Zak Sather

Proactive Invasive Plant Management in Northfield

Introduction

Invasive plant management has largely been a reactive process in Northfield. A new invasive plant threat propagates in an area, and only once it is a large and annoying problem do city and local governments act. The goal of this paper is to develop policy that prevents the introduction and spread of alien plants into Northfield that are likely to cause economic, environmental, or human health harm.

The USDA Forest system defines invasive plants as "Non-native (or alien) to the ecosystem under consideration; and, whose introduction causes or is likely to cause economic or environmental harm or harm to human health."[1] When thinking about policy in Northfield, the focus belongs on the 2nd clause of that definition. Northfield does not have the resources assigned to invasive plant management to fight all "unnatural" or alien plants. As pointed out in Anders, alien and native are not binary terms but rather each exists along a continuum.[2] Management of species should not be determined by a plant's status as native or alien, but rather by its role in the ecosystem and long-term behavior. Especially given the relative lack of resources, Northfield's invasive plant management policy needs to focus on preventing economic, environmental, or human health harm. I favor this pragmatic approach, as laid out by Anders Lundberg, "The management of any species should not be according to its status as native or alien, but according to a judgment of its role and long-term behaviour."[3] We should not

[1]"Invasive Species." Invasive Species | US Forest Service. US Forest Service. Accessed February 24, 2021. https://www.fs.usda.gov/managing-land/invasive-species.

[2] Lundberg, Anders. "Conflicts between Perception and Reality in the Management of Alien Species in Forest Ecosystems: A Norwegian Case Study." Landscape Research 35, no. 3 (May 2010): 319–38.

[3] Lundberg, Anders. "Conflicts between Perception and Reality in the Management of Alien Species in Forest Ecosystems: A Norwegian Case Study." Landscape Research 35, no. 3 (May 2010): 319–38.

control for all alien plants because it cannot be assumed that all alien plants are aggressive or invasive. Controlling for alien plants is also expensive in terms of both time and money, and can cause inadvertent harm. Lundberg gives an example of this in the use of Round-Up (which is labeled a non-selective, total kill herbicide) on *Acer pseudoplatanus* (Sycamore maple) trees in Norway. The use of Round-Up reaped destruction on all surrounding plants, and later research found that Sycamore maple was not in itself aggressive, invasive, or destructive to Norway's old-growth forests (where the control was taking place). When policymakers target alien species without considering that alien species' impact on their specific environment, they make decisions that waste resources and can cause broader harm.

Northfield Context

Currently, invasive plant management is not at all a priority in Northfield. This is obvious from the simple fact that no mention of invasive plants occurs in the Northfield Climate Action plan. The Parks & Streets department is theoretically responsible for invasive plant management. Yet it only has six members and is already responsible for plowing streets and mowing public spaces like parks -- currently, they do not have the resources to also handle invasive plants.

Northfield uses the Minnesota state noxious weed list as the city list of prohibited plants, but the city council has the authority to add to the list. Both public and private landowners are mandated to control for invasive plants that are on the Minnesota state noxious weed list. Minnesota statute 18.78 states "A person owning land, a person occupying land, or a person responsible for the maintenance of public land must manage all noxious weeds."[4] However, enforcement of this statute is nonexistent. More details about using this statute to control for invasive plants will appear later in this proposal.

[4] Minnesota State Statute Chapter 18, section 18.78.

Much of the action around invasive plant management occurs outside the Northfield city government. There are regional groups like the Cannon Valley Noxious Weed Collaborative, which is formed up of the 4 townships surrounding Northfield. There are also regional groups like the Rice County Soil and Water Conservation District, the Minnesota Invasive Species Advisory Council, the Minnesota Department of Agriculture, the United States Department of Agriculture, and the Midwest Invasive Plant Network. These groups can be drawn upon for both expertise and resources (in the form of money, equipment, or labor) that Northfield itself lacks.

There are also businesses that have an interest in invasive plant management, namely Paisley and Knecht's nurseries. These are businesses that potentially spread invasive plants through sales, but also could be valuable allies in the fight against invasive plants. These businesses will be addressed further in section 3.

There are also community and volunteer groups that can participate in invasive plant control programs. The Rotary Club, Boy and Girl Scouts, and any other volunteer organizations could prove valuable in augmenting the labor the city can put towards invasive plant management. The Garden Club is another one of these organizations and would be particularly valuable given their expertise and information networks.

The two colleges in Northfield, St. Olaf and Carleton, are also key to effectively managing this problem. These institutions control a myriad of resources, including academic expertise, free or cheap labor in the form of college undergraduates, equipment, and perhaps most importantly, the Cowling Arboretum and St. Olaf Natural Lands and the staff that comes with them. Protecting these natural lands from invasive plants must be a priority because unlike most areas, their value stems from their biodiversity. An invasion of invasive plants in these areas would cause extensive ecological harm, exactly what this plan is trying to avoid. The staff

of these lands are also valuable. They offer expertise in invasive plants and have a vested interest in protecting Northfield from invasive plant damage. Nancy Braker is the manager of the Carleton Arboretum, and her expertise has already proactively protected the city from the Amur Cork Tree, which will appear in more detail later in the paper.

One informative example of how invasive plant policy currently works around Northfield is that of the Wild Parsnip program developed by the Cannon Valley Noxious Weed Collaborative. In 2016, a resident complained to Northfield Township of injuries from Wild Parsnip. In 2018, Northfield and Bridgewater townships received a grant from the Minnesota Department of Agriculture. The grant brought the townships equipment, and funds to hire one person. Even so, they needed to use an army of volunteers, including some undergraduates from the colleges, to map locations of the Wild Parsnips and control for them. This program has been largely successful in reducing Wild Parsnip, yet it also shows the inefficiency of reactive invasive plant policy. According to Nancy Braker, Wild Parsnip has been in the Cowling Arboretum (and presumably the surrounding area) since the 1980s, and it was only one resident's accident that got the program off the ground. Even with the grant from the Minnesota Department of Agriculture, targeting Wild Parsnip has been time-consuming and the long-term results are unclear. This was a township project, not a city one, but it is an example of sound invasive plant management. The project would've been more efficient had it started earlier, and more effective had it included some revegetation efforts, but nevertheless, it is an excellent project. The proactive invasive plant management approach I will lay out seeks to address small problems in programs like these and create the conditions so these reactive projects are less necessary.

