

URBAN FORESTRY PLAN OF
BIRCH POINT PARK DISC GOLF COURSE

By

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ABSTRACT

This urban forestry plan is for the sustainable management of the Birch Point disc golf course in Thunder Bay. A tree inventory was conducted on the course to create a map and gain information to aid in making management decisions. Approximately 750 trees and 21 species were surveyed. White spruce, white birch and poplar were the most common species found on the course. The majority of trees surveyed were considered rather healthy. Issues seen on the course include erosion and compaction, health issues, trees growing in proximity to utility lines and the suspected presence of bronze birch borer and tomentosus. Some of the recommendations within the plan include application of woodchip mulch, use of alternate course layout, and the planting of a diversity of species. This plan is intended to aid with the continuing progression of the Birch Point disc golf course now and far into the future.

Keywords: Urban Forest, Urban Management Plan, Disc Golf, Health Benefits.

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INTRODUCTION AND OBJECTIVES

Urban forests are a valuable asset that adds many qualitative and quantitative benefits to cities. The urban forest affects many aspects of the urban setting and there is a need to ensure proper management. Through the implementation of proper management, urban planners can ensure that they are achieving the most benefits while operating in a sustainable manner within their municipalities. A common tool used by urban planners pertaining to the urban forest is an urban forest management plan.

The following thesis will be used to create an urban forest management plan for the Birch Point Disc Golf Course (BPDGC). Currently there is no management plan in place for this course. The work done in this thesis will help to ensure that the space will be properly managed now and well into the future. It is important that appropriate management be in place for urban recreational areas, to ensure sustainability while maximizing benefits. This plan will help with the continuing progression of the BPDGC.

The work for this thesis was mainly conducted in two locations, the BPDGC found at Boulevard Lake and at Lakehead University. A large portion of the urban management plan was creating a tree inventory of the disc golf course. Over 700 trees were inventoried, and based on the information gathered, other environmental and social influences, a management plan was created.

The data collected for this thesis was conducted following the work done by the City of Thunder Bay's urban forestry division. All information gathered for the tree inventory followed the same format of existing records of municipal tree inventories. The data collected consists of GPS coordinates and specific attributes of the trees on the disc golf course. The inventory was used to create an accurate map of the area that can assist in the management of the course. The thesis student as well as volunteers consisting of peers and members of the disc golf community collected the data.

The focus of the literature review is on three main topics, the sport of disc golf, the history of parks in cities, including the benefits of green spaces and Thunder Bay's urban forest. In addition, the history and use of Boulevard Lake is explored to gain context on the area. The urban forestry management plan of Thunder Bay will also be analyzed to help give direction to the plan for the disc golf course, as similar objectives will have to be met. The research conducted will help to create an effective management plan by highlighting the main aspects, history and the issues surrounding urban forestry.

The objective of this management plan is to manage the park area effectively to promote the sustainable growth and health of all trees and vegetation in the best interest of all park users. The plan will have to take into consideration achieving sustainability, appropriate management and consideration of time when making decisions. It is also recognized that the park area is found within the Robinson Superior treaty on Fort William First Nation traditional land. The plan will incorporate the management of existing trees as

well as new trees. Additional objectives of the plan include ongoing tree maintenance program. Scheduled tree pruning, removal and replanting efforts should be implemented. In addition, the park will need to be managed in a manner to enhance ecosystems functions and health. Regular monitoring will need to occur to evaluate the performance and identify any trends that may require a change in management approaches. Within the plan there will also be sections regarding social aspects of the community. The disc golf course provides the community with education and partnerships that can help to invigorate the local economy and maximize benefits for local citizens. A consultation process will be included within the plan to identify values and any concerns. These values will be incorporated into the plan and suggestions will be made for the ongoing maintenance and maximization of these values.

LITERATURE REVIEW

DISC GOLF

Disc golf is a sport that was started by Frisbee enthusiasts as a new and fun way to play with Frisbees. It is similar to regular golf; however, it differs where instead of using golf clubs and balls, players use different styled discs (Disc Golf Association n.d.). Discs vary for use, for example just as a regular golfer has a driver, 5 iron and a putter, disc golfers also use a different disc for driving, mid-range and putting (Disc Golf Association n.d.). Instead of aiming for a hole, discs are thrown at a metal basket that has chains hanging from above and a basket below (Disc Golf Association n.d.). Although the basket styled hole is the conventional style there are other types of holes that are found on disc golf courses (Disc Golf Association n.d.). Just as in regular golf, the main objective of disc golf is to finish each hole with as few throws as possible (Disc Golf Association n.d.). Courses vary with the amount of holes found, however typically courses can contain either nine or eighteen holes (Disc Golf Association n.d.). There is a designated amount of throws associated with each basket, which is referred to as par (Disc Golf Association n.d.).

It is believed that “Steady” Ed Headrick started Disc golf in Pasadena California. Headrick designed and installed the first ever course in 1975, and later that year he also founded the professional disc golf association (Trendaflova & Waller 2011). Before this, the sport was played in a more unofficial way, where Frisbees were thrown at designated golf holes (Disc Golf Association n.d.). These holes were usually distinguishable landmarks that

could be thrown to (Disc Golf Association n.d.). For example, light posts, fire hydrants, trees and water fountains were used as designated holes (Disc Golf Association n.d.). This early play of the sport influenced the creation of the sport and how it is played today.

