Enclosure #7

Identification of Exotic Plants Posing a Threat to Natural Communities

Presque Isle State Park
Exotic Plant Control Project
No. 88 - PSS.04

Final Report - September 28, 1989

Conducted by

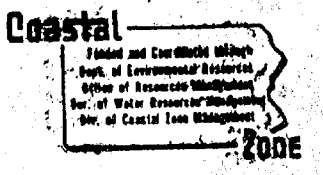
Botany Department
Cleveland Museum of Natural History
Wade Oval, University Circle
Cleveland, Ohio 44106

Funded by
A Grant From

Coastal Zone Management Program
and
Wild Resources Conservation Fund

Submitted to

Bureau of Forestry
Department of Environmental Resources
Post Office Box 1467
Harrisburg, Pennsylvania 17120



Identification of Exotic Plants Posing a Threat to Natural Communities

Presque Isle State Park
Exotic Plant Control Project
No. 88 - PSS.04

Final Report - September 28, 1989

Conducted by

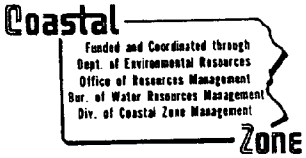
Botany Department
Cleveland Museum of Natural History
Wade Oval, University Circle
Cleveland, Ohio 44106

Funded by
A Grant From

Coastal Zone Management Program
and
Wild Resources Conservation Fund

Submitted to

Bureau of Forestry
Department of Environmental Resources
Post Office Box 1467
Harrisburg, Pennsylvania 17120



Acknowledgements

The Botany Department expresses gratitude to Museum Director Dr. J. Mary Taylor who approved acceptance of the contract for this study knowing that the Museum would recover only about one-third of the projected costs which would be incurred while conducting the exotic plant mapping project at Presque Isle State Park. Dr. Taylor supported the project because providing exotic plant encroachment information to the Bureau of Forestry, Division of Coastal Zone Management and Bureau of State Parks falls within the Museum's mission.

The Botany Department also thanks Kathleen McKenna, Bureau of Forestry, who suggested the project and offered valuable comments and assistance throughout the duration of the project.

Introduction

The encroachment of exotic plants into rare natural communities at Presque Isle State Park poses a great threat to the long-term survival of many rare species and rare natural communities within the park. This encroachment has been noted by many researchers during recent years. In particular, the surveys conducted by the Cleveland Museum of Natural History and Presque Isle Audubon Society since 1984 have revealed many cases where exotic plants appear to be invading natural communities at Presque Isle. In many parts of the park, this exotic plant invasion has contributed to reduction and probable loss of some of the rarest park species and ecosystems.

Choice of which exotic plant species would be mapped for this study was based primarily on the Museum field work conducted at the park between May 1985 and August 1988. During the 5-year study of Presque Isle conducted by the Museum, some natural communities at Presque Isle, containing high numbers of Plants of Special Concern in PA, were observed to be more threatened by exotic plants than others. Exotic plant species were mapped if they appeared to be encroaching a natural community type which supports one or several rare plants. Three natural communities which contain large numbers of rare plant species, the dry sand plain, the mixed emergent marshes, and palustrine sand plain are currently being degraded by exotic species encroachment.

Some natural communities containing large numbers of rare species are not currently showing decline or loss due to exotic species invasion. The sand dune and dry beach communities are good examples of communities which do not appear to be currently threatened by exotic plants. Although exotic species occur on the dunes and dry beaches, the exotic plants present within both natural communities cover a minor percentage of the ground surface in comparison to the native beach and dune species.

Some deep-water aquatic bed communities which occur within ponds isolated from Lake Erie were also mapped as part of this study because some very rare POSCIP species occur within them. One alien species, European water-milfoil (Myriophyllum spicatum), abundant elsewhere in the park, has not yet invaded these ponds but poses an obvious threat.

An acetate overlay map was prepared for each exotic plant species which was found to be invading one of the three following communities: undifferentiated mixed emergent marsh, dry sand plain, and palustrine sand plain. Overlay maps showing the most jeopardized of these three rare community types in the park were also prepared. Although the dry sand plain is currently

threatened by only one exotic plant, Japanese bush honeysuckle (Lonicera morrowi), the undifferentiated mixed emergent marsh and palustrine sand plain are currently being degraded by more than one exotic plant species.

The recommendations for managing exotic species encroachment into a rare community type are ranked numerically prioritizing specific areas where management is needed most. "Recommendation Number 1" corresponds to "Site Number 1" on the community type overlay. In most cases "Site Number 1" is the highest quality example of the natural community type most threatened by exotic species encroachment.

