Phragmites australis (Common Reed) Invasion and Typha (Cattails) Presence Among Wetland Habitats in Eastern Montgomery County, New York

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Capstone Project Research Paper

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Abstract

This research involves wetland areas among the upper eastern end of Montgomery County within the Mohawk Valley region of New York State. Four questions that this research sought to answer were:

- *Are there any wetland areas in Montgomery County, NY where the non-native invasive phragmites australis has not yet invaded?*
- *Are there any wetland areas in Montgomery County, NY that are dominated by the native cattail flora species instead of phragmites australis?*
- *Are there wetland areas in Montgomery County, NY where the non-native invasive phragmites australis and native cattail flora species coexist?*
- *Are there more flora species present at Phragmites australis dominated wetland habitats or within those dominated by native cattails?*

The primary data collected for this project shows that there are wetland areas in Montgomery County, NY where the non-native invasive Phragmites australis has not yet invaded. There are wetland areas in Montgomery County, NY that are dominated by the native cattail flora species instead of Phragmites australis. In Montgomery County, New York there are wetland areas where both the non-native invasive Phragmites australis and native cattail coexist. There are more flora species present at sites where cattails are a dominant species than at ones where phragmites australis dominates. This study provides evidence that although Phragmites australis has invaded many wetland areas in New York state including within Montgomery County certain native species, such as cattails, are able to strongly compete with non-native invasive flora species and continue to dominate some wetland areas.

Introduction

Biological invasions pose a great threat to native species and their habitats (Meyerson et al., 2009). Non-native invasive species are organisms that are introduced from outside of their historical range to novel ecosystems and cause great harm to the environment, the economy, and/or human and wildlife health. Non-native invasive species have the ability to alter both the structure and function of environmental systems from genes to ecosystems (Meyerson et al., 2009). Almost every state and ecosystem existing in the U.S. has been affected by non-native invasive species. Anthropogenic related causes frequently account for the arrival and establishment of non-native invasive plant species in novel terrestrial and aquatic environments (Meyerson et al., 2009).

Wetland areas that would have been otherwise naturally isolated by uninhabitable upland environments, have become connected because of linear development and are at increased risk of non-native invasive species invasion (Brisson et al., 2010). Wetland habitats are specifically vulnerable to non-native invasive plant invasions because of their unique downstream position in relation to other ecosystem types (Meyerson et al., 2009). Wetland areas are landscape sinks for nutrients and propagules which makes these unique habitats quite vulnerable to plant invasions (Hazelton et al., 2014).

The non-native invasive *Phragmites australis* also known as the "common reed" currently dominates many wetland areas in New York State leaving less habitat availability for other native species such as cattails (Typha) to live and thrive. *Phragmites australis* is a grass species that invades and forms monocultures in wetland habitats in New York state. This particular non-native invasive common reed forms thick stands that easily shade out native wetland species such as cattails. The non-native invasive common reed also clogs waterways and negatively impacts the expansion of wetland habitats. As mentioned previously, *Phragmites australis* are a tall wetland grass that can grow up to 15 or so feet. The alternate leaves of the non-native invasive *Phragmites australis* are elongate (Kavanaugh, 2009). Fluffy seed heads sit at the top of phragmites australis stalks and are golden or purple in color. Native common reed is generally more scattered and grows in random patches, often has spots on culms (from a native fungus that hasn't adapted to the exotic common reed), flower plumes are sparse and may not continue on the plant through winter (Swearingen et al., 2012), and the non-native invasive *Phragmites australis* forms very dense monospecific masses (Kaufamn & Kaufman, 2012). *Phragmites australis* is a perennial grass that mainly produces via vegetative growth (Saltonstall, 2001).

Plant species composition has drastically changed over the last few decades in North American wetlands on account of human activities and the invasion of non-native invasive species, such as *Phragmites austrails [Cav.] Trin. Ex Steud*. Hereafter, use of *Phragmites, Phragmites australis,* or common reed will refer to the non-native invasive form of *Phragmites australis*. (Bellavance & Brisson, 2010). *Phragmites australis [Cav.] Trin. Ex Steud* is classified as a non-native invasive species in many areas located in the Northeast of the U.S. including in New York State. During the 1950s, *Phragmites australis* was found at only a small number of scattered wetland areas in the northeast (Bellavance & Brisson, 2010). Since its introduction, *Phragmites australis* has drastically increased in abundance in both natural and highly disturbed wetlands. *Phragmites* are a clonal rhizomatous wetland grass with a cosmopolitan distribution (Hazelton et al., 2014). During the last fifty or more years, the number and size of the non-native invasive P*hragmites australis* populations have expanded in freshwater, brackish, and marsh wetland habitats in the U.S. including among New York state (Lelong et al., 2007). *Phragmites australis* are known as a "sleeper weed" which is an invasive plant that is introduced to a region, naturalizes, and then remains localized for a period of time. Sleeper weed populations suddenly rapidly increase, begin to spread, and become very invasive. Eurasian phragmites invasions in North America, including in the U.S., are surprisingly striking due to their rapid spread, abundances, and negative impacts (Hazelton et al., 2014).

During the 1800s, *Phragmites* were documented growing in areas throughout the U.S. where ship ballast was dumped or utilized to fill-in marshes that were being converted to railroad and shipping hubs (Saltonstall, 2001). The rapid spread of *Phragmites australis* began after European colonization and even faster after the era of the automobile and motor boat transport (Kaufman

& Kaufman, 2012). *Phragmites australis* spreads mainly by water which carries rhizome root fragments from one wetland area to another. In North America *Phragmites australis* have spread and become quite established because of the transport and burial of rhizome root fragments (Brisson et al., 2010.) *Phragmites* produce both vertical and horizontal rhizomes. The rhizomes of *Phragmites australis* play a very crucial role in their survival because they have carbohydrate and nutrient reserves and provide sturdy soil anchors (Winogrond & Kiviat, 1997). The horizontal rhizomes are mainly located at a depth up to one or more meters and are significantly responsible for *Phragmites* lateral expansion in New York and other states of the Northeast region of the U.S. *Phragmites* also produce runners (also known as stolons) which have the ability to develop from a fallen above ground stem or a vertical rhizome along with aerial shoots which have aided in this species formation of vast lateral colonies throughout the U.S. and Canada. The rapid spread of phragmites is partially the result of certain human activities that cause habitat disturbances or stresses such as pollution, changes in hydrologic regimes, and increased soil salinity.

Over time, the continuous development of linear infrastructures along with the construction of roads, railways, drainage ditches, and canals commonly result in novel habitats which provide a vast network of empty niches for non-native invasive species to exploit (Brisson et al., 2010). Unnatural linear habitat areas connect ecosystems, landscapes, and regions that usually wouldn't be, and these areas are at high risk involving invasion. Presently, *Phragmites* are in abundance among marsh communities as well as along the borders of lakes, ponds, and rivers (Saltonstall, 2001). Currently *Phragmites* can be found in all of the mainland of the U.S. as well as throughout areas of Southern Canada. Some other habitats phragmites invades include flood plains, wet meadows, and prairies (Kaufman & Kaufman, 2012). *Phragmites* thrive in disturbed wetland habitats, and the presence of this particular non-native invasive is a strong indicator of disturbed wetlands in the U.S. and Canada (Chambers et al., 1999).

Phragmites australis invades a wide variety of wetland types, and once established, it is the cause of a countless amount of ecological issues that negatively impact the environment and wildlife. *Phragmites australis* are well known for clogging waterways, and the tall stems and dense growth of this particular species easily shade out native plants (Kaufman & Kaufman, 2012). *Phragmites australis* stalks often break close to the midpoint but don't always fall to the ground resulting in a potential fire hazard and the continual refusal of light to lower growing wetland plants and animals. Studies have also found that the growth of dense stands of *Phragmites australis* greatly decrease the extent of wetlands. One main concern regarding *Phragmites* expansion into different wetland habitats is the recorded reduction in biodiversity (Chambers et al., 1999). The introduction of *Phragmites* can lead to negative consequences involving the natural functionality of tidal and other wetland types through the alteration of resource utilization, modification of trophic structure and organization, and/or change in the disturbance regime. *Phragmites* can cause reductions in wetland native plant diversity and changes in vegetative structures where large wading birds become excluded, wetland specialists are replaced by generalist species, and the overall species richness of bird species among and that visit these habitats are lessened (Chambers et al., 1999). The development of *Phragmites* monocultures among wetland areas result in community structure alterations leading to reductions in habitat types for wildlife and waterfowl. Areas where phragmites dominate marshlands, it strongly influences the hydrology and the hydro period through its negative effects on drainage density and other geomorphic features resulting in marsh habitats not functioning

naturally. (Weinstein & Balletto, 1999). *Phragmites australis* invasions are known for severely changing the ecological functions of wetlands in the U.S. (Lelong et al., 2007). *Phragmites* invasions are commonly associated with decreases in plant diversity, declines in habitat quality for fish and wildlife, causing disruptions to biogeochemical cycles, and negatively impacting other wetland ecosystem services (Hazelton et al., 2014).

