Evaluation of Trent's Invasive Species Management Practices

Includes:

Final Report, Site Coordinates from ERSC 1010 Buckthorn Lab in 2012, Site Coordinates from ERSC 1010 Buckthorn Lab in 2014, Informed Consent, Photos from Focus Group

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by

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An undergraduate community-based research project

with

Trent’s Nature Areas Stewardship Advisory Committee

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ERST 4830

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Executive Letter

The implementation of the Trent Lands and Nature Areas Plan (TLNAP) (Trent University, 2021) referred to invasive species management which has led to some changes in their management by Trent University. These changes have been quite positive. Some of these positive changes include the hiring of two new staff who work on invasive species management, an assessment of the ecosystems, corridors, and species distribution. However, there is still some work to be done to figure out everyone's specific role, particularity the Nature Areas Stewardship Advisory Committee (NASAC). NASAC could potentially provide valuable data to the management staff in regard to invasive species management, among many other topics. Before the implementation of TLNAP, the main actions regarding invasive species included community-based research (CBR) and a first-year environmental science course looking at buckthorn (*Rhamnus cathartica*) distribution on the drumlin. There were four community-based research projects about invasive species in the Nature Areas (NA). The first-year course could provide valuable monitoring data for invasive species such as buckthorn.

A focus group conducted with people who play a direct or indirect role in invasive species management in the NA revealed that buckthorn and dog-strangling vine (*Vincetoxicum rossicum)* are the most visible invasive species; there are ecological, social, and management impacts relating to invasive species; management strategies are very complex and need to take into consideration the current state of the ecosystem.

1. Introduction

This study was conducted on Treaty 20 and Williams Treaties territory and the traditional and contemporary territories of the Michi Saagiig Nishnaabeg and Chippewa Nations. I would like to honour and thank the first peoples of this land for their continued care for and teachings about the land, the earth, and our relations. In this work, I have strived to honour this land, the Indigenous Peoples of this territory, and the rich knowledge that has resulted from the scholarship and stewardship of the Michi Saagiig Nishnaabeg and Chippewa.

I would like to preface this work with an acknowledgement that there are many views, perspectives, and understandings of "invasive" species. As will be explored in this research, there are controversies about the distinction of species as "invasive," and as with many topics in ecology, new knowledge continually reshapes current perspectives on our valuation of species. Likewise, there are several stakeholders in discussions around invasive species. Crucially, any actions taken regarding invasive species in the Nogojiwanong (Peterborough) and broader area must be done so in collaboration with Michi Saagiig nations. In doing so, Western scientists, governments, and non-governmental organizations can work in an equitable way to include all stakeholders in these conversations and honour and respect the teachings and knowledge the Michi Saagiig Nishnaabeg hold from living on this land since time immemorial. In moving through this document, it is important to recognize that the current research was conducted through Western paradigms as reflected by my own positionality, and regardless of the information gathered in this project, the need for consultation is of paramount importance.

Understanding the history of the land-use in the Trent Nature Areas and the management plans that have been put in place can give an understanding of the species composition that can be found today. Some of the common paradigms about invasive species and their management can also give a better understanding about the way introduced species in the Trent Nature Areas have been and continue to be viewed and understood. This paper aims to outline how invasive

species were and continue to be managed and studied and the current views of invasive species management.

1.1 The Land-Use History of the Trent Nature Areas and its Plans

It is important to know the history of the land when talking about invasive species (Mosher et al., 2009). The past can serve as a predictor and explanation for colonization by exotic species. There are certain land-uses that promote a higher prevalence of invasive species than others. Of the landscapes Mosher et al. (2009) looked at, they found that abandoned agricultural fields have the highest level of invasive species presence. Areas that have been developed for commercial or residential use still have a high but slightly lower level than agricultural fields. Finally, areas that have not undergone land-use change for 75 years have the lowest number of invasive species present. Keeping this in mind, understanding the land use history of the Trent Nature Areas can explain the species diversity and distribution within the area.

Most of the available information about the history and management of the Trent Nature Areas can be found in the Stewardship Plan for Trent University Nature Areas from 2002 which was written by Trent professors in the departments of biology, environmental science/studies, and geography with assistance from some other Trent and community members (Jones et al., 2002). Another source is the Trent Lands and Nature Areas Plan from 2021 which was written by three consulting teams, and other various contributors including Indigenous groups, Trent faculty, students, and committees, and community members and organizations (Trent University, 2021).

The hilly terrain in the area was formed from subterranean rocks folding up into mountains which were then eroded down to hills (Trent University, 2021). Additionally, the

receding glaciers left drumlins that can be seen in some of the TNAs today. Before the settlers arrived on this hilly terrain, the Michi Saagiig Nishnaabeg lived on the land where Trent is situated since time immemorial. They would often travel to other locations where there were more resources available for one season or more at a time. Settlers started arriving in the area in the 1800s which resulted in the harvest and removal of trees, vegetation, and wildlife for the production of lumber, farming, fur-trade, food, and profit. The lumber mills that were situated on what is now Nassau Mills were the first source of pollution on the Otonabee river. The original 100 acres of Trent University were donated in 1962 (Jones et al., 2002). Over the next couple years, 1,630 acres were purchased. This land was mainly composed of agricultural land, but also had some businesses and residential developments.

There have been four plans put in place by Trent University that relate to the Trent Nature Areas. The Stewardship Plan for Trent University Nature Areas (SPTUNA) from 2002, the Endowment Lands Master Plan (ELMP) from 2006, the Trent Lands Plan (TLP) from 2013, and the Trent Lands and Nature Areas Plan (TLNAP) from 2021. The SPTUNA was the first campus-wide plan that focused on management of the TNAs (Jones et al., 2002). It focused on analyzing the TNAs which included exploring the ecological communities and recommending plans of action. Some of the invasive species management priorities relating to invasive species in the SPTUNA plan included cutting and treating stumps of European buckthorn, with the priority areas being Promise Rock, Lady Eaton Drumlin, and the Wildlife Sanctuary Nature Areas (Jones et al., 2002). The other management priority was to cut back Eastern white cedar (*Thuja occidentalis*) in areas where it is encroaching grassland habitats. Some other mentioned concerns include the invasion of purple loosestrife (*Lythrum salicaria)* and cattail in wetlands. Jones at al. (2002) also noted that landscapes that used to be old fields or houses are now

primarily composed of invasive species. The purpose of the ELMP from 2006 was to plan the development of lands with a focus on maximizing profit (Trent University, 2006). Some of the approaches they took with this plan were to integrate the lands with the development, enhance the profile of the university, make the plan accessible and clear for future use, add value to the land, and build on previous plans. This plan has no mention of invasive species. The TLP from 2013 was developed to incorporate the views of students, faculty, staff, the city, county, townships, and community members in the development of the endowment lands. Invasive species also were not mentioned in this plan (Trent University, 2013). The TLNAP from 2021 had the main purpose of creating a development framework for the university that aims to create a "Green Network" which would provide a space for learning, research, and interactions with nature through enhancing the green spaces (Trent University, 2021). It also aims to provide academic opportunities and infrastructure that makes all the amenities and offering of the campus accessible. The TLNAP mentions invasive species and their management on many occasions through the different parts of the plan. In part 2a, Trent Lands Plan, recommendations are made that invasive species management should be incorporated into the management of woodlands as development moves forward. Part 2b, Trent Lands Plan, acknowledges that invasive species affect all groups of biota, except for large mammals, and that invasive species should be managed in gathering and recreational spaces. In part 3, Nature Areas Stewardship Plan, the existing areas of invasive species and their spread were two of the general management issues mentioned. The management of invasive species was recognized to have a net benefit for the Green Network. It has also been recognized as an acceptable use of the land to achieve the goals for the Trent Nature Areas. Invasive species management was also part of the second priority which involved enhancing and restoring the lands. In part 4, Implementation Plan, the

restoration of invasive-dense areas is part of the third of four hierarchical mitigation measures taken to take into consideration when planning and developing the land.