Control of exotic plant species is possible and relatively inexpensive if control methods are employed at the time when the species first appears within a natural area. If hybrid cattail (Typha x glauca) had been recognized several decades ago as an introduced exotic species and removed, emergent wetlands of the park would not now be covered by acres of this introduced species. Control of hybrid cattail at Presque Isle would require a large financial commitment because the hybrid was not removed when it first entered the park.

Some of the exotic species identified at Presque Isle for this report have obviously made recent entries into the park. These more recent exotics, including European buckthorn (Rhamnus frangula), leafy spurge (Euphorbia esula), and reed canary grass (Phalaris arundinacea) have proven to be disastrous invaders in nearby regions of the country. Their limited invasion within the park would make control of them now both possible and reasonably inexpensive.

Table of Contents

Background

Sixty species listed as Plants of Special Concern in Pennsylvania (POSCIP) have been documented at Presque Isle State Park by the Botany Department of the Cleveland Museum of Natural History during the 1985 through 1989 field seasons. Three hundred and eighty (380) occurrences of the 60 species have been mapped. These rare plant maps, combined with the 1987 draft community map, and exotic species maps based upon field surveys for this report were used to prepare the community type overlay maps. (See methodology below).

The sixty POSCIP species reported from Presque Isle are found in the following six plant communities:

1. Palustrine Sand Plain
2. Dry Sand Plain
3. Dunes and Dry Beaches
4. Ponds
5. Mixed Emergent Marshes
6. Shrub Swamp

1. Palustrine Sand Plain

The palustrine sand plain is a moist, sparsely vegetated sandy flat. Standing water is often present in the spring. The water table often drops below the surface during the summer. Typical sand plain species includes: Juncus articulatus, Juncus balticus, Juncus alpinus, Cyperus rivularis, Cyperus flavescens, Agalinis paupercula, Carex viridula, Carex garberi, and Hypericum majus. This rare community type, shown in pink on the base map, is threatened by several alien species including Phragmites australis, Typha x glauca, Lonicera morrowi, and Phalaris arundinacea.

Twenty-six (26) POSCIP species were documented within the palustrine sand plain:

Agalinis paupercula	Tentatively Undetermined
Aster dumosus	Tentatively Undetermined
Carex bebbii	Endangered
Carex garberi	Endangered
Carex lasiocarpa	Tentatively Undetermined
Carex viridula	Endangered
Cyperus diandrus	Threatened
Cyperus odoratus	Tentatively Undetermined
Cyperus engelmannii	Threatened
Eleocharis elliptica	Endangered
Eleocharis intermedia	Threatened
Eleocharis olivacea	Tentatively Undetermined

Palustrine Sand Plain (continued)	
Eleocharis pauciflora	Endangered
Equisetum variegatum	Endangered
Hemicarpha micrantha	Endangered
Hypericum majus	Threatened
Juncus alpinus	Threatened
Juncus balticus	Rare
Juncus biflorus	Tentatively Undetermined
Juncus brachycephalus	Rare
Juncus torreyi	Threatened
Lathyrus palustris	Tentatively Undetermined
Lobelia kalmii	Endangered
Potentilla anserina	Threatened
Potentilla paradoxa	Endangered
Scirpus smithii	Endangered

2. Dry Sand Plain

The dry sand plain is an open, dry grassland usually dominated by Sorghastrum nutans, Panicum virgatum, and Andropogon scoparius. Other species common in the sand plain include: Carex muhlenbergii, Carex tonsa, Rumex acetosella and Dichanthelium sabulorum. Japanese bush honeysuckle (Lonicera morrowi) has invaded much of this community within the park.

Six POSCIP species are found on the dry sand plain:

Dichanthelium sabulorum	Threatened
Digitaria cognatum	Rare
Geranium bicknellii	Tentatively Undetermined
Lithospermum caroliniense	Endangered
Lupinus perennis	Rare
Opuntia humifusa	Rare

3. Dunes

Sand dunes and drift beaches at Presque Isle support nine POSCIP species. Ammophila breviligulata and Populus deltoides are the most frequent dune builders, but in some areas Panicum virgatum, Andropogon scoparius and Elymus canadensis are important dune builders. Active dunes at Presque Isle are best developed from the Light House eastward to the tip of Gull Point. Compared to other significant communities harboring rare plants within the park, the sand dunes and drift beaches are currently not greatly threatened by exotic species encroachment. The single clone of Japanese knotweed (Polygonum cuspidatum), mapped at Sunset Point, has not increased during five years of observation.

