

Getting into the Weeds: North Shields Pond Weed Management Plan

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Introduction

North Shields Ponds is one of the oldest natural areas in Fort Collins and is a southernmost refuge for wildlife before transitioning into the urban zone of Old Town. It is also a natural ecological transition zone, containing upland, riparian, and open water habitats that the Fort Collins Audubon Society terms an important bird area (City of Fort Collins Natural Areas, 2018). During Colorado's pioneer era, settlers cleared riparian forests for agriculture. Although this agriculture is less intensive now, establishment of cottonwoods is at risk. Its establishment is best achieved in mudflats, a landscape common in upper regions of the Colorado River (Andersen et al 2007) but not as commonly seen on the Eastern Slope. In the South Platte River, Cottonwood forests continue to regenerate, but are highly responsive to altered hydrology and may be negatively affected by climate change (Christensen et al 2023). North Shields Ponds natural area was acquired in 1962 when the city purchased 10 acres from Poudre Valley Bank. North Shields ponds has experienced many disturbances through the decades and has become a novel ecosystem from human modifications. During the 1950s, gravel mining began in the area, and former gravel pits began to fill in as ponds over the decades. A spring once existed on the west end of the property, and was filled around 1990 by gravel mining operations. Housing developments flanked the north end of the preserve starting in 1969. By 1998, approximately 85 percent of trees and shrubs, 67% of graminoids, and 56% of forbs were native. (Taylor et al. 1999). Attempts to mitigate human disturbance while creating more habitat for wildlife include the 2011 Poudre River restoration efforts, including changes to the site's hydrology. In 2013, the Josh Ames Diversion structure was removed during a restoration project that also included rock riffle installation, creating more habitat in Sterling Pond, the largest on the property (Fort Collins Natural Areas, 2013).



Figure 1. Major weed management zones in North Shields Ponds Natural Area, Fort Collins, CO. Polygons represent widespread weed occurrence, while points represent concentrated areas. Data were collected on ArcGIS Fieldmaps 18 Oct, 2024.

In this weed management plan, we list key species of conservation concern that will help shape future management actions. We then outline weed species of interest, their life history traits, and their relevance to the site. Next, we name our goals and objectives for North Shields Ponds and identify a narrower list of priority weed species. Then, we provide a framework for monitoring that can later be developed into protocol. Finally, we outline suggested management actions of priority weed species.

Property Description

North Shields Pond Natural Area is a riparian zone in close proximity to the Cache la Poudre located in Fort Collins, CO. This location serves as a quality recreation spot for locals and tourists. This site experiences little elevation differences, and the elevation of this site is roughly 5,000 feet (Fort Collins Gov n.d.). On average, North Shields Pond experiences an annual low temperature of 18°F and an annual high temperature 87°F (U.S. Climate Data, n.d.). Additionally, this site receives roughly 15 inches of precipitation annually (Fort Collins Govt n.d.).

The total size of North Shields ponds is roughly 54 acres, and this management plan is designed to encompass this total area (ColoradoWaterTrust 2011). In 2013, North Shields Ponds underwent restoration on 34 out of the 54 total acres that focused on filling some of the ponds with sediment to create more wetland type conditions and the removal of the Ames diversion structure which hadn't been used in over 20 years to create more natural stream channels and hydrology (Fort Collins Govt. n.d.). This was followed by revegetation of native species and invasive species management. However, nearly a decade later, weed management in this area must be revisited to help increase biodiversity and the overall resilience of this natural system. Some of the biggest challenges and reasons for restoration in this area include the large abundance and persistence of invasive species, unpredictable water levels in the wetlands which has reduced establishment of native species after planting, and large geese populations which have targeted important native species for food, especially younger plants (Fort Collins Govt. n.d.).

North Shields Ponds' location in a wildlife urban interface makes it a critical area for habitat. The site is known to support over 30 bird species, many pollinator species, small mammals, native fish, and amphibians (ColoradoWaterTrust 2011). Of these animals, there are common sightings of white-tailed deer, coyotes, bobcats, foxes, muskrats, prairie dogs, beavers, woodhouse's toads, American bullfrogs, Boreal chorus frogs, plains leopard frogs, barred tiger salamanders, Pacific chorus frogs, Western terrestrial garter snakes, plains garter snakes, gopher snakes, snapping turtles, pond sliders, painted turtles, and North American Racers (iNaturalist n.d.). There are also an abundance of fish species including black bullhead, channel catfish, bluegill, hybrid sunfishes, largemouth bass, and black crappie (Watterson, 2016). Similarly, common native plant species include showy milkweed, cottonwoods, cattails, fringed sage, American plum, silver sagebrush, bluestem willow, peach leaf willow, coyote willow, common chokecherry, Saskatoon serviceberry, western river birch, mountain ninebark, antelope bitterbrush, wax currant, and sand dropseed amongst others (Watterson 2016); (Felchle et al n.d.). Despite the presence of these native species, there has been a notable reduction in their abundance due to the presence of invasive species. The most prominent invasive species that this plan intends to intensively manage for include Canada thistle, smooth brome, kochia, Russian olive, leafy spurge, and buckthorn. Monitoring and mitigating the spread of invasive species is crucial to protecting habitat for three imperiled species: *Amorpha nana* is listed as S1: Critically Imperiled in Colorado. *Menzelia speciosa* (which is endemic to Colorado and Wyoming) is listed as vulnerable, with just over 18,000 known individuals. *Aquilegia chrysantha*, a plant adapted for hawkmoths, is imperiled in Colorado. (NatureServe, 2024)