Proposal

Given a 20-year time frame, I recommend Northfield develop a 5 stage approach for invasive plant management to proactively control threatening invasive plants inside the city. 1) The city should communicate with surrounding entities including state and city governments, businesses, community organizations, and academic institutions to identify invasive plant threats. 2) The city needs to prioritize these plants based on potential threats to economic, ecological, and human health. 3) Northfield needs to shut down pathways by which invasive plants are introduced via humans. 4) Northfield needs to identify the areas in town most susceptible to alien plant invasion. 5) The city should focus on revegetating and transforming these areas to protect them from invasive plants. Because of limited funding, much of this labor will have to be mobilized from outside of the city payroll.

Governmental Framework

Under this proposal, invasive plants will continue to be managed by the Streets and Parks Division. This is the simplest option, and relies on existing bureaucratic infrastructure rather than developing a new subcommittee without a set role in the bureaucracy. The Streets and Parks Division also has experience mowing public areas across the city. They know how to move equipment and efficiently attend to all public green spaces in the city, expertise which is very applicable to invasive plant management. However, as explained above, the Streets and Parks Division currently does not have the manpower or political will to prioritize invasive plants. Because of this, the department will have to take on someone as an Invasive Plants Coordinator. This could be a full-time hire, or part-time, or an appointment of a current staff member to the position along with taking away many of their other responsibilities. The Invasive Plants Coordinator could also take on other roles in the winter. They will be tasked with mostly office

work rather than fieldwork: coordinating volunteers, communicating with other stakeholders, working with the city council, pressuring businesses, etc. I recommend only one new position because the city lacks the financial resources and political will for a larger investment. With the Covid-19 pandemic, the city budget will be especially tight, and previous attempts to hire a City Forester have failed. Yet when the city budget does expand or this issue becomes more of a priority, more staff can be dedicated to implementing proactive invasive plant policy.

1) Identifying Invasive Plant Threats

Out of all the subsections, Northfield is currently handling the identification of potentially invasive plants quite well. The Minnesota Noxious weed list is quite extensive, and there are multiple sources for information about potential plant invaders. Especially important in the dissemination of this information are people like Nancy Braker who represents the Cowling Arboretum. Stakeholders like her who have both expertise and a vested interest in invasive plant management are invaluable to the city. The value of these stakeholders is demonstrated by the example of the Amur Cork Tree. The Amur Cork Tree was not a prohibited plant in Northfield before Ms. Braker took action. Ms. Braker started to find Amur Cork Tree in the Cowling Arboretum and went to the Northfield Environmental Quality Commission (EQC). She worked with members of the EQC and went to the Northfield city council with the issue. The city council has the authority to add any plant to the invasive species list with a majority vote and did so in the case of Amur Cork Tree. The rationale for the adding Amur Cork Tree to the Northfield list of prohibited plants included the fact that Wisconsin has listed it as an invasive species, and "the limited number of these trees currently in Northfield makes this the time to stop their spread here before the state requires it and the task becomes an expensive one."[5] This is an outstanding example of proactive invasive species identification. Under my plan action like this would be

[5] Northfield Environmental Quality Commision Meeting Minutes, November 20th, 2019.

encouraged, but would run through the Invasive Plants Coordinator rather than the EQC. This would give local stakeholders an effective avenue to disseminate their knowledge, and the Invasive Plants Coordinator would develop experience working through the bureaucracy and therefore be better able to get invasive plant threats quickly prohibited.

The Invasive Plants Coordinator can encourage these community contributions by simply reaching out to local actors regularly. This can be as simple as a quarterly email to the Northfield Garden club or even exceptionally active gardeners specifically, local nurseries and horticulturists, botany adjacent professors at St. Olaf and Carleton, and managers of both St. Olaf Natural Lands and the Cowling Arboretum. This communication could also take other forms wherever the city government interacts with the gardening community, including workshops, volunteer events, and community outreach that will be described later in this proposal.

Governmental agencies and cooperation throughout levels of government can provide oversight for a broader swath of the country than local actors. By monitoring a broader geographic section of the country, Northfield can develop an earlier alert system to the threat of invasive plants. By using information from neighboring states and surrounding counties, Northfield can monitor which invasive plants are successful in similar ecosystems. Again, the Amur Cork Tree example is pertinent here, as one of the reasons cited for why it should be prohibited was that it was already prohibited by Wisconsin and other eastern states where it proved invasive.

Checking noxious weed lists from neighboring states is an exceedingly simple and effective way to proactively identify invasive threats. Research from Kerri et. al examined noxious weed lists from across the country and found them to be excellent indicators of a species

propensity to spread in general.[6] Kerri et. al point out that noxious weed lists "provide a democratic representation of sociopolitical decisions, which gives an approximate ranking of the importance of weed targets."[7] Using this approach allows Northfield to save time and money as they won't have to do that extra research. Moreover, 2 of the 4 neighboring states (Wisconsin and Iowa) have tiered noxious weed lists. Tiered lists provide even more detail and help decide which species will be threats. For example, the Wisconsin invasive species list delineates between different species based on county. Plants classified as prohibited in counties neighboring Minnesota should be treated as a greater threat to spread in Minnesota.

Besides intergovernmental cooperation, there have been important developments in models used to predict which alien plants will become invasive. The most promising, and applicable of these models comes from a study by Herron et. al. The researchers looked at invasive plants in New England and used a statistical analysis to find which traits were indicative of invasiveness. They then used this data to form a predictive model which was highly effective: "The predictive model was able to correctly classify invasive plants 67% of the time (22/33), and non‐invasive plants 95% of the time (204/215)" and found that "The most effective predictors of invasiveness that emerged from our model were 'invasive elsewhere', 'fast growth rate', 'native latitudinal range."[8] Unfortunately, this model is New England specific, and so the actual model cannot be applied to the Northfield case. But the takeaways from the study are still important in increasing our power of predicting which alien species will become invasive. Also if an academic institution, Carleton, St. Olaf, the University of Minnesota, or any other midwest-based

---

[6] Skinner, Kerri, Lincoln Smith, and Peter Rice. "Using Noxious Weed Lists to Prioritize Targets for Developing Weed Management Strategies." Weed Science 48, no. 5 (2000): 640-44.
[7] Skinner, Kerri, Lincoln Smith, and Peter Rice. "Using Noxious Weed Lists to Prioritize Targets for Developing Weed Management Strategies." Weed Science 48, no. 5 (2000): 640-44.
[8] Herron, P.M., Martine, C.T., Latimer, A.M. and Leicht‐Young, S.A. (2007), Invasive plants and their ecological strategies: prediction and explanation of woody plant invasion in New England. Diversity and Distributions, 13: 633-644. https://doi.org/10.1111/j.1472-4642.2007.00381.x

research institution could perform a similar study that information would be invaluable. The research was conducted at the University of Connecticut in 2007, and with the advancements in technology within the last 20 years, it seems very feasible that the University of Minnesota could conduct a similar study, perhaps through the extension service.