1.2 Controversies and Perceptions of "Invasive Species"

There are many other terms, definitions, and perceptions of "invasive species." Koh et al. (2013) says that they can be defined as exotic species that adversely affect environments they invade. Invasive species are described as "a major threat to global biodiversity and an important cause of biotic homogenization of ecosystems," as "one of the most serious environmental problems facing the world," and as "one of the worst environmental problems facing the conservation of natural areas, because of their role in changing ecosystem function" (Fath, 2018; Middleton, 2008; Houlahan & Findlay, 2004). Many academic articles frame invasive species as the problem. Often times, this inflammatory language can lead to the vilification of non-native species and drastic management without the support of ecological evidence that that is the best solution to manage the plant (Davis, 2009). This view has also created a dichotomy in plants. For example, native vs non-native, native vs exotic, indigenous vs non-indigenous, invasive vs non-invasive. This view is problematic because there are many introduced species that fit into the new ecosystem with very few adaptations required. Even though the paradigm where native species are embraces and non-native plants are vilified is predominant, there are different paradigms that exist that can lead to different management strategies of invasive species. In other paradigms description words such as new species, recently arrived species, and new residents can be used and different questions such as what characteristics of the environment can be used to determine its vulnerability to invasion can be asked (Davis, 2009).

The way that temporal changes in ecosystems are understood can change the way invasive species are understood. Many of the labels that are assigned to biota are based on a

sense of time that idealizes and preserves “neutral” landscapes, conditions, or processes (Qvenild, 2013). Any change that occurs will be compared to the environments that occurred in the past. Changes in natural environments are quite often viewed as negative (Davis, 2009; Qvenild, 2013). However, the same thing that one person views as negative can be viewed as something neutral, or even positive for other people (Davis, 2009). For example, many people have different ideas of what greenspaces should look like. Qvenild (2013) compared the view of conservationists with views of landscape architects. In an attempt to restore a landscape, the conservationists wanted to plant a few native species and let nature take over the rest. However, the landscape architects planted plants that were not necessarily native to create “nature-like” environment that incorporate cultural values.

The concept of naturalization is also very important when thinking about invasive species management. An understanding of this topic can inform a different approach to manage these newly introduced species. An example of naturalization is purple loosestrife. This plant was described as a very invasive plant for many years (Lavoie, 2009). This concept was amplified through communication with the public through the media. The mediaalso used language that vilified the plant, which resulted in extreme measures to get rid of it andultimately led to other native species being negatively impacted from the use of pesticides (Davis, 2009). However, this plant has been considered naturalized in some locations across southern Quebec since 1865 (Lavoie, 2009). Other views of purple loosestrife can be seen in studies that show that it can be used as an indicator for anthropogenic disturbance as opposed to something that is the sole cause for less diverse ecosystems. When comparing the SPTUNA from 2002 to the TLNAP, differences can be seen in the context of purple loosestrife. In the SPTUNA from 2002, purple loosestrife was mentioned as one of the species of concern and that immediate management

action should be taken, but in the TLNAP from 2021, purple loosestrife was not one of the species mentioned in the report (Trent University, 2002; Trent University, 2021).

Despite the variety of language about recently arrived species, I have chosen to use the term “invasive” for this paper. This is because it is part of common language, and it is the language that is used by Trent staff and will likely be used for the next couple year.

1.3 About this project

The purpose of this Community-Based Research project

The findings of the focus group are going to be used to inform the committee and management for their future decisions. The people who are involved with invasive species management, including the Nature Area Stewardship Committee, the Environmental Advisory Board and the Facilities and Management Advisory Committee and the Trent community will have more knowledge about data and information that is available about suchspecies on campus. They will also know more about different perspectives of their management after a focus group. This will hopefully help management staff make more informed decisions .

The research question for this paper are: what are the previous and current management practices that have been in place for the Trent Nature Areas? What would the current members of the committees and facilities management like to see in terms of invasive species management in the future?

2. Invasive Species Management Practices in the Trent Nature Areas Before the Implementation of the TLNAP (before 2021)

The TLNAP was implemented in 2021. The last stewardship plan for Trent University Nature Areas that mentioned invasive species was published in 2002. So, it had been almost 20 years since the last updated plan in regard to invasive species management (Jones et al., 2002).

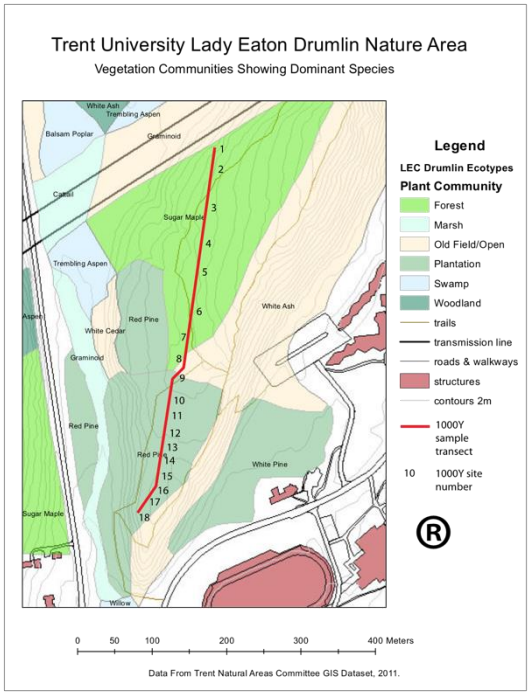
Even though both plans had had mentions of invasive species and calls to action, before the implementation of TLNAP there were no staff who tasked with managing the invasive species, or more broadly, managing the Trent Nature Areas (TNA) to improve the ecosystem health and diversity. This resulted in limited action being taken to remove invasive species from the TNAs. These finding are based on the information I have gathered throughout this project and people I have talked to. There have, however, been a first-year environmental course and a number of community-based research projects that investigated invasive species management and removal strategies in the TNAs.

2.1 First-Year Environmental Course: Buckthorn Lab

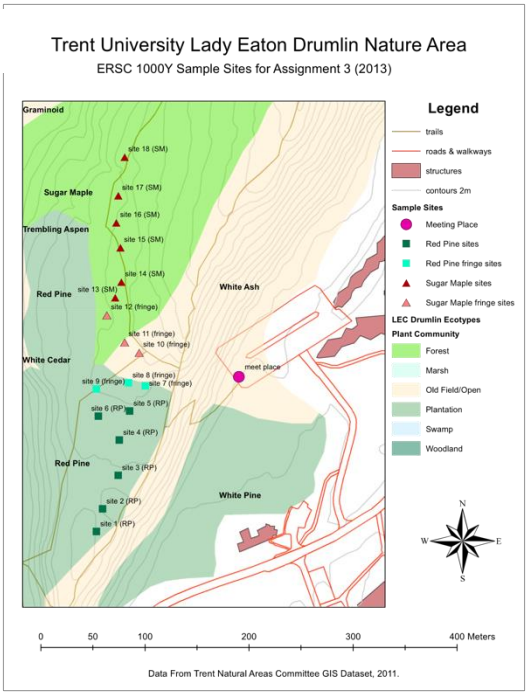
The first-year course, ERSC 1010: Foundation in Environmental Science/Studies, has conducted five buckthorn distribution laboratory assignments between 2012 and 2021. This assignment involved looking at buckthorn distribution on the Lady Eaton drumlin. The precision and accuracy of the data collected by the first-year students is uncertain since there were limited quality control and assurance tests, and the students had a small amount of training beforehand. Each year that the assignment was conducted, the sites and the methods changed slightly, which makes it more difficult to evaluate change over time. The assignments in 2012, 2013, and 2014 were consistent. However, the studies conducted in 2019 and 2021 were slightly different from each other and the first three years. The data collection methods that were used by the students in 2012, 2013, and 2014 were effectively identical, with slight variations in clarifying statements to the instructions. The sites used in this area are also quite similar, but not identical. There was also variation in the assignment details and data analysis, but that does not affect the data collected.