By the nineties disc golf began to emerge as a new sport, which provided an affordable option for all to play (Oldakowski & McEwen 2013). Over ninety percent of all disc golf courses in the United States are public courses (Oldakowski & McEwen 2013). Almost all of these public courses are found in existing parks, which also offer other recreational opportunities (Oldakowski & McEwen 2013). In some cases, there are also disc golf courses that are found on traditional golf courses that are no longer being used (Oldakowski & McEwen 2013). By 1990, there were approximately 250 courses in the United States and by the year of 2000 there were more than 800 courses (Oldakowski & McEwen 2013). In 2010 there were over 2720 courses within the U.S 20 of these courses being found in Hawaii and Alaska (Oldakowski & McEwen 2013). In addition, the popularity of the sport was also rising in the rest of the world, there were approximately 500 courses mainly being found in Canada and Europe (Oldakowski & McEwen 2013).

Disc golf has grown rather quickly as a sport compared to traditional golf. In its 35 years of existence over 3000 courses have been constructed, compared to golf where less than 1000 courses were constructed in its first 40 years of existence (Oldakowski & McEwen 2013). This could be due to the relative inexpensiveness of the sport, as disc golf courses are usually found in

public parks making less of a need for paying customers. These factors as well as low maintenance costs create an affordable option to create disc golf courses within communities (Oldakowski & McEwen 2013).

Disc golf courses are generally constructed to have minimal disruptive and invasive effects on the environment. The actual popularity of the sport could be attributed to this idea of preserving the natural landscape. There is little done to alter the natural environment other than the placement of tee pads and holes (Oldakowski & McEwen 2013). The tee pad is where the thrower makes their initial throw from; generally, there is a tee pad for each basket (Oldakowski & McEwen 2013). Tee pads vary in size and shape depending on the course (Oldakowski & McEwen 2013). Tee pads can be made from concrete, wood or other materials or can be as simple as stakes or worn down grass. It is important that tee pads are not a slippery surface when wet and placed in a high area to prevent flooding (Oldakowski & McEwen 2013).

There are many benefits associated with disc golf, such as providing an opportunity for users to enjoy green spaces at a relatively low cost (Siniscalchi & Pierskalla 2016). Courses are often found in park settings, meaning there are associated physiological and physical benefits that come from being in a green space (Siniscalchi & Pierskalla 2016). Disc golf provides valuable recreational opportunities to communities. Urban managers are tasked with the challenge to provide quality recreational opportunities to attract visitors while still maintaining the natural environment (Siniscalchi & Pierskalla 2016). The challenge is to preserve and promote local community's identity while

operating on limited economical resources. Disc golf can be viewed as a solution to this challenge (Siniscalchi & Pierskalla 2016).

Disc golf courses provide communities with a recreational opportunity that maintains the natural environment while being able to be created and maintained at a relatively low cost (Siniscalchi & Pierskalla 2016). Courses are easily constructed and are a fraction of the cost of conventional facilities (i.e. basketball courts, tennis courts and golf courses) (Siniscalchi & Pierskalla 2016). A disc golf course would cost a community approximately \$200-\$500 per hole (Siniscalchi & Pierskalla 2016).

Disc golf courses can help to revitalize unused spaces found within communities. Courses are easily constructed and can be constructed on a variety of terrains (Siniscalchi & Pierskalla 2016). There is a disc golf course in Santa Cruz, California, which was once an illegal dump that was high in unregulated ATV traffic (Siniscalchi & Pierskalla 2016). Since the course's construction, the space has been trash free and there is less ATV traffic (Siniscalchi & Pierskalla 2016). As discussed there are positive aspects associated to disc golf, however like many other outdoor recreational activities there are some negative ecological effects.

There are some negative ecological effects associated with disc golf, however, if properly managed for they can be minimized. There have been some cases in California where courses have been closed due to environmental problems associated with excessive use and lack of a management plan

(Trendaflova & Waller 2011). Specifically, destruction of undergrowth plants, damage to the bark of trees from discs, soil erosion and compaction are the main issues (Trendaflova & Waller 2011). Overall, the most prevalent ecological impact is soil compaction, specifically around tee pads and baskets (Trendaflova & Waller 2011).

Soil compaction is a serious ecological issue that commonly occurs at disc golf courses. Soil compaction can lead to reduced plant density, less successful reproduction of grass species and is the primary factor limiting plant growth in urban soils (Trendaflova & Waller 2011). High traffic is the main cause of soil compaction, as the soil becomes compacted there is decrease in the rate of water infiltration and an increase in soil erosion (Trendaflova & Waller 2011). This is apparent on disc golf courses in high traffic areas where players often congregate, where holes overlap and around pads and baskets (Trendaflova & Waller 2011). These negative impacts can be minimized or avoided through proper management and education. One way that soil compaction and erosion can be avoided is through the application of woodchip mulch (Trendaflova & Waller 2011). Approximately 6 inches of woodchip mulch can be spread around in areas of high traffic (Trendaflova & Waller 2011). The application of mulch increases the level of organic matter in areas where otherwise would have decreasing levels of organic matter due to high foot traffic (Trendaflova & Waller 2011). High foot traffic is unavoidable as it is part of the sport however there are certain management options that can be used to minimize the effects. The use of concrete tees, and defined pathways

along the fairway and between holes can minimize compaction and erosion (Trendaflova & Waller 2011). Another option that can be used is to move the baskets around the park every few months creating an alternate course layout (Trendaflova & Waller 2011). Moving the baskets would allow vegetation to grow back and recover as well as provide a different experience for players maintaining full enjoyment of the course (Trendaflova & Waller 2011).

Education of players can be a useful management strategy, as it is in fact human behavior that creates soil compaction. By educating players of what the existing problems are, they would be more likely to change their behaviors in attempts to minimize impacts (Trendaflova & Waller 2011). It can be assumed, that disc golf players typically appreciate green spaces and would be more than cooperative to act in a sustainable manner in order to sustain their local courses (Trendaflova & Waller 2011). However, it should be noted that compared to traditional golf, which uses chemicals to keep the fields green and the removal of trees to design the course, that disc golf's impacts are minimal (Trendaflova & Waller 2011).