Once city officials have compiled a list of potentially invasive plant threats by mining informal information networks, community groups, colleges, commercial horticulturalists, surrounding noxious weed lists, and recent biological studies, they must begin prioritizing these invasive threats. Due to limited resources for invasive control, Northfield must not spread itself too thin when trying to control these invasive plants.

2) Prioritizing Invasive Plant Threats

The main criteria when prioritizing which invasive plants to guard against should be preventing the spread of plants that jeopardize economic, environmental, and human health. The city of Northfield itself should not focus so much on preserving a specific aesthetic or maintaining "native" ecological character, for reasons laid out in the introduction. A plant's potential to cause economic, environmental, and human health harm is entirely dependent on how widespread an invasive plant becomes. For this reason, the propensity to spread and availability of an effective control method must be taken into account. If two species have a similar propensity to cause harm, but one is easily controlled and the other is tenaciously entrenched, the city should focus on what it can fix. In a similar vein, the city should take more precautions against a species that has effectively invaded similar ecosystems vs a species that has had little success in Northfield-like ecosystems -- even if the latter plant poses more potential harm should it take root.

The triaging of invasive species is a complicated question, often full of political differences and disagreements between different stakeholders. To assist in decision making, I propose borrowing a framework from Gaertner et. al. They group invasive species into 3 categories:

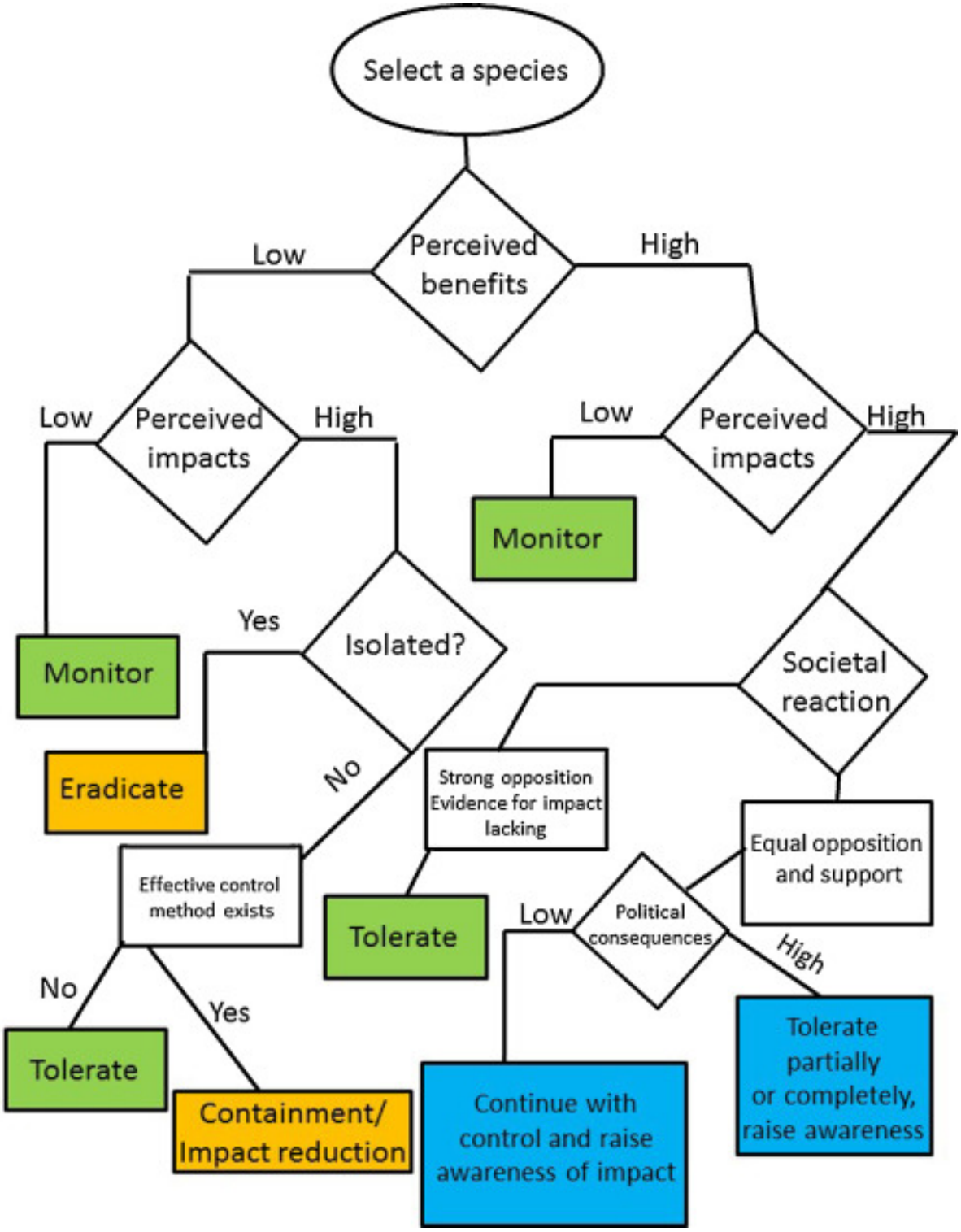
1) "Species with a low potential for negative impact, regardless of the benefits they deliver, would fall into a 'tolerance' category. These species would be generally acceptable to society and to conservationists, requiring very little management."

2) "Species that both provide benefits and have negative impacts fall into an 'active engagement' category. Their management will be more complex because the optimum course of action is less clear, and any option is likely to be controversial."

3) "Species with a relatively high potential for impact and that deliver relatively low benefits would fall into a "control priority" category. The 'control priority' category will include species to be eradicated (where eradication is possible) or controlled."[9]

Gaertner et. al offer a flowchart use when deciding which plant falls into which category. The flowchart accounts for perceived benefits, perceived impacts, societal reaction, plant isolation, and availability of an effective control method. How one defines each of these nodes in the flowchart has a great impact on how invasive plants are prioritized.