Some \ parameters of data collected from all five years are similar enough that it could be used to compare the differences between the years. These parameters include general location, total buckthorn, and total mature buckthorn. From this data, trends in change of distribution could possibly be noticed. Data analysis would be required to see if there are any noticeable changes. In Figure 2.1.1, the locations of the sites from the five years are shown in maps, and the exact coordinates are in Appendix A. Another difference is that in 2019 and 2021 each site only has one 10 x 10 m plot with the site marker in the south-east corner of the quadrat, whereas the earlier three years had four 10 x 10-meter plots surrounding the site marker. In the first three years of the study, the environment in which the plot was found was noted (red pine forest, sugar maple forest, or open field/no canopy). In 2019, a count of non-buckthorn plants that were taller than 1.3 m were recorded, and in 2021, data relating to other species was not collected by the students. The final main difference is that in the first three years, the diameter of the buckthorn was also recorded.

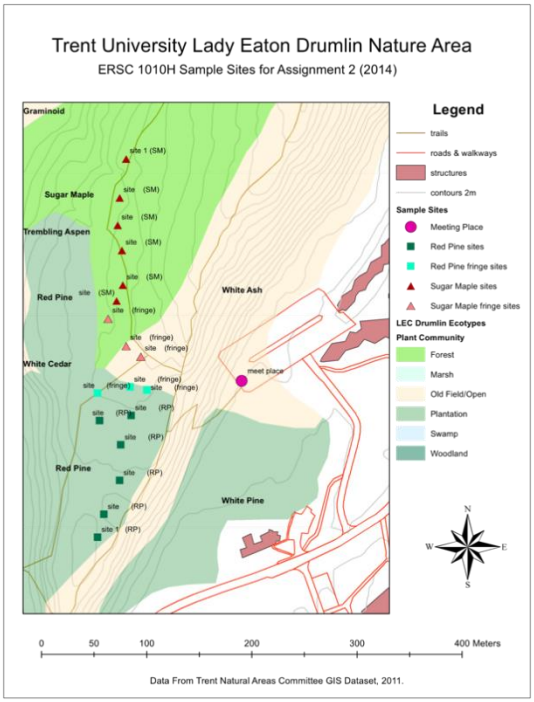
a)


Trent University Lady Eaton Drumlin Nature Area
Vegetation Communities Showing Dominant Species
Legend
LEC Drumlin Ecotypes
Plant Community
Forest
Marsh
Old Field/Open
Plantation
Swamp
Woodland
trails
transmission line
roads & walkways
structures
contours 2m
1000Y sample transect
10 1000Y site number
0 50 100 200 300 400 Meters
Data From Trent Natural Areas Committee GIS Dataset, 2011.

b)


Trent University Lady Eaton Drumlin Nature Area
ERSC 1000Y Sample Sites for Assignment 3 (2013)
Legend
trails
roads & walkways
structures
contours 2m
Sample Sites
Meeting Place
Red Pine sites
Red Pine fringe sites
Sugar Maple sites
Sugar Maple fringe sites
LEC Drumlin Ecotypes
Plant Community
Forest
Marsh
Old Field/Open
Plantation
Swamp
Woodland
Graminoid
Sugar Maple
Trembling Aspen
Red Pine
White Ash
White Cedar
White Pine
meet place
0 50 100 200 300 400 Meters
Data From Trent Natural Areas Committee GIS Dataset, 2011.

c)


Trent University Lady Eaton Drumlin Nature Area
ERSC 1010H Sample Sites for Assignment 2 (2014)
Legend
trails
roads & walkways
structures
contours 2m
Sample Sites
Meeting Place
Red Pine sites
Red Pine fringe sites
Sugar Maple sites
Sugar Maple fringe sites
LEC Drumlin Ecotypes
Plant Community
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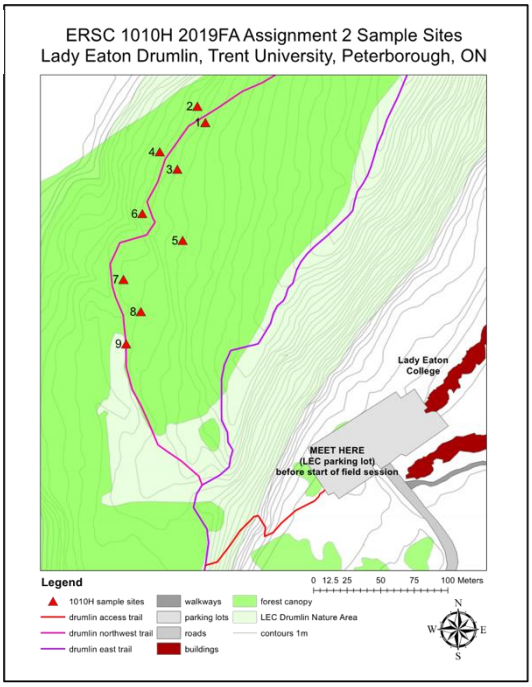
Plantation
Swamp
Woodland
Graminoid
Sugar Maple
Trembling Aspen
Red Pine
White Ash
White Cedar
White Pine
meet place
0 50 100 200 300 400 Meters
Data From Trent Natural Areas Committee GIS Dataset, 2011.

d)


ERSC 1010H 2019FA Assignment 2 Sample Sites
Lady Eaton Drumlin, Trent University, Peterborough, ON
Lady Eaton College
MEET HERE
(LEC parking lot)
before start of field session
Legend
1010H sample sites
drumlin access trail
drumlin northwest trail
drumlin east trail
walkways
parking lots
roads
buildings
forest canopy
LEC Drumlin Nature Area
contours 1m
0 12.5 25 50 75 100 Meters

e)

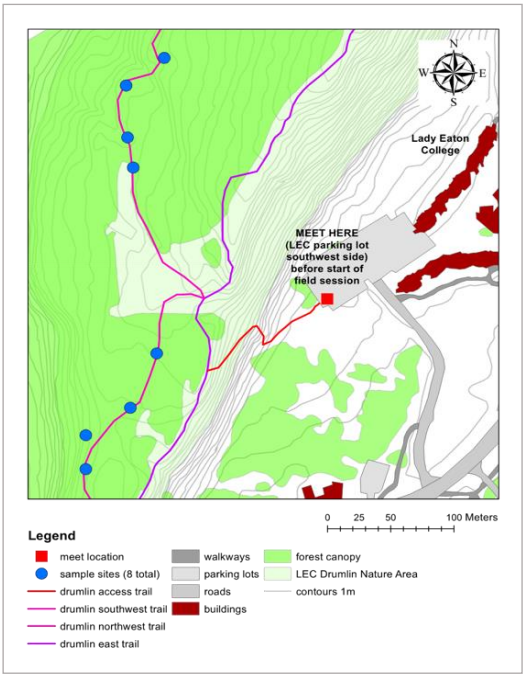


Figure 2.1.1. Sampling locations for the ERSC 1010 buckthorn lab. a) sampling locations in 2012. b) sampling locations in 2013. c) sampling locations in 2014. d) sampling locations in 2019. e) sampling location in 2021.

2.2 Community-Based Research Projects Invasive Species in Trent Nature Areas

In addition to the first-year environmental science/studies class, various undergraduate students completed four community-based research (CBR) projects with topics relating to invasive species and their management in the TNAs. There were two projects conducted in 2011 by Crowell and Pinder, K.; one in 2012 by Bolle; and one in 2016 by Fike, Fisher, and Fyfe.

Crowell (2011) conducted a CBR titled “Experimental eradication of invasive plant species.” This project involved an experimental eradication of Rhamnus cathartica (Common/European Buckthorn). They used three methods of eradication including glyphosate herbicide, cut and pull, and cut and cover. They observed a three-month growth period prior to the treatment and a three-month growth period after the treatment. Crowell found that applying herbicide was the most effective method at reducing the growth after the treatment. However, using herbicides poses many other threats to the ecosystem and requires significant financial resources, time, and effort. If there are enough resources, Crowell recommended using the

herbicide method or the cut and pull method. Otherwise, letting succession take its course is the best option moving forward.