Pest Species Inventory

North Shields Ponds has a number of pest species present, which have contributed to a loss of native species diversity and altered hydrology. Based on our data collected at the site, we know that there are known populations of white sweet clover, curly dock, common mullein, buckhorn, Siberian elm, Russian olive, kochia, Canada thistle, smooth brome, leafy spurge, and crested wheatgrass. The location of these species can be found in Figure 1. In general, our site assessment concluded that kochia, smooth brome, Canada thistle, and crested wheatgrass were quite abundant at this site, whereas populations of Russian olive, buckthorn, leafy spurge, Siberian elm, curly dock, white sweetclover, and common mullein were relatively less abundant. Similarly, we found that cattails were one of the most populous native species at this site. In addition to these invasive species, other sources have also seen Utah serviceberry, crack willow, wildoat, Japanese brome, cheatgrass, bebb's sedge, orchard grass, barnyard grass, sand love grass, reed canarygrass, fowl bluegrass, Kentucky bluegrass, and rabbit foot polypogon at North Shields Ponds (Felchle et al n.d.). Although these species were noted in past reports, we were unable to determine their exact distribution or location due to the limited seasonal window of our site visits. Based on the management history of the site and our site analysis, we have determined the most problematic/abundant species to include Canada thistle, smooth brome, kochia, Russian olive, leafy spurge, and buckthorn. In order to effectively manage each of these species, it's important to understand how these species interact with the environment and respond to various management strategies. In this section, we will go over known herbicide resistance, life forms, methods of reproduction, and favored climate for each species that we encountered in our site analysis:

white sweetclover (*Melilotus albus*):

Throughout the U.S., white sweetclover is an invasive species commonly found in riparian areas, especially in more arid regions, however, it can also be found along a range of disturbed ecosystems such as desert shrubs, sagebrush communities, etc (Gucker, 2009). White sweetclover is typically a biennial, and as such, in the first year the plant produces a single stem with multiple branches, and at the end of the growing season, nutrients are allocated to the tap root and root crown buds are formed (Gucker, 2009). In the second year, the plants grow much larger, and towards the end of the growing season, flowers and seeds are produced (Gucker, 2009). There are currently no known herbicides that white sweetclover is resistant to, and in general, it is recommended that small populations less 400 individuals be pulled manually (Invasive Species Centre, 2017). However, if the population is larger than this, 1.4% Glyphosate solution is recommended to be applied to the foliage annually until the seed bank is exhausted (Invasive Species Centre, 2017). Application should take place during the spring and the summer (Invasive Species Centre, 2017).

curly dock (*Rumex crispus*):

Curly dock is an invasive perennial plant that is part of the buckwheat family, and typically reproduces by seed, however, vegetative reproduction is also possible to a lesser extent (Weld County Public Works, n.d.). Curly dock flowers twice a year, and each plant has the ability to produce thousands of seeds (Weld County Public Works, n.d.). The seeds are primarily dispersed by wind and water, and the seeds can remain viable in the soil for 50-80 years, making it quite difficult to manage (Weld County Public Works, n.d.). Curly dock tends to grow in wet soils, however it has adapted to grow in most environments (Weld County Public Works, n.d.). Similarly, it grows best in full sun, and is readily found in disturbed locations (Weld County Public Works, n.d.). Currently, curly dock is not known to be resistant to any herbicides, and in Colorado Milestone (5-7 oz/acre), Escort XP (0.5-1oz/acre), Telar XP (1-2.5oz/acre), and Clarity + 2,4-D Amine (1qt/acre) are recommended for use (Weld County Public Works, n.d.). All of these herbicides should be applied during the spring and fall rosette stages (Weld County Public Works, n.d.).

common mullein (*Verbascum thapsus*):