Nine POSCIP species occur within the dunes and drift beaches at Presque Isle:

Ammophila breviligulata	Threatened
Artemisia campestris ssp. caudata	Endangered
Cakile edentula	Rare
Chamaesyce polygonifolia	Threatened
Cyperus schweinitzii	Rare
Lathyrus japonicus	Threatened
Ptelea trifoliata	Rare
Sporobolus cryptandrus	Rare
Triplasis purpurea	Endangered

4. Ponds

This plant community is found along the bay shoreline and within open ponds in the interior sections of the park. The ponds which have well developed aquatic beds are sometimes sparsely covered with Nuphar advena, Nymphaea odorata, Brasenia schreberi and Potamogeton natans. The overlay map for this community shows some ponds isolated from Lake Erie. Three of the POSCIP species listed below, Najas gracillima, Myriophyllum heterophyllum, and Myriophyllum verticillatum which occur within these ponds could be threatened by the accidental introduction of Myriophyllum spicatum.

Eleven (11) POSCIP species documented within the aquatic beds are:

Megalodonta beckii	Endangered
Najas gracillima	Tentatively Undetermined
Myriophyllum heterophyllum	Endangered
Myriophyllum verticillatum	Endangered
Potamogeton perfoliatus	Tentatively Undetermined
Potamogeton richardsonii	Endangered
Potamogeton zosteriformis	Tentatively Undetermined
Ranunculus longirostris	Endangered
Utricularia gibba	Tentatively Undetermined
Utricularia intermedia	Tentatively Undetermined
Utricularia minor	Tentatively Undetermined

5. Mixed Emergent Marshes

The emergent wetland complex includes Typha swamp, Carex meadows, Calamagrostis marshes, non-persistent Nuphar-Nymphaea-Pontederia marshes and Acer-Quercus-Nyssa-Cephalanthus savannahs with extensive mixed herbaceous marsh openings. Hybrid cattail (Typha x glauca) and common reed grass (Phragmites australis) have aggressively invaded much of this community type within the park. The community type is shown in green on the base map.

Nine POSCIP species were documented within the Mixed Emergent Marsh community type:

Acorus americanus	Endangered
Carex aquatilis	Threatened
Carex pseudocyperus	Endangered
Cladium mariscoides	Threatened
Eleocharis quadrangulata	Endangered
Polygonum amphibium stipulaceum	Tentatively Undetermined
Scirpus acutus	Endangered
Scirpus fluviatilis	Rare
Zizania aquatica	Rare

Shrub Swamp

Shrub swamps within the park are often dominated by pure stands of Cephalanthus occidentalis. Mixed shrub swamps dominated by mixtures of Cephalanthus, Vaccinium corymbosum, Viburnum recognitum, Ilex verticillatum, Alnus rugosa, Cornus obliqua, and Rosa palustris also occur frequently within the park. The single POSCIP species, Salix gracilis, found in the shrub swamps within the park is not currently threatened by any exotic species.

Single POSCIP species found within the shrub swamps at Presque Isle:

Salix gracilis	Tentatively Undetermined

Study Methodology

Base Map Preparation:

The draft 1987 Presque Isle State Park Natural Community Map, prepared by the Museum and Western PA Conservancy for the Coastal Zone Management and Bureau of Forestry, provided a base upon which exotic species could be mapped by Museum staff. At the onset of this study, the draft Natural Communities Map from the Presque Isle State Park: Botanical Survey and Natural Community Classification, December 1987 was reduced and revised. The draft natural communities map was reduced from 24" by 36" to 11" by 17" format for the purposes of the 1988-89 exotic species survey. The 1987 Natural Communities Map was altered to correspond to the USGS 7 and 1/2 minute topographic maps (scale 1:24,000) and aerial photographs from the Corps of Engineers (scale 1:4,800).

Broad groupings of natural community types are shown on the base map for this report. Significant areas within those communities being encroached by alien species are shown on the overlays.

Overlay Maps:

Exotic species overlay maps were compiled from exotic species cover maps made in the field. The exotic species field maps were made by marking approximate cover of each exotic species onto Xerox copies of April 1986 aerial photographs obtained from the Corps of Engineers (scale: 1:4800). The color photographs were taken into the field while mapping the exotic species onto the Xerox copies. Acetate overlay maps for each exotic species mapped were prepared by combining all the field Xerox copies.

Acetate overlay maps showing the best park occurrences of rare natural communities being invaded were also prepared. These overlay maps are based upon the 1987 draft Natural Community Map, concentration of POSCIP species determined from the 1985 through 1989 surveys and degree of invasion by exotic species.

