Platanthera psycodes

Purple Fringed Orchid
Orchidaceae

Platanthera psycodes Rare Plant Profile

New Jersey Department of Environmental Protection
Division of Parks and Forestry
New Jersey Forest Service
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New Jersey Natural Heritage Program

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Introduction

Platanthera psycodes is often confused with *P. grandiflora*, however several characteristics such as morphology, interspecies interactions and seasonality can be used to differentiate the two species. This Rare Plant Profile discusses many of the distinct features that makes *P. psycodes* unique. The most defining characteristic separating *Platanthera psycodes* from *Platanthera grandiflora* is the column shape and relative placement of the pollinia on their pollinators (Stoutamire, 1974). *P. psycodes* produces small flowers with a transverse oval or dumbbell shaped nectary opening whereas *P. grandiflora* produces larger flowers with a circular nectary opening. Rostellum lobes are noticeably different when viewed laterally between *P. psycodes* and *P. grandiflora.* *P. psycodes* is angular and with spreading lobes whereas *P. grandiflora* is rounded and has parallel lobes (Gange, 2018; Boufford, 1997). Pollinators that visit *P. psycodes* have been found to collect pollinia on their proboscis, which differs for the pollinators of *P. grandiflora* whom collect pollinia on their eyes due to the position of the viscidia. While both species are found growing together, they are phenotypically separated by blooming periods which, *P. grandiflora* performs earlier in the summer. The blooming period for *P. psycodes* is from late July until early August, whereas *P. grandiflora* typically blooms near the beginning of July (Stoutamire, 1974).

Life History

Platanthera psycodes produces 2 to 5 spreading leaves along its stem, which then reveals an ornate inflorescence up top with 50 or more purple, pink toned and occasionally white flowers reaching heights of 5 to 20 cm. These flowers have a 5 to 13 mm long fringed labellum that is divided into 3 parts. Flower color ranges from white, blue to purple, and pink to red (Native Plant Trust: Go Botany, 2019; Boufford, 1997; North American Conservation Center, 2011-2019). Their flowers begin to wither on the lower portions of the inflorescence before the buds open on the top whereas the flowers of *P. grandiflora* remain open longer (Stoutamire, 1974). Behind the flower, a 12 to 22 mm long club shaped spur can be found (North American Conservation Center, 2011-2019). The flowering period for *P. psycodes* is typically between June and August, but in specific geographical areas it is found flowering in September (Boufford, 1997). *P. psycodes* stands at a height of 14 to 101 cm with its leaves extending 5 to 22 cm in length (Boufford, 1997).

Platanthera psycodes forms noted by John Gange in *Platanthera grandiflora Versus Platanthera psycodes* (Gange, 2018):

- White flowered form: *Platanthera psycodes* f. *albiflora*
- Pink flowered form: *Platanthera psycodes* f. *rosa*
- Entire lip form: *Platanthera psycodes* f. *varians*

Although distinguishable by their seasonality and spatial isolation as well as their morphological characteristics, *P. psycodes* and *P. grandiflora* are not phenologically very different. The species overlap in distribution and phenologically, but it is often said that the flowers of *P. grandiflora* are larger than those of *P. psycodes.* While *P. psycodes* shows more variability in the depth, fringe and divergence of the lobes, this does not mean that *P. grandiflora* may not also exhibit

similar variations (see Fig, 1 and Fig 2.). The position of the labellum is a much more comparable characteristic rather than the shape of the lobes or fringe for *P. grandiflora.* The lobes between the species differ, with those of *P. grandiflora* curving forward, unlike those of *P. psycodes* that tend to be flat or bent away from the plane of the mid-lobe. Both species may present a white labellum claw, but it is more frequently observed in *P. grandiflora.* The later blooming periods of *P. psycodes* have a direct correlation with increase in latitude. While the blooming periods of the two species hasn't been clearly distinguished, *P. grandiflora* tends to flower prior to that of *P. psycodes.* Stoutamire had visited Vermont where he saw the two species flowering at the same time, however a few days prior in New York he had recorded seeing *P. psycodes* flower 10-14 days after *P. grandiflora*. Climatic and edaphic conditions affecting the flowering sequences have been suggested. Asa Gray commented in 1863 that there was a difference in anther position between the species, but further explanation was not included (Stoutamire 1974). Visual representation of both species can be seen below in Figures 1 and 2.

