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Early Detection Grant- *Typha domingensis*, Southern cattail removal
City of Middleton, WI
AIS Grant AIRR-178-15

Final Report

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Southern cattail in Costco stormwater swale

Project Area

Southern cattail (*Typha domingensis*) has been identified since 2011 in multiple locations within a 0.23 square mile area associated with stormwater swales and culvert outflows in areas tributary to Pheasant Branch Creek, and Esser Pond. The swale locations are in Dane County, WI, City of Middleton, T 7N, R 8E, NE ¼ of Section 10, E ¼ Section 11 and the Esser Pond location is Dane County, City of Middleton, T 7N, R 8E, SE ¼ Section 10.

Background

Southern cattail, *Typha domingensis*, was discovered in multiple locations in Middleton in 2011 by Dr. Galen Smith, Professor Emeritus at UW- Whitewater and life-long expert of the genus *Typha* (Dr. Smith is now deceased). Smith first noted a stand of *Typha domingensis* on the SW edge of Esser Pond at the base of a culvert outflow. Multiple stands were found in 2012 throughout the Deming Way/Confluence Pond area. Dr. Galen Smith took a number of herbarium samples and archived them at the UW-Whitewater herbarium. He also published a scientific poster at the Wisconsin Wetlands Association Annual Conference titled: "*Typha domingensis* Southern Cattail new to Wisconsin" in February, 2012.

The closest recorded stand of *Typha domingensis* is in a power cooling plant pond 150 miles south in Illinois.

Due to the threat of a possible three way hybrid with *T. latifolia* and *T. augustifolia*, already present in the state, control was begun in 2012. This strategy was recommended by Dr. Don Waller, Dr. Paul Zedler and Dr. Joy Zedler all of the University of Wisconsin.

City of Middleton received an Early Detection AIS grant for 2012-2013 control, and a second five year AIS grant to control the cattail from 2014-2018.

Field Notes

From our work with the late Dr. Galen Smith, we believed we had field characteristics to identify southern cattail. Originally we found that Southern cattail is very difficult to identify until the pale cinnamon colored spikes are present. These cinnamon colored stands are intermingled within the brown colored spikes of the Wisconsin "native" stands. The other identifiable feature we determined from Dr. Smith is to confirm identification is to pull a leaf away from the stalk. If there are brown mucilaginous "dots" in a line straight across the leaf sheath then the plant is a southern cattail according to Dr. Smith. The Wisconsin cattails- either narrow-leaved, broad- leaved or hybrid- have similar brown "dots" that do not form a straight line across. However, the leaf strategy is unworkable in identifying intermingled cattails- it is too time consuming. After

Southern cattail has a cinnamon colored spike and dots/line that extends across the leaf blade sheath. However this identification is not consistent with on-going genetic work by Dr. Geddes

staring at the cattails for hours the southern cattail appears to be a paler green color, however we do not know if this would be recognizable earlier in the year compared to Wisconsin cattails.

Waiting to treat the cattail until they are in the flowering stage has contributed to cattail pollen being released. The conundrum is that treating all cattail before the flowering stage in the vicinity of known stands would substantially increase the herbicide effort and discharge. Late summer, early fall treatment is recommended to maximize the effect on the cattail stand as the plant is pulling carbohydrates into roots at this time.

However, as discussed below, the rates of hybridization and difficulty in correctly identifying cattails correctly in the field have created a "cryptic" invasion. With additional genetic evidence, our field identification techniques are not accurate.

Summary of Control Efforts 2012-2018

The strategy from 2012-2017 has been to treat the southern cattail stands with 2.5 % Aqua Neat (adding surfactant and blue indicator dye) in late August-early October of each year. Four major areas have been treated: Esser Pond, Costco/UW Health Court, the Confluence Pond and Firefighters Memorial Park. Crews have varied from two to six persons for several days of control effort a year. In most years the southern cattail spikes have been cut and bagged for disposal prior to the plant being herbicided. One year (2014) the spikes were left on and herbicided due to budget and time constraints.

A series of mild winters was broken by a colder winter in 2013/2014 however there was no visible die back of southern cattail.

In November, 2015 we attempted to overseed cattail stands in the stormwater swales with cattail seed (*Typha angustifolia*) collected from Graber Pond. Some areas near the confluence pond were seeded with native bur reed (*Sparganium eurycarpum*). The addition of seed was intended to swamp out the effect of the Southern cattail seed bank.