Exotic Species Mapped

Alnus glutinosa

Betula pendula

Celastrus orbiculatus

Epilobium hirsutum

Euphorbia esula

Lonicera japonica

Lonicera morrowi

Lythrum salicaria

Myriophyllum spicatum

Phalaris arundinaceae*

Phragmites australis*

Polygonum cuspidatum

Rhamnus frangula

Typha angustifolia

Typha x glauca

Virburnum opulus var opulus

*Although these species are native to the U.S., many regional ecologists assume the strains now encroaching into area wetlands are probably European in origin.

Mixed Emergent Marsh - General Discussion

Hybrid cattail (Typha x glauca) is obviously the greatest threat to emergent marshes within the park. It has invaded many acres of the open, mixed emergent marsh communities at Presque Isle State Park. To a lesser degree phragmites (Phragmites australis) has also invaded the open, diverse emergent marshes at Presque Isle. Other exotic invaders of the mixed emergent marshes include purple loosestrife (Lythrum salicaria) and hairy willow-herb (Epilobium hirsutum).

Open emergent marshes at Presque Isle with small amounts of or no hybrid cattail and/or phragmites typically contain high quality common tussock sedge (Carex stricta) and/or water sedge (Carex aquatilis). Where hybrid cattail and/or phragmites has invaded large sections of emergent marshes at Presque Isle, the former stands of common tussock sedge and/or water sedge has been reduced or eliminated. Within the largest stand of hybrid cattail in the park, along the southeastern basin of Niagara Pond, the common tussock sedge and water sedge stands have been eliminated. The previous existence of common tussock sedge and/or water sedge can be ascertained from examining the evenly spaced large peat hummocks now covered by hybrid cattail. These peat hummocks are artifacts produced by the growth of common tussock sedge or water sedge.

If the spread of hybrid cattail into diverse common tussock sedge-water sedge marshes is not curtailed through management, hybrid cattail will likely eliminate water sedge from the flora of Pennsylvania since emergent marshes at Presque Isle State Park are the only place in Pennsylvania where water sedge is known to grow. The virtual elimination of common tussock sedge-water sedge marshes by hybrid cattail at Presque Isle could take place within the next several decades.

Other mapped exotic species which appear to pose a threat to emergent marshes at Presque Isle include: hairy willow herb (Epilobium hirsutum) and purple loosestrife (Lythrum salicaria). Neither of the latter two plants have replaced the emergent marshes to the extent that hybrid cattail and phragmites have. Herbarium records show that purple loosestrife has been in the park since 1916.

Recommendations:

Mixed Emergent Marshes - Site 1:
Map Set Number 1

This community along the north and south shores of Dead Pond within the eastern basin of the pond is both the best assemblage of mixed emergent marsh POSCIP species in the park and the most threatened by exotic species. The emergent marsh within the eastern basin of the pond contains the largest park stand of Eleocharis quadrangulata, the finest park stand of Scirpus acutus, a fine stand of Carex aquatilis, and the only remaining park stand of Cladium mariscoides. The Cladium mariscoides population within the basin has 58 culms. This fine complex of emergent POSCIP species is being invaded from the west by Phragmites australis and Typha x glauca. The aquatic form of Roundup (Rhodeo) should be hand applied to the aerial culms of the invading phragmites and hybrid cattail. In similar wetlands in Ohio, staff members of the Division of Natural Areas and Preserves, Ohio Department of Natural Resources, have used cotton socks to hand-apply to the aerial portions of cattail a 50 % solution of Rhodeo. The applicators have worn chemical resistent rubber gloves. A recommendation is to set up a 5 meter by 5 meter test plot along the advancing edge of the phragmites stand where some of the Cladium mariscoides culms occur.

Mixed Emergent Marsh - Site 2
Map Set Number 1

Site 2 on the Mixed Emergent Marsh overlay map, situated within the wetland basin west of Yellow Bass Pond, is the largest Carex stricta - Carex aquatilis sedge marsh in the park where there has been relatively little invasion by Phragmites australis and Typha x glauca. The Typha x glauca exotic species overlay map shows a massive area east of Yellow Bass Pond where Typha x glauca has invaded along the southern and western sections of the Niagara Pond Basin. The recommendation for Site 2 is to never allow the invasion of Typha x glauca or Phragmites australis into the Basin. A stewardship crew should be sent into the basin no less than every five years. Any Typha x glauca or Phragmites australis established should be removed through digging or hand application of Rhodeo as recommended for Dead Pond.