Figure 1: Flower of *Platanthera grandiflora.*

Figure 2: Flowers of *Platanthera psycodes.*

Platanthera psycodes is known to hybridize with *P. lacera* in the northeastern part of its range since the species blooming times tend to overlap. The hybrid is known as *P.* x *andrewsii*. Hybridization with *P. grandiflora* creating the hybrid known as *P.* x *engima* has been suggested but is rare (Boufford, 1997). The species has only been recognized in the state of Maine and is thought to be confused with specimens of *P.* x *andrewsii* or *P. grandiflora.* Some even believe that it is just a form, variation or subspecies of *P. grandiflora* (Brown, 2008). Other botanists from various locations throughout history have noted hybrid species occurring from *P. grandiflora,* but during Stoutamire's experiment where he conducted artificial crossing between *P. psycodes* and *P. grandiflora,* no hybridization was observed. Stoutamire reported that even if hybridization between the two species did occur, more than likely one column type would take over leaving it nearly impossible to detect the hybrid (Stoutamire, 1974). Measuring the depth of the fringe in relation to lip size as noted in many popular works, has been found to not be a successful aid in differentiating between species. The majority of specimens can fall into the 1/3 or less fringe for *P. psycodes* and 1/3 or more fringe for *P. grandiflora* but many plants exist that don't conform to these criteria. The only reliable criteria are those of the orifice shape, spur or ovary length and overall flower size. Often recognized is the nectary opening which is obstructed for *P. psycodes* and circular and unobstructed for *P. grandiflora* (Brown, 2008).

Figure 3: Flowers of *Platanthera* x *andrewsii.*

Figure 4: Flowers of *Platanthera lacera*.

In the publication by Stoutamire, herbarium specimens were observed for their column type, labellum and nectary lengths. *P. psycodes* contained a labella less than 10 mm in length with the exception of a few, whereas *P. grandiflora* exhibited a labellum over 10 mm in length. While differences were seen in column shape, size and nectary features in these specimens, differences in the structures involved in pollen transfer were observed. To clearly separate the two taxa, the column forms are distinct, each for serving different purposes. *P. psycodes* and *P. grandiflora* contain two pollinia, slightly enclosed by the column wings. Two lateral openings are produced by a projection on the roof of the nectary, which can be seen past the oblong nectary opening. In *P. grandiflora*, the nectary opening isn't obstructed, leaving the nectary opening to be funnel-shaped and beneath the stigma. (Stoutamire, 1974).

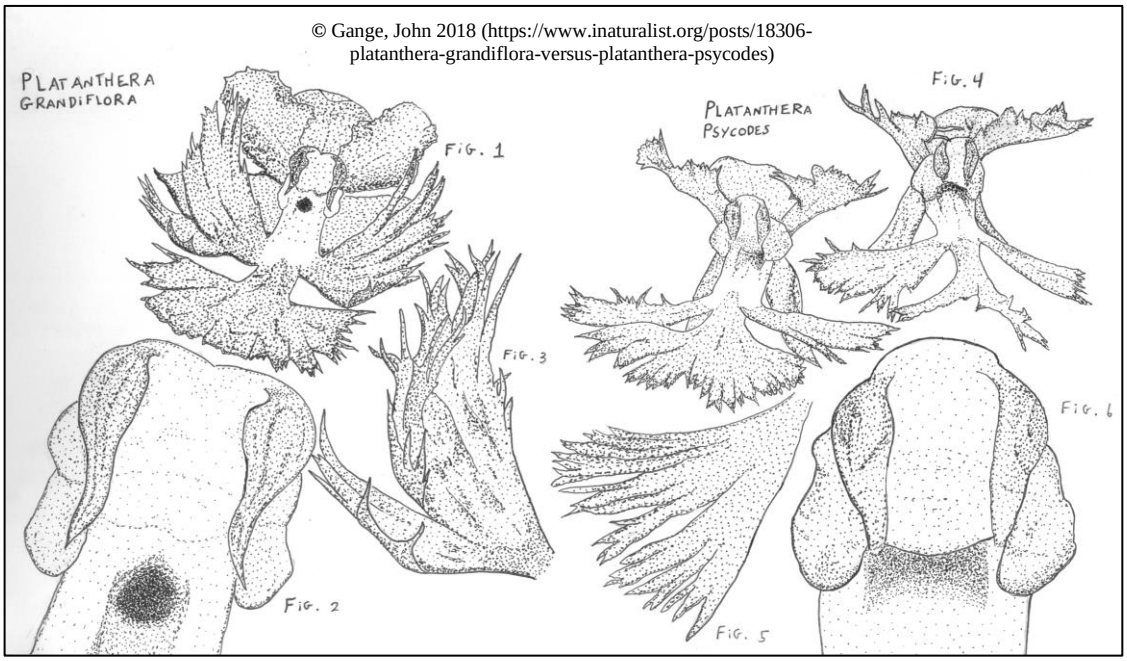


Figure 5: Illustration of *Platanthera grandiflora* (Fig. 1,2 and 3) and *P. psycodes* (Fig. 4,5 and 6).