Common mullein is an invasive biennial that can only reproduce by seed (Gucker, 2008). The flowers are often short lived, and typically only remain open for pollinators and cross pollination for one day, however if it is not pollinated within that time frame, it will self pollinate (Gucker, 2008). On average, each plant produces roughly 175,000 seeds, and the seed bank can remain viable for over 100 years (Gucker, 2008). Typically, in Colorado, mullein germinates in the late summer of fall (Larimer County, n.d.) In the first year, before the flower is formed, common mullein tends to form thick, deep taproots, however, the extent of these roots often vary greatly depending on latitude, with large root systems typically occurring in more southern places (Gucker, 2008). In general, common mullein has a wide range of tolerances, and is possible in most North American environments, as long as there is adequate sunlight, however it is most commonly found in disturbed areas (Gucker, 2008). Often times, it can be difficult to control common mullein due to their hairy leaves, however, some herbicide recommendations include Milestone at a rate of 7 fl oz/acre, Tordon at a rate of 1 pint/acre, Method@240 SL at rate of 8 fl oz/acre, and Escort@XP at a rate of 1 oz/ acre, which have been shown to have 100% control of common mullein when applied before bolting (Lawrence & Stevenson, 2024). Similarly, products with multiple active ingredients including MezaVue, Chaparral, Cimmaron Max, and Cimmaron plus, could be useful at controlling other broad-leaf species alongside common mullein (Lawrence & Stevenson, 2024).

common buckthorn (*Rhamnus cathartica*):

Common buckthorn is a large invasive shrub that is dioecious and occupies multiple ecosystems in the U.S. and in Canada including forests and woodlands, prairies, wetlands, riparian woodlands, and oak savannas (Zouhar, 2011). Typically, they grow in every environment except for arid regions (Zouhar, 2011). In general, seedling establishment and bud break begins in early spring from April-May, and seed dispersal can occur anytime between September and April (Zouhar, 2011). However, typically, buckhorn requires 5-6 of development before it is able to reproductively mature (Zouhar, 2011). Seeds are typically dispersed by gravity, zoochorically, or by water (Zouhar, 2011). Recommended management strategies include a combination of cutting and prescribed fire in fire adapted communities, however, where this is not appropriate, basal bark chemical girdling and stem treatment of herbicides can be effective (Zouhar, 2011). When using these methods, Glyphosate and triclopyr can be the most effective herbicides, especially when applied during the fall as energy is being transferred to the roots (Zouhar, 2011). Follow up treatments will likely be necessary for a couple of years after the initial spray (Zouhar, 2011).

leafy spurge (*Euphorbia esula*)

Leafy spurge is a creeping perennial that is listed as a Colorado List B Noxious weed, and is quite difficult to manage due to its extensive root system and nutrient reserves (Beck, 2013). It has the ability to reproduce both by seeds and vegetatively through root buds (Beck, 2013). Shoots of leafy spurge tend to emerge in early spring before most other plants, making it highly competitive (Beck, 2013). Flowers tend to occur in April and May, but it can be variable and may occur through the fall (Beck, 2013). Similarly, bracts emerge roughly two weeks before the flower boy can have a similar appearance, so this is important to distinguish to ensure herbicide application timing is correct (Beck, 2013). Typically each plant produces roughly 140 seeds, which are dispersed by water, animals, and people and can remain viable in the seed bank for eight years (Beck, 2013). To manage leafy spurge, using a combination of control mechanisms is recommended (Beck, 2013). There have been some reports of leafy spurge being resistant to Glyphosate, however, when used in combination with planting native grasses or application of 2,4-D in the fall, it can be more effective (Beck, 2013). Tordon 22k,

Plateau, Paramount, Perspective, and dicamba. Paramount (16 oz/ acre) in particular is a highly selective herbicide, and has shown to have minimal impact on native plant communities, however, Tordon (1 quart/acre) is known to be one of the most effective herbicides at managing these populations.

Siberian elm (*Ulmus pumila*):

Siberian elm is a tree or shrub that is considered a List C Colorado Noxious weed species that is hardy and fast growing, and can reach heights up to 70 feet (CDA, 2023). It reproduces by seed only, and the flowers can be cross-pollinated by wind or self-fertilized (CDA, 2023). Similarly, the seeds are typically dispersed by wind, animals, and humans (CDA, 2023). Typically, the seeds can last in the seed bank for up to eight years, and if there is enough moisture present, the seeds can germinate roughly two weeks after they are dropped from the tree mid-spring (CDA, 2023). Siberian elm does not tolerate flooding very well, and is often found in areas with high light, however, it can occupy a range of habitats including in pastures, along stream banks, and other disturbed areas such as roadsides due to its rapid reproductive abilities (CDA, 2023). In order to manage Siberian elm, chemical treatments are commonly recommended, however, for younger trees pulling may be effective (CDA, 2023). Triclopyr (1-1.5% solution), Glyphosate (1-1.5% solution), and Imazapyr (1-5% solution) are the three herbicides recommended for use in Colorado, and they are all most effective when applied to the foliage in the summer when the trees are actively growing and in the fall just before the leaf colors begin changing (CDA, 2023). Similarly, Glyphosate and Triclopyr can be applied after gridling or on stumps with 20-30% solutions (CDA, 2023).