HISTORY OF URBAN FORESTRY

Historically, settlers in North America were not interested in green spaces within their cities (Hutchison 2016). It was not until the late 1700's that communities began to think about planting trees within towns and around houses (Hutchison 2016). The first trees planted were mainly found within gardens owned by different religious orders (Hutchison 2016). Philadelphia

was one of the first main cities within the United States to incorporate having green spaces and introducing non-native species within their community (Hutchison 2016). The first botanical garden was established in Philadelphia in 1760 (Hutchison 2016). In New England, the city was built around a green space to allow an area to store livestock when under attack (Hutchison 2016). Later in the 1700s, these pasture lands were converted into parklands with trees and lawns (Hutchison 2016). After the United States independence, trees began to be viewed differently, with more of a moral connection towards them (Hutchison 2016). Cities began to dedicate more land to green space and plant more trees (Hutchison 2016).

Within Canada, British garrisons were the first to plant urban trees (Hutchison 2016). In Toronto specifically, there were no street trees or parks until the 1830s (Hutchison 2016). After the industrial revolution, the romantic landscape movement began to take hold within Canada (Hutchison 2016). This movement caused city beautification efforts such as the creation of landscaped city parks and an increase in the planting of trees on city land (Hutchison 2016). The first large city parks were constructed near the boundaries of cities but as the cities developed and expanded these parks began to become enclosed (Hutchison 2016).

The first early developments of vegetation management in North America mainly consisted of tree planting, tree maintenance and landscape architecture (Johnston 1996). It was not until the mid-1960s that the total management of urban forests systems took place (Johnston 1996). One of the

main reasons for the introduction of the proper management of urban forests was the emergence of deadly North American diseases such as the Dutch elm disease, Phloem Necrosis, and Oak Wilt (Johnston 1996). The need for proper management and research was recognized and specific courses in arboriculture began to be offered at many universities (Johnston 1996). These new courses were offered to meet the needs for competent individuals to be trained in urban forestry within cities (Johnston 1996).

It was in 1965 that the term urban forestry was first coined by the University of Toronto. The term was created in response to a request to name or give a title for a graduate student's study of the success and failure of municipal tree planting programs within Toronto. The term was not an immediate success in Canada, but professional foresters in the United States responded positively to the term and began to use it to describe the cultivation and management of trees in urban areas. The term was favored to the existing terminology used to describe this type of forestry. Historically Municipal forestry or arboriculture were terms used to describe this discipline of forestry, however they failed to effectively describe the integrated management of the entire urban forest (Johnston 1996). Although Urban Forestry originated in Canada, it mainly remained an academic subject (Johnston 1996). However, in the United States it became a national movement, there were positive attitudes toward the urban forestry as both a term and a concept (Johnston 1996).

The International Society of Arboriculture (ISA) was one of the main influences of the urban forestry movement and one of the main promoters of

the urban forest in North America and the rest of the world (Johnston 1996). The ISA produced publications, which played an important role in the early promotion of urban forestry concepts (Johnston 1996). In addition, the Society of American Foresters (SAF), a professional body of foresters in the United States, formed an Urban Forestry Working Group (UFWG) in 1972 (Johnston 1996). The formation of the UFWG showed that foresters were becoming more conscious of the urban role. Similar to the ISA, the SAF currently plays a leading role in the urban forestry movement in the United States (Johnston 1996).

The first comprehensive urban forestry conference took place in 1971 at the University of Massachusetts. The conference was titled "Trees and Forests in an Urban Environment" (Johnston 1996). During this conference, scientists raised their concerns with the difficulty of communicating results of their studies on urban trees to those who may use this information (Johnston 1996). There was a lack of sharing of information, and few authoritative sources which were recognized by all foresters (Johnston 1996). This lack of diversity made it difficult for scientists to know where to share their findings (Johnston 1996). To solve this problem a national urban forestry conference was held 1978 (Johnston 1996). The conference was very successful with over 450 delegates attending from the United States and Canada (Johnston 1996). The main goal of the conference was to bring together large numbers of scientists and practitioners and firmly establish the concept of Urban Forestry in the United States (Johnston 1996).

In the mid-20th century within America, Urban Forestry had grown into a sophisticated and lively field (Leahy 2016). There began to be a change in people's perspectives concerning the role of trees in the urban setting (Leahy 2016). The urban forest had begun to be more widely viewed as a value and there was a greater pressure for it to be managed appropriately. Various studies show the urban forests positive impacts on crime, domestic violence, ADHD symptoms, cultural isolation, neighborhood stability and student grades (Leahy 2016).

Urban forestry has evolved from individual tree care in the early 20th century to more comprehensive urban ecosystem management in the mid-20th century, to the current discipline today which is a fully integrated system encompassing other disciplines into urban forestry (Leahy 2016). In addition, as the discipline of urban forestry has developed there is a need for further education of the public to allow for recognition of just how valuable of an asset the urban forest truly is (Leahy 2016).

BENEFITS OF GREEN SPACES

Parks and recreation are a valuable resource and provide better quality of life for the public. A report conducted in America based on people's opinions on local recreation and park services, found that Americans almost unanimously agree that their communities benefit from local parks (National Recreation and Park Association 2016). This support was regardless of whether or not participants regularly used park services or local recreation

(National Recreation and Park Association 2016). Some of the main points of the survey were that the public strongly believes in parks and recreation and that the quality of life increased by public parks should be a more prominent concept in municipalities (Roth 2016).