Pollinator Dynamics

Pollinia are bound pollen grains which creates a complex yet unique relationship between the orchid and its pollinator (Sharma, 2002). The pollinia are found attached to the proboscis of pollinators to be shared with any subsequent flowers visited (Stoutamire, 1974; North American Conservation Center, 2011-2019). Shorter spur length has been noted to create a higher number of pollinator groups visiting the orchid. When larger lepidoptera are pollinating, the species will have a more restricted distribution in comparison to lepidoptera which are smaller in size. A flower might abort ovule development if not pollinated, leading to limited seed production. This is thought to have caused many species of orchid to adapt to a smaller seed set to prevent energy being lost during regeneration, thus ensuring viable seeds (Sharma, 2002).

According to Stoutamire, the odor produced by *Platanthera psycodes* is rather sweet, (more so than that of *P. grandiflora*) but becomes weaker at dusk leading to visits by sphingid and noctuid moths (Stoutamire, 1974; Gray, 1862).

The following species have been observed visiting *P.* psycodes: moths and butterflies such as *Autographa ampla, Epargyreus clarus, Hemaris diffinis, Hemaris thysbe, Papilio glaucus, Papilio polyxenes, Papilio Troilus, Polites mystic* (North American Conservation Center, 2011-2019).

Seed Dispersal

Seeds of *Platanthera psycodes* are released after the capsules have dried. These capsules point upward or are angled outward (Native Plant Trust: Go Botany, 2019; Bowles, 1999; North American Orchid Conservation Center, 2011-2019). The dust-like seeds produced by most orchid species, although they are capable of long-distance dispersal, more commonly land only meters from the parent plant. This would lead to decreased probability of finding new naturally occurring populations especially with decreasing and limited suitable habitat (Paul et al., 2013). Wallace found during his study of *The Cost of Inbreeding in Platanthera leucophaea,* that *P. leucophaea* was pollinated by hawk moths. Once successful pollination is achieved, seeds are then wind dispersed in the fall (Wallace, 2003). In general, the conditions required for seedling establishment are poorly understood for most species of orchids (Bowles, 1999). However, in Sharma's *Mycobionts, germination and conservation genetics of federally threatened Platanthera praeclara (Orchidaceae),* also discussed further (see Habitat section) seedlings are not only heterotrophic but also mycotrophic (relying on a symbiotic relationship with fungi for most if not all sources of nutrients) especially during the early stages of development. The lack of an endosperm in the seed creates this necessary relationship to absorb nutrients through consumption of mycorrhizal fungi. It is also further understood that temperate species have acquired a mechanism for physiological dormancy. Presence of this mechanism leads to a plausible explanation that fungi is required to break down the physiological dormancy barriers allowing for germination. Adapting to environmental conditions, could possibly explain lower seed set by *Platanthera* species. The need to expend less energy and increase in plant fecundity is accomplished through the reduced size of the seeds (Sharma, 2002). No further information was found on capsule or seed size.

Figure 4: Fruit of *Platanthera psycodes.*

Habitat

Platanthera psycodes prefers habitats of wetland areas such as swampy forests, marshes, moist meadows, and along roadsides or riverbanks (Benda, n.d.; North American Conservation Center, 2011-2019). Growing in partial shade and similar soils to those of *P. grandiflora*, it occurs in northern states from Minnesota to Maine and extends south to northern Georgia (Benda, n.d.; North American Conservation Center, 2011-2019).

Removing the species from the wild is detrimental since the species is known to rely on mycorrhizal associations in the soil that cannot be propagated (Benda, n.d.). As described in Sharma's *Mycobionts, Germination and Conservation Genetics of Federally Threatened Platanthera praeclara (Orchidaceae),* this related species of *Platanthera*, has been studied to understand the relationship it has with its environment. Being that *P. praeclara* is closely related to *P. psycodes*, it can help to understand more about the mycorrhizal associations. Sharma notes that the mycorrhizal orchid seedling of the study species is heterotrophic and heavily relies on fungi for nutrients, especially during non-photosynthetic stages of development. For embryos to develop in the seeds, fungal hyphae need to be digested by the orchids' cell to derive nutrients. When testing historical and extant sites to see if they were suitable to allow for natural seed germination and development, very few seeds were found to have germinated (Sharma, 2002).