[9] Gaertner, Mirijam, Brendon Larson, Ulrike Irlich, Patricia Holmes, Louise Stafford, Brian Wilgen, and David Richardson. "Managing Invasive Species in Cities: A Framework from Cape Town, South Africa." Landscape and Urban Planning 151 (July 2016): 1–9.


Select a species
Perceived benefits
Low
High
Perceived impacts
Low
High
Monitor
Perceived impacts
Low
High
Monitor
Isolated?
Yes
No
Eradicate
Societal reaction
Strong opposition Evidence for impact lacking
Equal opposition and support
Effective control method exists
Tolerate
Political consequences
Low
High
No
Yes
Tolerate
Containment/ Impact reduction
Continue with control and raise awareness of impact
Tolerate partially or completely, raise awareness

Benefits of invasive plants could be that they provide habitat for other species, are considered beautiful, require little maintenance, or any other reason a community member would want them. These benefits may seem superfluous, but they are valid and must be taken into consideration when deciding how to manage an invasive plant.

Negative impacts should be judged by a plant's propensity to cause economic, environmental, or human health harm. Examples of economic harm could be the costs associated with control (will control cost more than it's worth) and threats to crop yields. The main focus of preventing environmental harm should be protecting the Cowling Arboretum and St. Olaf Natural Lands. These areas are valuable because of their biodiversity, unlike most other areas inside city limits. Plants that are poisonous, or hazardous in some way (like Wild Parsnip) should be considered threats to human health.

This framework also takes societal reaction into account. Invasive plant management is difficult when it comes to societal reaction because most of the general public cares little about the issue, yet there exists a few stakeholders that have a dedicated vested interest. As pointed out by Epanchin-Niell, the costs and benefits of invasive species are not felt equally by each stakeholder.[10] Stakeholders that are well organized and face direct economic consequences from invasive plants are more likely to have an outsized voice. This includes agriculture (especially large agribusiness), nurseries and horticulturalists, and private landowners who don't want to incur the costs of invasive plant management. Besides agribusinesses (which only care about plants that threaten yields), these groups have incentives to oppose invasive plant control, especially policy that requires them to spend money to manage invasive plants. The Invasive Plant Coordinator must guard against the propensity to listen to the loudest and most powerful

[10] Epanchin-Niell, Rebecca S. "Economics of Invasive Species Policy and Management." Biological Invasions 19 (March 2017): 3333–54.

political actors when gauging “societal reaction”. Stakeholders like the garden club and faculty at both colleges should be consulted when trying to gauge societal reaction to try and balance out the power of groups who have an interest in lackluster invasive management. The Invasive Plants Coordinator should also be somewhat insulated from the influence of special interests because presumably whoever assumes the position of Invasive Plants Coordinator will be interested in invasive plant control.

Isolation refers to how widespread an infestation of invasive plants has become. If there is only a small outbreak, concentrated in one area, eradication may be viable. However, if the outbreak is widespread and not isolated, control and management may be the only effective solution. The availability of an effective control method should be treated similarly. If there exists no effective control method, the city should not waste resources pursuing sub-par control methods when their time and money could be better spent implementing effective control methods elsewhere.

By using this framework and flowchart, policymakers can identify and prioritize plants that pose a threat to the economic, environmental, and human health of Northfield. The city will then be responsible for using known effective control methods to prevent the spread of specific plants, specifically the species categorized into group three. This is the first aspect of proactive management of invasive plants in Northfield.

3) Shutting Down Human-Based Introduction Pathways

Two major vectors by which new invasive plants are introduced into Northfield are horticulture vendors (in Northfield Knecht’s and Paisley’s) and plant trade between gardeners. Horticulturists frequently sell invasive plants because they are better able to survive and spread than native plants -- qualities that make them invasive, but also attractive to gardeners. Research

by Reichard found that “82% of 235 woody plant species identified as colonizing outside of cultivation had been used in landscaping.”[11] Plants on the Minnesota noxious weed list are illegal to sell (except for 4 plants labeled “specially regulated” which can be sold with warning tags), but enforcement is nonexistent. The Invasive Plant Coordinator should make inspections to ensure that these businesses are following the law and not selling invasive plants. However, the city should seek to develop a mutually beneficial relationship with these businesses, not an adversarial one, as these nurseries are important stakeholders when it comes to invasive plants. Through the inspections by the Invasive Plant Coordinator, the city should offer a certification that certifies cooperative businesses as “green” or supportive of native plants. This way the nurseries have both a carrot (certification) and a stick (inspections) to ensure they follow invasive plant regulations. The city can build partnerships with these businesses by using their labor and plants in revegetation efforts. The city could only use plants from businesses in compliance with invasive species regulations when replanting with native species -- though expense could be an issue in that approach. They could also host revegetation events sponsored by these nurseries which would give the nurseries good press and the city more resources in fighting invasive plants. The city should also develop invasive plant workshops in concert with these businesses. An invasive plant workshop at one of these nurseries would be beneficial for both parties, as it would bring customers into the nurseries, and allow the city to educate gardeners on invasive plants.

The problem of gardeners trading or gifting invasive plants can be solved through education. Gardeners often unwittingly use invasive plants in their gardens and will often trade them with other gardeners. Yet if educated, gardeners are usually willing to change their

[11] Reichard, Sarah E. "Prevention of invasive plant introductions on national and local levels." In *Assessment and management of plant invasions*, pp. 215-227. Springer, New York, NY, 1997.

practices. Much of this outreach can be done through the Northfield Garden Club, including at their monthly meetings, where the Invasive Plants Coordinator could give talks about invasive plants to look out for. This could also be done through the University of Minnesota extension service through programs like Master Gardeners and Master Naturalists. These programs are already running but could be intensified and focused on invasive plants. The aforementioned workshops with nurseries would also contribute to invasive plant education.

4) Identify Areas Susceptible to Alien Plant Invaders

Research from Stajerova has found that human disturbance of an environment leaves that environment susceptible to invasion from alien plants.[12] As part of a proactive management strategy, Northfield must take steps to shore up parts of the city that are especially susceptible to alien plant invasion. This mainly involves limiting what Sheley et. al call "site availability" for invasive plants.[13] Site availability is defined as the availability of niches for plants to grow in on sight.

