidum*	*Cypripedium reginae*	*Eleocharis quinquefolia*	*Equisetum variegatum*	*Filipendula rubra*	*Galium labradoricum*	*Galium trifidum*	*Panicum boreale*	*Rhynchospora capillacea*	*Rudbeckia fulgida*	*Salix lucida ssp. lucida*	*Salix pedicellaris*	*Sisyrinchium montanum*	*Thuja occidentalis*	*Triglochin maritima*	*Trollius laxus ssp. laxus*	*Veronica catenata*
2.1	Species mortality	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2.2	Species disturbance																											
2.3	Indirect species effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

CMP THREATS & STRESSES TO WILDLIFE SGCN IN CALCAREOUS FEN HABITAT		Silver-bordered Fritillary	Canada warbler	Veery	Sedge Wren	Spotted turtle	Black-billed cuckoo	Least flycatcher	Bog turtle	Schweitzer's buckmoth	Red-headed woodpecker	Mitchell's Satyr (extirpated)	American woodcock	Northern parula	Kennedy's Emerald	Brush-tipped Emerald	Winter wren	Golden-winged warbler
		Boloria selene myrina	*Cardellina canadensis*	*Catharus fuscescens*	*Cistothorus platensis*	*Clemmys guttata*	*Coccyzus erythropthalmus*	*Empidonax minimus*	*Glyptemys muhlenbergii*	*Hemileuca nevadensis ssp. 2*	*Melanerpes erythrocephalus*	*Neonympha mitchellii*	*Scolopax minor*	*Setophaga americana*	*Somatochlora kennedyi*	*Somatochlora walshii*	*Troglodytes hiemalis*	*Vermivora chrysoptera*
CMP THREATS																		
1	**Residential and Commercial Development**																	
1.1	Housing and Urban Areas	?	Y	Y	Y	Y	Y	Y	Y	?	Y	?	Y	Y	Y	Y	Y	Y
1.2	Commercial and Industrial Areas	?	Y	Y	Y	Y	Y	Y	Y	?	Y	?	Y	Y	Y	Y	Y	Y
1.3	Tourism and Recreation Areas	Y				Y			Y									
2	**Agriculture and Aquaculture**																	
2.1	Annual and Perennial Non-timber Crops	y				Y			Y						Y	Y		
2.2	Wood and Pulp Plantations					N												
2.3	Livestock Farming and Ranching	?				Y			Y	?		?			Y	Y		
2.4	Marine and Freshwater Aquaculture																	
3	**Energy production and mining**																	
3.1	Oil and Gas Drilling					Y			Y						Y	Y		

CMP THREATS & STRESSES TO WILDLIFE SGCN IN CALCAREOUS FEN HABITAT		Silver-bordered Fritillary	Canada warbler	Veery	Sedge Wren	Spotted turtle	Black-billed cuckoo	Least flycatcher	Bog turtle	Schweitzer's buckmoth	Red-headed woodpecker	Mitchell's Satyr (extirpated)	American woodcock	Northern parula	Kennedy's Emerald	Brush-tipped Emerald	Winter wren	Golden-winged warbler
		Boloria selene myrina	*Cardellina canadensis*	*Catharus fuscescens*	*Cistothorus platensis*	*Clemmys guttata*	*Coccyzus erythropthalmus*	*Empidonax minimus*	*Glyptemys muhlenbergii*	*Hemileuca nevadensis ssp. 2*	*Melanerpes erythrocephalus*	*Neonympha mitchellii*	*Scolopax minor*	*Setophaga americana*	*Somatochlora kennedyi*	*Somatochlora walshii*	*Troglodytes hiemalis*	*Vermivora chrysoptera*
3.2	Mining and Quarrying	?				Y			Y	?		?			Y	Y		
3.3	Renewable Energy	?	Y	Y	Y	Y	Y	Y	Y	?	Y	?	Y	Y	Y	Y	Y	Y
4	**Transportation and service corridors**																	
4.1	Roads and Railroads	y	Y	Y	Y	Y	Y	Y	Y	y	Y	Y	Y	Y	Y	Y	Y	Y
4.2	Utility and Service Lines	?	Y	Y	Y	Y	Y	Y	Y	?	Y	?	Y	Y	Y	Y	Y	Y
4.3	Shipping Lanes																	
4.4	Flight Paths																	
5	**Biological Resource Use**																	
5.1	Hunting and Collecting Terrestrial Animals					Y			Y	?		y			Y	Y		
5.2	Gathering Terrestrial Plants																	
5.3	Logging and Wood Harvesting		Y	Y		Y	Y	Y			Y			Y	Y	Y	Y	Y

CMP THREATS & STRESSES TO WILDLIFE SGCN IN CALCAREOUS FEN HABITAT		Silver-bordered Fritillary	Canada warbler	Veery	Sedge Wren	Spotted turtle	Black-billed cuckoo	Least flycatcher	Bog turtle	Schweitzer's buckmoth	Red-headed woodpecker	Mitchell's Satyr (extirpated)	American woodcock	Northern parula	Kennedy's Emerald	Brush-tipped Emerald	Winter wren	Golden-winged warbler
		Boloria selene myrina	*Cardellina canadensis*	*Catharus fuscescens*	*Cistothorus platensis*	*Clemmys guttata*	*Coccyzus erythropthalmus*	*Empidonax minimus*	*Glyptemys muhlenbergii*	*Hemileuca nevadensis ssp. 2*	*Melanerpes erythrocephalus*	*Neonympha mitchellii*	*Scolopax minor*	*Setophaga americana*	*Somatochlora kennedyi*	*Somatochlora walshii*	*Troglodytes hiemalis*	*Vermivora chrysoptera*
5.4	Fishing and Harvesting Aquatic Resources																	
6	**Human Intrusions and Disturbance**																	
6.1	Recreational Activities	Y				Y			Y						Y	Y		
6.2	War, Civil Unrest and Military Exercises					Y			Y						Y	Y		
6.3	Work and Other Activities	y				Y			Y	y		y			Y	Y		
7	**Natural System Modifications**																	
7.1	Fire and Fire Suppression		Y	Y		Y	Y	Y	Y		Y			Y			Y	Y
7.2	Dams and Water Management/Use	y		Y		Y			Y	y		y			Y	Y		Y
7.3	Other Ecosystem Modifications					Y			Y									
8	**Invasive and other problematic species and genes**																	
8.1	Invasive Non-native/Alien species	y	Y	Y		Y	Y	Y	Y	y	Y	y		Y	Y	Y	Y	Y