In New Jersey, *P. psycodes* can be found in bogs, swamps, damp meadows and open woods (Walz, 2018). Occurring only in wetland systems where flowing water is present, and from unshaded areas to areas with 50% shrub cover. Many recorded New Jersey populations were found growing at the edge of seeps, wooded streamside habitats, swamps, marshes, near brooks and tributaries. All recorded areas noted a slope nearby, one which was described to be dry and populated by *Quercus* species. Farther into the swamp areas show great presence of *Acer rubrum*. Many other rare plants were also found to be present at the base of slopes where the soil is wetter (New Jersey Natural Heritage Program, 2019).

Associated species include, but are not limited to, *Platanthera grandiflora, Osmundastrum cinnamomeum, Osmunda regalis, Onoclea sensibilis, Acer rubrum, Acer saccharum, Liriodendron tulipifera, Betula lenta, Betula alleghensis, Fagus grandifolia, Rhododendron viscosum, Rhododendron maximum, Clethra alnifolia, Spiraea tomentosa, Impatiens campensis, Sparganium androcladum, Lycopus virginicus, Veronica scutellate, Typha latifolia, Epilobium coloratum, Epilobium leptophyllum, Veratrum virde, Thelypteris novoboracensis, Phegopteris connectillis, Lobelia cardinalis, Lilium canadense, Adiantum pedatum, Fraxinus nigra, Arisaema triphyllum, Symplocarpus foetidus, Chelone glabra, Viola cucullata, Ilex verticillata, Polygonum arifolium, Scirpus cyperinus, Thalictrum pubescens, Circuta maculata, Carex intumescens, Lysimachia thyrsifolia, Lysimachia ciliate, Hamamelis virginiana, Lindera benzoin, Vaccinium corymbosum, Carex bromoides, Glyceria melicaria, Bartonia virginica, Coptis groenlandica, Streptopus lanceolatus, Clintonia borealis, Ranunculus curicetorum, Ranunculus sempervirens, Parathelypteris noveboracensis, Maianthemum canadense, Trientalis borealia, Toxixodendron radicans, Corallorhiza maculata, Pilea pumila, Viola* sp., *Salix* sp., *Quercus* sp., *Carex* spp., *Solidago* sp. and other various species of ferns, forbs, moss and graminoids (New Jersey Natural Heritage Program, 2019). All of the previous species were present where New Jersey occurrences were recorded.

Wetland Indicator Status (Walz et al., 2018; USDA NRCS, 2019)

FACW – Usually occur in wetlands, but may occur in non-wetlands.

USDA Plants Code (USDA NRCS, 2019)

PLPS2

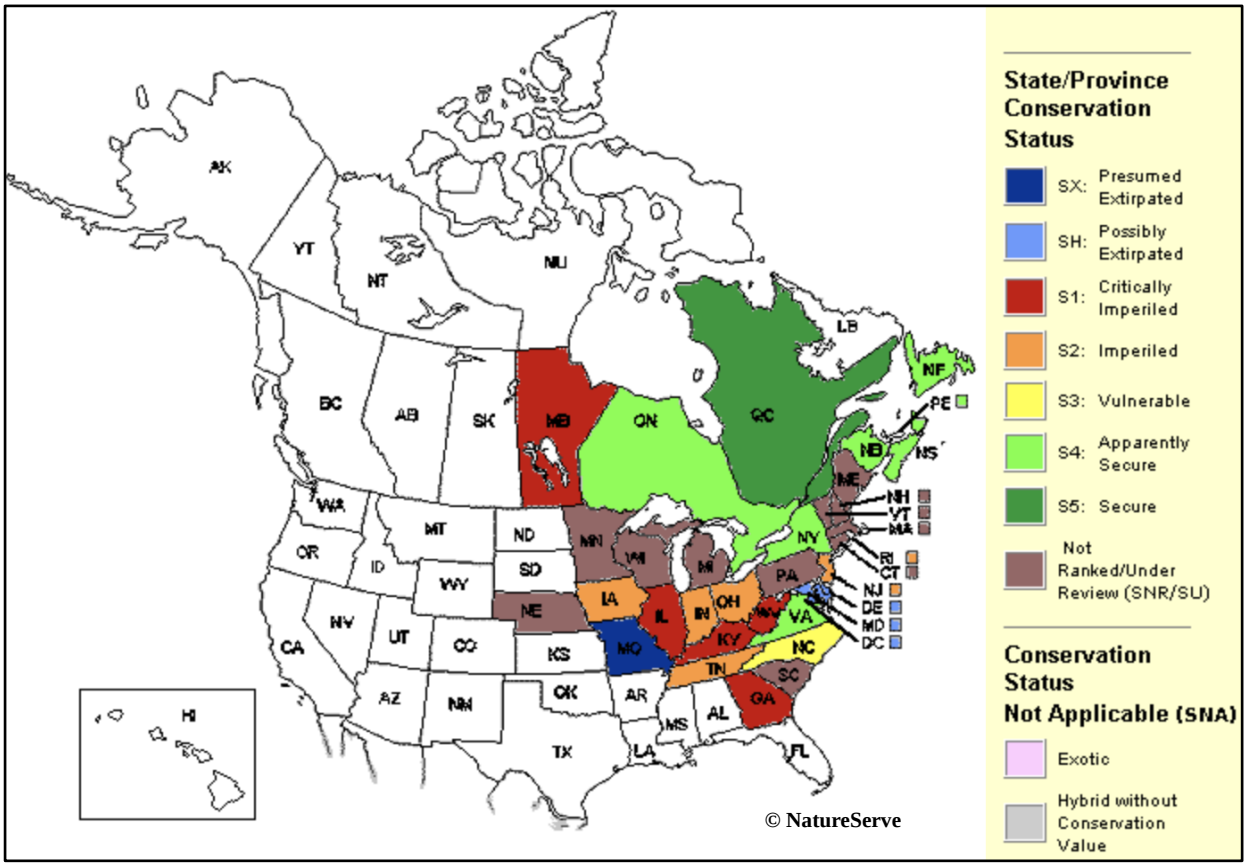
Coefficient of Conservatism (Walz et al., 2018)