Pinder (2011) conducted a CBR project titled "Experimental eradication of an invasive exotic vine in the Trent Nature Areas: Ecological implications of the management of dog-strangling vine (*Vincetoxicum Rossicum*)." This study looked into which herbicide would be most effective at eradicating the dog-strangling vine (DSV). The herbicides being tested were glyphosate treatment (Round Up) and acid treatment (Eco Clear) on the Lady Eaton Drumlin and the Morton Trail Drumlin in the Wildlife Sanctuary Trail, which were the two Trent Nature Areas with the highest concentration of DSV. A bi-weekly site analysis was conducted one week after the application of treatment in August. The study found that the glyphosate treatment was much more effective than the acid treatment. In terms of next steps, Pinder suggests communicating the results, which involves making the information accessible for people that are interested. Second, policies need to be revised and protocols need to be developed to support the growth of native plant communities in invaded areas and to develop eradication policies. Third, an action plan needs to be put in place, which could take the form of a campaign for the institution that encourages active stewardship. Finally, collaborations and partnerships should be promoted.

Bolle (2012) conducted a CBR titled "Quantity of Rhamnus *cathartica* L. (European buckthorn) found to have a deleterious effect on vegetative abundance and diversity on the Lady Eaton Drumlin, Trent University." This study was a follow up to the one that was conducted by Crowell (2011). The goal was to see if there was a relationship between the presence of European buckthorn and plant diversity. This was done by counting the number of *R. cathartica* present at each of the 13 sites as well as the number of other species at the site. Bolle found that

there was a negative relationship between the number of species and the amount of *R. cathartica* present. Bolle recommended involving the community for removal, creating a long-term plan if removal is the course of action, mapping out the density, tackling the areas that are less dense, and monitoring for future actions.

Fike, Fisher, and Fyfe (2016) conducted a CBR titled "Emerald ash borer (EAB) impact remediation." They did a generalized description of habitat and ecosystem characteristic for each of the nature areas to determine species composition, levels of succession, and intensity of invasive establishment. They then placed transects in priority areas with high ash density. At each transect, they determined multiple levels of species growth/establishment. They found that areas of priority were mainly populated by ash and buckthorn. This has effects on invasive gap succession where insects kill individual trees in invaded forest communities, which has a cascading effect on the ecosystem because the invasive trees take over the niche that the original tree was occupying (Gandhi & Herms, 2009). They suggest cutting down ash trees that may cause a problem if they fall. They also recommend keeping the wood that is cut down as local as possible, burn it, or mulch it heavily. Based on the distribution of buckthorn and its persistence, they recommend trying to suppress it so that it does not take over the niche. In addition to suppressing buckthorn, they recommend planting a combination of forbs, shrubs and trees that will contribute elements of biodiversity and ecosystem stability to the region.

All of these CBR projects can inform future management practices and provide some insight into the distribution and density of buckthorn and DSV as well as some of the other invasive species in the TNAs. Utilizing students to conduct research projects is a great opportunity to provide students with learning experience and can help the university collect data

that would otherwise cost too much. A similar project could also be conducted through the honors thesis course.

3. Invasive Species Management Practices in the Trent Nature Areas since the implementation of the TLNAP (2021) to current (2021- March 2023)

At Trent, there are a number of people who play a role in invasive species management within the Trent Nature Areas (NAs). The most hands-on person is the Land Stewardship Coordinator (LSC) (currently Ali Giroux). They then report to the Director of Campus Planning and Development (currently Jennifer Clinesmith), who in turn reports to the Associate Vice President of Facilities Management (currently Bruno Bianco). Additionally, they also receive guidance from the Vice President of External Relations and Development (currently Julie Davis). A systems-level plan for the University Green Network, which includes the TNAs, is in development. This will speak to prioritizing invasive species and their control. Implementation of invasive species actions will occur annually and involve the Director of Campus Planning and Development, the LSC, the Landscape and Grounds Ops Coordinator (currently Dave Grove), and the Manager of Facilities Services (currently Chris D'Innocenzo). There is also occasional consultation with the Nature Areas Stewardship Advisory Committee (NASAC). NASAC is a committee composed of Trent students, faculty, and staff who report to the Facilities and Grounds Advisory Committee (FGAC) (Trent University, n.d.). Their role includes providing advice about the management of the TNAs, develop proposals about appropriate university and public use of the TNAs, seek advice from the Environmental Advisory Board about environmental implications, and bring any educational policy implications of the TNAs to the attention of the FGAC. There have been some changes in the past couple years, including new positions, and the development and implementation of the Trent Lands and Nature Areas Plan

(TLNAP). So, the exact roles and responsibilities of each position and the NASAC are still being worked out regarding invasive species management.

In 2021, the TLNAP was finalized, and the Director of Campus Planning and Development was hired. Then, in 2022, a Land Stewardship Coordinator (LSC) was hired. In the 2021 TLNAP, there are several points that relate to invasive species management.

> Invasive Species Management: Map invasive species within the NAs (e.g., Dog Strangling Vine, European Buckthorn, Phragmites (australis)). Identify priorities for management (e.g., by species, severity, proximity to sensitive habitats). Conduct removal / management activities. Engage students and / or courses in conducting appropriate portions of this work (Trent University, 2021, p.184)

The LSC is responsible for writing a systems-level plan for the University Green Network (UGN), which includes the TNAs, and individual TNA Plans. The Director of Campus Planning and Development oversees the implementation of the TLNAP. Integral components of creating the system's-level plan and TNA Plans includes doing an assessment of the diversity within the TNAs, evaluating corridors and connections between natural areas, and getting a general idea of ecosystem health. One of the key parts of determining the ecosystem health of the TNAs is figuring out the distribution and abundance of various non-native invasive species. While refining the vegetation communities within the UGN, using the Ecological Land Classification for Southern Ontario manual (Lee et al., 1998), the LSC can also get an idea of invasive species occurrence and abundance. This method includes identifying species within the four vegetative layers in a community as seen in Table 1, and within each layer determining the abundance of each species, as seen in Table 2. This will help determine the vegetation

community classifications and help determine what invasive species are here and how abundant they are in each of the TNAs. Occurrences are also mapped, to assist with prioritization.

Table 3.1. Codes used in the ELC manual to stratify vegetation according to layers:

Code	Layer	Definition
1	Canopy	Highest layer of vegetation; receives incident (direct) sunlight
2	Sub-Canopy	Vegetation layer under the canopy; does not, for the most past, receive direct sunlight
3	Understory	Vegetation layer intermediate in height between the canopy and ground layer, e.g., in a forest it would be represented by the shrub and sapling layer
4	Ground (GRD) Layer	Vegetation layer that is nearest to the substrate surface

Table 3.2. Codes used in the ELC manual to estimate the abundance of plant species within the polygon:

Code	Abundance	Definition
R	Rare	Represented in the polygon by less than about three to five individuals or small clumps
O	Occasional	Represent as scattered individuals throughout the polygon or represented by one or more large clumps of many individuals; most species will fall into this category
A	Abundant	Represented throughout the polygon by large numbers of individuals or clumps; likely to be encountered anywhere in the polygon; usually forming > 10% ground cover
D	Dominant	Represented throughout the polygon by large numbers of individuals or clumps; visually more abundant than other species; forming > 10% ground cover and > 35% vegetation cover in any stratum

The NAs that are being evaluated were mapped and labelled. Refer to Figure 1

Figure 3.1. Map of communities being evaluated and their labels

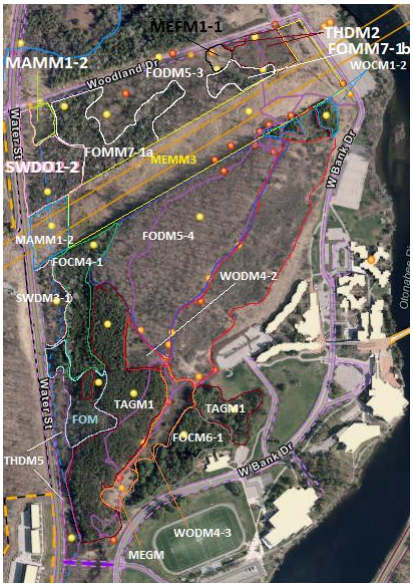


Table 3.3. Example of what the spreadsheet looks like once it has been filled out with the layer and abundance data.