CMP THREATS & STRESSES TO WILDLIFE SGCN IN CALCAREOUS FEN HABITAT		Silver-bordered Fritillary	Canada warbler	Veery	Sedge Wren	Spotted turtle	Black-billed cuckoo	Least flycatcher	Bog turtle	Schweitzer's buckmoth	Red-headed woodpecker	Mitchell's Satyr (extirpated)	American woodcock	Northern parula	Kennedy's Emerald	Brush-tipped Emerald	Winter wren	Golden-winged warbler
		Boloria selene myrina	*Cardellina canadensis*	*Catharus fuscescens*	*Cistothorus platensis*	*Clemmys guttata*	*Coccyzus erythropthalmus*	*Empidonax minimus*	*Glyptemys muhlenbergii*	*Hemileuca nevadensis ssp. 2*	*Melanerpes erythrocephalus*	*Neonympha mitchellii*	*Scolopax minor*	*Setophaga americana*	*Somatochlora kennedyi*	*Somatochlora walshii*	*Troglodytes hiemalis*	*Vermivora chrysoptera*
8.2	Problematic Native Species		Y	Y		Y	Y	Y	Y	y	Y			Y	Y	Y	Y	Y
8.3	Introduced Genetic Material														Y	Y		Y
9	**Pollution**																	
9.1	Household Sewage and Urban Waste Water					Y			Y						Y	Y		
9.2	Industrial and Military Effluents					Y			Y						Y	Y		
9.3	Agricultural and Forestry Effluents					Y		Y	Y		Y	y			Y	Y		
9.4	Garbage and Solid Waste					Y			Y						Y	Y		
9.5	Airborne Pollutants		Y	Y			Y	Y			Y			Y	Y	Y	Y	Y
9.6	Excess Energy																	
10	**Geological Events**																	
10.1	Volcanoes					Y			Y									

CMP THREATS & STRESSES TO WILDLIFE SGCN IN CALCAREOUS FEN HABITAT		Silver-bordered Fritillary	Canada warbler	Veery	Sedge Wren	Spotted turtle	Black-billed cuckoo	Least flycatcher	Bog turtle	Schweitzer's buckmoth	Red-headed woodpecker	Mitchell's Satyr (extirpated)	American woodcock	Northern parula	Kennedy's Emerald	Brush-tipped Emerald	Winter wren	Golden-winged warbler
		Boloria selene myrina	*Cardellina canadensis*	*Catharus fuscescens*	*Cistothorus platensis*	*Clemmys guttata*	*Coccyzus erythropthalmus*	*Empidonax minimus*	*Glyptemys muhlenbergii*	*Hemileuca nevadensis ssp. 2*	*Melanerpes erythrocephalus*	*Neonympha mitchellii*	*Scolopax minor*	*Setophaga americana*	*Somatochlora kennedyi*	*Somatochlora walshii*	*Troglodytes hiemalis*	*Vermivora chrysoptera*
10.2	Earthquakes/Tsunamis					Y			Y									
10.3	Avalanches/Landslides					Y			Y									
11	**Climage Change and Severe Weather**																	
11.1	Habitat Shifting and Alteration	Y	Y	Y		Y	Y	Y	Y	y	Y	Y		Y	Y	Y	Y	Y
11.2	Droughts		Y	Y		Y	Y	Y	Y		Y			Y	Y	Y	Y	Y
11.3	Temperature Extremes		Y	Y		Y	Y	Y	Y		Y			Y	Y	Y	Y	Y
11.4	Storms and Flooding	Y	Y	Y		Y	Y	Y	Y	Y		Y		Y	Y	Y		Y
11.5	*Phenology and Pollination/Pollinators*																	

CMP STRESSES																		
1	**Ecosystem/Community Stresses**																	
1.1	Ecosystem Conversion					Y			Y						Y	Y		

CMP THREATS & STRESSES TO <u>WILDLIFE SGCN IN</u> <u>CALCAREOUS FEN HABITAT</u>		Silver-bordered Fritillary	Canada warbler	Veery	Sedge Wren	Spotted turtle	Black-billed cuckoo	Least flycatcher	Bog turtle	Schweitzer's buckmoth	Red-headed woodpecker	Mitchell's Satyr (extirpated)	American woodcock	Northern parula	Kennedy's Emerald	Brush-tipped Emerald	Winter wren	Golden-winged warbler
		Boloria selene myrina	*Cardellina canadensis*	*Catharus fuscescens*	*Cistothorus platensis*	*Clemmys guttata*	*Coccyzus erythropthalmus*	*Empidonax minimus*	*Glyptemys muhlenbergii*	*Hemileuca nevadensis ssp. 2*	*Melanerpes erythrocephalus*	*Neonympha mitchellii*	*Scolopax minor*	*Setophaga americana*	*Somatochlora kennedyi*	*Somatochlora walshii*	*Troglodytes hiemalis*	*Vermivora chrysoptera*
1.2	Ecosystem Degradation					Y			Y						Y	Y		
1.3	Indirect Ecosystem Effects					Y			Y						Y	Y		
2	**Species stresses**																	
2.1	Species mortality					Y			Y						Y	Y		
	2.1.1 Herbicide Application to Phragmites australis or Goats Eating Herbaceous Species While Controlling Rosa multiflora					Y			Y									
2.2	Species disturbance					Y			Y						Y	Y		
2.3	Indirect species effects					Y			Y						Y	Y		