In the direct comparison of *Phragmites* growth with some other North American native wetland plant species, the non-native common reed has higher above ground biomass, a greater capacity for spread once becoming established, and a higher tolerance for fluctuating environmental conditions (Meyerson et al., 2009). Cattails (*Typha spp.)* are a native wetland species that are widespread in North America. Much like *Phragmites*, cattails are tolerant of salinity and disturbance and have dense rhizomes (Brisson et al., 2010). Both common reed and cattail are known for their heavy metal accumulation abilities, and some research data suggests that cattails are not as efficient as reeds in capturing and collecting heavy metals in their rhizome root parts (Grisey et al., 2011). *Phragmites australis* and cattails are clonal emergent species that have many similar morphological traits including tall shoots, heavy network of rhizomes, and form monoculture stands (Bellavance & Brisson, 2010). *Phragmites australis* is often found among the upper edges or elevated areas of wetland basins where water tables are usually lower (Chun, Y. & C, Y. D., 2009). On the other hand, cattails often establish in wetland depressions where water tables are exceptionally higher. Non-native *Phragmites australis* among more natural wetland sites has limited growth and expansion abilities because it is restricted to water depths that are less than approximately 100 cm (Robichaud, 2016). It is important to take note that the colonization of *Phragmites australis* normally starts among raised heaps and then expands into cattails dominated declines (Chun, Y. & C, Y. D., 2009). *Phragmites australis* can grow and establish within wetland area sites with either low or high water tables, but cattails prefer high water tables.

Phragmites australis can be found among many wetland areas in New York state. During the past, observing roadway ditches, wetland areas, and waterbody banks dominated by native cattails was a common experience for me in the state of New York. Over the years, the non-native invasive phragmites has formed monocultures among many wetland habitats in New York State, including within the Mohawk Valley region where I currently reside. My research will focus on some of the impacts *Phragmites australis* has on wetland habitats located in the Northeastern U.S.

This research focuses on wetland areas among the upper eastern end of Montgomery County within the Mohawk Valley region of New York State. Four questions that this research seeks to answer include:

- Are there any wetland areas in Montgomery County, NY where the non-native invasive *Phragmites australis* species has not yet invaded?
- Are there any wetland areas in Montgomery County, NY that are dominated by the native cattail flora species instead of *Phragmites australis*?
- Are there wetland areas in Montgomery County, NY where the non-native invasive *Phragmites australis* and native cattail flora species coexist?
- Are there more flora species present at *Phragmites australis* dominated wetland habitats or within those dominated by native cattails?

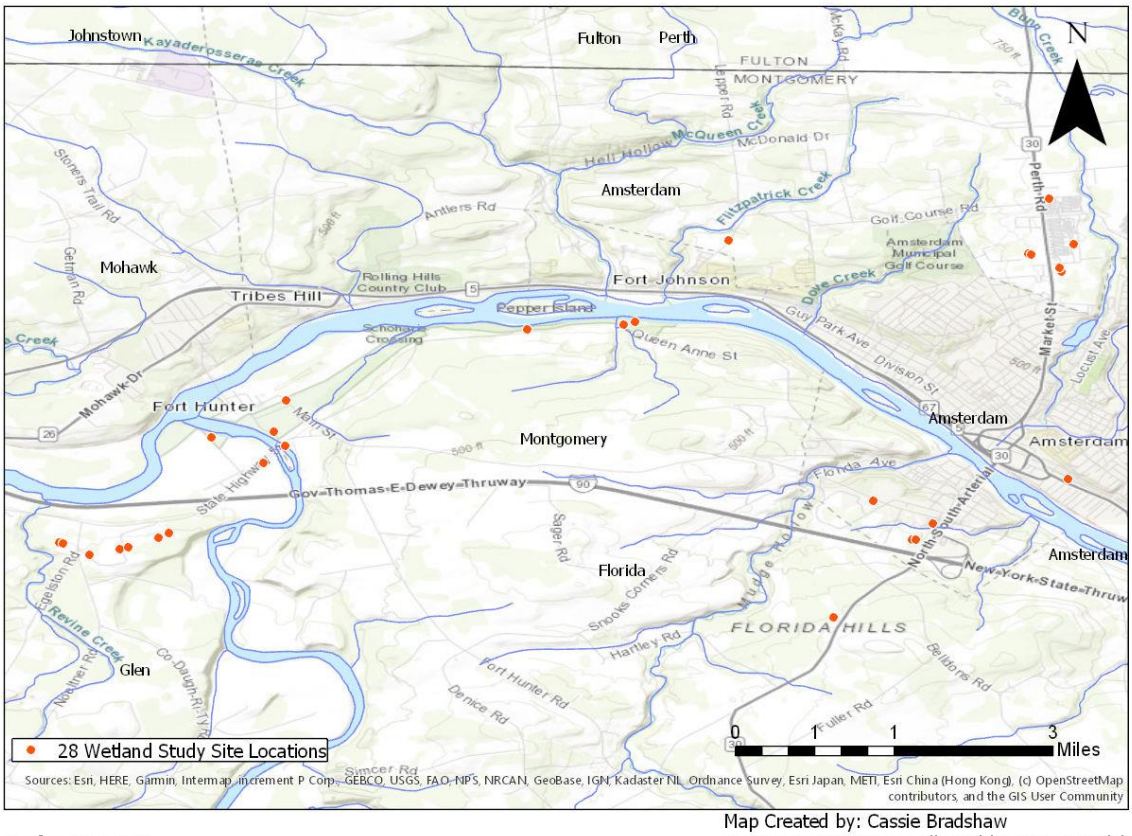
This research study was conducted during the Spring season of the year 2020 within Eastern Montgomery County in the State of New York. Two main goals of this research are to provide information to interested stakeholders, such as: iMapInvasives (New York's Online Invasive Species Database and Mapping System), Capital-Mohawk PRISM (Partnership for Regional Invasive Species Management), and the New York State Department of Environmental Conservation organizations regarding the further management of *Phragmites australis* and to aid in the future conservation and protection of New York state's essential wetland habitats.

Methods

Wetland Study Sites

For this study location, wetland condition, species presence, species dominance, species % cover, and species diversity measurement data was collected for 28 wetland sites (14 Disturbed and 14 Natural) of varying sizes ranging from small to large in Montgomery County, NY (refer to Figure 1). This study primarily focuses on two wetland flora species including native cattails and non-native *Phragmites australis*. The 28 wetland study sites used in this research are located on public lands within the upper eastern end of Montgomery County, NY and were chosen systematically (all identified wetlands within the study area of the upper eastern end of Montgomery County, NY are included). Roadside gutter and railroad buffer area linear wetlands were excluded as possible study sites for this research. Location data involving all twenty study sites was collected using a handheld GARMIN etrex 20x GPS device, and this coordinate information was later uploaded to ArcGIS Pro and mapped.

Wetland Study Site Locations in East Montgomery County, NY



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Current Time: 7/2/2020 3:27 PM

Map Created by: Cassie Bradshaw
Primary Data Source: Collected by Cassie Bradshaw
Secondary Data Source: www.gis.ny.gov

Figure 1. This map provides point data concerning the locations of the 28 wetland study sites in Eastern Montgomery County, New York included in this research.

Wetland Study Site Conditions

Study site condition determination includes classifying each site as either disturbed or natural. Wetland sites classified as "disturbed" are located among highly developed, greatly disturbed (human altered), fragmented areas. Wetland sites classified as "natural" include those that were not created by human alteration and are among natural habitats with little signs of anthropocentric caused disturbance. The data collected in the field involving each of the study sites was collected using a field journal, and later uploaded into an Excel spreadsheet which was then used as an attribute table (.CSV file) for information displayed on the maps that were created for this project using ArcGIS Pro.

Field Data Collection & Species Measurements

At each of the 28 wetland study sites the field data collected included plant species presence, species % dominance, species % cover, and species diversity data. Presence data included whether the focus species (*Phragmites australis* and cattail) were present and/or absent at each site and what other species were present (classified as other), if any. The wetland condition information that I collected included whether each habitat was natural (among natural habitats) or disturbed (among highly developed and disturbed areas). Species measurements involving any and all other species present at the 28 wetland sites were combined and placed into one category for analysis purposes which is "other" (flora species other than phragmites and cattail). Species % dominance data was measured using the following percentage scale: 0, 25, 50, and 100 % and involved abundances of each dominant species at all of the 28 study sites. Species % cover data was measured at every wetland study site using the Braun-Blanquet cover-abundance scale (Wikum & Shanholtzer, 1978). One component of species diversity was measured (species richness) by counting the number of species present at each study site and placing them in the following categories: 5 and under species present = low species diversity, 5 to 10 species present = moderate species diversity, and over 10 species present = high species diversity.

Data Analysis

The primary data collected in the field was all uploaded to ArcGIS Pro where it was mapped and analyzed. Secondary data used for this GIS research project was collected from the NYS Clearinghouse and the iMapInvasives organization and includes: a topographic base map, NYS inland hydrology, 2016 NLCD land use data, and *Phragmites australis* observational data collected between the years 1920 and 2020 by different members of the iMapInvasives organization. The secondary data collected for this research was uploaded to ArcGIS Pro as shapefiles and displayed in maps as data layers. Analysis of the collected data for this research included quantitative and qualitative data comparisons regarding the 28 wetland study sites using ArcGIS Pro. Data that was compared among the 28 wetland study sites included in this study was wetland site condition (disturbed or natural), *Phragmites australis* and cattail presence/absence information, species % cover and dominance, and species diversity. Species presence, % dominance, % cover, and diversity informational maps were created and compared involving all 28 wetland study sites using the GCS_WGS-1984 Datum in ArcGIS Pro. These maps were created by uploading an attribute table as a standalone table and the coordinate data for each of the 28 sites was displayed for each category in each table. Unique values and colors were set using the symbology tools for each species measurement category mentioned above for each map created. Maps were created using ArcGIS Pro layouts, exported, and saves as JPEG images. Wetland study site location and condition data, NYS hydrology and NLCD land use information, and past and present *Phragmites australis* observational data were all also utilized to create additional maps using ArcGIS Pro.