Additional invasives treated in the corridor include:

- A large stand of purple loosestrife on the southwest side of the intersection of University Ave. and HW 12/14 was also treated in 2014. It was not visible in 2015.
- A large stand of *Phragmites australis* in Firefighters Park adjacent the southern cattail stands was partially treated in 2015 and 2016.

For the first time in 2016 there were no southern cattails visible at the original stand at Esser Pond. However, the stands at the north end of the confluence pond adjacent Fireman's Park appeared to be as large as or larger than the 2014 population.

Early Detection AIS grant- *Typha domingensis* control- Fina

Control efforts 2017

Control continued in 2017 by stands treated with 2.5% Aqua Neat and the seed heads cut and bagged for the landfill. On August 8, 2017, treatment with a concentration of 1.2% Polaris was used at the Confluence Pond. On September 7, 2017, treatment with a concentration of 10% Aqua Neat was used at Esser Pond, Costco/UW Health Court, Confluence Pond, and Firefighters Memorial Park.

Southern cattail in center, narrow leaved cattail to right.

There was an increase in purple loosestrife and giant reed grass observed as well. Small stands of purple loosestrife were hand pulled and only small stands of giant reed grass were treated if they were intermingled with southern cattail populations. Large stands of giant reed grass were left untreated.

It was difficult to tell if there were positive results of over seeding the southern cattail stands with either Wisconsin cattail or bur reed in 2015.

Southern cattail locations were mapped from 2017 to show the current status of each population. Maps 1-4 show some successes and some intractable areas. We have no way of understanding the exact extent of hybridization currently within the corridor. A rough estimate was created using areas with southern cattail populations that were controlled between 2011 and 2016, as less potential hybrid zones in yellow. Areas with intractable southern cattail populations that either arrived or expanded since 2011 are shown with a ring of greater potential hybrid zone around them in blue.

Esser Pond: Esser Pond appears currently free of southern cattail as shown on Map 1. The small stand at the southwest edge of Esser Pond was not found in 2016, and the small stands on the north end of Esser Pond were absent since 2014. This needs to be verified in 2018. However, we cannot rule out the presence of Southern cattail X Narrow leaved cattail hybrids. We estimate from 6.68 acres of a greater potential hybrid zone to an additional 5.72 acres of less potential hybrid zone.

Costco/ UW Health lot: Southern cattail was located within four stormwater swales in the Costco parking lot/UW Health Court vicinity since 2012 as shown on Map 2. Currently it is absent from three locations, but there are on-going persistent plants in the largest swale east of the Costco parking lot. We cannot rule out the presence of Southern cattail X Narrow leaved cattail hybrids. We estimate a greater potential hybrid zone of 1.8 acres as compared to additional 1.58 acres of less potential hybrid zone. This area was regraded after the 2018 flooding and many of the cattails no longer are present.

Confluence Pond: One stand on the southwest side of the Confluence Pond was eradicated by 2014. There are large patches on the north side of the Confluence Pond that are persistent and appear to be expanding from the original footprint as shown on Map 3. There is preliminary evidence of Southern cattail X narrow leaved cattail hybridization at this location (Geddes, 2018). We estimate a greater potential hybrid zone of 3.82 acres with an 0.96 additional less potential hybrid zone.

Firefighters Memorial Park: There is a large stand east of the stream accessible by the parking lot adjacent PPD, Inc., 3230 Deming Way as shown on Map 4. This stand is very persistent and mixed in with a very large population of the invasive *Phragmites*. We attempted treatment of the *Phragmites* in 2015 and 2016 while working on the southern cattail, however it is a large area and difficult to effectively manage at the same time as the southern cattail. A stand south west of the stream was eradicated by 2014. We cannot rule out the presence of Southern cattail X Narrow leaved cattail hybrids. We estimate a greater potential hybrid zone of 3.06 acres with an additional 1.6 acre lesser potential hybrid zone.

Is cattail spreading by rhizomes or seeds?

The Invasive Species Compendium (www.cabi.org) has an excellent discussion of southern cattail and the following ecological notes are taken from the southern cattail webpages. Cattails produce rhizomes and spread laterally. Southern cattail can form a clone by expanding by rhizomes 10-30 feet (3-10 meters) in a year. Rhizome production is stimulated by short days and cold temperatures.

A single southern cattail flowering spike can produce over 600,000 seeds. Hybrids of southern cattail and broadleaved cattail are known to be infertile, but hybrids of southern cattail and narrow leaved cattail are highly fertile. Seedling establishment requires moist soil and sunlight, plants generally flower in the second year. While there are no studies on the persistence of southern cattail seed banks, general discussions of *Typha* seeds indicate long persisting seed banks.