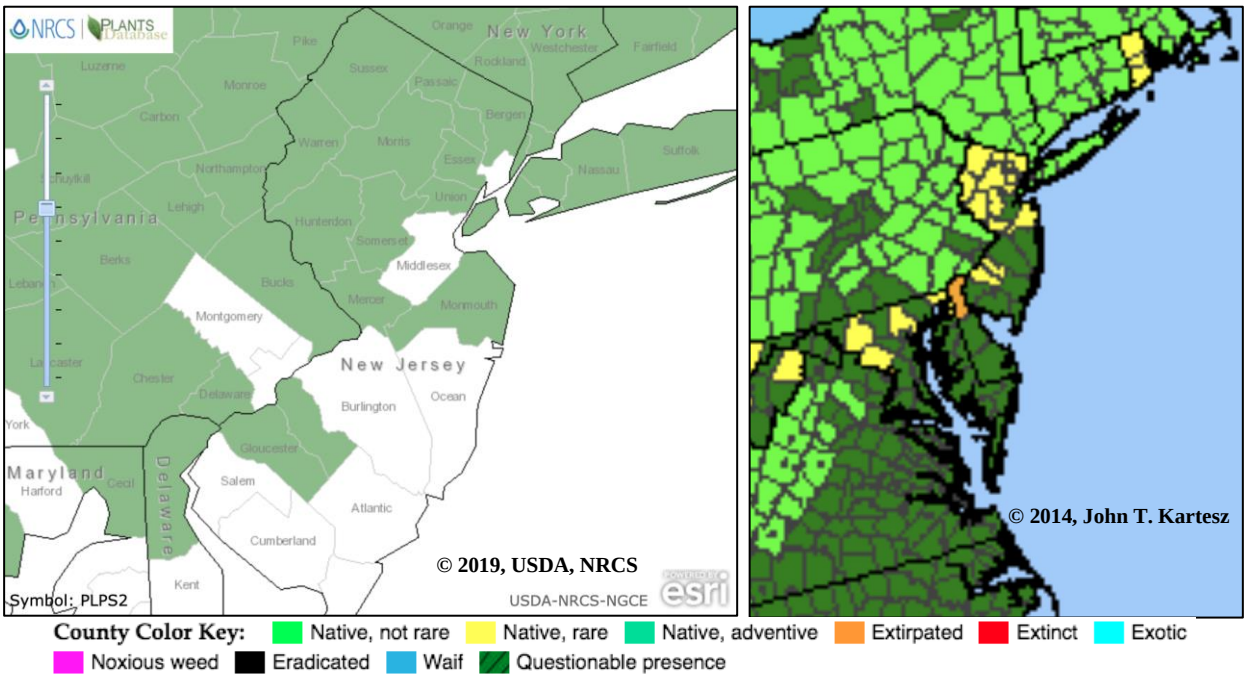
CoC = 10; Native with a narrow range of ecological tolerances, high fidelity to particular habitat conditions, and sensitive to anthropogenic disturbance.