For over 200 years in America, it has been recognized that parks are essential to community health (Lombardi 2016). Parks improve ecological health through plant and water systems in parks and community health through clean air and access to nature (Lombardi 2016). Neighborhoods associated with greenness were associated with lower chronic disease risks for residents on these blocks (Lombardi 2016). Specific risk reductions were found: 14% decrease in diabetes, 13% decrease in hypertension and a 10% decrease in lipid disorders. A general statistic that they found was 49 fewer chronic conditions per 1,000 residents (Lombardi 2016).

Health disparities within the United States are often closely related to social, economic and environmental disadvantages faced by an individual (Yingling 2016). These disadvantages are often found in segregated neighborhoods that lack proper investment in infrastructure and amenities (Yingling 2016). Typically, there is a lack of green spaces found in these lower income areas, and it is important to incorporate green spaces as they offer many health benefits. Those who use parks are overall healthier than non-park-users (Yingling 2016). Parks provide the space to be able to perform a variety of physical activities, and provide natural settings for people to visit and social interactions that help to reduce stress and promote a healthy lifestyle (Yingling

2016). In addition, parks and recreation facilities that offer free and low cost activities can help to alleviate health disadvantages in lower income populations (Yingling 2016).

The Journal of Environmental Health Perspectives found that the higher the amount of green near a person's home the lower the risk of all-cause, non-accidental mortality (Banner 2016). This green was described as any street trees, parks or abandoned spaces. Living near green spaces reduces one's chances of cancer, heart disease and diabetes (Banner 2016).

Where there is a lack of green infrastructure there is a decrease in quality of life. Unfortunately, there is a lack of access to parks and green spaces in the most disadvantaged communities, which is rather unfortunate as these areas could benefit the most (Banner 2016). These more disadvantaged communities are often found in areas with fewer trees, polluted waterways, higher levels of air pollution and a higher chance of experiencing crimes or violence (Banner 2016). There is also a much shorter life expectancy within these communities (Banner 2016)

Urban forests provide significant benefits for the environment. Trees provide important ecological functions that can be seen as direct cost savings for a municipality as well as invigoration of local economy (City of Vancouver 2007). In comparison to traditional urban structures that are man-made and devalue over time, the benefits of green infrastructure only grow. Storm water management is a significant cost of urban planning and can be a serious

problem in storm event (City of Vancouver 2007). The urban forest helps to reduce the load on municipal water treatment facilities as well as removes pollutants from the water (City of Vancouver 2007). In addition, trees help to improve air quality, by absorbing air pollutants and filtering particulate matter. Most importantly trees produce oxygen, which is vital for all life (City of Vancouver 2007).

There is also a sense of value that is associated with urban forests. It is proven that improving the aesthetics of a community is directly linked with economic benefits (City of Vancouver 2007). A city that is filled with large recreational areas and green spaces will attract more people to live and visit. An easily measurable benefit is property value in the real estate market. A property with trees and vegetation will be more likely to be sold at a higher price than a property without these (City of Vancouver 2007). Furthermore, trees can entice people to spend more money at a retail location (City of Vancouver 2007).

URBAN FOREST MANAGEMENT PLANS

As discussed, the urban forest has many benefits and it is very much associated with many aspects of urban planning. As it is such a valuable asset it is integral that it be managed effectively. The urban forest needs to be considered during urban planning as it affects urban infrastructure such as power lines, sewers, sidewalks and roads (City of Vancouver 2007). To address this municipalities create an urban forest management plan. An urban forest management plan aids in making decisions to maximize benefits and ensure

sustainability (City of Vancouver 2007). These plans are created to enhance and preserve the urban forest for usually a period of ten to twenty years (City of Vancouver 2007).

Urban forests vary significantly from that of a natural forest, thus there is need be managed differently. The urban setting can be a very harsh, unfavorable setting for trees to grow. Planning must occur to ensure that the urban forest succeeds. Proper management will help to achieve sustainability and tree vigor in the urban forest (City of Vancouver 2007). The ideal urban forest is one that is comprised of trees of different ages and species, as diversity helps to make a resilient forest that is more resistant to large-scale pests or disease infestations (City of Vancouver 2007). A simple general rule can be followed regarding to species selection; no more than 10% of the urban tree population should be the same species, no more than 20% of any genus and no more than 30% of any family (City of Vancouver 2007). Ideally, species which are resistant to drought, poor soil conditions and other urban setting conditions should be chosen (City of Vancouver 2007).

A tool often used by urban foresters that is an important part of an urban forest management plan is a tree inventory. A tree inventory helps to properly manage an urban forest, by having an accurate and precise inventory; managers are able to make informed decisions regarding the management of trees (Hutchison 2016). When making certain decisions regarding specific species, or certain ages of trees, a tree inventory can be very helpful (Hutchison 2016). Inventories allow managers to quantify the monetary value of their urban

forests. By being able to determine a value of the urban forest it is easier for managers to show municipal government the benefits of investing in the urban forest (Hutchison 2016). In addition, inventories can also be used to identify trees of special concern which, should be properly protected. These trees can be special due to their large size or historical significance within communities (Hutchison 2016).

Tree inventories provide crucial information that can be used throughout the municipal government. The management of urban forests is connected with other departments such as planning and streets, as a result of this there is a need for up to date accurate information (Hutchison 2016). Inventories allow managers to be able to provide important information when communicating about management decisions (Hutchison 2016). In addition, inventories allow managers to provide property owners with quick and sufficient answers to questions pertaining to urban trees (Hutchison 2016).

Another tool that is used by urban managers to benefit the health of the urban forestry is a citizen pruner program. As there are typically limited resources available for municipal urban forestry sectors, having a citizen pruner program is invaluable (Cornell 1990). City arborists do not always have enough time to maintain all trees (Cornell 1990). This is why having a pruning program can be very effective, producing high quality work at a low cost to the municipality (Cornell 1990). Citizen Pruning programs provide an opportunity for citizens to get involved in their urban forests. Volunteers are trained by the city to work on public trees and run the program. Through education citizens

are able to maintain urban trees which they see as values within their municipality (Cornell 1990). Volunteers view the program as an opportunity to maintain their urban forests and help to beautify their city (Cornell 1990). In addition, citizens learn valuable skills that they can apply on their own trees at their homes (Cornell 1990). Citizen pruner programs are a valuable tool that can be incorporated within urban forestry plans.