Russian olive (*Elaeagnus angustifolia*):

Russian olive is a perennial tree or shrub that is listed under the List B Colorado Noxious Weed Species that can grow to 30 feet tall (CDA, 2015). It can reproduce by seeds and vegetatively through root suckers (CDA, 2015). Seeds are often spread by birds, and can stay viable in the soil for three years (CDA, 2015). Russian olives can grow in a variety of habitats, however, they prefer spacious areas and riparian zones (CDA, 2015). In general, they are shade tolerant, and do grow above 8,000 feet in elevation. Russian olives are detrimental to native populations because they outcompete desirable species for water, and since it can fix its own nitrogen, it can grow in bare soils and reduce the presence of the surrounding plant communities (CDA, 2015). The most effective methods of control are the “cut stump” treatment in combination with herbicides that are sprayed to the cut stems and stumps directly after (CDA, 2015). Typically, the best herbicides to use in Colorado include Triclopyr (20-30% solution) and Glyphosate (100% solution) in the late summer to early fall, so that the herbicide can be transferred to the roots (CDA, 2015).

kochia (*Bassia scoparia*):

Kochia is a problematic summer annual that reproduces only by seed, which means that management before the seed sets is ideal for best rates of success (Bokan et al 2012). It will often germinate multiple times throughout the growing season, starting in May and ending in August, and seeds are dispersed once the plant turns into a tumbleweed (Bokan et al 2012). Kochia is found growing in a wide range of ecosystems, and has been identified in all states except for Alaska (Bokan et al 2012). It is often found in disturbed sites, pasturelands, road sides, fields, gardens, etc (Bokan et al 2012). Kochia has shown resistance to Group 2, Group 9 (Glyphosate), Group 4, and Group 5 herbicides, making it a challenge to manage (Bayer, 2024). In general, the herbicides that are used are most effective when sprayed before the kochia has exceeded two inches in height (Bayer, 2024). Similarly, hand pulling can be effective at this same stage of development, however, once the kochia has begun to flower, it's important to collect these cuttings and dispose of them properly (Bokan et al

2012). Mowing is not typically an effective treatment, because the leftover stems can continue to produce seed (Bokan et al 2012).

Canada thistle (*Cirsium arvense*):

Canada thistle is an invasive, cool season, perennial plant that tends to reproduce by seed and vegetatively through rhizomes (Colorado Department of Ag., n.d.). Generally, vegetative reproduction is the primary method of reproduction, however, the seeds can remain viable for up to 22 years in the seed bank (Beck, 2024). These plants tend to grow up to 2-4 feet in height (Colorado Department of Ag., n.d.), and their horizontal roots may extend 6-15 feet deep (Beck, 2024). These far extending and deep roots are what makes Canada thistle so challenging to manage (Beck, 2024). Canada thistle grows in a variety of soil types, however, it does best in areas that are deep, well aerated, and cool and that receive 17-35 inches of annual precipitation (Beck, 2024). Typically, Canada thistle will emerge from the root system in mid-late spring and in the fall (Beck, 2024). The most effective way to manage Canada thistle is to deplete its stored energy in the root system with different mechanical control treatments such as mowing before the herbicide is applied (Beck, 2024). There are currently no known herbicides that Canada thistle is resistant to in the U.S. (Penn State Ag Communications, 2020), however, in Colorado, it can be best controlled with Milestone at an application rate of 5-7 fl oz/acre during the spring before the flower blooms, or in the fall (Beck, 2024). There are multiple herbicides that can be used, however, Milestone is recommended for sites neighboring ponds or streams, however, retreatment may be required for 1-2 years (Beck, 2024).

smooth brome (*Bromus inermis*):

Smooth brome is an invasive cool season, perennial grass that typically grows to be 1.3-3.2 feet in height (USDA, 1996). In general, smooth brome reproduces through seeds, rhizomes, and tillers, however seed dispersal is typically the most dominant form of reproduction (USDA, 1996). The seeds are known to remain viable for 22 months-14 years in the seed bank, and seeds are able to germinate with minimal sunlight and colder temperatures, but may have better success with more ideal conditions (USDA, 1996). Smooth brome is widely adapted to a variety of climates and habitat types, however, it is best adapted to regions that receive more than 15 inches (380mm) of annual precipitation, and has limited survival chances in areas with less than 11 inches of precipitation annually (USDA, 1996). Similarly, it thrives best in well-drained, but wet soils (USDA, 1996). Smooth brome can tolerate the cold temperatures quite well, but can also be found in warmer climates, and reproductive success is largely dependent on moisture regimes (USDA, 1996). In Colorado, there are few reports of herbicide resistance for smooth brome, however, timing of application largely affects the efficacy. The optimal time of application should be just a few days after the first or last hard freeze in the spring and fall, when the temperature has fallen below 30°F for a couple hours as a signal to the plant to begin to allocate resources to the roots (Nebraska Pheasants Forever, 2015). After this period of cold, it is important to wait until there is 2-3 days of weather with minimal wind and 50°F before spraying the herbicide to make sure that the plants' metabolic activity is more active (Nebraska Pheasants Forever, 2015). The most common herbicide for smooth brome is Glyphosate, which should be applied at a rate of 1.5-3 lbs/acre (Nebraska Pheasants Forever 2015); (DiTomaso et al 2013). Similarly, Fluazifop is another recommended herbicide that should be applied post-emergence in the spring at a rate of 4-6 oz/acre (DiTomaso et al 2013).