Results

Of the 28 wetland sites involved in this research study, 14 are categorized as disturbed, and the remaining 14 are categorized as natural. The number of natural wetland study sites dominated by native cattails is 11 and *Phragmites australis* 3. There are more natural wetland study sites dominated by native cattails than by *Phragmites australis*. The number of disturbed wetland study sites dominated by cattails is 6 and *Phragmites australis* 8. There are more disturbed wetland study sites dominated by *Phragmites australis* than by the native cattail flora species. The natural wetland study sites involved in this study are among woody wetlands, rural/pasture (agricultural fields), and developed land use types. The disturbed wetland study sites included in this study are among developed lands and pasture land use types (Refer to Figures 2 and 3).

Phragmites australis and/or cattails were found at all 28 wetland study sites. *Phragmites australis* and/or cattails are dominating species at all sites. My findings conclude that native cattails are a dominant species at 17 of the 28 wetland sites included in this study. *Phragmites australis* is the dominant species at 11 out of 28 study sites. Overall, more wetland study sites are dominated by native cattails than by *Phragmites australis*. Cattails were found present at 20 sites out of 28, and *Phragmites australis* 15 out of 28. Native cattails were present at more wetland study sites than the non-native invasive *Phragmites australis*. The number of study wetland sites with only native cattails present is 6. The number of wetland study sites with only non-native invasive *Phragmites australis* present is also 6. The number of study wetland sites with both native cattails and non-native invasive *Phragmites australis* present is 7 out of 28 (5 disturbed and 2 natural) (Refer to Figures 4-6).

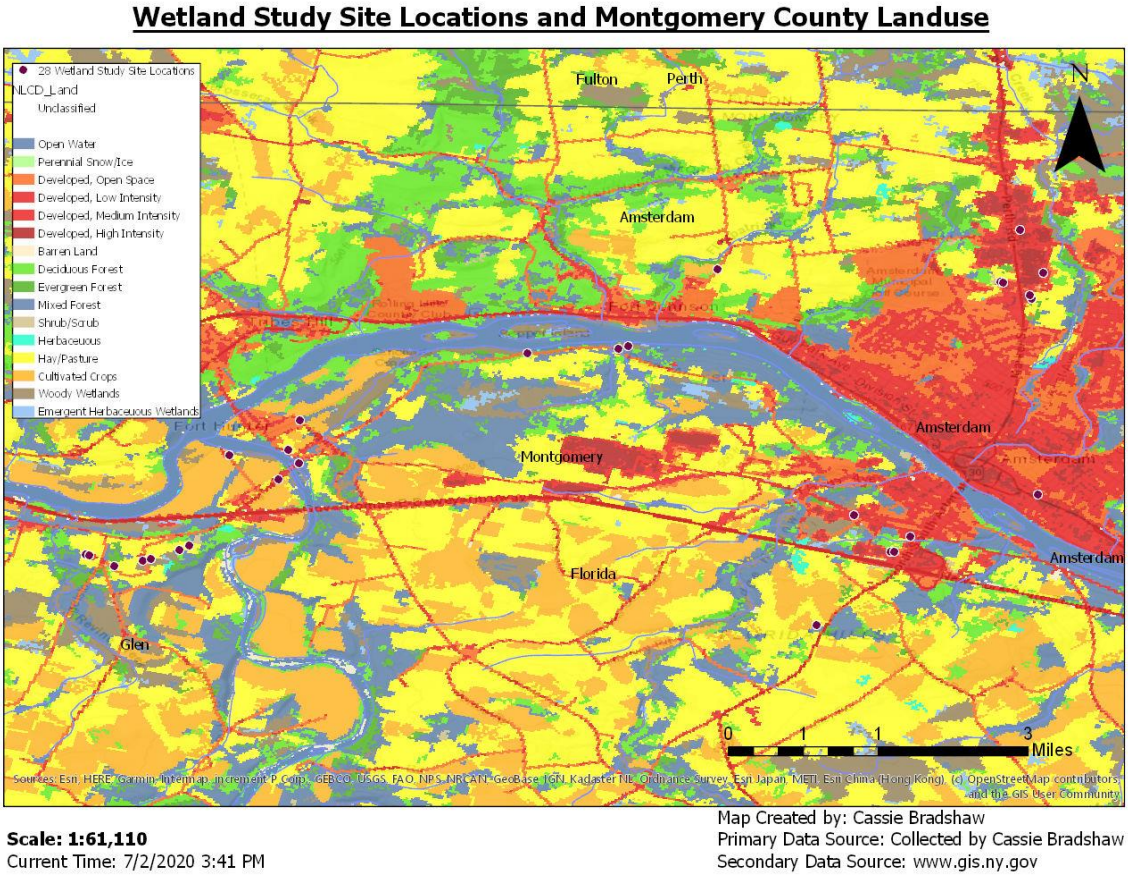
Concerning species diversity (low-moderate-high) at each of the 28 wetland sites, 24 are categorized as having low species diversity, 2 moderate, and the remaining 2 high. Of the 24 sites with low species diversity (5 or under amount of species present), 7 of them have both *Phragmites australis* and cattails present, 10 with cattails present and *Phragmites australis* absent, and the remaining 7 sites have phragmites australis present but cattails are not present. The 2 wetland sites that have moderate species diversity (over 5 but under 10 flora species present) have cattails present (and are the dominating species) but *Phragmites australis* is not present, and the same is true for the 2 wetland sites with high species diversity (10 or more species present) 3 of which are categorized as natural wetlands. All of the wetland sites with *Phragmites australis* present have low species diversity. The wetland sites that have cattails present have a species diversity that ranges from low to high (Refer to Figure 7).

All wetland study sites dominated by *Phragmites australis* the % species cover for this non-native invasive ranges from 60 to 100%. Of the 11 wetland sites phragmites australis dominates, 6 have 100 % *Phragmites australis* % cover (no other species present). Four wetland study sites dominated by *Phragmites australis* also have cattails present and this native species % cover at these sites ranges from 5 to 20 %. The one wetland site dominated by *Phragmites australis* that has species present other than cattails has a “other species present” (*Onoclea sensibilis* (native sensitive fern), *Symplocarpus foetidus* (native skunk cabbage), and unknown) % cover of 40 %. Out of the 17 sites with cattails as a dominating species, only 6 have a % species cover of 100% for cattails. Of the 11 wetland sites without a 100 % species cover concerning cattails, cattail % species cover ranges from 50 to 98 %. The other 11 wetland sites

with native cattails as a dominating species have species present other than cattails some including skunk cabbage, sensitive fern, and *Phragmites australis*. Of the 17 sites with cattails as a dominating species, 9 have flora species present other than cattails and *Phragmites australis*. The % species cover of the other species present at wetland sites (other than *Phragmites australis*) with cattails as a dominating species have a % species cover ranging from 2 to 50%. A higher number of wetland sites have other species present (other than *Phragmites australis* and cattails) among cattail dominated sites than of *Phragmites australis* dominated sites, and % species cover measures for other species present are also higher than at any site dominated by the non-native invasive (Refer to Figures 8-10).

The 11 wetland sites that are dominated by *Phragmites australis* all have 100 % species dominance (there is not another dominate species present other than phragmites australis) concerning phragmites australis. Of the 17 sites with native cattails as a dominate species, 13 have a 100 % species dominance regarding cattails. The other 4 wetland sites that have cattails as a dominating species have % species dominance ranges as follows: 25 to 50 % species dominance by flora species other than *Phragmites australis* and cattails, and 25 to 30 % species dominance by *Phragmites australis* (Refer to Figures 11-13).

The four main research questions included in this study are successfully answered. The primary data collected for this research project shows that there are wetlands (both disturbed and natural) in Eastern Montgomery County, New York where the non-native invasive *Phragmites australis* has not yet invaded. There are wetland areas in Montgomery County, NY that are dominated by the native cattail flora species with and without *Phragmites australis* present. In Montgomery County, NY there are wetland areas where both *Phragmites australis* and native cattail coexist and, in some instances, even are codominant. There are wetlands in Montgomery County, NY where only native cattails are present and dominate, and ones where only *Phragmites australis* is present and dominates. Overall, my study shows that typically there are more flora species present at sites where native cattails are a dominant species than at ones where *Phragmites australis* dominates.



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Map Created by: Cassie Bradshaw
Primary Data Source: Collected by Cassie Bradshaw
Secondary Data Source: www.gis.ny.gov

Figure 2. This map shows what land use types the 28 wetland sites are among in eastern Montgomery County, NY.