Distribution and Range

The range of the species with their respective rankings in the United States are as follows Connecticut (SNR), Delaware (SH), District of Columbia (SH), Georgia (S1?), Illinois (S1), Indiana (S2), Iowa (S2), Kentucky (S1), Maine (SNR), Maryland (SH), Massachusetts (SNR), Michigan (SNR), Minnesota (SNR), Missouri (SX), Nebraska (SNR), New Hampshire (SNR), New Jersey (S2), New York (S4), North Carolina (S3), Ohio (S2), Pennsylvania (SNR), Rhode Island (S2), South Carolina (SNR), Tennessee (S2), Vermont (SNR), Virginia (S4), West Virginia (S1), Wisconsin (SNR) (NatureServe, 2018).

In New Jersey there are currently twenty occurrences documented in the Biotics database, all of which are believed to be extant (NJ Natural Heritage Program, 2019). Of these, twelve require further surveys to access their integrity. Seven of these populations are small to medium sized, with potential for more individuals in the surrounding area. One population was assessed to have poor integrity and viability. Only one individual was documented, and only meters away from a powerline right-of-way (ROW). This occurrence faces threats of invasive species introductions as well as off-road vehicle (ORV) usage and logging. Twelve of the occurrences are recorded from Sussex County, seven from Morris County and lastly one from Hunterdon County (NJ Natural Heritage Biotics database, 2019).





Conservation Status (Walz et al., 2018)

Please note, additional occurrence information present in herbaria or other sources that are not yet documented in the NJNHP Biotics may occur. Ongoing digitization efforts by herbaria around the world will lead to an increase in occurrences in the near future.

G Rank: G5 (New Jersey Department of Environmental Protection List of Endangered Plant Species of Plant Species of Concern, 2010)
Demonstrably secure globally; although it may be quite rare in parts of its range, especially at the periphery **(**New Jersey Department of Environmental Protection Explanations of Codes Used in Natural Heritage Reports, 2010).

S Rank: S2 (New Jersey Department of Environmental Protection List of Endangered Plant Species of Plant Species of Concern, 2010)
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 **(**New Jersey Department of Environmental Protection Explanations of Codes Used in Natural Heritage Reports, 2010).

Regional Status Codes for Plants and Ecological Communities: HL (New Jersey Department of Environmental Protection List of Endangered Plant Species of Plant Species of Concern, 2010)
Indicates taxa or ecological communities protected by the Highlands Water Protection and Planning Act within the jurisdiction of the Highlands Preservation Area **(**New Jersey Department of Environmental Protection Explanations of Codes Used in Natural Heritage Reports, 2010).

Threats

Just like other orchids around the world, *P. psycodes* is faced with threats due to climate change, habitat fragmentation and loss, invasive species, disease and unsustainable harvest for orchid trade (Paul et al., 2013; NatureServe, 2018; Southern Appalachian Species Viability Project, 2002). Transplanting orchids has been recorded as unsuccessful and collection of orchids for herbaria also pose a threat (Sharma, 2002). Climate change could drastically change the period at which orchids bloom causing more overlap in blooming periods or possibly switching all together (Brown, 2008). Since *P. psycodes* prefers cooler climates, this species is also moving further north due to warming. While thought to increase biodiversity and be the "driving force in plant evolution", hybridization in eastern Canada between *P. leucophaea* and *P. psycodes* otherwise known as *P. reznickekii*, poses a threat to both species and should be considered into prospective management plans. From this study (*Conservation genetics of an endangered orchid in eastern Canada),* hybridization was found to interfere with pollination because of genetic dilution (Wallace, 2003; Paul et al., 2013). The inter-specific hybridization occurs in a bidirectional manner when both species are found to be sympatric and can lead to the extinction of 'pure' populations of species. Small populations will tend to have lower genetic diversity due to inbreeding reducing gene flow. Overall, the lack in genetic variation leads to the inability to evolve new reproductive isolating barriers and makes it difficult for species to adapt to new and changing environmental conditions (Wallace, 2003; Paul et al., 2013).

Just as noted in Sharma's study (*Mycobionts, Germination and Conservation Genetics of Federally Threatened Platanthera praeclara (Orchidaceae)),* habitat destruction is one of the major causes of decline in species populations, and without the information relating to the plant's ecology, seed germination, and genetics, it's very difficult to propose management plans for existing populations (Sharma, 2002).