CMP THREATS & STRESSES TO STATE ENDANGERED PLANT SPECIES IN CALCAREOUS SINKHOLE POND HABITAT		Large Water-plantain	Appalachian Mountain Boltonia	Cloud Sedge	Hop-like Sedge	Small Floating Manna Grass	Larger Canadian St. John's Wort	Water-marigold	Lake Water-cress	Wiry Panic Grass	Arum-leaf Arrowhead	Torrey's Bulrush	Small Burr-reed	Lesser Bladderwort
		Alisma triviale	*Boltonia montana*	*Carex haydenii*	*Carex lupuliformis*	*Glyceria borealis*	*Hypericum majus*	*Megalodonta beckii*	*Neobeckia lacustris*	*Panicum flexile*	*Sagittaria cuneata*	*Schoenoplectus torreyi*	*Sparganium natans*	*Utricularia minor*
THREATS														
1	**Residential and Commercial Development**													
1.1	Housing and Urban Areas	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
1.2	Commercial and Industrial Areas	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
1.3	Tourism and Recreation Areas	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2	**Agriculture and Aquaculture**													
2.1	Annual and Perennial Non-timber Crops	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2.2	Wood and Pulp Plantations													
2.3	Livestock Farming and Ranching	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2.4	Marine and Freshwater Aquaculture													
3	**Energy production and mining**													
3.1	Oil and Gas Drilling													
3.2	Mining and Quarrying	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

CMP THREATS & STRESSES TO STATE ENDANGERED PLANT SPECIES IN CALCAREOUS SINKHOLE POND HABITAT		Large Water-plantain	Appalachian Mountain Boltonia	Cloud Sedge	Hop-like Sedge	Small Floating Manna Grass	Larger Canadian St. John's Wort	Water-marigold	Lake Water-cress	Wiry Panic Grass	Arum-leaf Arrowhead	Torrey's Bulrush	Small Burr-reed	Lesser Bladderwort
		Alisma triviale	*Boltonia montana*	*Carex haydenii*	*Carex lupuliformis*	*Glyceria borealis*	*Hypericum majus*	*Megalodonta beckii*	*Neobeckia lacustris*	*Panicum flexile*	*Sagittaria cuneata*	*Schoenoplectus torreyi*	*Sparganium natans*	*Utricularia minor*
3.3	Renewable Energy													
4	**Transportation and service corridors**													
4.1	Roads and Railroads	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
4.2	Utility and Service Lines	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
4.3	Shipping Lanes													
4.4	Flight Paths													
5	**Biological Resource Use**													
5.1	Hunting and Collecting Terrestrial Animals													
5.2	Gathering Terrestrial Plants													
5.3	Logging and Wood Harvesting	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
5.4	Fishing and Harvesting Aquatic Resources													
6	**Human Intrusions and Disturbance**													
6.1	Recreational Activities	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
6.2	War, Civil Unrest and Military Exercises													

CMP THREATS & STRESSES TO STATE ENDANGERED PLANT SPECIES IN CALCAREOUS SINKHOLE POND HABITAT		Large Water-plantain	Appalachian Mountain Boltonia	Cloud Sedge	Hop-like Sedge	Small Floating Manna Grass	Larger Canadian St. John's Wort	Water-marigold	Lake Water-cress	Wiry Panic Grass	Arum-leaf Arrowhead	Torrey's Bulrush	Small Burr-reed	Lesser Bladderwort
		Alisma triviale	*Boltonia montana*	*Carex haydenii*	*Carex lupuliformis*	*Glyceria borealis*	*Hypericum majus*	*Megalodonta beckii*	*Neobeckia lacustris*	*Panicum flexile*	*Sagittaria cuneata*	*Schoenoplectus torreyi*	*Sparganium natans*	*Utricularia minor*
6.3	Work and Other Activities	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
7	**Natural System Modifications**													
7.1	Fire and Fire Suppression													
7.2	Dams and Water Management/Use	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
7.3	Other Ecosystem Modifications	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
8	**Invasive and other problematic species and genes**													
8.1	Invasive Non-native/Alien species	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
8.2	Problematic Native Species	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
8.3	Introduced Genetic Material													
9	**Pollution**													
9.1	Household Sewage and Urban Waste Water	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
9.2	Industrial and Military Effluents													
9.3	Agricultural and Forestry Effluents	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
9.4	Garbage and Solid Waste	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

CMP THREATS & STRESSES TO STATE ENDANGERED PLANT SPECIES IN CALCAREOUS SINKHOLE POND HABITAT		Large Water-plantain	Appalachian Mountain Boltonia	Cloud Sedge	Hop-like Sedge	Small Floating Manna Grass	Larger Canadian St. John's Wort	Water-marigold	Lake Water-cress	Wiry Panic Grass	Arum-leaf Arrowhead	Torrey's Bulrush	Small Burr-reed	Lesser Bladderwort
		Alisma triviale	*Boltonia montana*	*Carex haydenii*	*Carex lupuliformis*	*Glyceria borealis*	*Hypericum majus*	*Megalodonta beckii*	*Neobeckia lacustris*	*Panicum flexile*	*Sagittaria cuneata*	*Schoenoplectus torreyi*	*Sparganium natans*	*Utricularia minor*
9.5	Airborne Pollutants													
9.6	Excess Energy													
10	**Geological Events**													
10.1	Volcanoes													
10.2	Earthquakes/Tsunamis													
10.3	Avalanches/Landslides													
11	**Climate Change and Severe Weather**													
11.1	Habitat Shifting and Alteration	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
11.2	Droughts	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
11.3	Temperature Extremes													
11.4	Storms and Flooding	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
11.5	*Phenology and Pollination/Pollinators*													
STRESSES														