Mixed Emergent Marsh - Site 3
Map Set Number 1

These mixed emergent marshes located southwest of the Beach 11 parking area and northwest of the northwest shore of Horseshoe Pond contain some of the finest populations of Carex aquatilis within the park. As shown on the exotic species overlay maps,

small populations of Phragmites australis and Typha x glauca have established along the edges of these high quality Carex aquatilis marshes. If the Phragmites australis and Typha x glauca control methods prove successful within Dead Pond, the same method of control should be used in the Site 3 marshes.

Mixed Emergent Marsh - Site 4
Map Set Number 1

The Carex aquatilis stand at Site 4 has been mapped as an important site to monitor. Long-term observation of this Carex aquatilis stand, flanked by Typha x glauca, will reveal how well Carex aquatilis withstands competition from Typha x glauca.

Mixed Emergent Marsh - Site 5
Map Set Number 1

Reed canary grass (Phalaris arundinacea) is now confined primarily to emergent marshes and palustrine sand plains along the neck of the peninsula adjacent to the shores of Presque Isle Bay. Although reed canary grass has not yet invaded the open emergent wetlands within the Ecological Reservation, the species has demonstrated the ability to invade and diminish the diversity of emergent marshes in the southwestern basin of Lake Erie.

Site 5 appears to be a vanguard stand of reed canary grass in the park. As the reed canary grass map shows, this species currently occurs from Site 5 southward along the bay side of the peninsula. If possible this species should be removed from the park before it moves further north into the Ecological Reservation. Control of this species should begin at Site 5 and proceed to the other mapped areas for the grass south of Site 5.

General Discussion - Dry Sand Plain

A single exotic species, Japanese bush-honeysuckle (Lonicera morrowi), currently poses the greatest threat to dry sand plains at Presque Isle State Park. Another exotic, Japanese knotweed (Polygonum cuspidatum), has established at a few sites within the dry sand plain.

Dry sand plains at Presque Isle are found on sandy ridges inland from the active dune areas, along the eastern section of Long Ridge and in some level, sandy openings on the neck of the peninsula. Dry sand plains are open, dry sandy often sparsely vegetated grassland usually dominated by indian grass (Sorghastrum nutans), switchgrass (Panicum virgatum), and little bluestem (Andropogon scoparius). Bayberry (Myrica pensylvania) shrubs are often scattered on dry sand plains within the northeastern section of the park's Ecological Reservation.

POSCIP species found within the Dry Sand Plain include hairy puccoon (Lithospermum caroliniense), lupine (Lupinus perennis), and panic grass (Dichanthelium sabulorum var. patulum).

Recommendations:

Dry Sand Plain - Site 1
Map Set Number 2

The dry sand plain on both sides of PA 832 south of Beach 9 has become choked with Japanese bush-honeysuckle (Lonicera morrowi). This species has virtually eliminated native plant species in several areas of the dry sand plain at the site. Mowing, car traffic and foot traffic from park visitors has curtailed the invasion of the bush-honeysuckle adjacent to PA Rt. 832 east of the Light House. Possible control methods for this species could be extension of the area of mowing followed by hand-pulling. Another control method for the Japanese bush-honeysuckle could be the application of the herbicide Roundup with a wick-type applicator.

Japanese bush-honeysuckle has invaded other sand plains within the park. If control of the species were successful along PA Rt. 832 at Beach 9, the methods should be used in other parts of the park.

Dry Sand Plain - Site 2
Map Set Number 2

Control of leafy spurge (Euphorbia esula) within a dry sandy opening located approximately .1 mile west of the northwest shore

of Graveyard Pond should be attempted. Thus far, this exotic has not been found anywhere else in the park. According to Heidel, 1982, this species is extremely difficult to eradicate and does not respond to herbicide application. Perhaps a black sheet of heavy polyethylene could be placed over the leafy spurge during the growing season as a possible method of control. Park visitors are not apt to enter the area where the spurge was found growing.

Dry Sand Plain and Open Beach - Site 3
Map Set Number 2

The small stands of Japanese knotweed (Polygonum cuspidatum) should be removed from the dry sand plain - open beach located just north of PA 832 at Sunset Point and adjacent to the Light House. The other mapped occurrences of Japanese knotweed are not located within a natural community which supports Plants of special Concern In Pennsylvania.