Species	Dominance	Notes
Canopy:		beautiful deciduous forest, EWPE calling; identifed as an FOM in Figure 6
Sugar Maple	D	**FODM5-3: Dry-Fresh Sugar Maple - Oak Deciduous Forest Type**
Trembling Aspen		
White Ash	A	
Paper Birch	O	
Red Oak	D	
Sub-canopy:		
Ironwood	A	
White Cedar	O	
White Ash	A	
Basswood	O	
Buckthorn	O	
American Elm	R	
Balsam Fir	O	
Blue Beech	O	

Once an assessment of the TNAs has been completed, management plans can be developed. One of the primary goals includes increasing the biodiversity so that the ecosystem can be healthier, and this includes removing invasive species to allow the ecosystem and native species to flourish unimpeded. For individual invasive species control, the LSC refers to the 'Best Management Practices Database' published by the Invasive Species Centre (Invasive

Species Centre, n.d.). In this database, there are management plans for different species that were developed by a variety of organizations.

The Director of Campus Planning and Development and the Land Stewardship Coordinator have determined that invasive phragmites management is a priority due to the threat it poses to the wetlands in the TNAs and its highly invasive nature. In order to determine which areas to focus on first for phragmites management, the LSC used a prioritization tool created by the Ontario Phragmites Working Group (Ontario Phragmites Working Group, n.d.). Control of invasive phragmites will involve an integrated pest management approach using pesticides. Additionally, a large patch of dog-strangling vine was cut and then mechanically and chemically controlled. For buckthorn management, the LSC plans to start in areas that have a lower density of buckthorn and pending success in these areas, will move to the areas with higher density, over the next couple years.

4. Focus group

A focus group was conducted with people who play a direct or indirect role on the management of invasive species management in the TNAs

4.1 Focus Group Methods Outline

Logistics

Date: Monday February 27th from 1:30 PM – 3:00 PM

Location: KWIC Centre, ESB B.101

Confirmed participants: Colin Cassin, Jennifer Clinesmith, Chris D'Innocenzo, Ali Giroux, Stephen Hill, Robert Loney, Eric Sager, Tom Whillans, and

Cannot attend: Joanna Freeland

Brief description of people invited to participate:

- Colin Cassin: Policy and Program Development Manager at Invasive Species Centre. He is also a Trent alumnus.
- Jennifer Clinesmith: Director of Campus Planning & Development. She is in charge of leading the implementation of the Trent Lands and Nature Areas Plan. She started in 2021.
- Chris D'Innocenzo: Manager of Facility Services. He is in charge of any facilities management, which includes the nature areas.
- Joanna Freeland: Professor in the biology department and current chair of the Nature Areas Stewardship Committee.
- Ali Giroux: Land Stewardship Coordinator. She is in charge of creating the Nature Areas Plan which will be a part of Trent's Green Network Plan. She started in 2022.
- Stephen Hill: Director of the Trent School of the Environment and associate professor in the Trent School of the Environment. He was on the NASAC for several years.
- Robert Loney: Demonstrator-Technician for the Trent School of the Environment. He has also been part of the NASAC for many years.
- Eric Sager: Course Instructor at Trent and program co-coordinator for the Ecological Restoration Joint Program with Fleming College. He also has an interest in invasive species and their management.
- Tom Whillans: Professor emeritus and program co-coordinator for the Ecological Restoration Joint Program with Fleming College. Was on the Nature Areas Stewardship Committee for many years.

The consent form was sent out and signed by all participants before the focus group. This form can be found in Appendix B.

The purpose of this focus group was to ascertain a baseline understanding of staff and faculty perceptions of invasive species and invasive species management on the Trent University Peterborough Campus, specifically in the Trent Nature Areas. A secondary purpose of this focus group is to develop hypothetical future directions for Trent University's invasive species management plans.

This focus groups had three main goals. The first being that the participants partake in engaging conversation about invasive species and their management the TNAs. The second is that organized dialogue space will be provided in which meaningful conclusions can be reached. The final goal was to gain insight into various perspectives of invasive species management in the TNAs.

Agenda

- The entire focus group will last one and one half (1.5) hours.
- The first 15 minutes will be spent introducing the project and explaining how the focus group will work. Each participant will also have the opportunity to introduce themselves and how they influence the management of invasive species in Trent's Nature Areas.
- The remaining time will be divided into 15-minute periods. Each 15-minute time period will consist of participants writing answers to the questions on cue cards and discussing, as a group, their collective answers.
- During each 15-minute time period, participants will have 5 minutes to write down their answers in groups of two or three. During the remaining 10 minutes the small groups will rejoin and discuss their ideas as a whole group.
- After each time period, the cue cards will be collected and placed together. Once the cards are placed, a photo will be taken of the cards to be analyzed in the final paper.

Notes about activity.

- For the activity, we will be using the free listing and pile sorting method. This will involve introducing the following questions, one at a time:

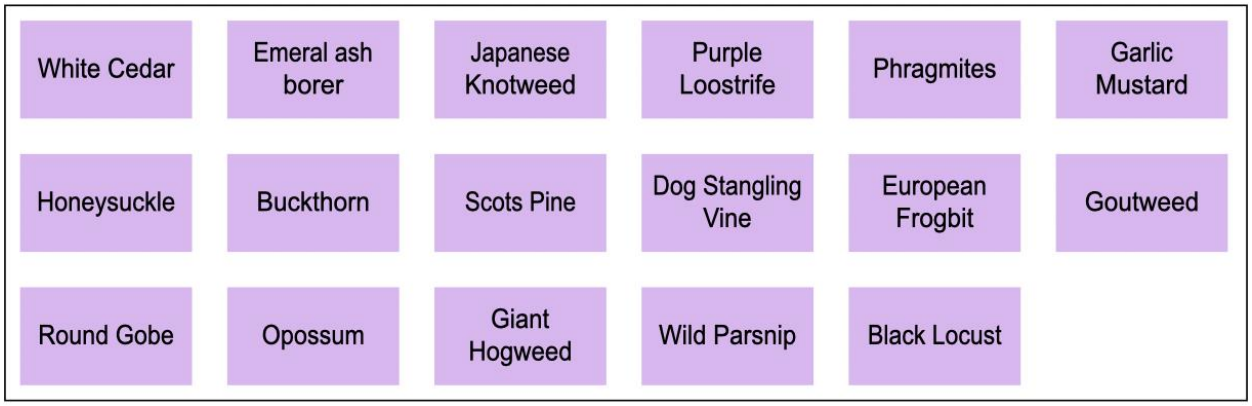
1. Of the invasive species found in the Trent Nature Areas, which are you most concerned about?
2. Of the species that you are concerned about, what are some ecological impacts or threats they pose?
3. Taking into consideration resources available and the ecological impacts of invasive species in the Trent Nature Areas, what management practices would you like to see implemented?
4. How has your perception of invasive species management changed over time?
5. What do you know about the concept of naturalization, and would you give the invasive species in the Trent Nature Areas the opportunity to naturalize?

- Once the group has heard the question, the participants will go into groups of two or three (or individually for question 4). Each group will write down 2-4 responses to each question. The main idea (or central theme) will be written on the front of the card. Any additional detail can be written on the back of the card.
- Once everyone is done writing their answers (5 minutes), the participants will place their cards down one at a time in the center of the table. If the cards are the same, they can be piled on top of the other. If they are similar, they can be placed one above the other, for example.