CMP THREATS & STRESSES TO STATE ENDANGERED PLANT SPECIES IN CALCAREOUS SINKHOLE POND HABITAT		Large Water-plantain	Appalachian Mountain Boltonia	Cloud Sedge	Hop-like Sedge	Small Floating Manna Grass	Larger Canadian St. John's Wort	Water-marigold	Lake Water-cress	Wiry Panic Grass	Arum-leaf Arrowhead	Torrey's Bulrush	Small Burr-reed	Lesser Bladderwort
		Alisma triviale	*Boltonia montana*	*Carex haydenii*	*Carex lupuliformis*	*Glyceria borealis*	*Hypericum majus*	*Megalodonta beckii*	*Neobeckia lacustris*	*Panicum flexile*	*Sagittaria cuneata*	*Schoenoplectus torreyi*	*Sparganium natans*	*Utricularia minor*
1	**Ecosystem/Community Stresses**													
1.1	Ecosystem Conversion	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
1.2	Ecosystem Degradation	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
1.3	Indirect Ecosystem Effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2	**Species stresses**													
2.1	Species mortality	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2.2	Species disturbance													
2.3	Indirect species effects													

CMP THREATS & STRESSES TO WILDLIFE SGCN IN CALCAREOUS SINKHOLE POND HABITAT		Jefferson Salamander	Marbled Salamander	Long-tailed Salamander
		Ambystoma jeffersonianum	*Ambystoma opacum*	*Eurycea longicauda longicauda*
CMP THREATS				
1	**Residential and Commercial Development**			
1.1	Housing and Urban Areas	Y	Y	Y
1.2	Commercial and Industrial Areas	Y	Y	Y
1.3	Tourism and Recreation Areas	Y	Y	Y
2	**Agriculture and Aquaculture**			
2.1	Annual and Perennial Non-timber Crops	Y	Y	Y
2.2	Wood and Pulp Plantations	Y	Y	Y
2.3	Livestock Farming and Ranching	Y	Y	Y
2.4	Marine and Freshwater Aquaculture			
3	**Energy production and mining**			
3.1	Oil and Gas Drilling	Y	Y	Y
3.2	Mining and Quarrying	Y	Y	Y
3.3	Renewable Energy	Y	Y	Y
4	**Transportation and service corridors**			
4.1	Roads and Railroads	Y	Y	Y
4.2	Utility and Service Lines	Y	Y	Y
4.3	Shipping Lanes			
4.4	Flight Paths			
5	**Biological Resource Use**			
5.1	Hunting and Collecting Terrestrial Animals			
5.2	Gathering Terrestrial Plants			
5.3	Logging and Wood Harvesting	Y	Y	Y
5.4	Fishing and Harvesting Aquatic Resources			

CMP THREATS & STRESSES TO WILDLIFE SGCN IN CALCAREOUS SINKHOLE POND HABITAT		Jefferson Salamander	Marbled Salamander	Long-tailed Salamander
		Ambystoma jeffersonianum	*Ambystoma opacum*	*Eurycea longicauda longicauda*
6	**Human Intrusions and Disturbance**			
6.1	Recreational Activities	Y	Y	Y
6.2	War, Civil Unrest and Military Exercises	Y	Y	Y
6.3	Work and Other Activities	Y	Y	Y
7	**Natural System Modifications**			
7.1	Fire and Fire Suppression	Y	Y	Y
7.2	Dams and Water Management/Use	Y	Y	Y
7.3	Other Ecosystem Modifications	Y	Y	Y
8	**Invasive and other problematic species and genes**			
8.1	Invasive Non-native/Alien species	Y	Y	Y
8.2	Problematic Native Species	Y	Y	Y
8.3	Introduced Genetic Material			
9	**Pollution**			
9.1	Household Sewage and Urban Waste Water	Y	Y	Y
9.2	Industrial and Military Effluents	Y	Y	Y
9.3	Agricultural and Forestry Effluents	Y	Y	Y
9.4	Garbage and Solid Waste	Y	Y	Y
9.5	Airborne Pollutants			
9.6	Excess Energy			
10	**Geological Events**			
10.1	Volcanoes			
10.2	Earthquakes/Tsunamis			
10.3	Avalanches/Landslides			
11	**Climate Change and Severe Weather**			

CMP THREATS & STRESSES TO WILDLIFE SGCN IN CALCAREOUS SINKHOLE POND HABITAT		Jefferson Salamander	Marbled Salamander	Long-tailed Salamander
		Ambystoma jeffersonianum	*Ambystoma opacum*	*Eurycea longicauda longicauda*
11.1	Habitat Shifting and Alteration	Y	Y	Y
11.2	Droughts	Y	Y	Y
11.3	Temperature Extremes	Y	Y	Y
11.4	Storms and Flooding	Y	Y	Y
11.5	*Phenology and Pollination/Pollinators*			
CMP STRESSES				
1	**Ecosystem/Community Stresses**			
1.1	Ecosystem Conversion	Y	Y	Y
1.2	Ecosystem Degradation	Y	Y	Y
1.3	Indirect Ecosystem Effects	Y	Y	Y
2	**Species stresses**			
2.1	Species mortality	Y	Y	Y
2.2	Species disturbance	Y	Y	Y
2.3	Indirect species effects	Y	Y	Y

CMP THREATS & STRESSES TO STATE ENDANGERD PLANT SPECIES PINE BARREN SAVANNA HABITAT		Pickering's Reed Grass	Spreading Pogonia	Rough Cotton-grass	Pine Barren Boneset	New Jersey Rush	Bog Asphodel	Yellow Fringeless Orchid	Knieskern's Beaked-rush	Long's Woolgrass	Lace-lip Ladies'-tresses	False Asphodel	Reversed Bladderwort	Fringed Yellow-eyed-grass	Death-camus
		Calamagrostis pickeringii	*Cleistes divaricata*	*Eriophorum tenellum*	*Eupatorium resinosum*	*Juncus caesariensis*	*Narthecium americanum*	*Platanthera integra*	*Rhynchospora knieskernii*	*Scirpus longii*	*Spiranthes laciniata*	*Tofieldia racemosa*	*Utricularia resupinata*	*Xyris fimbriata*	*Zigadenus leimanthoides*
THREATS															
1	**Residential and Commercial Development**														
1.1	Housing and Urban Areas														
1.2	Commercial and Industrial Areas														
1.3	Tourism and Recreation Areas	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2	**Agriculture and Aquaculture**														
2.1	Annual and Perennial Non-timber Crops	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2.2	Wood and Pulp Plantations														
2.3	Livestock Farming and Ranching														
2.4	Marine and Freshwater Aquaculture														
3	**Energy production and mining**														
3.1	Oil and Gas Drilling														
3.2	Mining and Quarrying														
3.3	Renewable Energy														
4	**Transportation and service corridors**														
4.1	Roads and Railroads														
4.2	Utility and Service Lines	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