In New Jersey, extant populations are already being threatened by deer herbivory and presence, invasive species, climate change, as well as powerline ROW maintenance. Hemlock and Black Spruce trees are facing dieback due to the wooly adelgid, hemlock scale diseases and climate change. This directly affects the forest floor by increasing the amount of light through the canopy and affecting the soil composition. Increased amounts of light lead to an increase in presence of invasive species. Changes to the soil composition whether due to environmental changes or increased invasive species may prevent the persistence of associated fungi required for seed germination and seedling development by *P. psycodes*. The populations are also threatened by logging impacts from proposed forest management plans. Logging not only increases the amount of light, but also causes hydrologic changes such as those to the water table, surface, sediments, and nutrient flow. Increased amounts of herbicides and/or those that are applied liberally can

again change soil composition, travel further in the soil, and through the waterways. If the soil composition changes, *P. psycodes* populations will not only be directly affected but will become absent from these areas due to the specific habitat requirements of most orchid species, which again is significantly understudied (New Jersey Natural Heritage Program, 2019).

Management Summary and Recommendations

Further studies and surveys should be conducted on New Jersey occurrences to better understand their integrity and viability. Occurrences outside of New Jersey should also be studied for understanding and knowledge of environmental factors required by the species. It would not be suitable for these particular areas to be treated by herbicides; the reason being that herbicides could make their way into the wetland systems, directly affecting the stream corridor and soil composition. Therefore, removal or invasive species without the use of herbicides is recommended.

The mycorrhizal relationship that exists with *Platanthera psycodes* and other orchid species has been understudied, and this species as well as others in this orchid group would greatly benefit from future studies. Surveying should be conducted in areas that have been noted as having high probability of occurrences and suitable habitat such as the Weldon Brook, Mahlon Dickerson, and Rockaway River Wildlife Management Areas (New Jersey Natural Heritage Program, 2019).

Synonyms

Lesser Purple Fringed Orchid
Small Purple-Fringed Orchid

Habenaria psycodes (L.) Spreng.
Blephariglottis psycodes (L.) Rydb.
Orchis psycodes L.

At one point in time, both *Platanthera psycodes* and *Platanthera grandiflora* had the epithet *fimbriata* applied to them.

References

Barnes, Dr. Thomas G. (2013). Close view of cluster of purplish pink fringed orchid *Habenaria* psycodes blossoms on stem.jpg. *Wikimedia Commons*. Retrieved October 15, 2019, from https://commons.wikimedia.org/wiki/File:Close_view_of_cluster_of_purplish_pink_fringed_orchid_harbenaria_psycodes_blossoms_on_stem.jpg#filelinks

Benda, Christopher David. (n.d.). United States Department of Agriculture: Plant of the Week: Lesser Purple Fringed Orchid (*Platanthera psycodes*) *U.S. Forest Service* Received from: https://www.fs.fed.us/wildflowers/plant-of-the-week/Platanthera-psycodes.shtml

Boland, Todd (2017). Flickr. Retrieved from: www.flickr.com/photos/toddboland/35359748493

Boufford, D. E. (1997). *Fumaria*. In: Flora of North America Editorial Committee, eds. 1993+. Flora of North America North of Mexico. 20+ vols. New York and Oxford. Vol. 26, pp. 565 and 552, 566, 567.

Brown, P.M. (2008). A long-known, but enigmatic Platanthera hybrid from eastern North America. *North American Native Orchid Journal, 14,* 225.

Brown, P.M., Smith, C., & Shriver, J.S. (2008). A new fringed Platanthera (Orchidaceae) from the central Appalachian Mountains of eastern North America. *North American Native Orchid Journal, 14,* 239-254.

Bowles, M. L., & Snelling, F. (1999). EASTERN PRAIRIE FRINGED ORCHID Platanthera leucophaea (Nut tall) Lindley RECOVERY PLAN. *Prepared for US Fish and Wildlife Service (USFWS), Region, 3*.

Evans, John Richard. (2006). Identification and Comparison of the Pollinators for the Purple-fringed Orchids Platanthera psycodes and P. grandiflora. University of Tennessee Honors Thesis Projects. Retrieved from https://trace.tennessee.edu/utk_chanhonoproj/953

Gange, John. (2018-2019). Platantheraphile Account. *Flickr.* Retrieved from: https:/www.flikr.com/photos/166183394@N05/

Gange, John. (2018). Platanthera grandiflora Versus Platanthera psycodes [Arethusa's Journal, iNaturalist.org] Retrieved from:https://www.inaturalist.org/posts/18306-platanthera-grandiflora-versus-platanthera-psycodes

Gray, A. (1862). Structure and fertilization of certain orchids. *Amer. J. Sci. 34,* 420-428.