First, this requires identifying where site availability would be in Northfield. Disturbance is the most common cause of site availability. Disturbances are changes in ecological conditions that cause a pronounced change in an ecosystem. Disturbances can be natural: floods, wildfires, insect outbreaks, and Northfield may have to deal with these natural disturbances more as the climate changes. However, human-caused disturbances are the largest issue for a city like Northfield. Human-caused disturbances are simply when our behavior uproots the normal course of an ecosystem. "When these changes happen, they often open up areas to new or different plants by creating a change in conditions, altering the natural succession of plant

[12] Stajerova, Katerina, Petr Smilauer, Josef Bruna, and Petr Pysek. "Distribution of Invasive Plants in Urban Environment Is Strongly Spatially Structured." Landscape Ecology 32 (January 2017): 681–92.
[13] Sheley, Roger L, and Brenda S Smith. "Ecologically Based Invasive Plant Management: Step by Step." Rangelands 34, no. 6 (December 2012): 6–10.

communities. Disturbance reduces the intensity of plant competition, changes environmental conditions, and alters the supply rates of resources."[14] These disturbances happen frequently, by both private actors, businesses, and the government. In forming policy, managers should be cognizant that these disturbances open up weaknesses to invasive plants. The specifics of these disturbances and their role in the Northfield context are laid out below.

Analysis from Stajnerova et. al found that "highly transformed" ecosystems-- ruderal sites (disturbed places near built-up areas, industrial facilities, and dumps), railway sites, and road margins -- are the biggest vectors for alien plant invasion.[15] Factors such as the disturbance frequency, high amount of available nutrients, and propagule pressure (the number of individuals of a species released into a region to which they are not native), including opportunities for spreading by water or human activities are especially concentrated in these areas. City centers are also especially susceptible because sites near the city center have limited water supply and high temperatures -- again factors of human disturbance. This gives invasive species an advantage as native plants don't perform as well under those unnatural conditions. Stajnerova et. al also found that areas with high habitat turnover (areas that are frequently or have been recently disturbed) are vulnerable, as well as areas that have many different habitats close together. This study was conducted in a city of 100,000 older and more developed than Northfield. However, the identification of highly disturbed areas (ruderal sites, railway sites, and road margins) is incredibly pertinent to Northfield. The appendix of this proposal contains maps of where these highly disturbed areas are located within the city.

---

[14] Sheley, Roger L, and Brenda S Smith. "Ecologically Based Invasive Plant Management: Step by Step." Rangelands 34, no. 6 (December 2012): 6–10.
[15] Stajerova, Katerina, Petr Smilauer, Josef Bruna, and Petr Pysek. "Distribution of Invasive Plants in Urban Environment Is Strongly Spatially Structured." Landscape Ecology 32 (January 2017): 681–92.

The goal of a proactive approach to invasive plant management should be replacing these especially vulnerable areas with less vulnerable ones. Northfield should start by targeting ruderal sites, railway sites, and road margins. These sites are highly disturbed and offer ample resources for invasive plants to take advantage of. These sites cannot be eliminated, but they can be monitored and they can be improved. The convenient thing about these sites is their relative accessibility. We know where railroad sites and road margins are. Ruderal sites are a bit more difficult to access and manage because they are often on or adjacent to private land -- but it is not hard to find these disturbed places near built-up areas, industrial facilities, and dumps.

5) Revegetation and Mobilization

It is one thing to target these areas, another to pull together the resources and limit invasive plant spread in these highly disturbed habitats. Northfield itself has limited money and manpower when it comes to invasive species management. Most of the Streets and Parks Division's resources are dedicated to maintaining parks and other city spaces and snow removal. Because of this, a proactive invasive plant approach will involve participation from groups outside the city payroll. The city will have to rely on community groups, volunteers, businesses, and other levels of government to effectively prevent alien plant invasion. Not only that, certain idiosyncrasies of Northfield (the Cowling Arboretum, St. Olaf natural lands, Cannon River) will need more specific strategies.

To manage and prevent invasive plant spread, Northfield should utilize native revegetation strategies. By replanting with native plants, competition crowds out would-be invaders in the fight for resources by eliminating site availability. Research by Mosert et. al has demonstrated the ineffectiveness of passive restoration when compared to active restoration.[16]

[16] Mostert E, Gaertner M, Holmes PM, O'Farrell PJ, Richardson DM. A multi-criterion approach for prioritizing areas in urban ecosystems for active restoration following invasive plant control. Environ

Passive restoration involves simply the removal of invasive alien plants. This however does not address the underlying ecological conditions that allowed for the spread of invasive plants, namely high disturbance and ample available resources with little competition. Active restoration involves taking additional measures besides just invasive plant removal. While a proactive approach hopes to prevent invasive plants from appearing in the first place, these principles still stand. Northfield needs to address the underlying ecological conditions that allow invasive plants to spread by introducing native plants. A literature review by Schulster backs this approach, finding that an overwhelming majority of studies support the idea that herbaceous invasive species can be stymied by revegetation: "80% of studies of herbaceous revegetation (28 of 35) found herbaceous revegetation to suppress invasive plant species under at least some conditions and 75% of studies targeting herbaceous invasive plant species (27 of 36) reported herbaceous invasive plant species to be suppressed under at least some circumstance."[17] Northfield should therefore prioritize an active restoration strategy centered on revegetation. A passive approach costs less time, manpower, and money, but poses a higher risk of invasion and reinvasion -- rendering that investment useless. While an active restoration approach centering on revegetation will be more expensive in the short term, it will be made up for in the long run as the risk of reinvasion is significantly reduced.

This level of involvement required for proactive invasive plant management will tax Northfield's resources significantly. This is why I propose strict prioritization, as laid out in the first half of the paper. However, the city can expand its invasive plant management operation by incorporating different groups outside the city payroll.

Manage. 2018 Dec;62(6):1150-1167. doi: 10.1007/s00267-018-1103-9. Epub 2018 Sep 21. PMID: 30242527.

[17] Schuster, MJ, Wragg, PD, Reich, PB. Using revegetation to suppress invasive plants in grasslands and forests. J Appl Ecol. 2018; 55: 2362– 2373. https://doi.org/10.1111/1365-2664.13195

One place where Northfield can utilize outside help in invasive plant management is the two natural areas, the Carleton Arboretum and St. Olaf natural lands. These two places deserve extra protection because their value stems from their biodiversity. Preventing invasive plants from encroaching on these areas should be a priority. The city should work with the staff of these two areas to facilitate the management of highly disturbed areas in the vicinity, specifically on the north side of town. This needs to be a mutually beneficial relationship. Northfield cannot afford to be spending time and money inside the Arboretum or Natural Lands -- that is the purview of the colleges themselves. The city should utilize the resources of the colleges (expertise, undergrad labor, research) as much as possible given the work it is doing to protect the Arboretum and Natural Lands from invasive plants. The city should allow staff of the colleges to manage highly disturbed areas around the Arboretum and Natural Lands. Specifically, the colleges should be allowed (and encouraged) to monitor and mow road margins around their lands. The colleges have their own equipment, and any help in maintaining and monitoring these highly disturbed areas would help to take the burden off limited city resources.