Palustrine Sand Plain - General Discussion

The palustrine sand plain community contains more rare plants than any other community in the park. This community, marked in pink on the base map, occurs on open to partially shaded low-relief, moist sandy flats within the park. Phragmites (Phragmites australis) poses the greatest threat to the palustrine sand plain, especially within the Gull Point area of the Ecological Reservation. To a lesser extent, Japanese bush-honeysuckle, hairy willow-herb (Epilobium hirsutum), and hybrid cattail pose threats to this community.

Many of the rarest species within this community are not present in the park every year. Some of these infrequently seen species are stored in the moist sandy or peaty substrates beneath the water surface of the interior ponds and Presque Isle Bay during periods of high Lake Erie water levels. The long term storage of some species within substrates is known as the seed bank. When the level of Lake Erie goes through a period of lowering, these seed bank species appear on the newly exposed low-relief shorelines along interior ponds and Presque Isle Bay. For some species at Presque Isle such as (Eleocharis pauciflora) and (Eleocharis caribaea), another seed bank phenomenon has been observed to take place. At Presque Isle the latter two species appeared when the level of Lake Erie reached record highs during 1985 and 1986. Both species disappeared from the park in 1988 when the level of Lake Erie fell two feet below the 1985-86 levels.

Recommendations:

Palustrine Sand Plain - Site 1
Map Set Number 3

Phragmites is spreading into and eliminating the palustrine sand plain throughout much of Gull Point. Bulldozing, following the breeding season for birds, may be the only method for controlling the phragmites at Gull Point. This method not only removes the phragmites but also exposes open, level, moist, bare sand plains required by the many rare Palustrine Sand Plain species.

Palustrine Sand Plain - Site 2
Map Set Number 3

The palustrine sand plain located north and south of the mouth of the bay at this site should be closely monitored for encroachment from three nearby exotic plants: hairy willow-herb (Epilobium hirsutum), purple loosestrife (Lythrum salicaria), and

hybrid cattail (Typha x glauca). The palustrine sand plain which appears at this site during low water stages of Lake Erie seed banks the only Smith's bulrush (Scirpus smithii) thus far located at Presque Isle. This Endangered species in Pennsylvania is also listed as Endangered in Ohio. Smith's bulrush is an annual which can remain viable within water-covered sediments for long periods of time. Prior to discovery of four specimens of Smith's bulrush at this palustrine sand plain on October 13, 1988 the species was last reported for the park in 1926. During the high levels of Lake Erie in 1985 and 1986 this site was covered by approximately two (2) feet of water.

A large stand of hairy willow-herb has established on the palustrine sand plain south of the bay mouth at Site 2. This population should be removed by pulling or digging with a shovel. Extensive stands of purple loosestrife and hyrbrid cattail occur adjacent to the site. If either or both of the latter species invades the palustrine sand plain where the Smith's bulrush has been found, they should be removed. Disturbance of the sparsely vegetated sandy surface through the process of digging exotics should promote Smith's bulrush since it grows upon bare or sparsely vegetated, moist sandy flats.

Palustrine Sand Plain - Site 3
Map Set 3

Long term maintenance of the trail flat where few-flowered spike-rush (Eleocharis pauciflora) and Caribbean spike-rush (Eleocharis caribaea) occur in the park is crucial to the long term survival of both species in Pennsylvania. (This is the only site where either species grows in Pennsylvania.) These two seed bank species grow on the trail flat only during high Lake Erie water levels such as occurred during 1985 and 1986. As with most of the 26 POSCIP species found within the Palustrine Sand Plain, few flowered spike-rush and Caribbean spike-rush tolerate foot traffic along the trail. The same foot traffic prevents entry of the nearby hybrid cattail during periods of high lake levels. When the level of Lake Erie dropped in 1988, both species disappeared from the trail flat.

General Discussion - Aquatic Bed and Non-persistent Marsh
Map Set Number 4

One exotic submersed aquatic plant, European water-milfoil (Myriophyllum spicatum), poses a great threat to submersed aquatic plants listed as POSCIP species in Pennsylvania. Based upon examination of herbarium specimens, European water-milfoil first appeared at Presque Isle in 1950. Soon after European water-milfoil entered the lake waters surrounding Presque Isle, a native water milfoil, American water-milfoil (Myriophyllum exalbescens) disappeared from the park. All interior ponds at Presque Isle which have large channel connections to Lake Erie contain large populations of European water-milfoil. Three interior ponds: Ridge, Niagara, and Meander, with little or no connection to Lake Erie currently harbor two water milfoil species, variegated water milfoil (Myriophyllum variegatum) and broad-leaf water-milfoil (Myriophyllum herterophyllum). Both species are listed as Endangered in Pennsylvania by the Pennsylvania Natural Diversity Inventory. Broad-leaved water-milfoil is a southern species known from one other site in Pennsylvania. Variegated water-milfoil is a northern species known to occur at two other sites in Pennsylvania.