CMP THREATS & STRESSES TO STATE ENDANGERD PLANT SPECIES PINE BARREN SAVANNA HABITAT		Pickering's Reed Grass	Spreading Pogonia	Rough Cotton-grass	Pine Barren Boneset	New Jersey Rush	Bog Asphodel	Yellow Fringeless Orchid	Knieskern's Beaked-rush	Long's Woolgrass	Lace-lip Ladies'-tresses	False Asphodel	Reversed Bladderwort	Fringed Yellow-eyed-grass	Death-camus
		Calamagrostis pickeringii	*Cleistes divaricata*	*Eriophorum tenellum*	*Eupatorium resinosum*	*Juncus caesariensis*	*Narthecium americanum*	*Platanthera integra*	*Rhynchospora knieskernii*	*Scirpus longii*	*Spiranthes laciniata*	*Tofieldia racemosa*	*Utricularia resupinata*	*Xyris fimbriata*	*Zigadenus leimanthoides*
4.3	Shipping Lanes														
4.4	Flight Paths														
5	**Biological Resource Use**														
5.1	Hunting and Collecting Terrestrial Animals														
5.2	Gathering Terrestrial Plants	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
5.3	Logging and Wood Harvesting	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
5.4	Fishing and Harvesting Aquatic Resources														
6	**Human Intrusions and Disturbance**														
6.1	Recreational Activities	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
6.2	War, Civil Unrest and Military Exercises														
6.3	Work and Other Activities	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
7	**Natural System Modifications**														
7.1	Fire and Fire Suppression	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
7.2	Dams and Water Management/Use	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
7.3	Other Ecosystem Modifications														
8	**Invasive and other problematic species and genes**														

CMP THREATS & STRESSES TO STATE ENDANGERD PLANT SPECIES PINE BARREN SAVANNA HABITAT		Pickering's Reed Grass	Spreading Pogonia	Rough Cotton-grass	Pine Barren Boneset	New Jersey Rush	Bog Asphodel	Yellow Fringeless Orchid	Knieskern's Beaked-rush	Long's Woolgrass	Lace-lip Ladies'-tresses	False Asphodel	Reversed Bladderwort	Fringed Yellow-eyed-grass	Death-camus
		Calamagrostis pickeringii	*Cleistes divaricata*	*Eriophorum tenellum*	*Eupatorium resinosum*	*Juncus caesariensis*	*Narthecium americanum*	*Platanthera integra*	*Rhynchospora knieskernii*	*Scirpus longii*	*Spiranthes laciniata*	*Tofieldia racemosa*	*Utricularia resupinata*	*Xyris fimbriata*	*Zigadenus leimanthoides*
8.1	Invasive Non-native/Alien species														
8.2	Problematic Native Species	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
8.3	Introduced Genetic Material														
	8.2.1 Deer grazing	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	8.2.2 Beaver dam flooding	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
9	**Pollution**														
9.1	Household Sewage and Urban Waste Water	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
9.2	Industrial and Military Effluents														
9.3	Agricultural and Forestry Effluents	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
9.4	Garbage and Solid Waste														
9.5	Airborne Pollutants														
9.6	Excess Energy														
10	**Geological Events**														
10.1	Volcanoes														
10.2	Earthquakes/Tsunamis														
10.3	Avalanches/Landslides														
11	**Climate Change and Severe Weather**														

CMP THREATS & STRESSES TO STATE ENDANGERD PLANT SPECIES PINE BARREN SAVANNA HABITAT		Pickering's Reed Grass	Spreading Pogonia	Rough Cotton-grass	Pine Barren Boneset	New Jersey Rush	Bog Asphodel	Yellow Fringeless Orchid	Knieskern's Beaked-rush	Long's Woolgrass	Lace-lip Ladies'-tresses	False Asphodel	Reversed Bladderwort	Fringed Yellow-eyed-grass	Death-camus
		Calamagrostis pickeringii	*Cleistes divaricata*	*Eriophorum tenellum*	*Eupatorium resinosum*	*Juncus caesariensis*	*Narthecium americanum*	*Platanthera integra*	*Rhynchospora knieskernii*	*Scirpus longii*	*Spiranthes laciniata*	*Tofieldia racemosa*	*Utricularia resupinata*	*Xyris fimbriata*	*Zigadenus leimanthoides*
11.1	Habitat Shifting and Alteration	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
11.2	Droughts	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
11.3	Temperature Extremes														
11.4	Storms and Flooding	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
11.5	*Phenology and Pollination/Pollinators*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
STRESSES															
1	**Ecosystem/Community Stresses**														
1.1	Ecosystem Conversion	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
1.2	Ecosystem Degradation	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
1.3	Indirect Ecosystem Effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2	**Species stresses**														
2.1	Species mortality														
2.2	Species disturbance														
2.3	Indirect species effects														