- Once all the cards have been placed, the group can go over the results, add anything that is missing, and/or reorganize the cue card in a manner that makes sense for the question and answers.

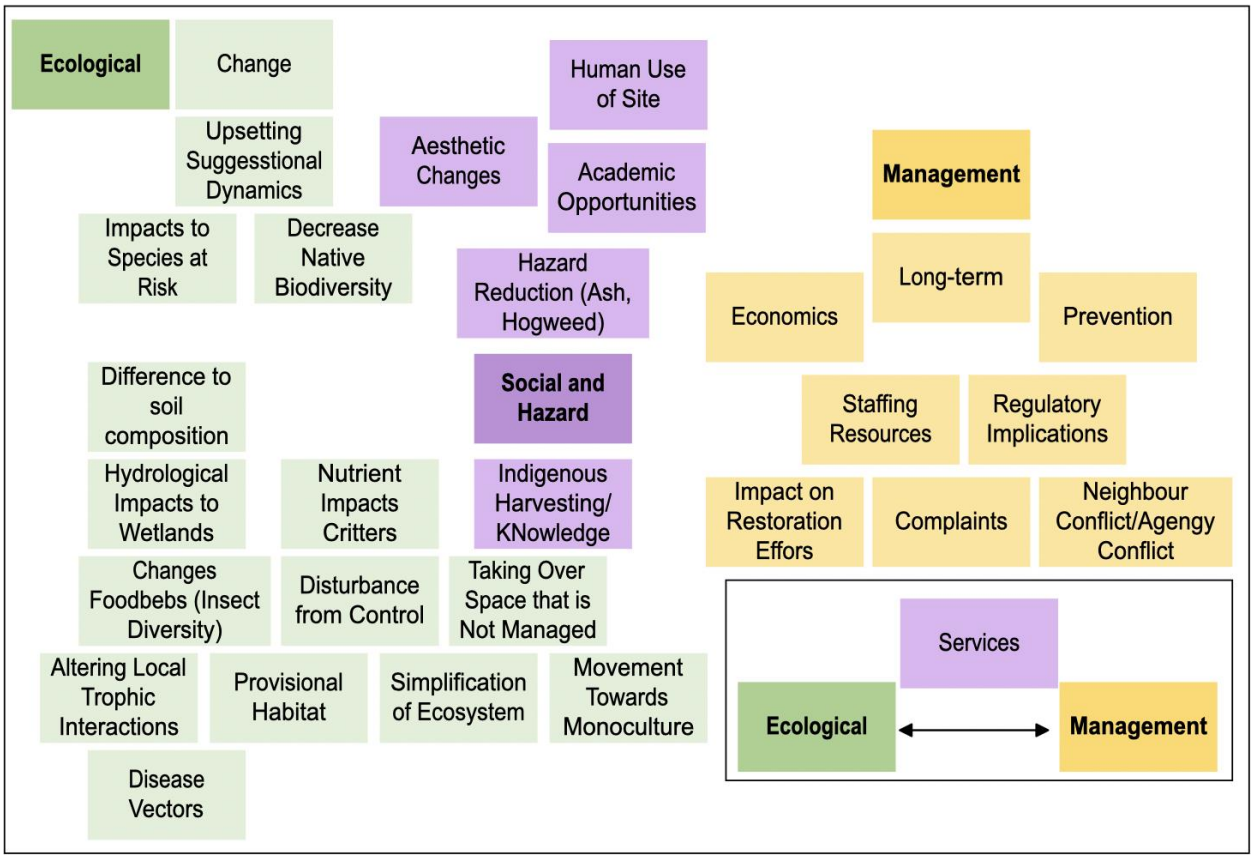
4.2 Focus Group Summary

Figure 4.2.1. Responses from the first question: Of the invasive species found in the Trent Nature Areas, which are you most concerned about? Photo in Appendix C.1



The list of species mentioned by the participants of the focus group were based on the individual's definition and perceptions of "invasive species." One of the participants asked if the species they could list also included species that have invasive tendencies (i.e., native species with the potential to dominate an ecosystem and damage biodiversity). In general, participants listed species that have been identified as "invasive" by invasive species organizations. However, one in particular, white cedar, is not typically considered "invasive." During the discussion for this question, white cedar did not really come up. But in a side discussion in one of the later questions, the density, overpowering population, and the history of white cedar in the TNAs was brought up. Buckthorn and dog-strangling vine (DSV) were the two main invasive species that everyone mentioned, showing that these are the most visible species. Most of the other species (listed in Figure 4.2.1) were mentioned one to three times.

Figure 4.2.2. Of the species that you are concerned about, what are some ecological impacts or threats they pose? Photo in Appendix C.2



The participants ended up sorting the results from the second question into two main categories, ecological (in green) and management (in yellow). Caught in between the ecology and the management are the impacts on the human users of the land (in purple). Invasive species management also affect a variety social service. This can be positive or negative. This is because the areas where the invasive species are shared with many people who use the land and often don't like the presence of the invasive species.

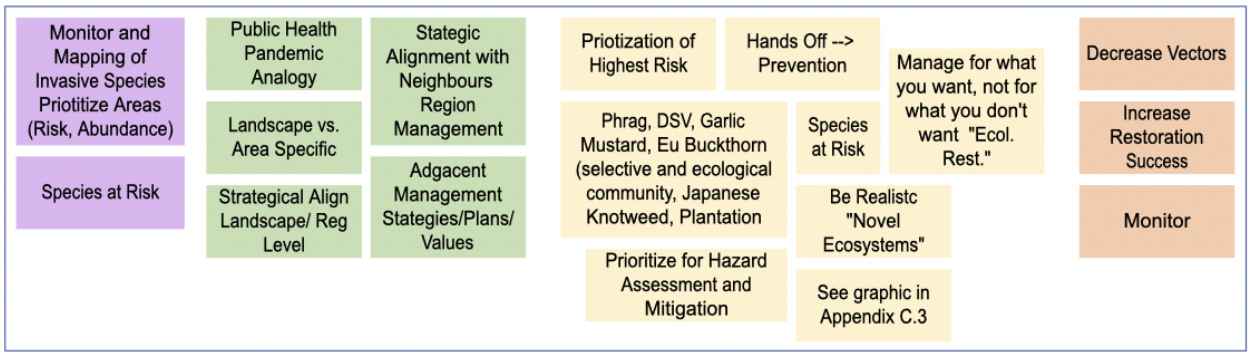
The ecological impacts that were written down include a variety of changes. The concern about change is a common theme in the literature (Davis, 2009). One of the negative impacts of management that was mentioned was relating to the disturbance that is caused by control and

mitigation of invasive species to the broader ecosystem beyond the impacts of the invasive species. There was also the beneficial impact of provisional habitat that invasive species provide.

Another aspect to the problem is the management aspect of invasive species. Invasive species cause problems for the people who are in charge of managing the land and who deal with public relations. Management and ecological issues influence each other because the management affects the ecology of the land, and the ecological integrity determines the management of the lands.

Most of the responses were related to the ecological impacts of invasive species. This could be interpreted to show that most people are knowledgeable about the ecological impacts, and the social and managerial impacts of invasive species are a side thought. This could be because only a few people need to deal with the social and managerial impacts of invasive species.