In a discussion of dispersion in the Invasive Species Compendium (www.cabi.org) southern cattail can disperse by wind, water or human and animal agents. Pathways of dispersion listed include inter waterway, inter basin, self-propelled (wind), hitchhiker (human or animal) or in mud on agricultural implements. Agriculture, soil disturbance, prolonged, stable hydroperiods and high nutrients (phosphorous) are noted as promoting southern cattail. Seeds or rhizomes hitchhiking on soil caught on trucks, mats, vehicles or construction equipment is not specifically listed, but is a likely vector as well.

The pattern of southern cattail in Middleton is puzzling, as it has multiple locations with large gaps. The Esser Pond population appears to be hydrologically separate from the other populations. It is not clear where the Southern cattail stands originated as they are scattered within 0.23 square miles, however they appear to be in the vicinity or associated with the Deming Way development of stormwater features. We note that southern cattail is concentrated in areas with stormwater features, in stormwater swales, at outflows of culverts, ponds and rip rapped outflows. The development of these stormwater features appear to be in 2003 (Esser Pond outlet), 2005 (grading north of confluence pond), and 2008 (Costco swale).

If southern cattail was brought in during construction of stormwater features or buildings then it could have been introduced anytime between 2003 and 2008 when construction was at a peak. The first stand was identified by Dr. Galen Smith in 2011, however the

remaining stands were located in 2012 as soon as we began to look further afield. We don't know if the introduction was a single point that radiated out to multiple locations, or was introduced in multiple locations. If the plant was introduced in 2008 and set seed in 2009, at a minimum there could have been three years of southern cattail seed production before we began widespread treatment in 2012. If the plant was introduced in 2003 or 2005 then the seed bank could be more extensive.

If the plants were replicating by rhizome expansion greater than seed production then we would expect the past five years of repeated herbicide application on a clone to be successful at limiting the stands, particularly since the treatment is late in the growing season when transport of carbohydrates to the roots pulls herbicide down as well.

Some smaller stands were eliminated in three years of herbicide application, and these may have been single clones with limited seed bank establishment.

Cattail Hybridization

At the 2018 Wisconsin Wetland Association Conference in Lake Geneva, Wisconsin, Dr. Pamela Geddes presented research on the "*Potential for an invasive hybrid involving southern cattail"*. Dr. Geddes highlighted the traits of the plant that promote successful invasion under climate change. Their asexual reproduction along with rapid rates of seed dispersal, their short generation times, survival within disturbed habitats, and vast tolerance to abiotic factors all lead to incessant survival as climate changes over time.

There have been three possible cattail species in the Midwest: broad leaved cattail -*Typha latifolia* (native); narrow leaved cattail -*Typha angustifolia* (invasive), and a hybrid of *T.latifolia* and *T. angustifolia* which is *Typha X glauca* (highly invasive).

The concern has been that this new population of southern cattail – *Typha domingensis* is able to hybridize with the three cattail species already present. Middleton southern cattail vegetation samples were collected on September 9, 2017 and sent to Dr. Pamela Geddes, Associate Professor at Department of Biology and Environmental Science, Northeastern Illinois University. She is using molecular markers to identify cattail species and potential hybrids. The samples from Middleton were collected from five locations. Two samples were from Firefighters Memorial Park, one from the Confluence Pond, and two from Costco/UW Health Court.

Dr. Geddes is comparing the molecular markers from the Middleton cattails with Southern cattail molecular markers from a population in Florida. Her first task was to find molecular markers unique to Southern cattail in order to distinguish them from the other cattail species. The samples were DNA tested using molecular tools (microsatellites) with expectations to reveal the southern cattail phenotype characteristics. Dr. Geddes lab tested six microsatellite primers that have been previously used by their lab to distinguish among three cattail species (southern cattail, narrow-leaved cattail, and broad-leaved cattail) on 11 southern cattail samples. It was determined that all six primers used amplified southern cattail DNA from preliminary results. Two of the primers

exhibited molecular signals of both narrow-leaved cattail and broad-leaved cattail. Four of the primers exhibited potential molecular signals unique for southern cattail. To accurately conclude if the primers are precise enough to differentiate southern cattail from the other cattail species additional testing is required, but this could be the evidence of a new potential hybrid between the three different cattail species according to Dr. Geddes.

Geddes states "Preliminary molecular analyses of Middleton samples suggest that further studies are needed. The molecular markers used to identify other cattail species may not be adequate to uniquely identify *T. domingensis* and further markers may be needed. In addition, preliminary results suggest that, assuming the markers are adequate, hybridization of *T. domingensis* with other cattail species may already be occurring. Further testing is required to confirm the adequacy of the primers and assess potential hybridization events."