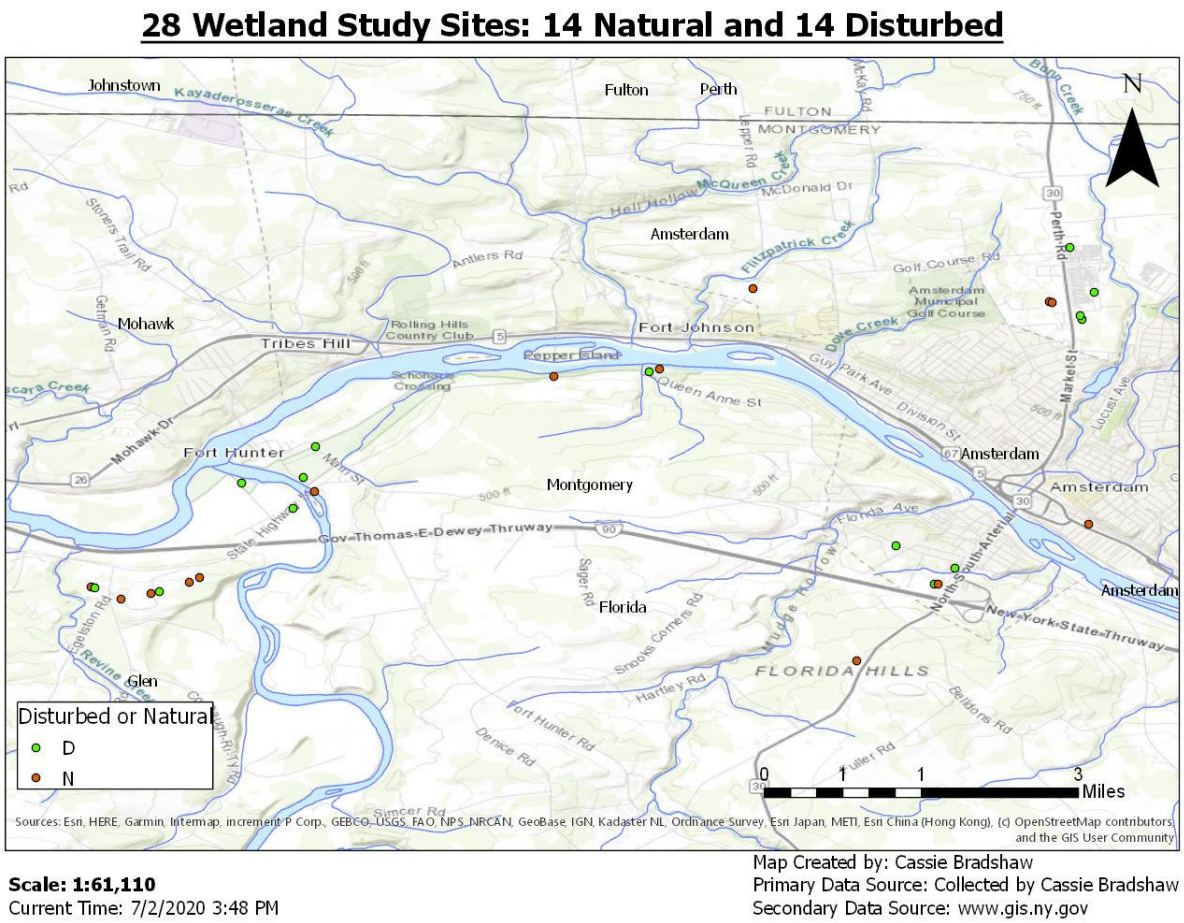
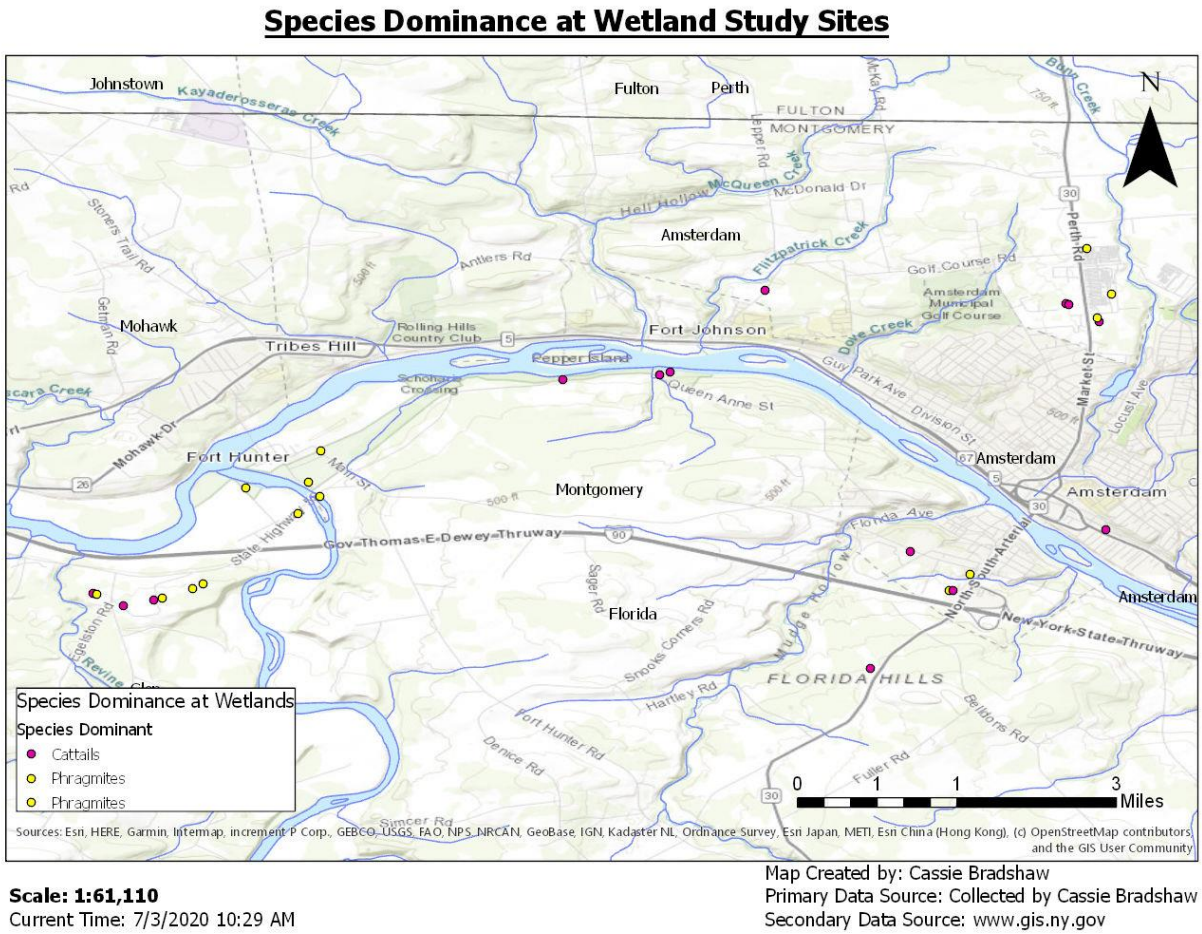


Figure 3. This map shows which of the 28 wetland sites are natural and which are categorized as disturbed.



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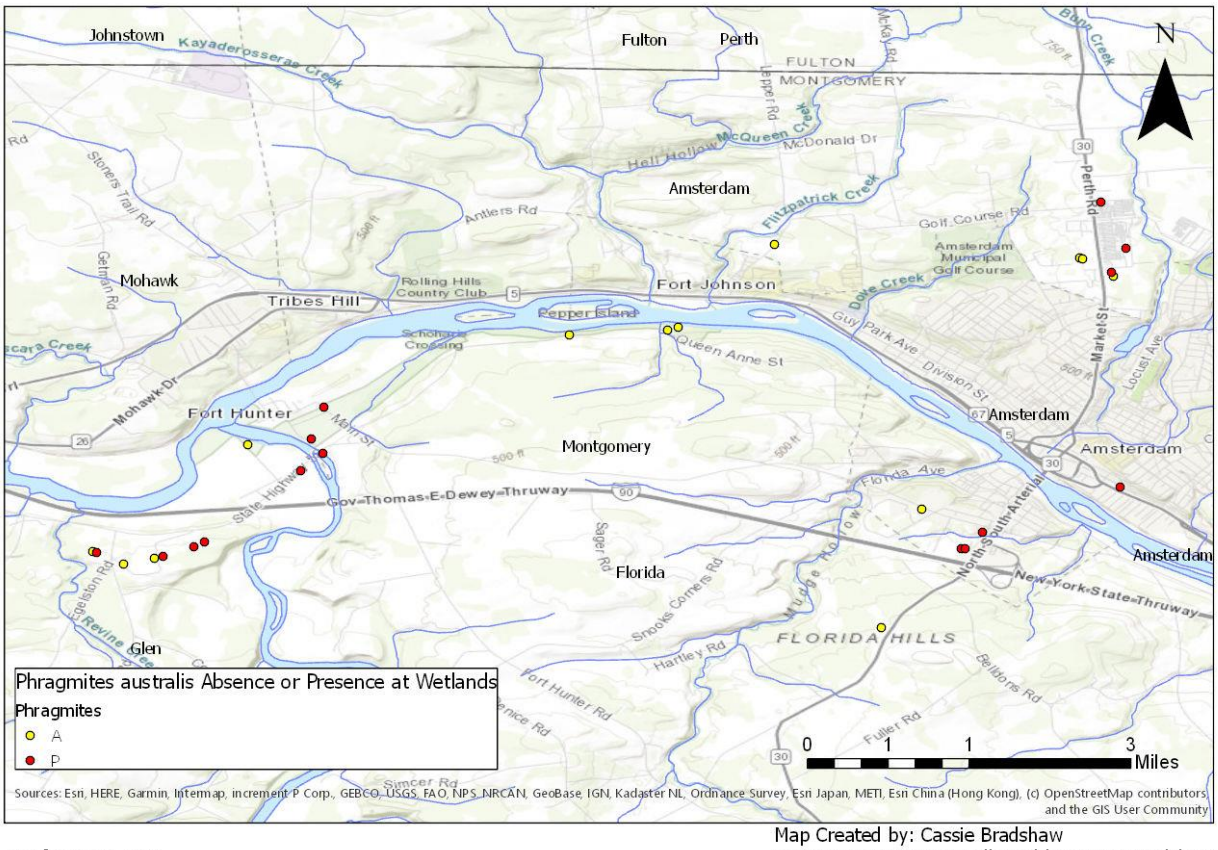
Map Created by: Cassie Bradshaw
Primary Data Source: Collected by Cassie Bradshaw
Secondary Data Source: www.gis.ny.gov

Figure 4. This is a map showing which of the two foci species of this study are the main dominant species (Phragmites australis or Cattails) at each of the 28 wetland sites.