crested wheatgrass (*Agropyron cristatum*):

Crested wheatgrass is a long-lived perennial C3 grass that reproduces primarily by seed, but also is capable of vegetative reproduction through rhizomes (Quiroz, 2015). It can grow in a variety of habitats, and has a wide tolerance to “frost, drought, grazing, and fire” (Quiroz, 2015). It does best in locations that receive roughly

230-380mm of rainfall (Quiroz, 2015). Flowers typically bloom from June to August, and distribution of seed is primarily through wind (Quiroz, 2015). It is generally cross-pollinated, but has the ability to self pollinate as well (Quiroz, 2015). The use of Glyphosate can be effective in controlling crested wheatgrass, as long as it is coupled with other management strategies such as seeding or grazing, and applied with higher air temperatures to increase take up of Glyphosate by the plant (USDA, 2021). Other herbicides that can be used include Imazapic and chlorsulfuron+sulfometuron methyl, however, they are not considered to be more effective than Glyphosate, and there has been little research done about the effectiveness of other herbicides (USDA, 2021). Mowing can also be a good technique to limit the dispersal of seed if done before the flower blooms, however, it is not completely effective since it leaves fragments of the plant in the soil (USDA, 2021).

Cattails (*Typha latifolia*, *Typha angustifolia*, *Typha x glauca*):

Although *Typha latifolia* (broad-leafed cattail) is native, it can crossbreed with *Typha angustifolia* (narrow-leafed cattail) to make the hybrid *Typha x glauca* (Wisconsin Wetlands Association 2018). Cattails are in a family of monocots that reproduce through runners and seeds, making them prolific. Their primary habitat is in shallow ponds and slow-moving bodies of water. Many birds need ponds with emergent vegetation for food sources and cover from predators while nesting, but harvesting invasive cattails can increase their food sources (Lishawa et al 2020). In North Shields Ponds, cattails line and in some places fill the ponds, creating virtual monocultures. In a semi-urbanized environment, cattails are highly tolerant of pollution and nutrient influxes of phosphorus and nitrogen, bioaccumulating Cd, Cr, Fe, Ni, Pb, and Zn. While they provide important cover for wetland birds, they can also come to dominate wetland areas over time and prevent the growth of other key species like bulrush according to Ryan Vincent, Fort Collins Natural Areas Supervisor (personal communication). Cattails also have culinary uses. For example, the Anishinaabe of the eastern woodlands have been known to eat the stalks (Bansai et al 2019).

Priority Species

1. **Smooth brome:** Currently, there are many dense monocultures of smooth brome at the North Shields Ponds restoration site. According to various land managers that we have talked to, these dense stands have greatly reduced the overall biodiversity of plant species and potential bird habitat in these areas. In order to improve habitat, diversity, and resilience of this system, it's essential that we prioritize this invasive species.
2. **Cattails:** At this site, cattails are of high abundance at North Shields Ponds due to their exceptional competitive ability in disturbed and polluted ecosystems. In order to increase biodiversity at this site, it is essential that these species be managed for, and that native species such as bullrush and other are planted to replace cattail presence.
3. **Canada thistle:** Canada thistle is a List B Colorado Noxious weed species, and it is quite abundant at the site. Due to this disproportionate abundance, we feel that it is essential to manage these populations in order to increase native diversity and quality habitat and forage at North Shields Ponds.
4. **Kochia:** Based on our conversation with Natural Areas supervisor Ryan Vincent, who is familiar with past work on North Shields Ponds, it seems that kochia has been a priority species at this site since the restoration project began in 2011 and 2013. However, it is still relatively prevalent, so we feel that it is best to continue to prioritize management of these species.
5. **Russian olive:** Russian olive is a List B Colorado Noxious Weed Species. It has the ability to alter and deplete the water table, which is an essential element of wetlands functioning and health. Due to this, we

feel that it is necessary to manage for, and try to eradicate this species from the site to prevent long-term impacts of increased abundance.

6. **Buckthorn:** Buckthorn has the ability to be disproportionately competitive and adaptable, so although the species are not currently super abundant, we want to reduce the chances of buckthorn forming a complete monoculture at this site, which has been an issue for other natural areas.
7. **Leafy spurge:** Due to the toxicity of leafy spurge, we feel that it is essential to manage these populations in order to improve forage availability for native ungulates such as mule deer, white tail deer, and others that may frequent the site. Similarly, based on our conversation with land managers (Ryan Vincent), we found that prior restoration on this site focused on leafy spurge as a management priority, so we want to continue treatment and monitoring for this project.