CMP THREATS & STRESSES TO WILDLIFE SGCN IN PINE BARREN SAVANNA HABITAT		Arogos Skipper	No Common Name	Red-headed Woodpecker	Helicta Satyr (formerly Georgie	Carter's Moth	Northern Parula	Southern Bog Lemming
		Atrytone arogos arogos	*Dichagyris reliqua*	*Melanerpes erythrocephalus*	*Neonympha helicta (formerly areolata)*	*Photedes (Spartiniphaga)*	*Setophaga (Parula) americana*	*Synaptomys cooperi*
THREATS								
1	**Residential and Commercial Development**							
1.1	Housing and Urban Areas			Y			Y	
1.2	Commercial and Industrial Areas			Y			Y	
1.3	Tourism and Recreation Areas							
2	**Agriculture and Aquaculture**							
2.1	Annual and Perennial Non-timber Crops							
2.2	Wood and Pulp Plantations							
2.3	Livestock Farming and Ranching							
2.4	Marine and Freshwater Aquaculture							
3	**Energy production and mining**							
3.1	Oil and Gas Drilling							
3.2	Mining and Quarrying							
3.3	Renewable Energy			Y			Y	
4	**Transportation and service corridors**							
4.1	Roads and Railroads			Y			Y	Y

4.2	Utility and Service Lines			Y			Y	
4.3	Shipping Lanes							
4.4	Flight Paths							
5	**Biological Resource Use**							
5.1	Hunting and Collecting Terrestrial Animals							
5.2	Gathering Terrestrial Plants							
5.3	Logging and Wood Harvesting			Y			Y	?
5.4	Fishing and Harvesting Aquatic Resources							
6	**Human Intrusions and Disturbance**							
6.1	Recreational Activities	Y						Y
6.2	War, Civil Unrest and Military Exercises							?
6.3	Work and Other Activities							
7	**Natural System Modifications**							
7.1	Fire and Fire Suppression	Y		Y			Y	?
7.2	Dams and Water Management/Use							
7.3	Other Ecosystem Modifications	Y				Y		
8	**Invasive and other problematic species and genes**							
8.1	Invasive Non-native/Alien species			Y			Y	Y
8.2	Problematic Native Species			Y			Y	
	8.2.1 Deer Grazing						Y	
	8.2.2 Beaver dam flooding	Y						?
8.3	Introduced Genetic Material							
9	**Pollution**							
9.1	Household Sewage and Urban Waste Water							?
9.2	Industrial and Military Effluents							?
9.3	Agricultural and Forestry Effluents			Y				?
9.4	Garbage and Solid Waste							
9.5	Airborne Pollutants			Y			Y	
9.6	Excess Energy							
10	**Geological Events**							

10.1	Volcanoes							
10.2	Earthquakes/Tsunamis							
10.3	Avalanches/Landslides							
11	**Climate Change and Severe Weather**							
11.1	Habitat Shifting and Alteration	?		Y			Y	Y
11.2	Droughts			Y			Y	Y
11.3	Temperature Extremes	?		Y			Y	?
11.4	Storms and Flooding						Y	?
11.5	*Phenology and Pollination/Pollinators*							
STRESSES								
1	**Ecosystem/Community Stresses**							
1.1	Ecosystem Conversion							
1.2	Ecosystem Degradation							
1.3	Indirect Ecosystem Effects							
2	**Species stresses**							
2.1	Species mortality							
2.2	Species disturbance							
2.3	Indirect species effects							

CMP THREATS & STRESSES TO STATE ENDANGERED PLANT SPECIES IN COASTAL PLAIN INTERMITTENT POND HABITAT		Southern Boltonia	Wrinkled Jointgrass	Marsh Flat Sedge	Hirst Brothers' Panic Grass	Larger Buttonweed	Knotted Spike-rush	Featherfoil	Barton's St. John's-wort	Clasping-leaf St. John's-wort	Boykin's Lobelia	Narrow-leaf Primrose-willow	Awned Meadow-beauty	Small-head Beaked-rush	Slender Arrowhead	Torrey's Bulrush	Dwarf White Bladderwort	Reversed Bladderwort
		Boltonia asteroides var. glastifolia	*Coelorachis rugosa*	*Cyperus pseudovegetus*	*Dichanthelium hirstii (Panicum hirstii)*	*Diodia virginiana*	*Eleocharis equisetoides*	*Hottonia inflata*	*Hypericum adpressum*	*Hypericum gymnanthum*	*Lobelia boykinii*	*Ludwigia linearis*	*Rhexia aristosa*	*Rhynchospora microcephala*	*Sagittaria teres*	*Schoenoplectus torreyi*	*Utricularia olivacea*	*Utricularia resupinata*
THREATS																		
1	**Residential and Commercial Development**																	
1.1	Housing and Urban Areas	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
1.2	Commercial and Industrial Areas	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
1.3	Tourism and Recreation Areas	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2	**Agriculture and Aquaculture**																	
2.1	Annual and Perennial Non-timber Crops	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2.2	Wood and Pulp Plantations																	
2.3	Livestock Farming and Ranching	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2.4	Marine and Freshwater Aquaculture																	
3	**Energy production and mining**																	

3.1	Oil and Gas Drilling																	
3.2	Mining and Quarrying	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
3.3	Renewable Energy																	
4	**Transportation and service corridors**																	
4.1	Roads and Railroads	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
4.2	Utility and Service Lines	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
4.3	Shipping Lanes																	
4.4	Flight Paths																	
5	**Biological Resource Use**																	
5.1	Hunting and Collecting Terrestrial Animals																	
5.2	Gathering Terrestrial Plants	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
5.3	Logging and Wood Harvesting	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
5.4	Fishing and Harvesting Aquatic Resources																	
6	**Human Intrusions and Disturbance**																	
6.1	Recreational Activities	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
6.2	War, Civil Unrest and Military Exercises																	
6.3	Work and Other Activities	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
7	**Natural System Modifications**																	
7.1	Fire and Fire Suppression	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
7.2	Dams and Water Management/Use	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
7.3	Other Ecosystem Modifications	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
8	**Invasive and other problematic species and genes**																	
8.1	Invasive Non-native/Alien species	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
8.2	Problematic Native Species	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
8.3	Introduced Genetic Material																	
9	**Pollution**																	
9.1	Household Sewage and Urban Waste Water	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
9.2	Industrial and Military Effluents	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
9.3	Agricultural and Forestry Effluents	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
9.4	Garbage and Solid Waste	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