THUNDER BAY'S URBAN FOREST

In 2011, the City of Thunder Bay contracted Davey Resource Group to create an urban forestry management plan. The main vision of the management plan is to have a sustainable, safe, healthy and diverse forest that optimizes public and environmental benefits (Davey Resource Groups 2011). Along with this vision, objectives were outlined within the plan including: recommendations, a comprehensive review of the urban forest, establishment of short, medium and long term strategic management objectives and a seven-year urban forest management work program (Davey Resource Groups 2011).

Thunder Bay is the largest City in Northwestern Ontario; it is surrounded by the Boreal Forest and Lake Superior (Davey Resource Groups 2011). The urban forest of Thunder Bay is not the most immense compared to other major Canadian cities (Davey Resource Groups 2011). In total, the urban forest consists of 989 hectares of forested land, 960 hectares of designated park land and 29 hectares found in suburban residential areas (Davey Resource Groups 2011). Thunder Bay's urban forestry program is operated through the

Parks division and is lacking proper funding and workers (Davey Resource Groups 2011). The Parks division is a part of the cemeteries, Forestry and Horticulture section of Thunder Bay (Davey Resource Group 2011).

There were a variety of recommendations which were created as a result of the management plan pertaining to Thunder Bay's urban forest. The recommendations applied to a variety of sectors of urban forestry including; tree inventory, costs, municipal forestry management, tree planting and maintenance, urban forest health, risk management and plan implementation (Davey Resource Groups 2011). Looking at some of the recommendations that were all deemed as a high priority, a theme of improper management becomes apparent (Davey Resource Groups 2011). Increased tree diversity, improvements in pruning programs, revamped tree by-laws, and the emerald ash borer infestation are just a few recommendations which can all be linked to a lack of proper funding (Davey Resource Group 2011).

The City of Thunder Bay's urban forestry program operates under an underfunded budget. The urban forestry program's current yearly budget is \$705,000 (Davey Resource Groups 2011). Overall the main cost for the City involves the removal, pruning and planting of trees, with 68% of the budget going to paying for these expenses (Davey Resource Groups 2011). The rest of the budget pays for litter and storm cleanup, administration, inspection, along with many other expenses (Davey Resource Group 2011).

Thunder Bay's urban forest offers many quantifiable benefits to the City and its citizens. The total annual benefits to the community are estimated to be

\$1.6M, or \$85 per tree (Davey Resource Groups 2011). A benefit-cost ratio concluded that the benefit-cost ratio of managing the urban forest exceed 2:1 (Davey Resource Groups 2011). For every dollar spent, the City receives benefits of approximately \$2.21 (Davey Resource Groups 2011).

Currently the City of Thunder Bay has a citizen pruner program which, has been in place since 2011 and was the first of its kind in Canada (City of Thunder Bay n.d.). Each year the program trains 25 new volunteers, in return the volunteers must be involved in a minimum of three two hour supervised work sessions in a calendar year (City of Thunder Bay n.d.). A local arborist provides the volunteers with intensive training on proactive tree pruning (City of Thunder Bay n.d.) The program has been rather successful with a high level of interest from the community (City of Thunder Bay n.d.).

BOULEVARD LAKE

Boulevard Lake is a recreational area found within the City of Thunder Bay. There is a rich history of the lake that has evolved along with development of the City of Thunder Bay. Some of the Boulevard Lake area was originally private land owned by James Lyon, one hundred and twenty three acres of land were acquired by the City of Port Arthur from 1893-1914 (City of Thunder Bay n.d.). The entire Boulevard Lake complex area is approximately 650 acres (City of Thunder Bay n.d.). Initial construction in the area began with the original dam being constructed in 1902 that, was then replaced by the current dam in 1907 (City of Thunder Bay n.d.). Throughout the following years

further development occurred in the area with Black Bay Bridge being constructed in 1911, Lyon Boulevard park drive being opened and the boat house in 1936 (City of Thunder Bay n.d.).

The area has been used for a variety of events within the community. Which, incorporate the lake as well as the path that circles the lake. Athletic events including biathlons, triathlons and various walks and runs have all taken place at the lake (City of Thunder Bay n.d.). As well, there have been many boating events: for example, the annual dragon boat races and wake board contests (City of Thunder Bay n.d.). The space also has a public beach with lifeguards on duty in the summer months, and a public skating rink on the lake in the winter (City of Thunder Bay n.d.).

Within the Boulevard Lake area is the Birch Point Park. The area was given a park status by the City of Thunder Bay in 2000 (City of Thunder Bay n.d.). Birch Point Park provides space to enjoy the outdoors, with picnic areas, bathrooms, parking lots and a disc golf course (City of Thunder Bay n.d.). In 2010 the BPDGC was installed (City of Thunder Bay n.d.). The course was the first of its kind in Thunder Bay, and is an 18-hole par 3 and 4 course (City of Thunder Bay n.d.). The course provides something for all levels of players, and has been a great success within the City of Thunder Bay (City of Thunder Bay n.d.)

Currently there is a Boulevard Lake area improvement plan that is being developed by the City of Thunder Bay. The plan is being made in collaboration

with consultants from EDS Group, True Grit Consulting Ltd, and Northern Bioscience (City of Thunder Bay n.d.). It is a high-level conceptual plan that contains recommendations pertaining to future developments and management of Boulevard Lake (City of Thunder Bay n.d.). Highlighting some of the main aspects of the plan are community engagement, site assessment, conceptual design, accommodation of uses, and phased implementation (City of Thunder Bay n.d.).