Figure 4.2.3. Responses from the third question: Taking into consideration resources available and the ecological impacts of invasive species in the Nature Areas, what management practices would you like to see implemented? Photo in Appendix C.3



In order to determine where the areas of priority are, a general assessment needs to be done of the Trent Nature Areas, including species at risk and abundance of invasive

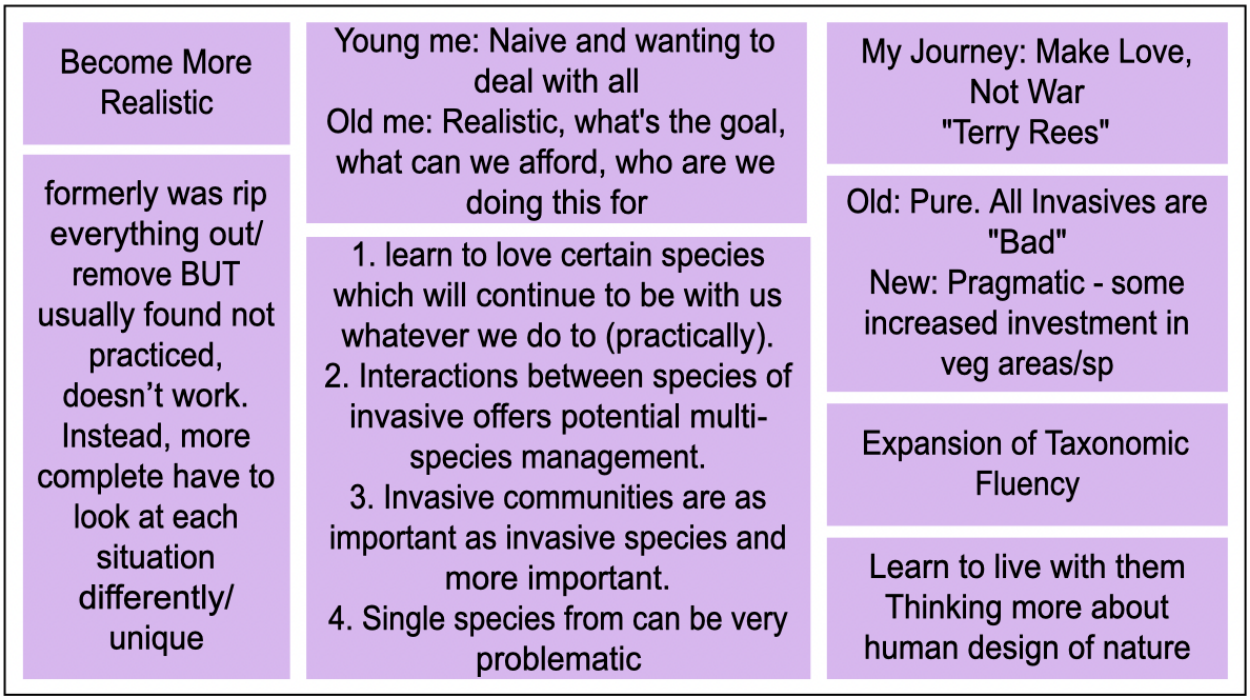
species. Once that has been done, an assessment of local policies, strategies, and values can be taken into consideration. From there, the management strategies can be decided on. This decision needs to be made based on a variety of priorities and goals. Priorities for species risk, which incorporates some of the ecological impacts discussed in the second question. Other possible priorities could include hazard assessment and mitigation/prevention. Once priorities have been set, some goals can be set to guide management. These could include reaching a novel ecosystem as opposed to what was there before, as well as managing for what is desired as opposed to managing for what is undesirable. Another goal mentioned was increased restoration success.

Finally, monitoring the area is also important. The initial mapping is only useful for setting a baseline and is only applicable for a couple years. Monitoring will help inform management decisions and priorities.

Participants also highlighted the potential detrimental impacts of invasive species in communities where knowledge systems and subsistence are intimately intertwined with the natural environment. Specifically, concerns were raised regarding the effects of a changing ecological landscape on the knowledges and harvesting of local First Nations. This concern is consistent with the mandates outlined in the TNA Plans (Trent university, 2021) to include Michi Saagiig and other Indigenous Peoples as equal stakeholders in decisions regarding the lands, including relevant invasive species management discussions.

Something that wasn't mentioned in the focus group, but it a common theme in the literature is the importance of public engagement (Moon et al., 2015). In order for invasive species management to be socially acceptable, stakeholders need to understand the reasoning behind management.

Figure 4.2.4. Responses to the fourth question: How has your perception of invasive species management changed over time? Photo in Appendix C.4.



A lot of the participants seemed to have had a relatively significant shift in their thinking of invasive species management over time. There were a couple comments that mentioned the influence of human intentions on management strategies. In their new way of thinking, the participants said they thought about "human design of nature" and "who we are doing this for," for example. Others have simply become more aware of the existing species around them. Others have become more practical in their understanding of invasive species management. Whether or not the reasoning behind this change in understanding was relating to a broader question about the rationale behind management or simply practicality is another question. There were also a few comments that mentioned learning to live with the invasive species. In this case, people might still want to rip everything out, but acknowledge that it is not possible with the resources available. There are many different stages of understanding, depending on individual interactions with nature. As some of the participants have started working with these species, they have

found that you cannot simply remove everything and the goals and reasoning behind the action needs to have more thought put into it. In general, most people started off with the idea that everything should be removed. This shows that there is a general societal idea that plants that are considered to be “invasive” are to be removed, that they are all bad, and that removal is the only solution to obtain a healthy ecosystem.

The final question was not discussed during the focus group due to time constraints. The final question was: what do you know about the concept of naturalization, and would you give the invasive species in the Nature Areas the opportunity to naturalize? This question would have provided more insight into some alternate management strategies. It would have also given an idea of people’s thoughts on naturalization in the Trent Nature Areas. This question could be incorporated into future research.

5. Discussion and Recommendations

5.1 Focus Group

The results from the focus group show that the species of concern, the impacts as a result of the presence of invasive species, the management and the perspectives on invasive species are very intersectional and there are many stakeholders. Therefore, including as many voices when it comes to decision making and methods of decision will be very important. The voices of the Indigenous elders, knowledge holders, students, and community members are especially important because of their teachings and knowledges are very connected with the land. Including Indigenous voices may be slightly more challenging in the setting of a community-based research project because of the time restraints and the process of ethical approval.

5.2 Management Recommendations

Since one of the barriers to management is the amount of effort that is takes, engaging student and community members in invasive species removal events could be effective. This way, Trent staff wouldn't have as much to do, and it would provide students and community members with a great opportunity. The NASAC has provided guidance and support for community-based research projects and the members of the committee have some good ideas and valuable knowledge regarding invasive species management. As the management structure is sorted out and the mandates for NASAC are developed, accessing the committee as a resource for advice on invasive species management could prove to be very valuable. The Michi Saagiig Elders and Traditional Knowledge Keepers Council, and Land Consultation Officers, as well as the First People's House of Learning (FPHL) were contributors in the creation of the TLNAP (Tret University, 2021). In future discussions and decisions, these contributors must be present. Likewise, researchers and Trent administrators should consult with them about other important Indigenous voices whose ideas and expertise should help inform invasive species planning, such as representatives from local First Nations, Elders, and other knowledge keepers. Finally, since one of the main contributors to the amount of invasive species found in the TNAs today was from the abandonment of old-field, management plans for potential abandoned lands should be in place.

5.3 Undergraduate Opportunities

Both courses and research courses could provide a great opportunity for students and valuable information for management of the land. Based on the data collected by the ERSC 1010: Foundations of Environmental Science/Studies, student data collection as part of a class is a great way to collect a large amount of data, provides an opportunity for meaningful

assignments, and helps the university have a better understanding of the changing ecosystem and inform their management decisions. Since some of the data collected is consistent between the years of data collection, an assessment could potentially be done to see if any trends are noticeable throughout the sporadic decade of data collection. Moving forward, looking into methods for a long-term monitoring program for ERSC 1010 would be a very useful. Looking into other invasive species that could be monitored during the school year and measurable by students would also be very useful. Two or potentially three species could be monitored in a cycle. Jones et al. (2002) also suggest incorporated a course where students on nature and environmental education would learn how to conduct an interpretive walk in the Nature Areas. CBR projects and honors thesis projects are a great opportunity as well.