9.5	Airborne Pollutants																	
9.6	Excess Energy																	
10	**Geological Events**																	
10.1	Volcanoes																	
10.2	Earthquakes/Tsunamis																	
10.3	Avalanches/Landslides																	
11	**Climate Change and Severe Weather**																	
11.1	Habitat Shifting and Alteration	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
11.2	Droughts	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
11.3	Temperature Extremes																	
11.4	Storms and Flooding	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
11.5	*Phenology and Pollination/Pollinators*																	
STRESSES																		
1	**Ecosystem/Community Stresses**																	
1.1	Ecosystem Conversion	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
1.2	Ecosystem Degradation	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
1.3	Indirect Ecosystem Effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2	**Species stresses**																	
2.1	Species mortality																	
2.2	Species disturbance																	
2.3	Indirect species effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

CMP THREATS & STRESSES TO WILDLIFE SGCN IN COASTAL PLAIN INTERMITTENT POND HABITAT		Scarlet Bluet	Pine Barrens Bluet	Pine Barrens Treefrog	Golden-winged Skimmer	Carpenter Frog
		Enallagma pictum	*Enallagma recurvatum*	*Hyla andersonii*	*Libellula auripennis*	*Rana virgatipes*
THREATS						
1	**Residential and Commercial Development**					
1.1	Housing and Urban Areas	y	Y	Y	Y	Y
1.2	Commercial and Industrial Areas	y	Y	Y	Y	Y
1.3	Tourism and Recreation Areas			Y		Y
2	**Agriculture and Aquaculture**					
2.1	Annual and Perennial Non-timber Crops	Y	Y	Y	Y	Y
2.2	Wood and Pulp Plantations	Y	Y	Y	Y	Y
2.3	Livestock Farming and Ranching			Y		Y
2.4	Marine and Freshwater Aquaculture					
3	**Energy production and mining**					
3.1	Oil and Gas Drilling			Y		Y
3.2	Mining and Quarrying			Y		Y
3.3	Renewable Energy	?		Y		Y
4	**Transportation and service corridors**					
4.1	Roads and Railroads	Y	Y	Y	Y	Y
4.2	Utility and Service Lines			Y		Y
4.3	Shipping Lanes					
4.4	Flight Paths					
5	**Biological Resource Use**					
5.1	Hunting and Collecting Terrestrial Animals					
5.2	Gathering Terrestrial Plants					
5.3	Logging and Wood Harvesting	Y	Y	Y	Y	Y
5.4	Fishing and Harvesting Aquatic Resources					
6	**Human Intrusions and Disturbance**					

CMP THREATS & STRESSES TO WILDLIFE SGCN IN COASTAL PLAIN INTERMITTENT POND HABITAT		Scarlet Bluet	Pine Barrens Bluet	Pine Barrens Treefrog	Golden-winged Skimmer	Carpenter Frog
		Enallagma pictum	*Enallagma recurvatum*	*Hyla andersonii*	*Libellula auripennis*	*Rana virgatipes*
6.1	Recreational Activities	Y	Y	Y	Y	Y
6.2	War, Civil Unrest and Military Exercises			Y		Y
6.3	Work and Other Activities	?	?	Y	?	Y
7	**Natural System Modifications**					
7.1	Fire and Fire Suppression			Y		Y
7.2	Dams and Water Management/Use	Y	Y	Y	Y	Y
7.3	Other Ecosystem Modifications	Y	Y	Y	Y	Y
8	**Invasive and other problematic species and genes**					
8.1	Invasive Non-native/Alien species	Y	Y	Y	Y	Y
8.2	Problematic Native Species	Y	Y	Y	Y	Y
8.3	Introduced Genetic Material	Y	Y		Y	
9	**Pollution**					
9.1	Household Sewage and Urban Waste Water	Y	y	Y	Y	Y
9.2	Industrial and Military Effluents	Y	y	Y	Y	Y
9.3	Agricultural and Forestry Effluents	Y	y	Y	Y	Y
9.4	Garbage and Solid Waste	Y	y	Y	Y	Y
9.5	Airborne Pollutants	Y	y		Y	
9.6	Excess Energy					
10	**Geological Events**					
10.1	Volcanoes					
10.2	Earthquakes/Tsunamis					
10.3	Avalanches/Landslides					
11	**Climate Change and Severe Weather**					
11.1	Habitat Shifting and Alteration	Y	Y	Y	Y	Y
11.2	Droughts	Y	Y	Y	Y	Y

CMP THREATS & STRESSES TO WILDLIFE SGCN IN COASTAL PLAIN INTERMITTENT POND HABITAT		Scarlet Bluet	Pine Barrens Bluet	Pine Barrens Treefrog	Golden-winged Skimmer	Carpenter Frog
		Enallagma pictum	*Enallagma recurvatum*	*Hyla andersonii*	*Libellula auripennis*	*Rana virgatipes*
11.3	Temperature Extremes	Y	Y	Y	Y	Y
11.4	Storms and Flooding	Y	Y	Y	Y	Y
11.5	*Phenology and Pollination/Pollinators*					
STRESSES						
1	**Ecosystem/Community Stresses**					
1.1	Ecosystem Conversion	Y	Y	Y	Y	Y
1.2	Ecosystem Degradation	Y	Y	Y	Y	Y
1.3	Indirect Ecosystem Effects	Y	Y	Y	Y	Y
2	**Species stresses**					
2.1	Species mortality	Y	Y	Y	Y	Y
2.2	Species disturbance	Y	Y	Y	Y	Y
2.3	Indirect species effects	Y	Y	Y	Y	Y

Appendix D

Sample Sidebars and Information Boxes for SWAP 2015

Inventory and Monitoring

Goal: Inventory and monitor SGCN animals

Methods: Survey methods can range from a single site visit to multiple site visits; from counting from the edge of the habitat to walking transects through the habitat.
Differing plant and animal phenology means that surveying (and related disturbances) could potentially occur throughout the growing season, depending on what species are being monitored.