MATERIALS AND METHODS

All of the data was collected at Birch Point Park (48.45, -89.19.), a municipal park in Thunder Bay. Data collection occurred in the spring and fall of 2016. Surrounding the park is Boulevard Lake a manmade lake found along the Current River. A dam is located on the lake that regulates water flow, increasing and decreasing water levels. The water flowing out of the lake follows the Current River into Lake Superior. A recreational path cuts through the park and circles the entire lake. To the east of the park is a residential area known as Current River in Thunder Bay.

The thesis student as well as many volunteers from the disc golf community, and peers recorded the data. As the park contained many trees, it took several outings to complete. Every tree on the greens of the course was assessed.

The management plan area was defined by the boundary of the BPDGC. An inventory of the original BPDGC area had been collected in 2010, and this

information was provided to the thesis student. Using a handheld Global Positioning System (GPS) device, all the trees within the area of the original BPDGC were located based on their coordinates (latitude and longitude), and their mensuration information updated. However, it should be noted that the pre-existing inventory, was missing GPS coordinates for many of the trees found on the course, because the current BPDGC covers an expanded area within Birch Point Park. In instances where the tree being surveyed was not found within the pre-existing inventory, a new GPS waypoint was created. These waypoints were recorded using a Garmin GPSMAP64 unit, while holding the unit as close to the tree as possible.

Individuals surveyed in pairs to collect all the information. Typically, it was the thesis student along with a volunteer collecting the data. The thesis student was always in charge of ensuring data collection was organized and pairs were working in the right areas. Typically, the thesis student was the one collecting all the data and GPS coordinates.

In addition to their locations, data was collected to develop the forest inventory used in this management plan. For each tree, diameter at breast height (DBH), tree height class, health rating, species, proximity to power lines and any additional notes were recorded. DBH was measured to the nearest 0.1 cm using DBH measuring tape, which was wrapped around the trunk of each tree at 1.3 meters above the ground.

The species of each tree was identified using features and appropriate reference material (Farrar 1995). Typically, surveyors assisting with the inventory were forestry students so their findings can be considered reliable.

When a health rating was assigned to each tree, surveyors looked for apparent health defects like frost cracks, broken branches, poor form, and exposed roots. To determine the health rating the entire tree was assessed including roots, trunk, scaffold branches, smaller branches, twigs, foliage and buds. Each tree was assigned a health rating between 1 and 5. A health rating of 1 was assigned to trees that were dead and a health rating of 5 indicated the tree was in perfect condition. It is important to note that it was rare to achieve a health code of 5 in the natural landscape and can be usually only achieved in an arboretum. If a tree had no apparent health defects, then a rating of 4 was given. As trees were assessed the rating decreased proportionally depending on the severity of defects or pathogens that were observed. For example, a tree with only one relatively small health defect (frost crack) was given a rating of 3.5. If a tree had two defects or one defect of a very large size (broken branches and exposed roots, or highly damaged trunk) it was given a rating of 3. If a tree had three or four health defects it was given a 2.5 or 2. Lastly the rating of 1.5 was assigned to trees that were critically damaged and are susceptible to mortality in the near future. As this rating system is subjective, there was some room for variability amongst results.

Each tree was also assigned a height rating between 1 and 3, 1 was a juvenile tree, 2 an intermediate tree and 3 was a mature tree. Height was based

on the apparent size of the tree however, the DBH was used to help with the classifying of height class. Any trees with a DBH less than 10 cm were given a height rating of 1 a DBH of 10 cm – 25 cm were given a height rating of 2 and trees with a DBH greater than 25 cm were given a height rating of 3.

While surveying trees, they were also inspected for any potential conflict with power lines or city infrastructure. Several trees on the BPDGC have grown into, or were growing underneath power lines and may require removal or pruning at some point. Potential for power line conflict was recorded as a simple yes or no. Any additional notes were also recorded for each tree. These notes could be regarding specific tree health issues, interesting features or anything of important relevance to that tree.

In addition to the inventory of individual trees on the disc golf course, species composition and basal area were determined using a 2.0m²/h a wedge prism in more densely wooded areas of the course. The locations of the plots can be seen in figure 1 below: prism sweeps 1-3 were found in grove 1; 4 was grove 2; 5-7 was grove 3; and 8-9 was grove 4. Wedge prism sweeps were a standard method used by foresters to determine the basal area of a stand in m²/ha. To conduct a prism sweep one marked a central spot on the ground and moved in a complete circle above this spot holding the prism at arm's length viewing all trees. When looking through the prism the user determined whether trees were in, out or borderline. If a tree's trunk extended in continuation above and below the prism it was in. If there was a gap in between the view of the prism and the tree above or below then it was out. In circumstances where the

surveyor is unsure and the tree is deemed borderline a simple test was done to determine whether or not it was in. To perform this test, the distance between the center of the tree in question and the surveying point needed to be measured. Next the DBH of this tree is needed to be measured and multiplied by .3535, if the distance measured was less than this calculation, it was in and was out if it was greater. Lastly, the number of trees determined in was multiplied by the prism's basal area factor (2) to calculate the basal area.



Figure 1 Location of prism plots

Upon completion of data collection for the tree inventory, the data was organized and inputted into a spreadsheet. This file was formatted to show all trees and their associated attributes and waypoints. Each tree had its own

individual column along with its respective attributes including: species, height, DBH, relation to power lines, health and any comments. Once all data was compiled into a spreadsheet it was converted into a shapefile and uploaded into ArcMap™ version 10.4.1(ESRI n.d.)