Aquatic Bed - Site 1
Map Set Number 4

The large population of broad-leaf water-milfoil in Ridge Pond should never be exposed to competition from European water-milfoil as a result of dredging a channel from Ridge Pond to any pond which connects to Lake Erie. In addition, any researchers who carry equipment or canoes from Grave Yard Pond or Big Pond into Ridge Pond should be careful not to accidentally transport any pieces of European water-milfoil into Ridge Pond. European water-milfoil normally spreads from one body of water to another as fragments attached to boat motors or anchors.

Aquatic Bed - Site 2
Map Set Number 4

Niagara Pond has a large population of large-leaf water-milfoil and no European water-milfoil. In order to prevent movement of European water-milfoil from Misery Bay into Niagara Pond, no large culverts should be placed beneath PA Rt. 832 between Misery Bay and Niagara Pond. Anyone who takes a canoe or equipment into Niagara Pond should be careful not to transport any fragments of European water-milfoil into Niagara Pond.

Aquatic Bed Site 3
Map Set Number 4

Meander Pond, the narrow body of water east of the east shore of Horse Shoe Pond contains the only park site for variegated water-milfoil. European water milfoil is abundant within the open waters of Horseshoe Pond. A channel should never be dredged between the waters of Meander Pond and Horseshoe Pond because such a channel would allow European water-milfoil to enter Meander Pond. As with Ridge Pond and Niagara Pond, anyone taking a canoe or equipment from ponds connected to Lake Erie into Meander Pond should be cautioned not to accidentally transport any scraps of European water-milfoil.

General Discussion - Miscellaneous Exotic Species Map
Map 5

Five exotic species were mapped because they may pose a threat to POSCIP species in the near future.

The single occurrence of European buckthorn (Rhamnus frangula) should be eradicated from the park as soon as possible. This species has degraded many rare natural communities within nearby northeastern Ohio and could enter the Palustrine Sand Plain or Dry Sand Plain at Presque Isle.

The Chinese bittersweet (Celastrus orbiculatus) has choked several sections of the cottonwood savannah forests within the vicinity of the Park Administration Building. This species could spread into the Ecological Reservation.

European alder (Alnus glutinosa) has become established within several shrub swamps along the neck of the peninsula. This species tends to form dense thickets and will probably spread into the Ecological Reservation.

European high-bush cranberry (Viburnum opulus var. opulus) has become well established within shrub swamps on the neck of the peninsula and there are a few occurrences of this species within the Ecological Reservation.

European white birch (Betula pendula) has become well established within the cottonwood forests between the Beach 11 parking area and the east shore of Misery Bay. This species produces allelopathins in the soil. Continued spread of this species in the park could eventually pose a threat to the Palustrine Sand Plains in the park.

Bibliography

Andres, L.A. 1977. The economics of biological control of weeds. Aquat. Bot. 3:11-113.

Apfelbaum, Steven L. 1985. Cattail (Typha spp.) Management. Natural Areas Journal 5(3):9-17.

Bedford, B.L., E.H. Zimmerman, and J.H. Zimmerman. 1974. The wetlands of Dane County, Wisconsin. Dane County Regional Planning Commission, Madison, WS. 581 pp. (Control of Phalaris arundinacea, Typha spp.)

Bonasera J.J., and M.A. Leck. 1978. An allelopathy study of marsh plants and soils. Bull. N.J. Acad. Sci. 23(2):83.

Bratton, S.P. 1982 The effects of exotic plant and animal species on nature preserves. Natural Areas Journal 2(3):3-13.

Croizat, L. 1945. Euphorbia esula in North America. American Midland Naturalist 33:231-243.

Decker, Daniel J. and Jody W. Enck, eds., Exotic Plants with Identified Detrimental Impacts on Wildlife Habitats in New Your State. The Exotic Plant Committee of the New York Chapter - The Wildlife Society, Cornell Cooperative Extension, New York State College of Agriculture and Life Sciences, Cornell University, Ithaca, New York. Series 29, July 1987. (Phragmites australis, Lythrum salicaria, Myriophyllum spicatum)

Dewey, Sharon L. 1986. Effects of the Herbicide Atrazine on Aquatic Insect Community Structure and Emergence. Ecology 67(1):148-162.

Ebinger, John E. 1983. Exotic Shrubs, A Potential Problem in Natural Area Management in Illinois. Natural Areas Journal 5(1):3-5.