Geddes explained in her talk at Wisconsin Wetlands Association (2018) that cattails are very difficult to identify correctly using techniques such as leaf shape, gap in spikelets etc. that have been previously touted as field markers. She has found that hybridization rates are high and that field identification with morphological markers is incorrect ~ 75% of the time.

Thus, given the difficulty in identification in the field, and high rates of hybridization, she terms this issue a **cryptic invasion**. While up front control is crucial, the lag time in identification, and difficulty in field identification leads to an intractable **hybrid swarm** with cattail hybrids and backcrosses to the original species.

Estimating the hybridization zone is very difficult. In recent communication Dr. Geddes states first…"expansion is rarely linear, so when we think of a hybrid zone we think of the invasive "front" advancing in one dimension. However, at least some of the work that I've done with collaborators … suggests that this may not be true, and some cattail invasive may happen as a **"leap-frog"** event: some colonists move further up in any direction and establish a small population, and from there, the same continues happening. Therefore, the calculation of a hybrid zone (if hybridization is happening) may not be possible (or very hard to do)." Secondly… "usually these patches are fairly circular, and they move/expand in all directions, OR they could have a main axis of spread, so it will be hard to calculate depending on the behavior of the invading patch." Finally, "you need to be able to delineate where your invasive is and where your native is (or other species are). This becomes a true challenge when you are talking about species that look similar to each other (e.g., cattails)."

Summary:

While control efforts to eradicate Southern cattail in Middleton were met with some success initially, the long term prognosis it that it is very difficult to control a species that is cryptic, and eludes field identification.

Despite six years of chemical control with 2.5 % glyphosate, the Southern cattail stands persist, although a few small stands were eradiated in the initial treatment. According to preliminary results of molecular analysis of Middleton cattail samples by Dr. Pamela Geddes, Northeastern Illinois University, hybridization of Southern cattail with other cattail species may already be occurring. Further testing is required to confirm the adequacy of the primers and assess potential hybridization events. To date, Dr. Geddes has been unable to identify the "southern cattail" samples to match samples from Florida, however the genetic material appears dissimilar to Wisconsin cattails.

This project led to the scientific presentation "Can we control Southern Cattail (*Typha domingensis*) in a Midwest Wetland System? A Cryptic Invasion" by Thompson at the UMISC-NAISMA conference October 2018 in Rochester, MN; the Southeastern Conservation Summit November 3, 2018 and Wisconsin Wetlands Association on February 20, 2019. The pdf of the talk is attached.

The summary of the talk is: "We have found barriers to effective control or eradication include: the lag time in detection, the resultant seed bank, difficulties in field identification and on-going hybridization with local cattails. *Learning from our experience, an immediate broader control zone of all cattails surrounding a similar cryptic invader capable of hybridizing could be warranted.* Climate change could be exacerbating the invasion with warmer winters, and extreme flooding a factor promoting the colonization of this species."

Following a meeting at WDNR (3.23.2017) the close out of the grant was discussed with the idea of having a training session in 2018 to train volunteers in cattail identification and promote citizen monitoring of cattails. The training session was not implemented due to extreme flooding in August 2018 that caused extensive creek and wetland damage and was a focus for Middleton at that time. Most importantly it became apparent from Dr. Geddes genetic work that our ability to identify Southern cattail in the field was not consistent and misleading. Thus, any observations from trained volunteers would not lead to data that could inform control responses.

Though this grant did not lead to the eradication of a southern invader, the collaboration with the City of Middleton, the WDNR, Thompson and Associates, Adaptive Management and Dr. Pamela Geddes and her lab provided important scientific evidence of the cryptic nature of cattail invasion and could inform future responses to other cattail invasions.

Immediate control of the invader and a potential hybrid zone of native cattails would lead to a much larger area of herbicide control but possibly a better ultimate response. However, given the size of the Middleton invasion as it presented to us in 2012, even if we applied this hard earned knowledge in hindsight, I think the area of control needed would have been too large to be practicable.

We are indebted to the late Dr. Galen Smith who originally found these Southern cattails and whose bright smile and love of cattails inspired us. We are also indebted to Dr.

Pamela Geddes and her lab at Northeastern Illinois University for their pro-bono work on the Middleton cattail samples. Finally, we are indebted to the WDNR for funding and the City of Middleton for their strong advocacy of wetlands and waters.