The city should also utilize different community, business, and volunteer groups that have a vested interest in protecting the city from invasive plants. The Northfield Garden Club is one organization that should be further utilized. Certain ruderal sites could be greatly improved by the efforts of the Garden Club. Ruderal sites that are not especially treacherous or unappealing could be quickly transformed and maintained by Garden Club efforts. This could be mutually beneficial. If there is a dilapidated area in which no stakeholder has an interest, the city or the business that owns the land should make that land available to the Garden Club. Any human management that deters invasive plant growth (invasive plant removal, revegetation) would bolster Northfield’s defenses against invasive species.

The city can also utilize resident's sense of place attachment to compel them to manage threatening invasive plants.[18] If neighborhood associations or groups were educated about the risks of invasive plants, they could take it upon themselves to manage them in their neighborhoods. Invasive plants in parks could be partially managed by "Friends of the Park" groups composed of those who live near the parks and use them frequently. Central Park and Way Park specifically have active Friends of the Park groups who already do some gardening and upkeep. If they could be educated about invasive plants, they could take up some of the labor needed for management. Volunteer groups like the Rotary Club and Boy/Girl Scouts could also participate in community volunteer events that both foster place attachment and protect the city from invasive plants.

Perhaps the most valuable tool for invasive plant management is that private landowners are required by Minnesota Statute 18.78 to manage invasive plants on their property. Unfortunately, enforcement has been severely lacking. If this mandate could be thoroughly enforced, it would be very effective in limiting site availability throughout Northfield without costing the city resources. Private landowners own many of the sites most vulnerable to alien plant invasion, including railway margins and disturbed places near built-up areas, industrial facilities, and dumps. Railroad companies especially are large enough, and have the ability to control invasive species, yet have abdicated that responsibility. One simple action the Invasive Plant Coordinator should take would be to pressure railroad companies to follow state law by controlling invasive species on their property. The same goes for industrial companies or any other large landowner who fails to follow state law. If these companies actually managed

[18] Anguelovski, Isabelle. *Neighborhood as refuge: Community reconstruction, place remaking, and environmental justice in the city*. MIT press, 2014.

invasive plants, as mandated by state law, it would take a lot of pressure off the already overburdened Parks and Streets department.

Timeframe

This proposal has no set time frame over the next 20 years. Instead, the framework includes the flexibility to scale up or down depending on available resources and political will. If more resources became available the city could scale up each of the stages of the plan: 1) Better identification, persuade an academic institution to conduct a study similar to Herron et. al 2007. 2) More active management of lower priority group 3 plants and group 2 plants. 3) More workshops and partnerships with nurseries. 4) GIS mapping of susceptible areas. 5) More Streets and Parks employees focused on invasive plants.

Conclusion

While reactionary invasive plant management will always be needed, proactive management strategies are optimal for the effective and efficient management of invasives. Preventing the spread of invasives in the first place is much less costly in both money and manpower, and is more effective in preventing reinvasion. In pursuing an invasive plant management strategy, Northfield should keep in mind the overarching goal of preventing economic, environmental, or human health harm. This approach allows for economical utilization of limited resources and the greatest harm reduction in the long and short term.

Given a 20-year time frame, I recommend Northfield develop the multi-stage approach to invasive plant management laid out in this proposal. 1) The city should communicate with surrounding entities including state and city governments, businesses, community organizations, and academic institutions to identify invasive plant threats. 2) The city needs to prioritize these plants based on potential threats to economic, ecological, and human health. 3) Northfield needs

to shut down pathways by which invasive plants are introduced via humans. 4) Northfield needs to identify the areas in town most susceptible to alien plant invasion. 5) The city should focus on revegetating and transforming these areas to protect them from invasive plants. Because of limited funding, much of this labor will have to be mobilized from outside the city payroll.

Given limited resources, this proactive approach will require participation from the colleges, business, and community groups in Northfield. By enlisting the help of these stakeholders to first identify and prioritize specific invasive plant threats, and then proactively and actively preventing their spread, Northfield can minimize invasive plant harm to the economic, environmental, and human well-being of the city's residents.

Bibliography

Anguelovski, Isabelle. *Neighborhood as refuge: Community reconstruction, place remaking, and environmental justice in the city*. MIT press, 2014.

Epanchin-Niell, Rebecca S. "Economics of Invasive Species Policy and Management." Biological Invasions 19 (March 2017): 3333–54.

Gaertner, Mirijam, Brendon Larson, Ulrike Irlich, Patricia Holmes, Louise Stafford, Brian Wilgen, and David Richardson. "Managing Invasive Species in Cities: A Framework from Cape Town, South Africa." Landscape and Urban Planning 151 (July 2016): 1–9.

Herron, P.M., Martine, C.T., Latimer, A.M. and Leicht‐Young, S.A. (2007), Invasive plants and their ecological strategies: prediction and explanation of woody plant invasion in New England. Diversity and Distributions, 13: 633-644. https://doi.org/10.1111/j.1472-4642.2007.00381.x

"Invasive Species." Invasive Species | US Forest Service. US Forest Service. Accessed February 24, 2021. https://www.fs.usda.gov/managing-land/invasive-species.

Lundberg, Anders. "Conflicts between Perception and Reality in the Management of Alien Species in Forest Ecosystems: A Norwegian Case Study." Landscape Research 35, no. 3 (May 2010): 319–38.

Minnesota State Statute Chapter 18, section 18.78.

Mostert E, Gaertner M, Holmes PM, O'Farrell PJ, Richardson DM. A multi-criterion approach for prioritizing areas in urban ecosystems for active restoration following invasive plant control. Environ Manage. 2018 Dec;62(6):1150-1167. doi: 10.1007/s00267-018-1103-9. Epub 2018 Sep 21. PMID: 30242527.

Northfield Environmental Quality Commision Meeting Minutes, November 20th, 2019.