Hanna, Jack. 1989. Purple Invader. Seasons, Federation of Ontario Naturalists 29(2)20-23.

Harberg, M.C. and T. Modde. 1985. Feeding behavior, food consumption, growth, and survival of hybrid grass carp in 2 South Dakota ponds. N. Am. J. Fish Manageme. 5:457-464.

Harty, Francis M. 1986. Exotics and Their Ecological Ramifications. Natural Areas Journal 6(4):20-26.

Haslam, S.M. 1973. Some aspects of the life history and autecology of Phragmites communis Trin. A review. Pol. Arch. Hydrobiol. 20:79-100.

Heidel, Bonnie. 1982. Leafy spurge - a challenge in natural areas management. Natural Areas Journal 2(2):10-13.

Howard, R., D.G. Rhodes and J.W. Simmers. 1978. A review of the biology and potential control techniques for Phragmites australis. Internal Working document D-78-26, Dredged Material Research Program, Environmental Laboratory, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. 78 pp.

Nichols, S.A., and B.H. Shaw. 1983. Review of management tactics for integrated aquatic weed management of Eurasian water-milfoil (Myriophyllum spicatum), curly-leaf pondweed (Potamogeton crispus), and elodea (Eleodea canadensis). Pages 181-192 in J. Taggart and L. Moore, eds. Proc. 2nd Ann. Conf. of the N.Am. Lake Manage. Soc. Vancouver, BC. 26-29 Oct.

Rawinski, T.J., and R.A. Malecki. 1984. Ecological relationships among purple loosestrife, cattail and wildlife at the Montezuma National Wildlife Refuge. N.Y. Fish Game Journal 31:81-87.

Reuter, D. Dayton. 1985. Effects of seasonal cutting, torching and prescribed burning on hydrophytic shrubs in a central Wisconsin sedge meadow wetland. Master's thesis, University of Wisconsin, Madison, WS. 94 pp.

Reuter, D. Dayton. 1986. Sedge Meadows of the Upper Midwest: A Stewardship Summary. Natural Areas Journal (6)4:27-34.

Shamsi, S.R.A., and F.H. Whitehead. 1977b. Comparative eco-physiology of Epilobium hirsutum L. and Lythrum salicaria L. 4. Effects of temperature and interspecific competition and concluding discussion. J. Ecol. 65:71-84.

Thompson, Daniel Q., R.L. Stuckey, E.B. Thompson. 1982. Spread, Impact and Control of Purple Loosestrife (Lythrum salicaria) in North American Wetlands. Fish and Wildlife Research 2, United States Department of the Interior, Washington, DC. 55 pp.

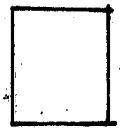
U.S. Fish and Wildlife Service. 1982. Spread of Eurasian water-milfoil into the Great Lakes. Research Information Bulletin No. 82-8.

Wilcox, D.A., S.I. Apfelbaum, and R. Hiebert. 1984. Cattail invasion of sedge meadows following hydrologic disturbance in the Cowles Bog Wetland Complex, Indiana Dunes National Lakeshore. J. Soc. of Wetlands Scientists 4:115-128.

APPENDIX

Key to Base Map
for
1989 Exotic Plant Survey

Undifferentiated Mixed Emergent Marsh
Including Typha marshes, mixed Carex - Calamagrostis marshes, and Acer-Quercus-Nyssa-Cephalanthus savannahs with extensive mixed herbaceous marsh openings.



Dry Sand Plain
Open, dry, sandy often sparsely vegetated grassland usually dominated by Sorghastrum nutans, Panicum virgatum, and Andropogon scoparius.

Palustrine Sand Plain
Moist, sparsely vegetated sandy flats. Standing water is present in the spring.

Undifferentiated Lacustrine, Palustrine Ponds and Non-persistent Nuphar-Nymphaea-Pontederia marshes.
Includes mixed aquatic bed communities, non-persistent marshes and open waters of Lake Erie.

Calamagrostis canadensis Communities
Includes all communities with Calamagrostis canadensis as the dominant understory.

Great Lakes Broadleaf Sandplain Forest
Populus deltoides sandy loam forest with various mixtures of Salix fragilis and Robinia pseudoacacia.

Mixed Hardwood Forest
Includes all Acer rubrum-Quercus borealis-Quercus-velutina-Prunus serotina-Fraxinus americana-Sassafras albidum forest communities on old dune ridges. No Poscip species occur within this community.

Undifferentiated Swamp Forests and Shrub Swamps

Undifferentiated Open Sand Dune and Open Beach.