Holmgren, N. H., Holmgren, P. K., & Gleason, H. A. (1998). Illustrated companion to Gleason and Cronquist's manual. *New York Botanical Garden*.

Kartesz, J.T., The Biota of North America Program (BONAP). (2015). *Taxonomic Data Center*. (http://www.bonap.net/tdc). Chapel Hill, N.C. [maps generated from Kartesz, J.T. 2015. Floristic Synthesis of North America, Version 1.0. Biota of North America Program (BONAP). (in press)]

Kartesz, J.T., The Biota of North America Program (BONAP). (2015). North American Plant Atlas. (http://bonap.net/napa). Chapel Hill, N.C. [maps generated from Kartesz, J.T. 2015. Floristic Synthesis of North America, Version 1.0. Biota of North America Program (BONAP). (in press)].

Native Plant Trust: Go Botany (2019). *Platanthera Psycodes (L.) Lindl.* Retrieved from https://gobotany.nativeplanttrust.org/species/platanthera/psycodes

NatureServe. (2018). NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://explorer.natureserve.org. (Accessed: October 15, 2019).

New Jersey Department of Environmental Protection. (2010). *List of Endangered Plant Species of Plant Species of Concern*. Trenton, New Jersey. Retrieved from https://www.state.nj.us/dep/parksandforests/natural/heritage/jan2010plantlist.pdf

New Jersey Department of Environmental Protection. (2013). N.J.A.C. 7:5C Endangered Plant Species Program Rules. *N.J.A.C. 7:5C-3.1 Plant species of concern.* (pp. 4) Trenton, New Jersey. Retrieved from https://www.nj.gov/dep/rules/rules/njac7_5c.pdf

New Jersey Department of Environmental Protection. (2013). N.J.A.C. 7:5C Endangered Plant Species Program Rules. *N.J.A.C. 7:5C-5.1 Endangered Plant Species List.* (pp. 4) Trenton, New Jersey. Retrieved from https://www.nj.gov/dep/rules/rules/njac7_5c.pdf

New Jersey Natural Heritage Program. (2019). Biotics 5 Database. NatureServe. Trenton New Jersey. (Access date: March 19, 2019).

New Jersey Department of Environmental Protection. 2010. *Explanation of Codes Use in Natural Heritage Reports*. Trenton, New Jersey. Retrieved from https://www.state.nj.us/dep/parksandforests/natural/heritage/nhpcodes_2010.pdf

NJ Natural Heritage Program. (2019). Biotics5 Database. NatureServe. Trenton, New Jersey.

North American Orchid Conservation Center. (2011-2019). *Platanthera psycodes* (L.) Lindl. Lesser Purple Fringed Bog Orchid. Retrieved from http://goorchids.northamericanorchidcenter.org/species/platanthera/psycodes/.

Paul, J., Budd, C., & Freeland, J.R. (2013). Conservation genetics of an endangered orchid in eastern Canada. *Conservation Genetics, 14*(1), 195-204. doi:http://dx.doi.org.proxy.libraries.rutgers.edu/10.1007/s10592-012-0443-x

Sharma, J. (2002). Mycobionts, germination, and conservation genetics of federally threatened Platanthera praeclara (Orchidaceae) (Doctoral dissertation, University of Missouri-Columbia).

Southern Appalachian Species Viability Project. (2002). A partnership between the U.S. Forest Service-Region 8, Natural Heritage Programs in the Southeast, regionally and locally rare species in the Southern Appalachian and Alabama region. Database (Access 97) provided to the U.S. Forest Service by NatureServe, Durham, North Carolina

Stoutamire, W. P. (1974). Relationships of the purple-fringed orchids Platanthera psycodes and P. grandiflora. *Brittonia*, *26*(1), 42-58.

USDA, NRCS. (2019). The PLANTS Database (http://plants.usda.gov, 9 July 2019). National Plant Data Team, Greensboro, NC 27401-4901 USA.

Wallace, L.E. (2003). The cost of inbreeding in Platanthera leucophaea (Orchidaceae). *American Journal of Botany, 90*(2), 235-242.

Walz, Kathleen S., Linda Kelly, Karl Anderson and Jason L. Hafstad. (2018). Floristic Quality Assessment Index for Vascular Plants of New Jersey: Coefficient of Conservancy (CoC) Values for Species and Genera. New Jersey Department of Environmental Protection, New Jersey Forest Service, Office of Natural Lands Management, Trenton, NJ, 08625. Submitted to United States Environmental Protection Agency, Region 2, for State Wetlands Protection Development Grant, Section 104(B)(3); CFDA No. 66.461, CD97225809. Retrieved from https://universalfqa.org/