Reichard, Sarah E. "Prevention of invasive plant introductions on national and local levels." In *Assessment and management of plant invasions*, pp. 215-227. Springer, New York, NY, 1997.

Schuster, MJ, Wragg, PD, Reich, PB. Using revegetation to suppress invasive plants in grasslands and forests. J Appl Ecol. 2018; 55: 2362– 2373. https://doi.org/10.1111/1365-2664.13195

Sheley, Roger L, and Brenda S Smith. “Ecologically Based Invasive Plant Management: Step by Step.” Rangelands 34, no. 6 (December 2012): 6–10.

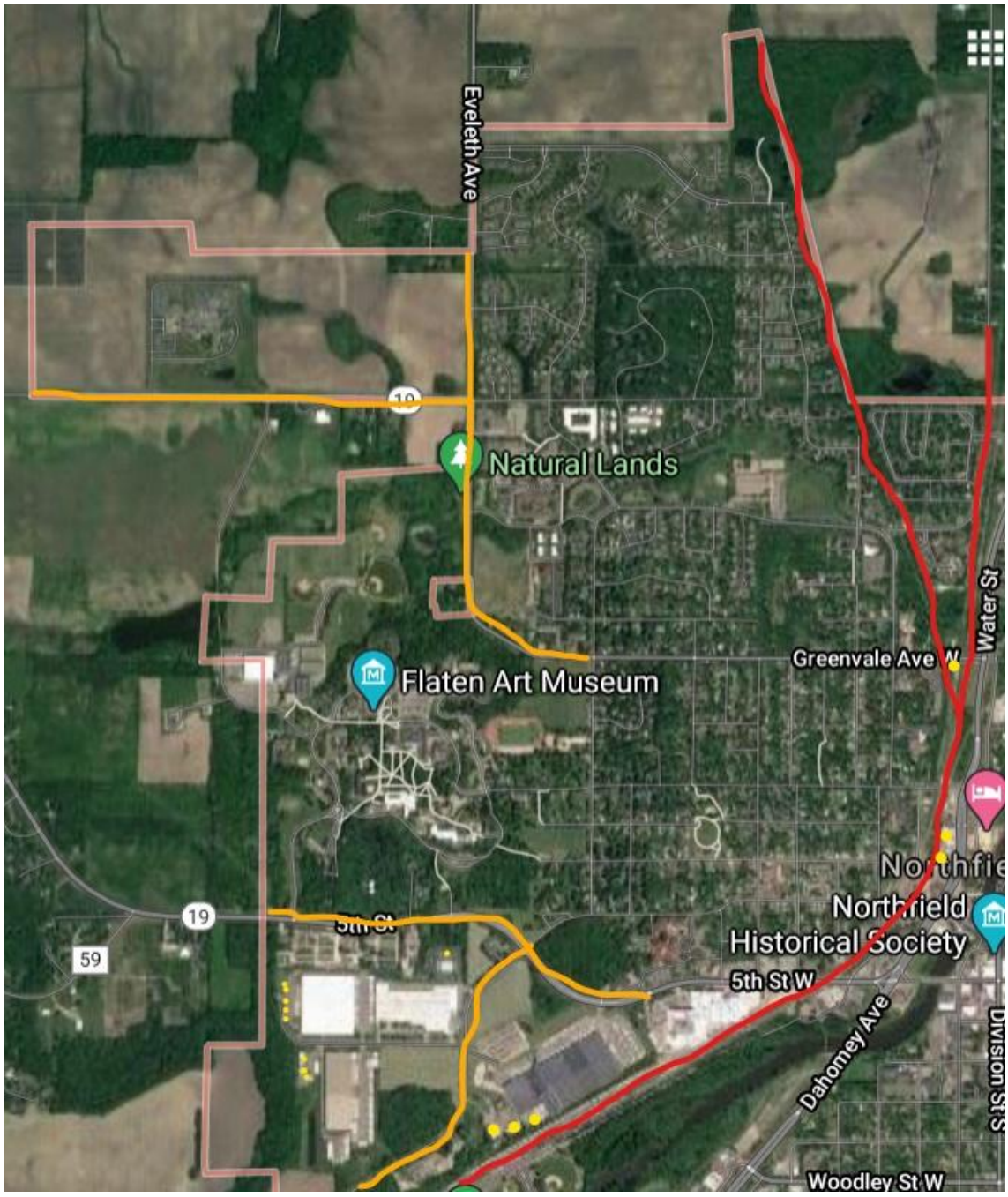
Skinner, Kerri, Lincoln Smith, and Peter Rice. "Using Noxious Weed Lists to Prioritize Targets for Developing Weed Management Strategies." Weed Science 48, no. 5 (2000): 640-44.

Stajerova, Katerina, Petr Smilauer, Josef Bruna, and Petr Pysek. “Distribution of Invasive Plants in Urban Environment Is Strongly Spatially Structured.” Landscape Ecology 32 (January 2017): 681–92.