Land Use Goals and Objectives

In the most recent Cache la Poudre zone update of 2023, the City of Fort Collins created four goals including, to “conserve and protect lands and water, protect and improve ecosystem health and resilience, provide meaningfully education and appropriate recreation opportunities, responsibly steward the communities resources.” (Rentschlar et al, 2023). These goals align with our restoration values, so we plan to continue to incorporate these objectives into this management plan. In the first year we will provide an initial assessment of wetland plug establishment. Additionally, plan to adaptively manage the following six species that we found to diminish important ecological functions at this site:

- **Common buckthorn-** eliminate populations within the first year, even though it is not present in great numbers, because we want to avoid any adverse effects that may occur if the population were to get out of control.
- **Smooth brome-** reduce population size by 80% after three years of intensive management in key potential biodiversity hotspots, as shown in Figure1.
- **Canada thistle-** reduce to 10% prevalence in monitoring plots, as shown in Figure 1 with continuous management, reevaluating progress after three years.
- **Kochia-** reduce population size by 50% after three years of intensive management in key potential biodiversity hotspots, as shown in Figure1.
- **Leafy spurge-** reduce population size by 70% after three years of intensive management in key potential biodiversity hotspots, as shown in Figure 1.
- **Russian olive-** Eradicate all mature Russian Olives in the natural area within one season and continue to manage for new seedlings over time.
- **Cattails-** Replace 25% of cattails with bulrush and other native species within three years
- **Native species:** achieve 80 percent native species cover in our plots within three years.

Management and Monitoring

North Shields Ponds Critical Management Areas



Figure 2. North Shields Ponds key critical management zones focus on areas likely to support high biodiversity and are important for recreation. The 40m transects attempt to capture the full extent of ecological transitions within the zone.

The goal of this monitoring is for easy repeatability. Wildlife monitoring will be done twice a season (for a total of 8 data collection periods per year) by field crews from Fort Collins Natural Areas and/ or by Master Naturalists who are part of the Fort Collins Natural areas program. [This iNaturalist project](#) will be reviewed monthly for the occurrence of both priority weed species and priority protected species. Bird Conservancy of the Rockies will also assist in monitoring with their Poudre River monitoring program as described in Sparks et al. 2019. Vegetation monitoring protocol will also be conducted twice a season. As part of the vegetation monitoring protocol, a site walkthrough of the critical management areas will be done to quickly reassess the prevalence of invasive species, including smooth brome. Confirmed wildlife habitat will be noted in the first year using Avenza or a similar software so monitoring crews can return to this habitat over time. Six transects (Figure 2.) will be set up to monitor the frequency of our target invasive species as well as the top three native species with subsamples, and a photopoint facing outward from each transect endpoint will be taken in the four cardinal directions. Additionally, every species in a 10-meter radius of the transect's endpoints will be recorded, paying special attention to the presence of imperiled species. All data will be recorded on survey software like Survey123 to save time. Adapted from Elzinga et al (1998), Each plot has a single 40-meter transect that will have one 1x1m subsample every 2 meters, for a total of 20 subsamples per transect. Transects will extend into water in some areas, but vegetation assessment should be kept consistent.

Management Actions

The bulk of management will focus on invasive weed reduction, relying on the seed bank for native plant establishment and distribution. After three years of data collection, native species seed supply will be assessed within the natural area. If some valuable species are reduced, or if a species of concern is found, the seeds will be harvested and multiplied in Colorado State University's greenhouse to supply to areas affected by weed control and ensure genetic diversity. The following actions will be taken for species of interest in North Shields Ponds:

Cattails Management Plan: Cattails have been an ongoing species of concern as they have crowded out planted wetland species (Personal communication from Fort Collins Natural Areas Supervisor Ryan Vincent). Invasive hybrid species are of particular concern. The following three active management actions will be evaluated during the next three years. The first action to be evaluated is using Imazamox with handheld sprayers. According to Bansai et al (2019), Imazamox is a common herbicide for cattail population management (Rodgers and Black [2012](#)), although it requires multiple applications and there is a risk of resistance when herbicides are applied in low doses. As a Group 2 ALS synthase inhibitor, it will prevent cattails from making branched chain amino acids. According to the EPA herbicide label, application rates can range from 32-64 ounces per acre, but we will start at 32. The second action will be cutting cattails below the water level. According to Lishawa et al (2017), harvesting cattails below water results in high mortality but can also lead to a reduction in native species. However, in 2020, Lishawa found that harvesting cattails at the right time can improve overall plant diversity. A third action will be using handheld sprayers to kill cattails with the herbicide glyphosate. Glyphosate can be used to treat cattails (Schimming et al. [1987](#)) at 100-166 oz/ac (United States Environmental Protection Agency) which we are considering for smooth brome as well. Zhang et al (2017) has noted that glyphosate absorption was four times higher in the native cattails than in hybrid ones.