ArcMap™ was used to create a map of the BPDGC showing the entire tree inventory and features of the course. To create the map, first the attributes of the inventory along with the waypoints were imported into ArcMap™ as shape files. Next, the tree attributes and GPS coordinates shapefiles were joined to match the waypoints with their respective attributes. Separate symbols were used for coniferous and deciduous trees, and the relative size of the symbols used reflected the different height codes associated with each tree. The geographic coordinate system used for the map was GCS_WGS_1984. World street map, a generic basemap available within ArcMap™ was used to show Boulevard Lake, the roads, and the paved recreational path within Birch Point Park on the map. Coordinates for the locations of beginner tee pads, regular tee pads and baskets were also incorporated into the map.

RESULTS

MAP OF INVENTORY

The map shows the entire tree inventory, as well as specific features such as baskets, regular and beginner tee pads, tee distances, and Boulevard Lake. Also found on the map is infrastructure including the recreational path, parking lots and nearby roads. The map is presented on the next page.

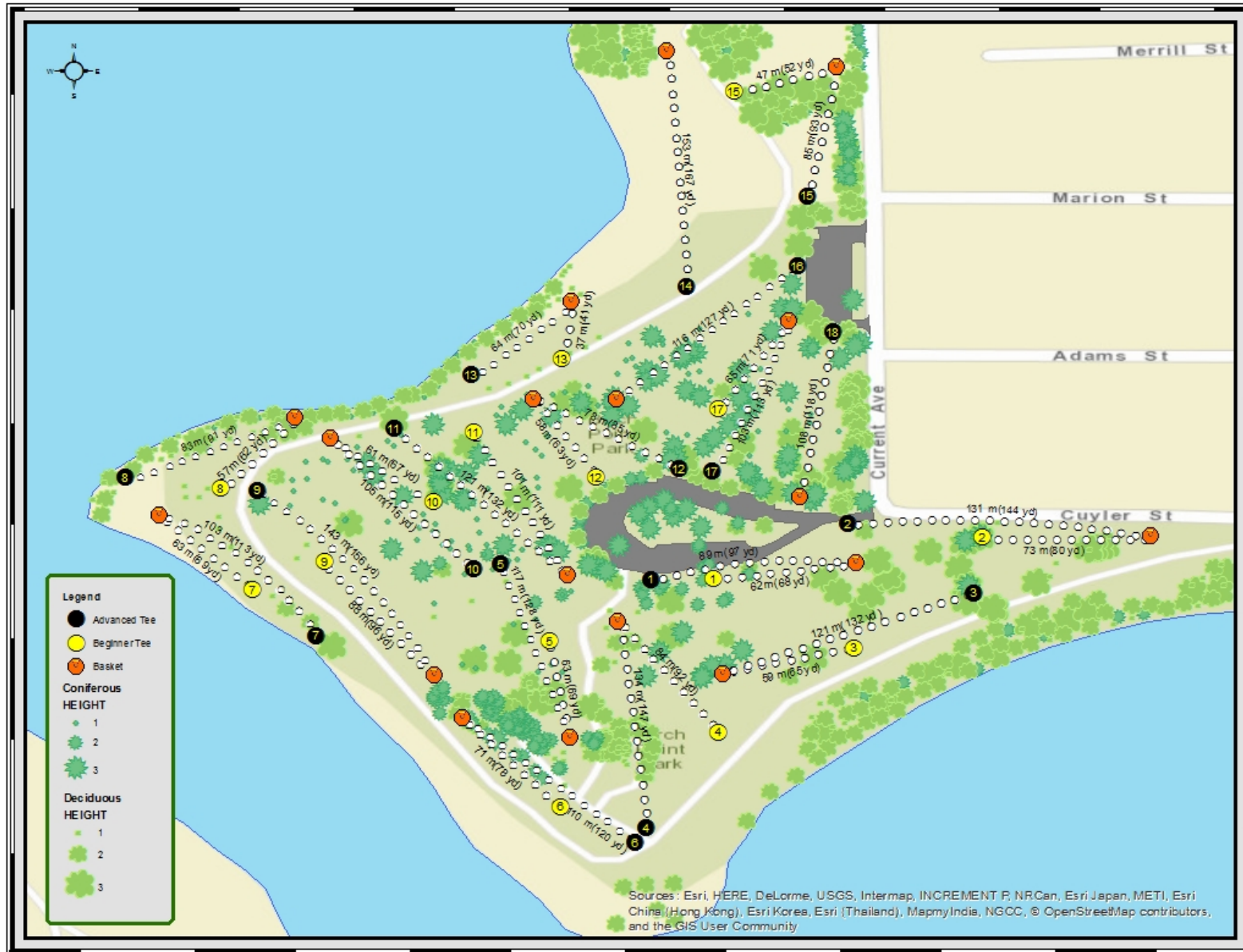


Figure 2 Map of Birch Point Disc Golf Course

SIZE DISTRIBUTION

Trees inventoried varied in size from large mature trees to newly planted juvenile trees. Of the 749 trees inventoried, 341(46%) were tall mature trees (height class 3), 217 (29%) were mid-sized trees (height class 2), and 191(26%) were juvenile trees (height class 1). The height distribution across the various species inventoried can be seen in Tables 1 and 2. As the majority of the trees are in the mature height class showing that the course has many older trees that will be in need of removal and replacement in the future.