Phragmites australis Presence (P) or Absence (A) at Wetland Study Sites



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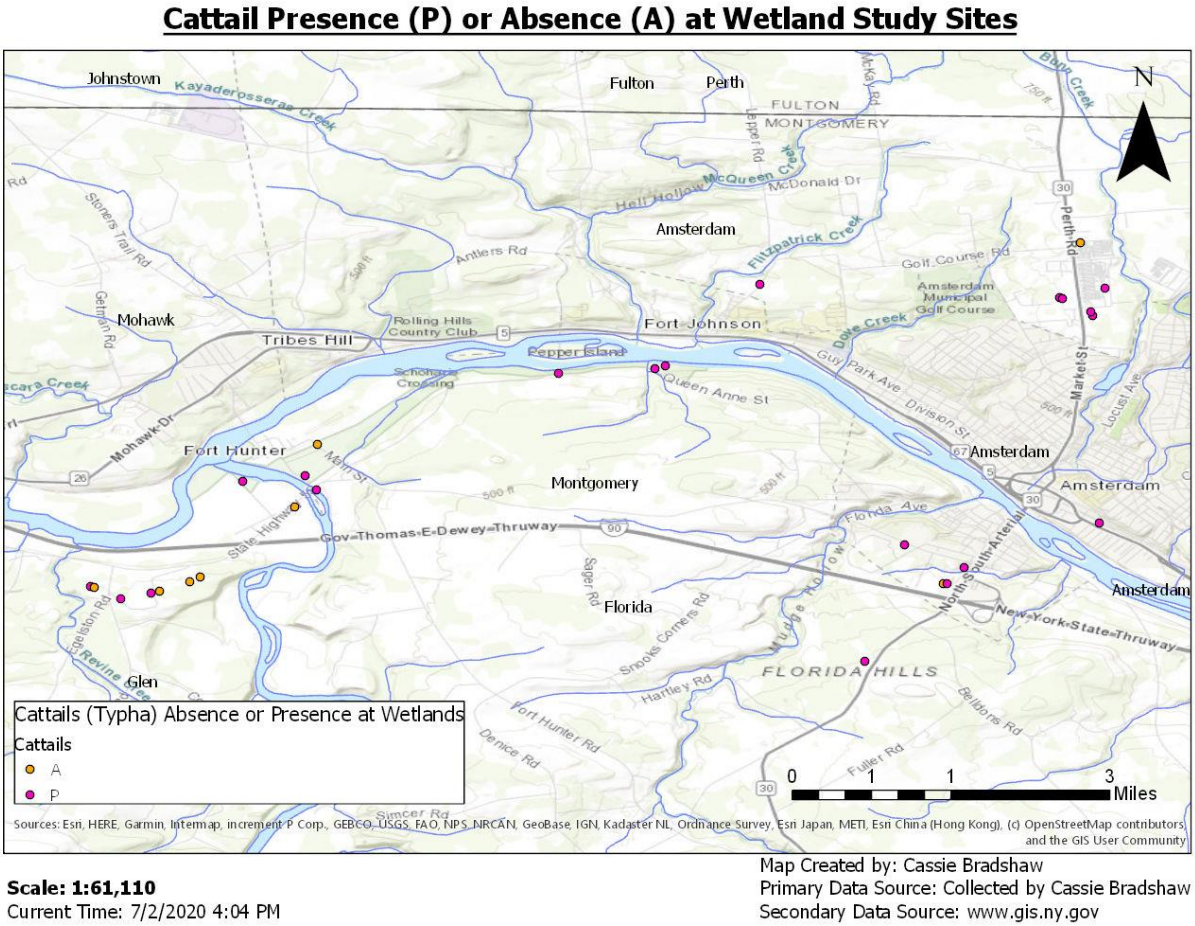
Map Created by: Cassie Bradshaw
Primary Data Source: Collected by Cassie Bradshaw
Secondary Data Source: www.gis.ny.gov

Figure 5. This map displays information concerning the presence or absence of Phragmites australis at each wetland site.



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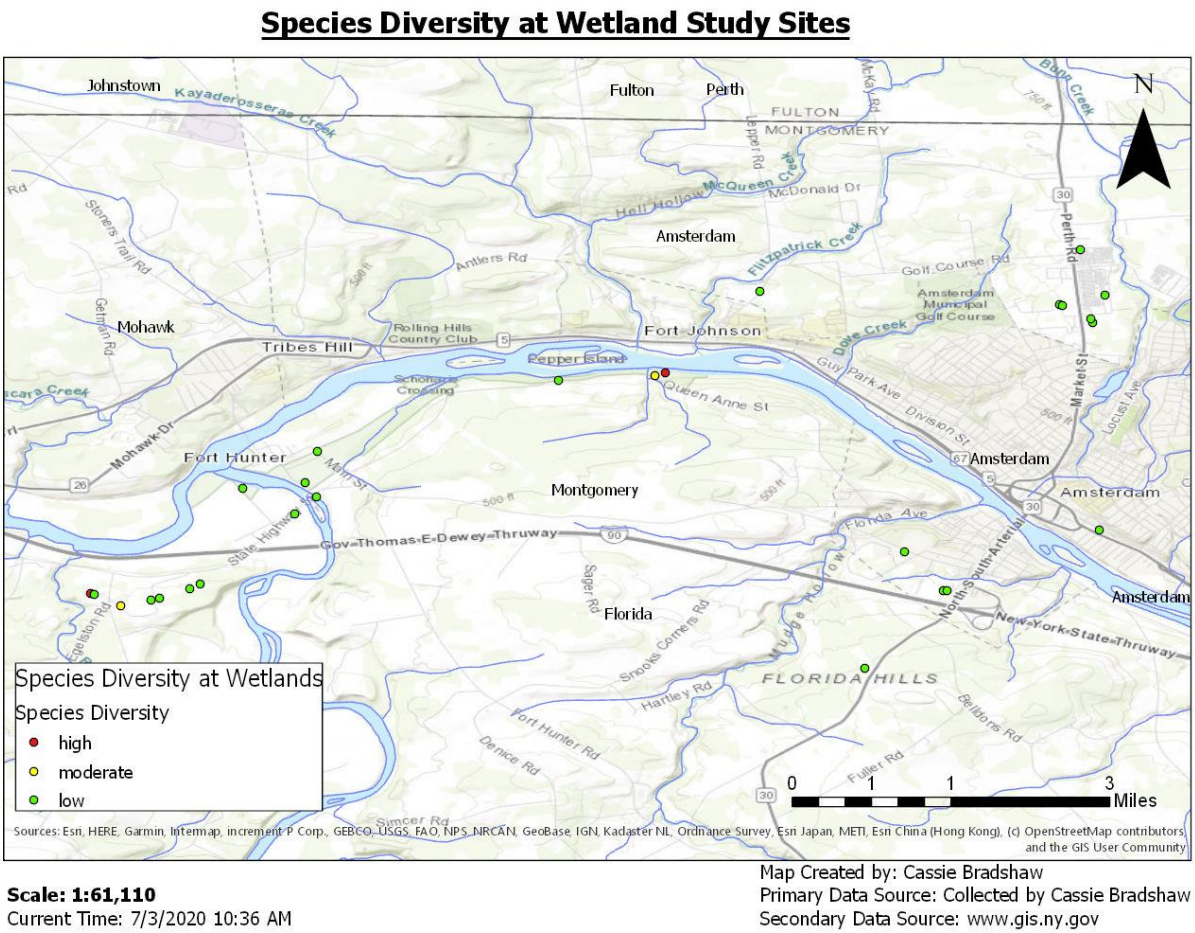
Map Created by: Cassie Bradshaw
Primary Data Source: Collected by Cassie Bradshaw
Secondary Data Source: www.gis.ny.gov

Figure 6. This is a map that displays data concerning the presence or absence of the native cattail flora species at each of the wetland sites involved in this study.