For all sites, nutrient management from nonpoint sources can be difficult but effective, since cattails are stimulated by nutrient load. Part of our weed management notice sent to neighbors of the property will include information about how nutrient loads make cattails crowd out other wetland species. In the first year of our management plan, nutrient loads will be monitored with water samples that will be sent to the Fort Collins Utilities Water Testing facility. Four 3-meter radius test plots will be established in a cattail zone in the first year of management, each with one of the three active management options. Plot locations are indicated by Figure 2. These test plots will assess three management techniques and one control, which will be photographed during regular monitoring. The three management techniques, numbered by plot, will be 1) a control plot (do nothing), 2) mowing under the water level, 3) Imazamox application, and 4) glyphosate application. A data entry spreadsheet and more in-depth protocol will be prepared in the future for in-depth monitoring.

Canada thistle Management Strategies: To manage Canada thistle, we will enact a mow-regrow-herbicide regime, which has been shown to be the best way to manage the population of Canada thistle (Southwestern Reion Forest Service, 2014). We will mow the Canada thistle in the spring and then do repeat mowing throughout the growing season to minimize the height of the specimens and then follow up in the fall with application of the herbicide Milestone. Milestone as an herbicide is especially effective in riparian areas so it will not contaminate the area like other herbicides would. Milestone is an Aminopyralid that causes uncontrollable growth and utilizing it at a rate of 5-7 ounces per acre in a backpack sprayer at a concentration of 3-5% is the rate that we will utilize for this management action and this herbicide needs to be applied in either the spring before the flower bud stage or in the fall (USDA, 2014). For older groupings of Canada Thistle utilizing a higher rate allows for Milestone to be more effective in managing growth, a notable aspect of

Milestone is that it will need to be reapplied in one to two years so a year after application the monitoring plots will need to be reassessed to see the effectiveness of the herbicide and if reapplication needs to happen already or if another season can pass before reapplication. Additionally, if herbicide treatments are not effective, we will consider using biological control including the Canada Thistle Gall Fly and the stem mining weevil to help limit the populations. Fire is ineffective for managing Canada thistle so ensuring that fire does not spread into areas of Canada thistle is imperative because it is an early successional species so fire would only increase the amount of Canada Thistle in the natural areas.

Common buckthorn and Russian Olive Management Strategies: Due to the low population sizes of Russian olive and common buckthorn, we will use the “cut stump” method, which entails chopping down the tree and immediately applying herbicide to the stumps and stems (CDA, 2015). For both of these species, we will apply triclopyr in the late fall with varying concentration solutions depending on the diameter of the stump (CDA, 2015);(Zouhar, 2011). According to the USDA if the Russian Olive is less than 8 inches in diameter utilize a 50% triclopyr solution and if the tree is more than 8 inches in diameter then a 75% to 100% percent solution needs to be utilized (USDA,2014). The following year, we will determine the effectiveness of this treatment through monitoring, and pull and dispose of any young specimens that are found. In the third year, if this treatment has still not been effective, we will repeat the cut stump process and apply 100% solution of Glyphosate to these species (CDA, 2015). Additionally for younger specimens of Russian Olive and Buckthorn, if the specimens are too thin to effectively utilize the cut stump method but too thick to pull utilizing spot spraying with 10% glyphosate is effective in killing the younger specimens (USDA, 2014). This process can also be effective for Siberian elm, so although this is a priority species, we plan to also use this method for control of this species when able.

Kochia Management Strategies: Kochia is known to be resistant to multiple herbicides including ones belonging to Group 2, Group 9, Group 4, and Group 5, which can make it difficult to manage (Bayer, 2024). Many of the herbicides that are recommended for kochia are not safe to use near water sources, so we will use a combination of Fluroxypyr and Dicamba which are more suitable for use near water sources, despite the fact that roughly 4% of kochia populations are known to be resistant to this combination of herbicides (Geddes et al 2021). Due to the fact that this area is not constantly sprayed with herbicides, we believe that this combination will have improved efficacy at this site. For increased effectiveness, we will apply this combination of herbicides in the spring before the plants reach a height of two inches or during the spring rosette stage as it is recommended (Bayer, 2024). Dicamba will be applied at a rate of 8-16 fl oz/acre (Weld County Public Works, n.d.), and Fluroxypyr will be applied at a rate of 16-32 oz/acre (Bokan, 2012). In addition to using these herbicides, we also plan to hand pull kochia at all stages of development throughout the growing season, however, a large amount of this hand pulling method will be allocated to targeting the plants earlier in the growing season before seed development (Bokan et al 2024). This process will be repeated over the course of three years and changed as needed depending on the data we obtain from long-term monitoring.

Smooth Brome Management Plan: We will apply Glyphosate at 32 oz/acre based on the recommendations of DiTomaso et al (2013) after the last freeze of spring, when temperatures have reached 10 degrees celsius for more than two days. Our focus will be in the identified key habitat zones (Figure 2) to prioritize native plant establishment for pollinator habitat, including in monitoring plots. Glyphosate has been commonly used to control smooth brome, although it is done in concentrated areas. We recommend spraying only in priority habitat areas to manage smooth brome such as for ground nesting birds, as the weed is expected to return and

persist even after continuous herbicide applications. Due to concerns over water quality, spraying by the river near critical habitat areas will be excluded.