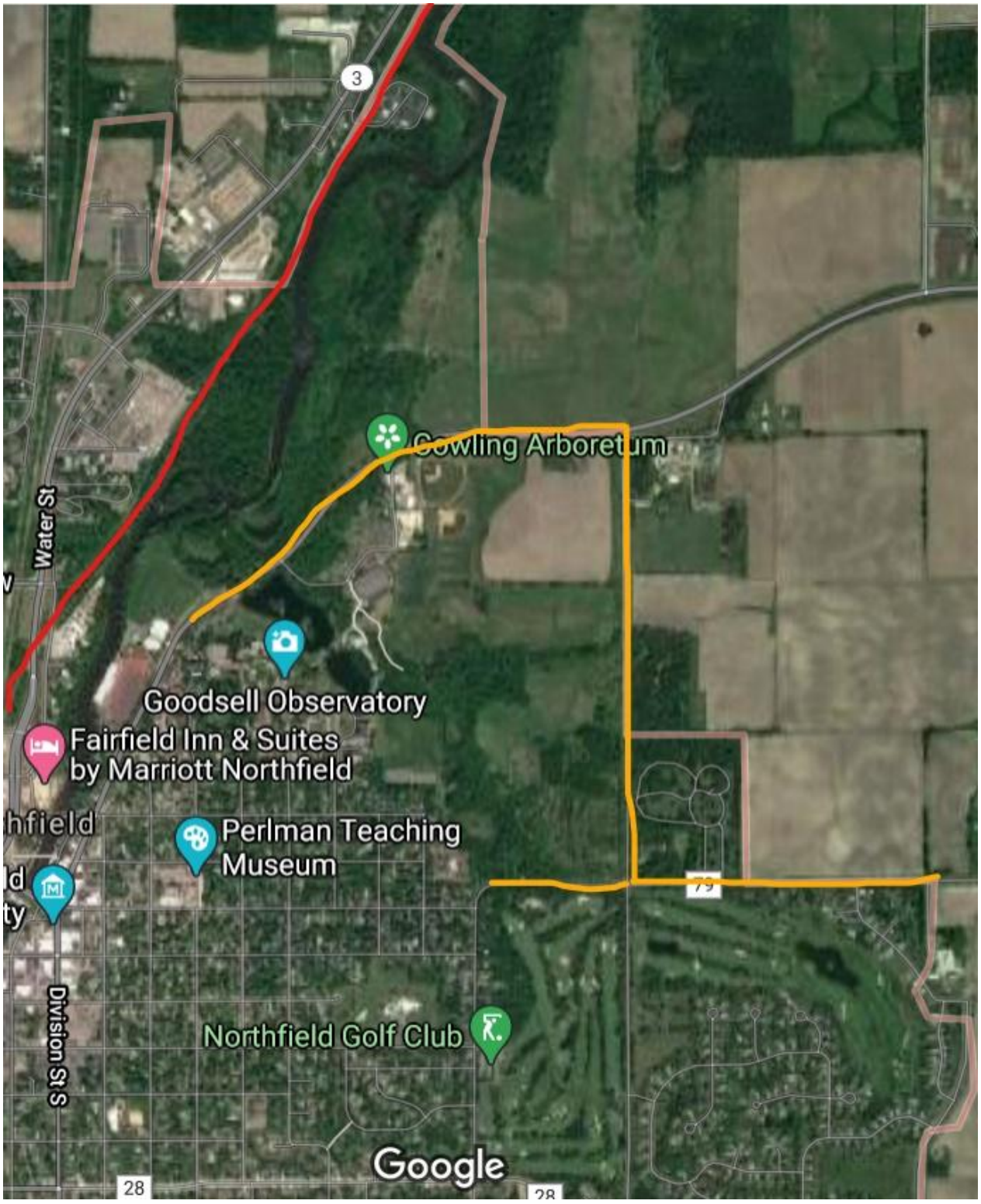
Appendix

Railway sites are marked in red, susceptible road margins are marked in orange, and ruderal sites are marked in yellow.

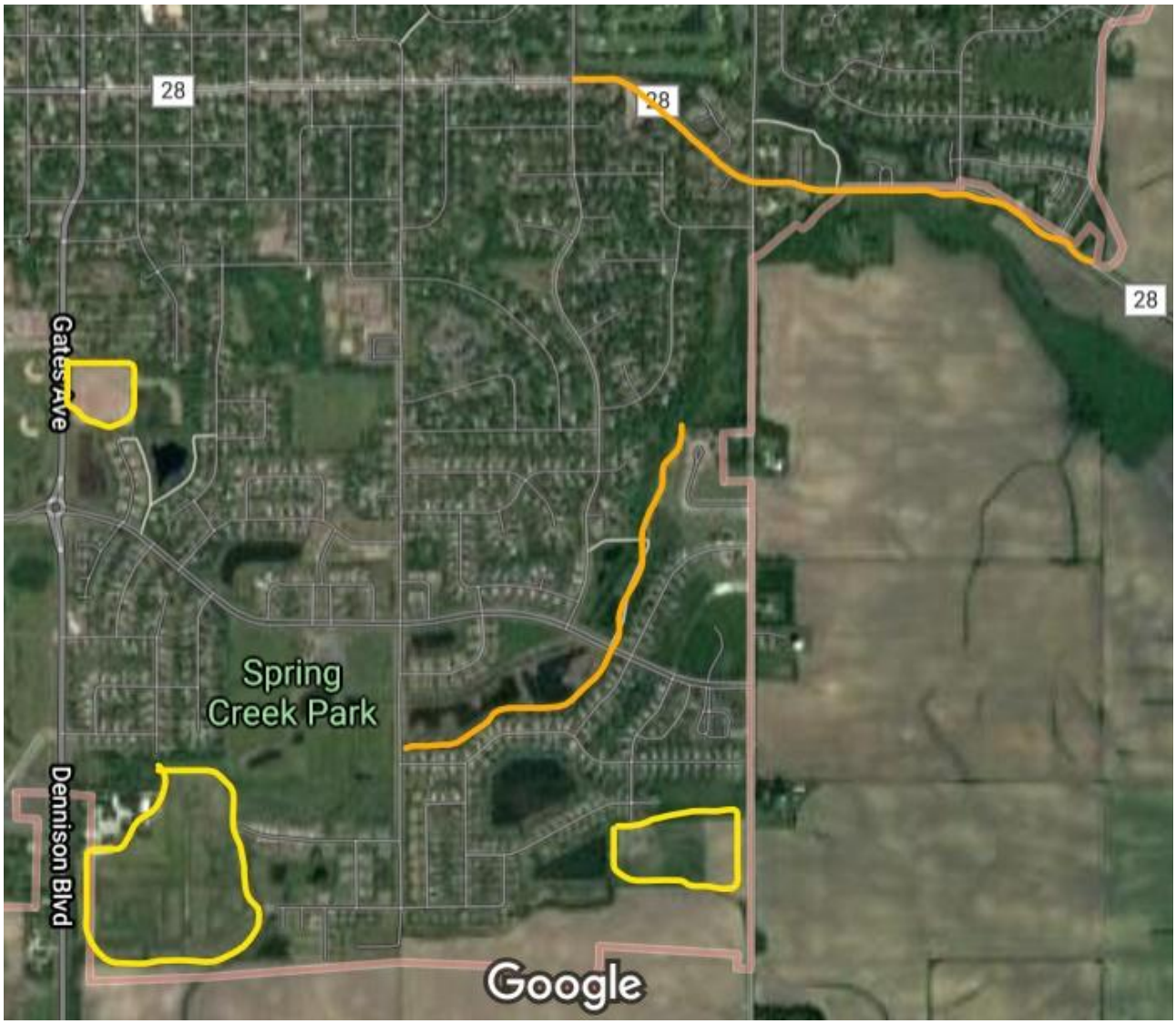
Northwest Quadrant



Northeast Quadrant



Southwest Quadrant



Southwest Quadrant