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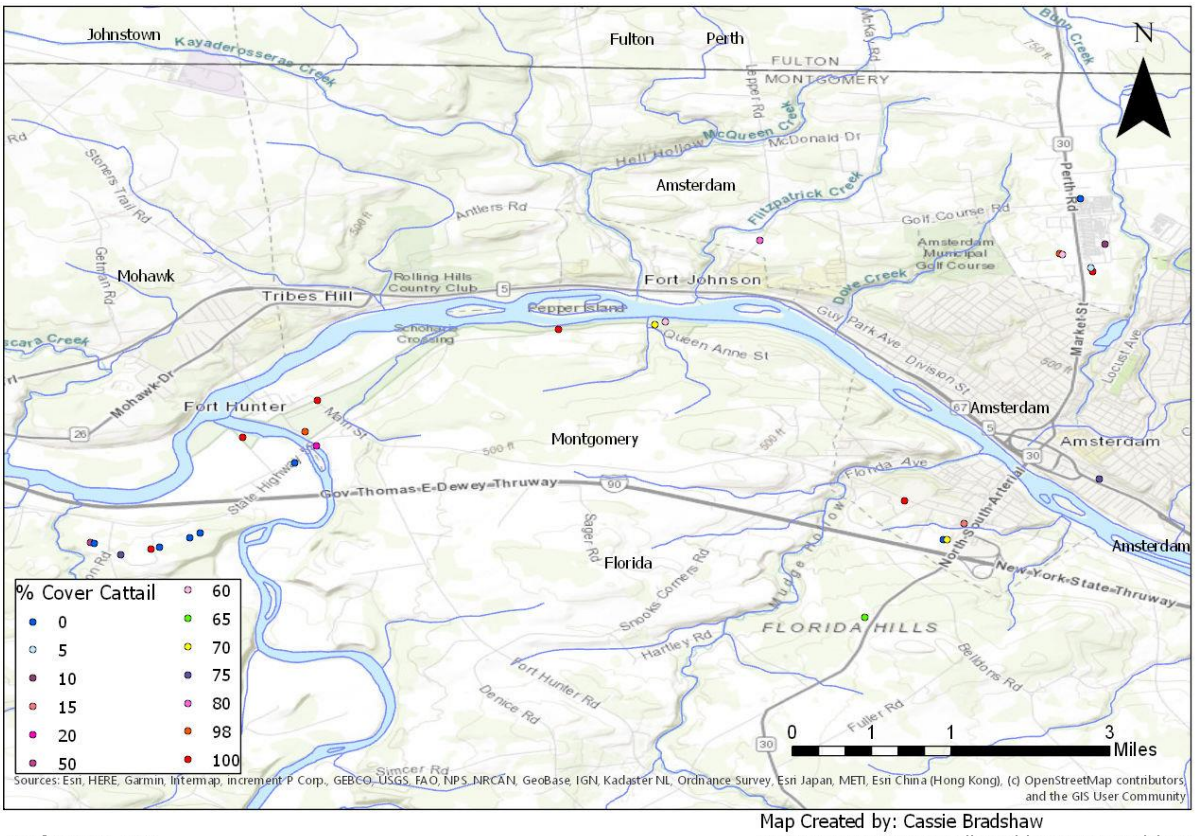
Map Created by: Cassie Bradshaw
Primary Data Source: Collected by Cassie Bradshaw
Secondary Data Source: www.gis.ny.gov

Figure 7. This map shows species diversity (low, moderate, and high) data concerning each of the 28 wetland study sites.

Cattail % Cover at Weland Study Sites



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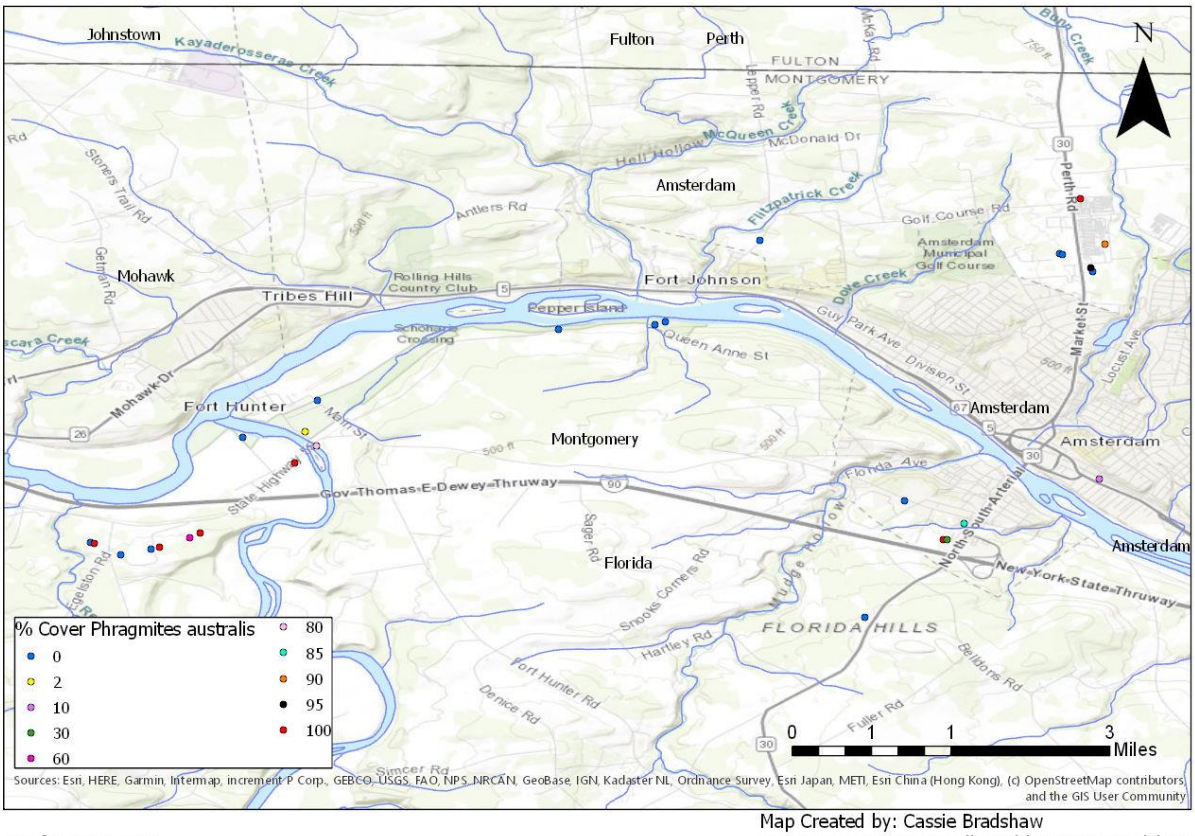
Map Created by: Cassie Bradshaw
Primary Data Source: Collected by Cassie Bradshaw
Secondary Data Source: www.gis.ny.gov

Figure 8. This is a map showing % species cover data concerning the native cattail species at each of the wetland sites.

Phragmites australis % Cover at Weland Study Sites



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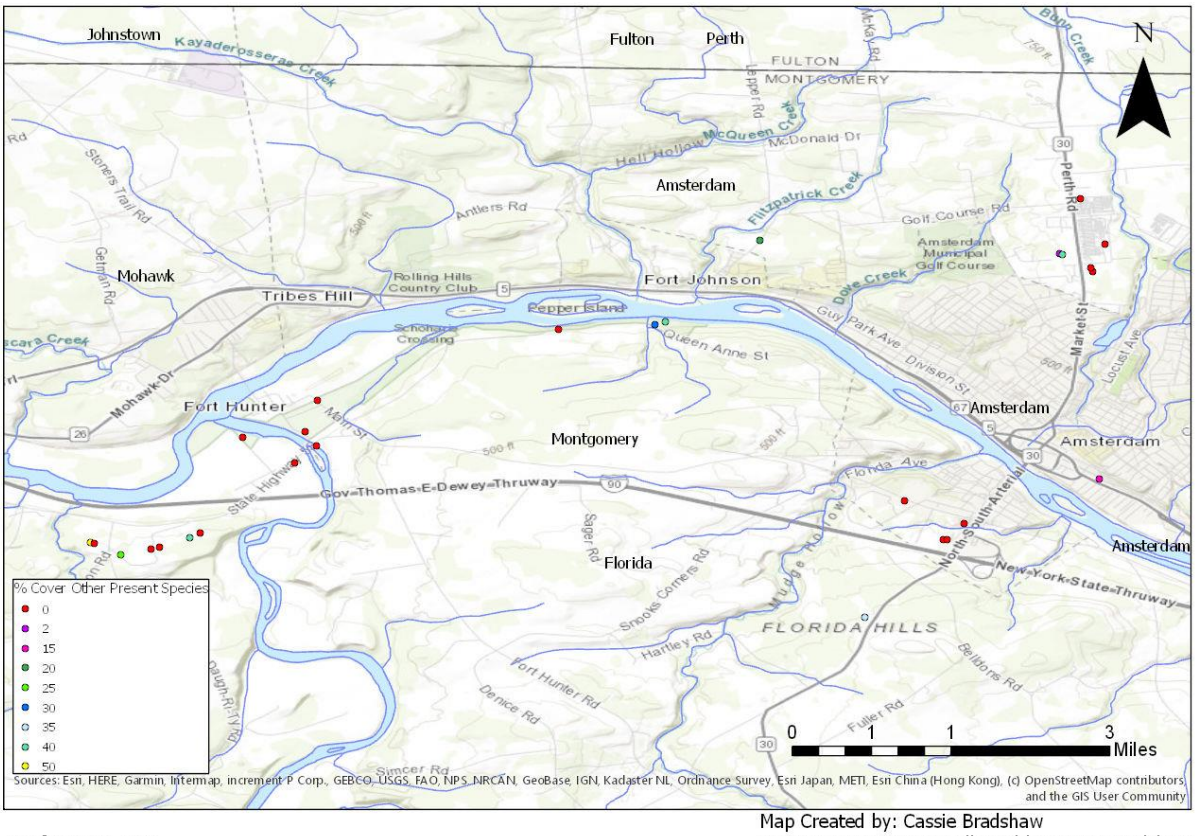
Map Created by: Cassie Bradshaw
Primary Data Source: Collected by Cassie Bradshaw
Secondary Data Source: www.gis.ny.gov

Figure 9. This is a map showing % species cover data concerning the non-native invasive Phragmites australis at each of the wetland sites.