Leafy Spurge Management Plan: Leafy spurge is extremely hard to control so the management plan will take place over a couple years to ensure that management objectives are met. In the first year, we will utilize the herbicides Tordon and Plateau. Tordon will be applied once a year over the span of 3-4 years depending on the success of the herbicide. The CSU extension office advises an application of 16-24 oz/acre of Tordon per acre in the spring and in the fall Plateau will be applied at a rate of 8-12 oz per acre. Applying Plateau will also control smooth brome. If this process does not work then we will apply Glyphosate to the leafy spurge at a rate of 32 oz/ acre, however, this application process has to occur when combined with late grass seeding so we are aiming to make these two activities coincide (Southwestern Region Forest Service, 2014). If neither of these strategies are effective, we will consider the use of biological controls to manage the Leafy spurge population. We plan to consider the black dot flea beetle to control the leafy spurge population, but if this species does not work, there are three other biological control species that can be introduced that could work which include the brown dot flea beetle and the black spurge flea beetle (Beck, 2013).

Conclusion

This management plan outlines some of the major biodiversity concerns in North Shields Ponds, a deeply human altered wildlife urban interface. We will continue to follow the Poudre Conservation Area goals of “conserve and protect lands and water, protect and improve ecosystem health and resilience, provide meaningful education and appropriate recreation opportunities, and responsibly steward the communities resources.” (Rentschlar et al, 2023). Several important bird, mammal, herptile, and possible imperiled plant species exist in the area, which will be managed with both botanical information from established monitoring plots and with the wildlife observations of local citizen science organizations like Fort Collins Audubon Society, iNaturalist, and Bird Conservancy of the Rockies. Special consideration will be given to Smooth Brome and Cattail, the most prevalent and problematic species of the area, while a selection of both chemical and cultural control methods will be employed for our selected priority species. We hope that the strategies suggested here will provide a springboard for monitoring protocols, data parameters, and further connection with experts to optimize costs and meet our goals.

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Appendix A. Herbicide Chart

Planned acreage was assessed with Google Earth polygons. U.S. EPA herbicide labels (linked) and extension fact sheets were consulted for specific concentrations.

Herbicide (Labels linked)	Precautions Taken (Based on label)	Species Treated	Amount Applied (Oz/ac)	Planned Acres applied 3 years	Cost/acre for application
Glyphosate	Avoid contact with eyes/face Wear long sleeves Wash clothes after use REI = 4 hrs	smooth brome, cattails buckthorn Russian olive	Smooth brome: 32 Cattails: 32 Buckthorn: 100% R.O: 100%	6	
Imazamox	Long sleeved shirt and long pants, nitrile gloves and avoid contact	cattails	32	1	
Milestone	Long sleeve shirt and long pants and shoes with socks.	Canada thistle	6	0.36 acres	16 dollars
Fluroxypyr	Protective eyewear, long sleeved shirt and long pants with shoes and socks. Chemical resistant gloves made of barrier laminate, butyl rubber>14 mils, nitrile rubber>14 mils, neoprene rubber>14 mils, polyvinyl chloride >14 mils or viton>14 mils.	kochia	32	0.26 acres	59 dollars
Dicamba		kochia	12	0.26 acres	
Tordon	Chemical resistant gloves that are also waterproof. Long sleeved shirt and long pants. Show extreme care with cleaning after herbicide application	leafy spurge	10	1 (spot treatment)	

Plateau	Chemical resistant gloves that are also waterproof. Long sleeved shirt and long pants	leafy spurge	10	1 (spot treatment)	
Triclopyr	Shoes and socks, nitrile gloves, remove clothes after use, wash hands	Russian olive, buckthorn, Siberian elm	TBD	TBD	TBD

Appendix B. Cost/Time Commitment

(Excludes herbicide application, which will be evaluated on a case-by-case basis)

*monitoring materials and supplies are assumed to already be in possession of Fort Collins Natural Areas.

Management Action	Duration/amount for 3 years	Cost	Accumulated Cost
Cattail harvesting labor 2x/year, 2 people (it will take 10 hours each time with hand tools)	60 hours	\$20/hr/person	\$1200
Monitoring Crew (includes 40m transects, cattail trials), 2 crews of 3 for 10-hr workdays	24 times or 240 hours	\$20/hr/person	\$28,800
Seed collection (volunteering) (10 people, 6-hour workdays, 4 days/year, plus 5 pizzas/day (~\$100))	720 hours	N/A	\$1200
Greenhouse space = 2 benches	4 months	\$30/month/quarter bench	\$960
Greenhouse labor- weekly watering/maintenance for 4 months, 2hr/shift	26 hours	\$20/hr/person	\$520
Plug planting after growouts (volunteering)- 10 people, 1 10-hour workday, 5 pizzas	10 hours	N/A	\$100
Water testing	6 hours	\$27/hour	\$162
Tree removal labor- volunteering- 10 people, pizza	6 hours	N/A	\$100
Total			\$33,042