5.4 Future Research

There are many possible avenues where research could expand on this topic and on other topics relating to the Nature Areas. One of the most obvious avenues as a follow up to this study would be to do another evaluation of Trent's Invasive Species Management within the Nature Areas. Since the TLNAP was recently implemented, there are still some things being sorted out. Doing another assessment 3-10+ years from now would likely have some interesting findings. Doing a project that focuses more on the perceptions of a wider range of stakeholders including students, Indigenous People, faculty, staff, community members and experts of invasive species management in the Nature Areas would also be a really interesting study. A survey could potentially be used to gather information about perceptions of stakeholders. Future studies could also look into what people think about naturalization. Some of the research opportunities that are suggested by Jones et al. (2002) include looking into geomorphology and climate research, recreation use, and impact studies. They also suggest that the nature areas are a great place to

look at successional studies of farmlands, large rivers, and river edge ecological studies. Another idea would be to look at how the reduction of habitat diversity effects plant and animal populations. Future research should incorporate Indigenous voices through the willing and enthusiastic participation of local First Nations. In order for the topic of research to be relevant and useful, consultation with the LSC, NASAC, FPHL, management staff, and professors is suggested.

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Appendix A

A.1. Site coordinates from ERSC 1010 buckthorn lab in 2012

Site No.	Location- Latitude	Location- Longitude
16	44° 21' 23.8" N	78° 17' 43.9" W
15	44° 21' 24.2" N	78° 17' 44.1" W
6	44° 21' 31.4" N	78° 17' 44.0" W
9	44° 21' 28.1" N	78° 17' 43.9" W
2	44° 21' 35" N	78° 17' 43.7" W
5	44° 21' 32.3" N	78° 17' 44.0" W
4	44° 21' 32.7" N	78° 17' 43.9" W
8	44° 21' 29.1" N	78° 17' 44.7" W
14	44° 21' 24.7" N	78° 17' 43.9" W
12	44° 21' 25.9" N	78° 17' 43.9" W
17	44° 21' 23.3" N	78° 17' 45.0" W
18	44° 21' 22.7" N	78° 17' 45.7" W
13	44° 21' 25.3" N	78° 17' 44.0" W
10	44° 21' 27.4" N	78° 17' 44.1" W
11	44° 21' 26.8" N	78° 17' 44.4" W
1	44° 21' 36.1" N	78° 17' 44.0" W
7	44° 21' 30.5" N	78° 17' 44.2" W
3	44° 21' 33.8" N	78° 17' 43.9" W

A. 2 Site coordinates from ERSC 1010 buckthorn lab in 2013

Site No.	Location- Latitude (° N)	Location- Longitude (° W)
1	44.3564	-78.29573333
2	44.3566	-78.29565
3	44.35688333	-78.29545
4	44.35718333	-78.29541667
5	44.35743333	-78.29528333
6	44.3574	-78.29566667
7	44.35765	-78.29508333
8	44.35768333	-78.29528333
9	44.35763333	-78.29568333
10	44.35793333	-78.29515
11	44.35803333	-78.29531667
12	44.35826667	-78.29551667
13	44.35841667	-78.29541667
14	44.35855	-78.29533333
15	44.35885	-78.29533333
16	44.35906667	-78.29536667
17	44.3593	-78.29533333
18	44.35963333	-78.29525

A. 3 Site coordinates from ERSC 1010 buckthorn lab in 2014

Site No.	Location- Latitude (° N)	Location- Longitude (° W)

1	44.3564	-78.29573333
2	44.3566	-78.29565
3	44.35688333	-78.29545
4	44.35718333	-78.29541667
5	44.35743333	-78.29528333
6	44.3574	-78.29566667
7	44.35765	-78.29508333
8	44.35768333	-78.29528333
9	44.35763333	-78.29568333
10	44.35793333	-78.29515
11	44.35803333	-78.29531667
12	44.35826667	-78.29551667
13	44.35841667	-78.29541667
14	44.35855	-78.29533333
15	44.35885	-78.29533333
16	44.35906667	-78.29536667
17	44.3593	-78.29533333
18	44.35963333	-78.29525

Appendix B

Research Participant Consent Agreement

You are being invited to participate in a focus group. Please read this consent form so that you understand what your participation will involve. Before you consent to participate, please ask any questions you need to be sure you understand what your participation will involve.

INVESTIGATOR:

This research study is being conducted by Kira Nixon (student in the Trent School of the Environment department, Trent University).

If you have any questions or concerns about the research, please feel free to contact Kira Nixon at kiranixon@trentu.ca.

PURPOSE OF THE STUDY:

This undergraduate community-based research project is being done for Trent's Nature Areas Stewardship Committee. The previous and current invasive species management practices will be reviewed for this project, in addition to the focus group. This focus group will be conducted with people who play a direct or indirect role in invasive species management in the Trent Nature Areas. This might include members of Trent's Nature Areas Stewardship Committee and facilities management. The focus group will aim to acquire information about what the current members think should be done to address the invasive species within the Trent Nature Areas. It will also aim to get the participants thinking about their view of invasive species management.

WHAT PARTICIPATION INVOLVES:

In participating, you will be asked to do the following:

- To consider and sign this consent form.
- To participate in a focus group discussion, activity involving writing ideas on cue cards in a group.

The cue cards will be amalgamated and analyzed for the final report.

POTENTIAL BENEFITS:

The results of this study will have benefits for the participants because it will help improve invasive species management in the Trent Nature Areas. It will also help generate ideas for potential invasive species management in the Trent Nature Areas.

WHAT ARE THE POTENTIAL RISKS TO YOU AS A PARTICIPANT?:

No risks are anticipated.

CONFIDENTIALITY:

At any point during the focus group, the participants can stop participating. The participants can also scratch out or remove any contributions during the focus group, if they would like. The responses cannot be associated with any of the participants directly. Therefore, once the focus group is done, participants can no longer remove their responses.

You have the option to include your name in the study. Your name will not be associated with the responses.

INCENTIVES FOR PARTICIPATION:

There are no incentives for participation.

COSTS TO PARTICIPATION:

There are no costs to participate in this study.

COMPENSATION FOR INJURY:

By agreeing to participate in this research, you are not giving up or waiving any legal right in the event that you are harmed during the research.

VOLUNTARY PARTICIPATION AND WITHDRAWAL:

Participation in this study is completely voluntary. You can choose whether to participate or not. If any question makes you uncomfortable, you can skip participation without penalty. Your choice of whether and how to participate will not influence your future relations with Trent University and the investigator (Kira Nixon) involved in the research, or your ability to participate in future research.

You may withdraw from this study at any time by leaving during the focus group. Once the focus group finishes, the responses cannot be changed.

POTENTIAL CONFLICTS OF INTEREST:

There are no potential conflicts of interest to report.

POTENTIAL COMMERCIALIZATION OF THE RESEARCH FINDINGS:

We do not anticipate any commercialization of the research findings.

QUESTIONS ABOUT THE STUDY:

If you have any questions about the research now, please ask. If you have questions later about the research, you may contact Kira Nixon (kiranixon@trentu.ca).

This study has been reviewed by the Trent University Research Ethics Board, the study number is [ROMEO Protocol Number 28292]. If you have questions regarding your rights as a participant in this study, please contact:

Jamie Muckle,

Coordinator, Research Conduct and Reporting.

Phone: 705-748-1011 ext. 7896.

Email: jmuckle@trentu.ca jmuckle@trentu.ca

CONFIRMATION OF AGREEMENT:

☐ I have read, or have had read to me, the information in this agreement;

☐ I consent to having my name mentioned in the report;

☐ I have asked any questions I have about the study;

☐ By signing, I agree to participate in the study;

☐ I am aware I can change my mind and withdraw consent to participate before or during the focus group;

☐ I have been given a copy of this agreement; and

☐ I am not giving up any legal rights by signing this consent agreement.

_____

Name of Participant (please print)

_____ _____

Signature of Participant Date

Appendix C

Photos from the focus group

C.1. Photo from the first question

C.2. Photo from the second question

C.3. Photo from the third question

C.4. Photo from the fourth question