Other Species Present (Other than phragmites or cattail) % Cover at Weland Study Sites



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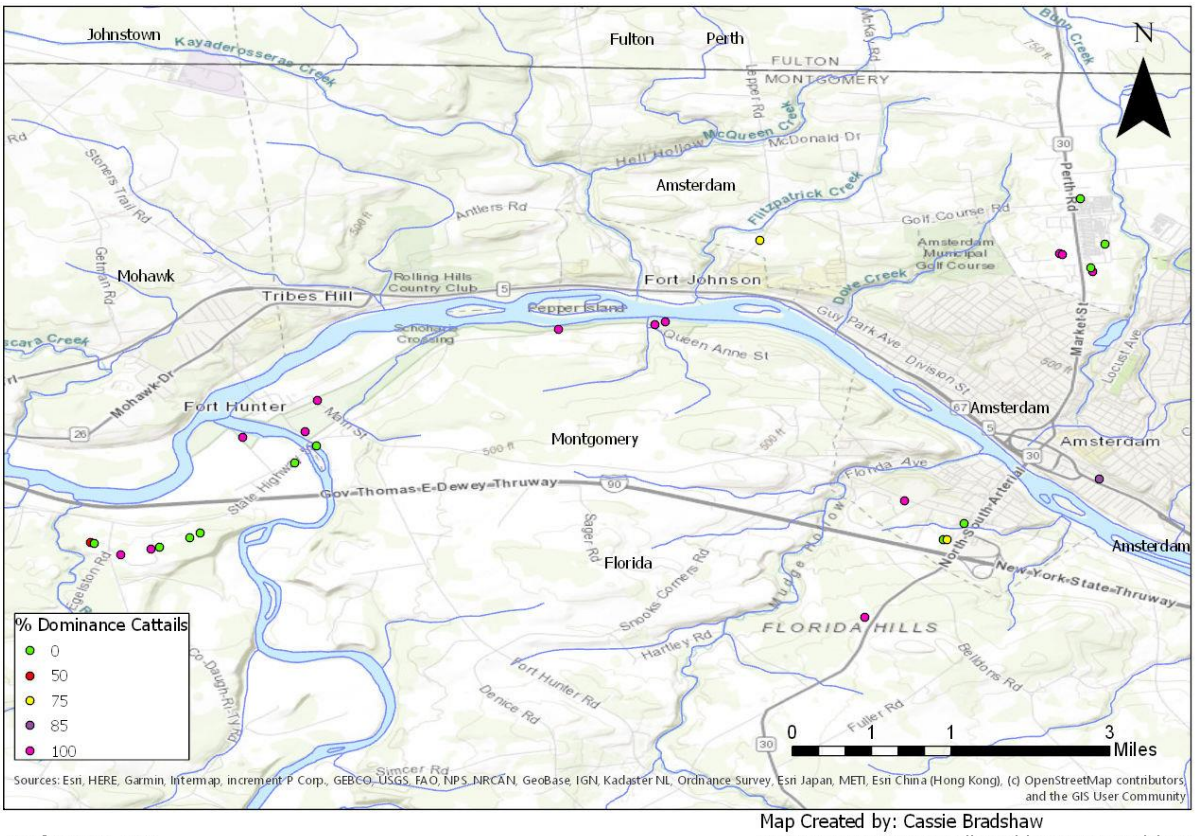
Primary Data Source: Collected by Cassie Bradshaw
Secondary Data Source: www.gis.ny.gov

Figure 10. This is a map showing % species cover data concerning all other species present (other than Phragmites australis and cattails) at each of the wetland sites.

Cattail % Species Dominance at Weland Study Sites

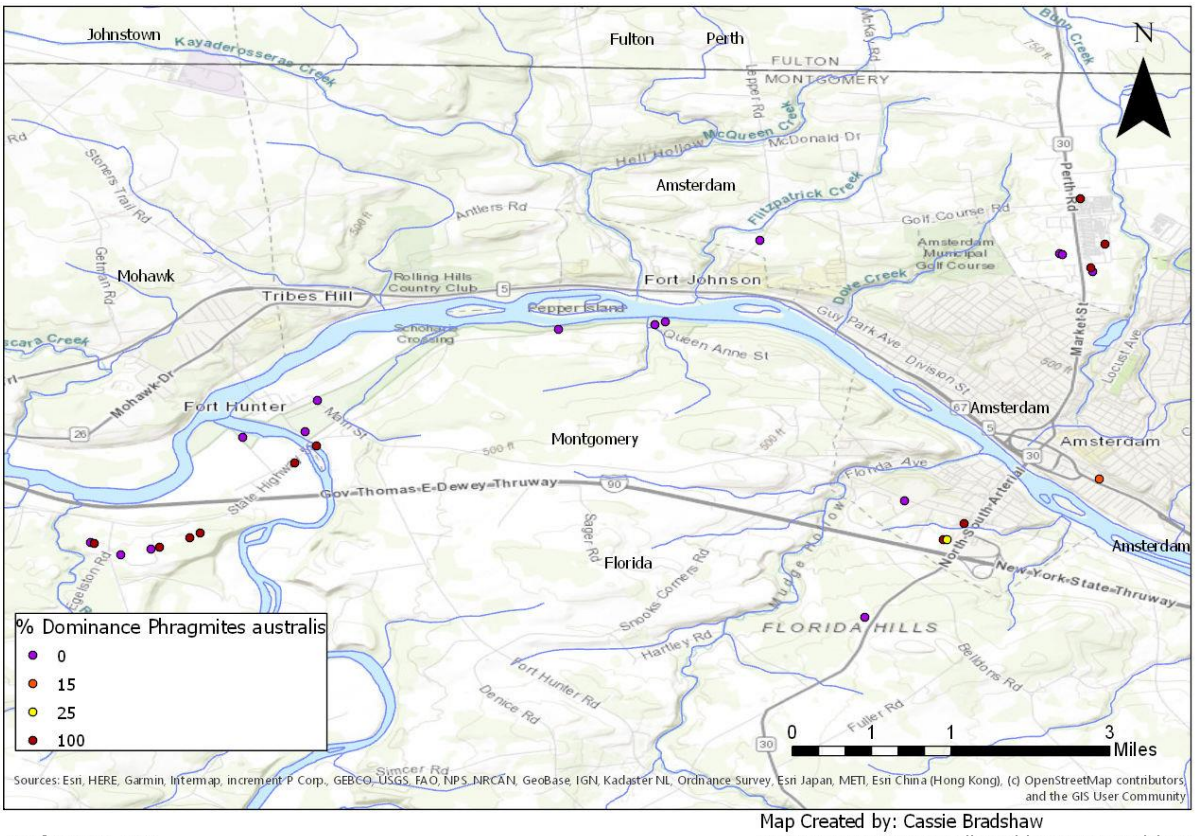


Scale: 1:61,110
Current Time: 7/4/2020 3:16 PM

Map Created by: Cassie Bradshaw
Primary Data Source: Collected by Cassie Bradshaw
Secondary Data Source: www.gis.ny.gov

Figure 11. This is a map showing % species dominance data involving the native cattail species at each of the wetland sites.