Impacts: Typical impacts to plant and animal species include trampling of vegetation, possible harm to larval invertebrates and nests of ground-nesting birds, disturbance to nesting birds during breeding season, transmission of invasive weed seeds into new habitat.

Challenge: How to monitor multiple species at a site without harm to species and/or habitat.

Recommendations:

- Develop a base map with locations of particularly rare or sensitive plant and animal species noted, before developing and implementing a monitoring plan.
- Stagger monitoring activities over several years. Do not survey all taxa at a site (e.g., birds, Lepidoptera, turtles, plants) in the same year if possible, and not year after year. Give the habitat a rest.
- Practice good field hygiene. Clean boots and other survey equipment between visits to different sites to prevent spread of weed seeds and/or disease.

Calcareous Fens – Vegetation Management

Conservation Action: Managing woody vegetation

Methods: May include manual removal (e.g., selective cutting and tree removal, mowing or brush-hogging), targeted use of herbicides, and/or use of grazing animals such as goats.

Impacts: Managing for one species may inadvertently harm others. Using goats to manage habitat for bog turtles, for example, will remove critical shrub habitat for scrub-shrub nesting birds and may result in the loss of rare plant populations grazed by goats and/or critical food plants required by rare Lepidoptera. Use of herbicides can harm non-target species.

Challenge: How best to manage fen vegetation for all fen-dependent species (e.g., scrub-shrub birds, rare plants, rare Lepidoptera, bog turtles, rare odonates)?

Recommendations:

- Where possible, manage fens holistically – protecting areas that meet the needs of scrub-shrub birds and rare Lepidoptera while also maintaining the more open areas needed by bog turtles and providing critical microclimates needed by rare plants.
- In some cases, individual sites may best be managed for a single species (e.g., bog turtles) whereas other sites can be managed for multiple species (e.g., rare plants and Lepidoptera).

Fire Management in New Jersey Pine Barrens Savannas

Challenge: Fire management, whether prescription burns or wildfire suppression, has a major effect on the persistence and quality of Pine Barrens habitats, including savannas and their associated rare plants and SGCN wildlife.

Recommendations:

- Thoroughly assess what rare plant and SGCN animals are present in the habitat, their tolerances to fire, and their distribution on the landscape
- Develop a plan for when and if to burn, what to burn, and how intensely. Consider the needs of all species, plant and animal, occurring at a site.
- Leave unburned refugia for plant and animal species. Do not burn entire sites in a season.
- Use care when locating firebreaks.
- Other vegetation management techniques such as mowing are sometimes used in place of fire. The ecological and species-specific effects of such management practices must be assessed for each rare species as to whether the results are beneficial, harmful, or benign.
- Research on fire and its effects on plants, habitats and wildlife SGCN will provide a better understanding of landscape effects of fire in Pine Barrens habitats.

Guidelines for Cleaning Field Equipment

To prevent the spread of invasive species propagules and/or disease pathogens (e.g. Chytrid fungus, Ranavirus) among wetland sites follow these recommendations between site visits: 1) wash boots and field equipment with soap and water; 2) rinse in clean water; and 3) disinfect with a 10% bleach solution and allow to air dry.

Did You Know?

Orchids can live underground for 20 or more years and reappear aboveground to flower when environmental conditions are just right.

APPENDIX E

N.J.A.C. 7:7A
Freshwater Wetlands Protection Act Rules
Statutory authority: N.J.S.A. 13:9B-1 et seq.
Date last amended: December 7, 2009

"Vernal habitat" means a wetland as identified at N.J.A.C. 7:7A-2.3, or State open water, as defined at N.J.A.C. 7:7A-1.4 above that meets all of the criteria at 1 through 4 below. Evidence of breeding by an obligate species under 2i below creates a rebuttable presumption that the criteria at 3 and 4 below are met:

1. Occurs in or contains a confined basin depression without a permanent flowing outlet;
2. Features evidence of breeding by one or more species of fauna adapted to reproduce in ephemeral aquatic conditions, identified in N.J.A.C. 7:7A, Appendix 1, incorporated herein by reference. The following shall constitute evidence of breeding by such a species:
    i. One or more obligate species listed in Appendix 1, or evidence of such a species, is found in or immediately adjacent to the area of ponded water; or
    ii. Two or more facultative species listed in Appendix 1, or evidence of the presence of such a species, are found in or immediately adjacent to the area of ponded water;
3. Maintains ponded water for at least two continuous months between March and September of a normal rainfall year; and
4. Is free of reproducing fish populations throughout the year, or dries up at some time during a normal rainfall year.

APPENDIX 1

OBLIGATE AND FACULTATIVE FAUNA SPECIES FOUND IN VERNAL HABITATS

Obligate Species
Marbled Salamander
Blue-spotted Salamander*
Jefferson Salamander
Eastern Tiger Salamander*
Wood Frog
Spotted Salamander
Eastern Spadefoot Toad
Jefferson x Blue-spotted Salamander*
Fairy shrimp (order Anostraca)

Facultative Species
Snapping Turtle
Eastern Mud Turtle

Spotted Turtle
Eastern Painted Turtle
Red-spotted Newt
American Toad
Fowler's Toad
Pine Barrens Treefrog*
Northern Gray Treefrog
Southern Gray Treefrog*
Upland Chorus Frog
Northern Cricket Frog
New Jersey Chorus Frog
Bull Frog
Green Frog
Southern Leopard Frog
Four-toed Salamander
Northern Spring Peeper
Long-tailed Salamander**
Wood Turtle**

*Listed as a New Jersey State endangered species
** Listed as a New Jersey State threatened species

SOURCE: http://www.nj.gov/dep/rules/rules/njac7_7a.pdf