Phragmites australis % Species Dominance at Weland Study Sites

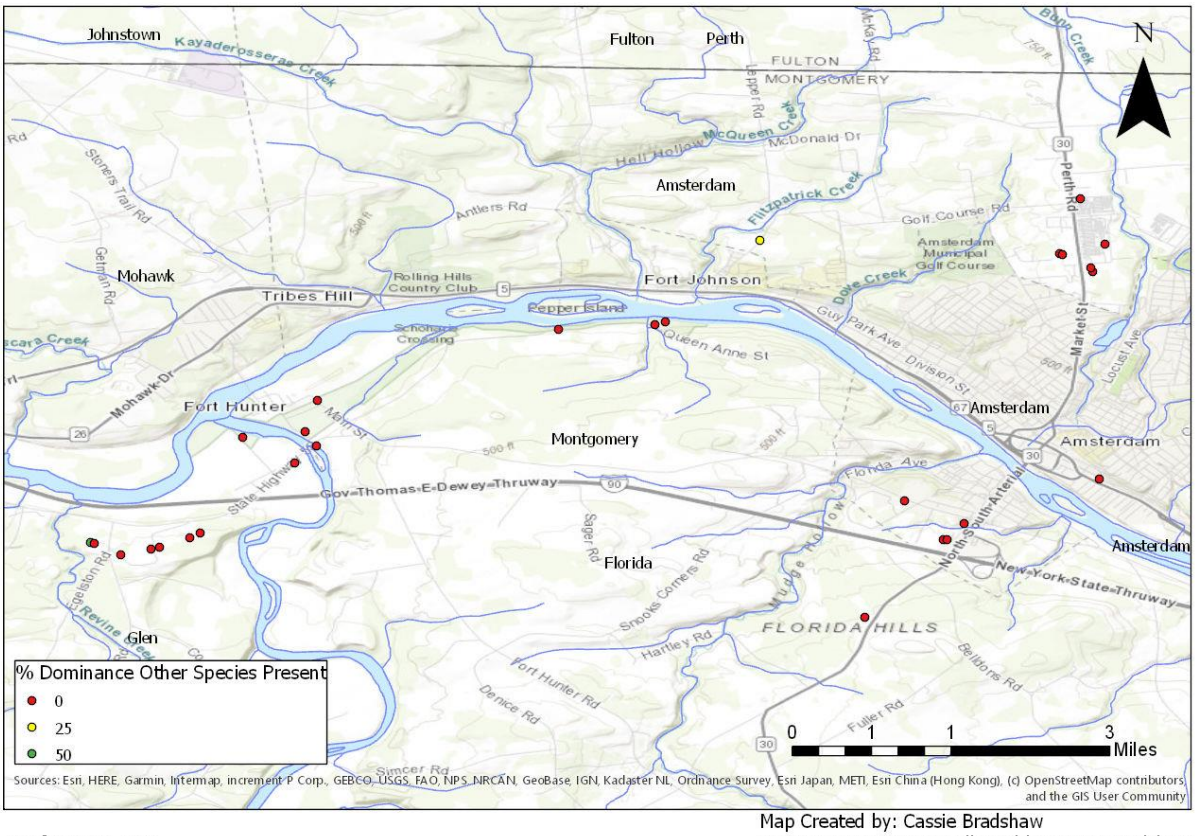


Scale: 1:61,110
Current Time: 7/4/2020 3:10 PM

Map Created by: Cassie Bradshaw
Primary Data Source: Collected by Cassie Bradshaw
Secondary Data Source: www.gis.ny.gov

Figure 12. This is a map showing % species dominance data involving Phragmites australis at each of the wetland sites.

Other Species Present (other than phragmites or cattail) % Species Dominance at Weland Study Sites



Scale: 1:61,110
Current Time: 7/4/2020 3:22 PM

Map Created by: Cassie Bradshaw
Primary Data Source: Collected by Cassie Bradshaw
Secondary Data Source: www.gis.ny.gov

Figure 13. This is a map showing % species dominance data involving the other species present (other than Phragmites australis and cattails) at each of the wetland sites.

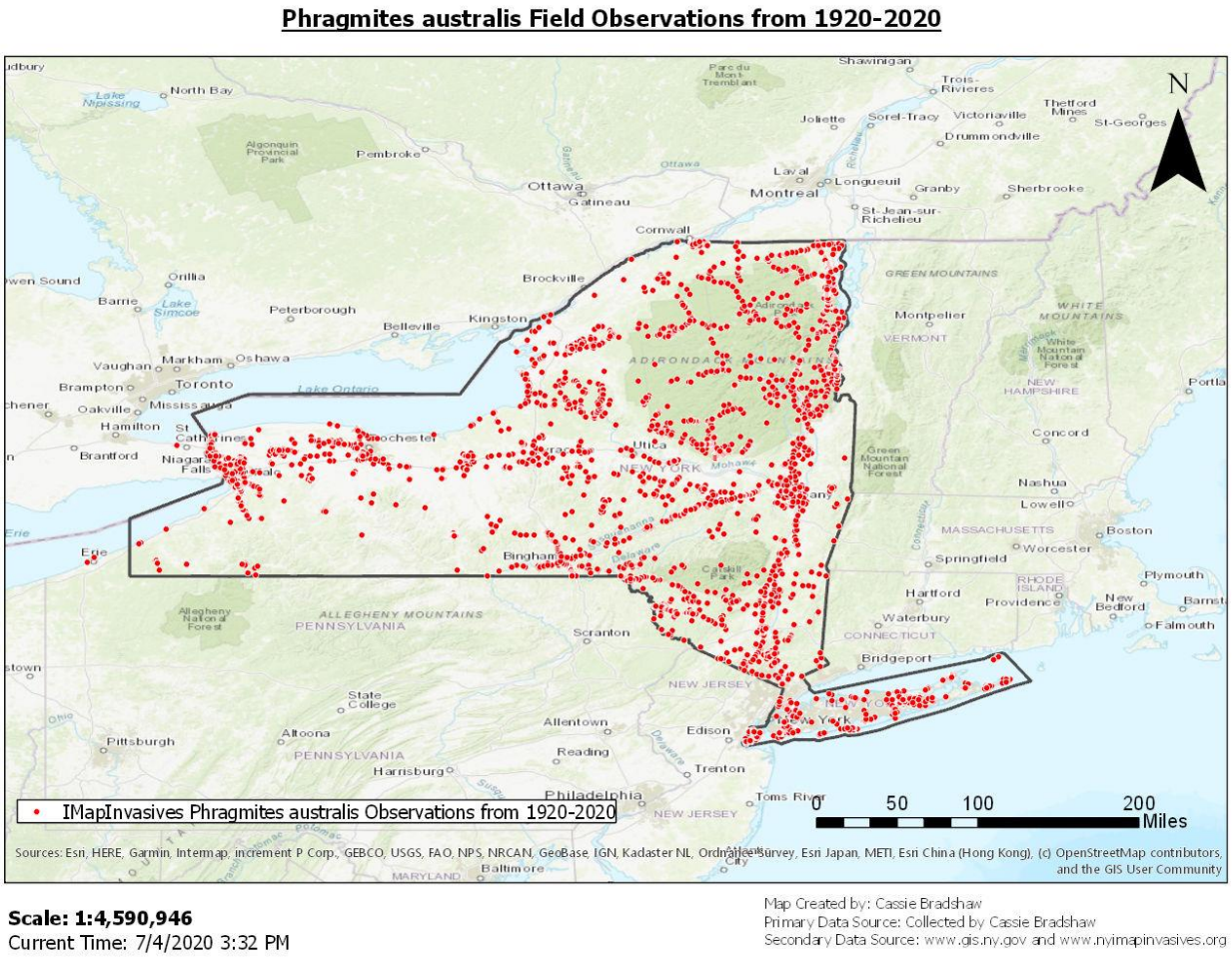


Figure 14. This is a map showing the iMapInvasives organization's *Phragmites australis* field observations recorded between the years 1920 and 2020 in the State of New York.

Discussion

For this research only 28 wetland sites were included. The research sites involved in this study are not necessarily representative of all of the wetland areas located in the entire Montgomery County or the State of New York because only a small portion of the eastern end of Montgomery County was included in the overall study area.

The four main research questions included in this study are successfully answered. The primary data collected for this research project shows that there are wetland areas in Montgomery County, New York where *Phragmites australis* plant has not yet invaded. There are wetland areas in Montgomery County, NY that are dominated by native cattail instead of *Phragmites australis.* Cattails are a dominant species at more study sites than *Phragmites australis*. In Montgomery County, NY there are wetland areas where both *Phragmites australis* and native cattail coexist. There are wetlands in Montgomery County, NY where only native cattails are present. Also, there are wetlands that exist among the study area where only

Phragmites australis is present. Overall, this study provides evidence that there is a higher amount of flora species present at sites where native cattails are a dominant species than at ones where *Phragmites australis* dominates.

Phragmites australis is present among and is the dominate species of the majority of disturbed wetland study sites. Native cattails dominate the majority of natural wetland study sites, but is present among both disturbed and natural wetlands as is *Phragmites australis.* Overall, native cattails are present at more study sites than *Phragmites australis*. There is the same amount of study sites with only native cattails present and with only *Phragmites australis* present which could indicate that native cattails are not only coexisting with this non-native invasive plant but are also a strong competitor of it. Figure 14 shows that there are many areas throughout the state of New York that have been invaded by the non-native invasive *Phragmites australis* plant including among Montgomery County. *Phragmites australis* is a disturbance indicator plant when present among wetland areas, and this research further supports this theory.

Conclusion

Phragmites australis has invaded many wetland areas throughout New York and other states located in the Northeast. Once *Phragmites australis* is introduced to a habitat and becomes established it strongly competes with native wetland plants, such as cattails, for resources. This study provides evidence that although *Phragmites australis* has invaded many wetland areas in New York State including within Montgomery County, certain native species, such as cattails, are able to strongly compete with non-natives and still dominate some wetland areas. There is still hope for New York State's wetlands because some still exist that are not over taken by a non-native invasive such as *Phragmites australis*. The control and/or eradication of all nuisance species present at wetland areas that are invaded by one or more non-native invasive species should be considered a high management priority. Wetland habitats in New York State that are not yet invaded by a non-native invasive species are in need of continuous surveying and protection efforts in order to conserve their natural state over time.

Phragmites australis have been managed in North America for over 35 years, and land managers have spent well over 5 million dollars on management efforts (Hazelton et al., 2014). Once a *Phragmites* invasion starts, eradication of this species is difficult. Smaller-sized *Phragmites australis* stands can be controlled through repeated cuttings (Kaufman & Kaufman, 2012). Larger stands can be managed via controlled burnings, flooding, animal grazing, disking, and aerial spraying of herbicides. Leaving behind a hedge of trees and/or shrubs along highways could be an efficient way to confine dense phragmites stands to road side areas (Jodoin et al., 2008). Among regions in the Northeast, including New York State, where *Phragmites australis* may not yet be widespread, salt tolerant shrubs can be planted within roadside ditches to inhibit the expansion of common reed along major roadways.

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