Table 1 Size distribution of coniferous trees

Species	Height Class	Number of trees	Mean Diameter	Diameter range (min-max)
Balsam Fir	2	1	19.7	-
Balsam Fir	3	32	37.8	21.0-55.1
Black Spruce	2	3	17.8	14.2-23.9
Black Spruce	3	2	39.7	35.0-44.4
Jack Pine	1	15	2.8	1.0-8.6
Jack Pine	2	31	13.0	8.1-18.6
Jack Pine	3	2	34.6	25.8-43.3
Lodgepole Pine	2	1	11.0	-
Red Pine	1	8	3.2	1.4-5.8
Red Pine	2	1	6.0	-
Red Spruce	1	1	5.8	-
Scots Pine	3	8	40.4	28.7-49.5
Tamarack	2	3	17.0	13.0-20.5
White Spruce	1	91	2.6	1.0-9.8
White Spruce	2	137	7.9	1.0-25.3
White Spruce	3	148	43.5	25.3-71.0
Eastern White Cedar	1	10	5.4	2.8-7.3
Eastern White Cedar	2	6	11.1	9.1-14.3
Eastern White Cedar	3	1	34.2	-
White Pine	3	1	28.5	-

Table 2 Size distribution of deciduous trees

Species	Height Class	Number	Mean Diameter	Diameter range (min-max)
Elm	1	1	7.0	-
Elm	3	1	41.6	26.0-63.8
Green Ash	1	4	5.9	4.9-7.4
Green Ash	2	1	18.0	-
Green Ash	3	3	25.4	15.4-30.9
Linden	1	1	3.8	-
Linden	2	6	19.9	13.0-25.7
Linden	3	3	28.9	26.1-31.5
Mountain Ash	1	7	2.7	1.7-4.2
Mountain Ash	2	4	14.7	11.0-19.3
Poplar	1	22	4.9	1.2-8.7
Poplar	2	30	16.2	10.0-20.9
Poplar	3	61	35.4	22.0-56.9
Red Oak	1	7	2.5	1.4-3.8
Red Oak	3	7	40.3	21.5-70
Silver Maple	1	17	14.3	2.0-7.3
Silver Maple	2	4	20.7	14.8-23.2
White Birch	1	29	5.9	1.5-9.8
White Birch	2	37	13.1	10.0-19.6
White Birch	3	62	44.9	21.5-78.6
Bur Oak	3	2	42.9	40.6-45.2
Willow	1	8	2.9	2.2-3.8
Willow	2	1	19.2	-
Willow	3	1	61.6	-
Yellow Birch	1	7	2.0	1.1-5.7

SPECIES COMPOSITION

Within the tree inventory 21 different species were identified. The most common species seen on the course were white spruce, white birch and poplar.

The relative abundance of coniferous and deciduous species inventoried is summarized in Figures 3 and 4 respectively.

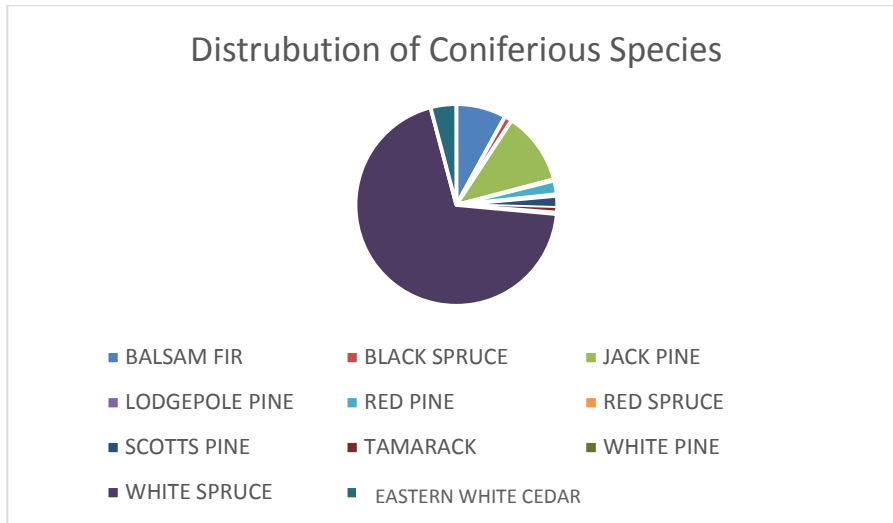


Figure 3 Distribution of coniferous species

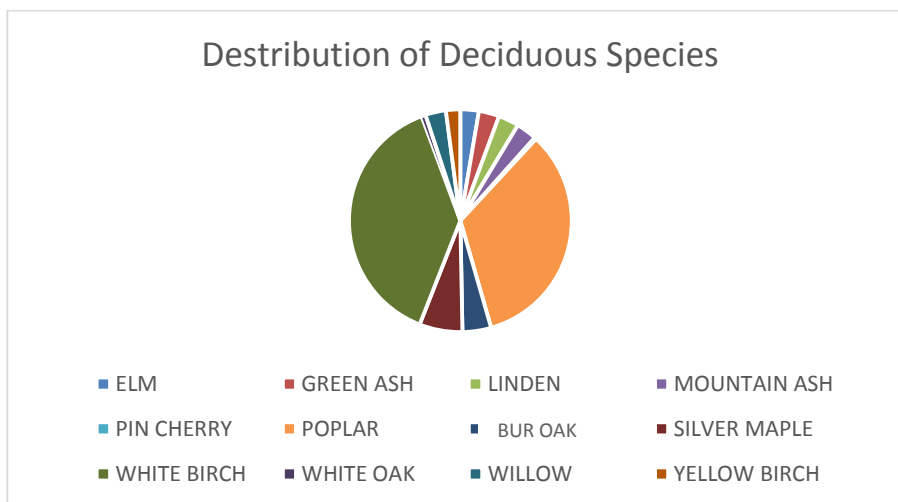


Figure 4 Distribution of deciduous species

TREE HEALTH

The trees inventoried exhibit a wide range of tree health conditions. Trees varied, from being quite healthy to rather unhealthy and at risk of failure. There were also trees that had begun to fail if not already dead. The poorest health was seen in white birches because 50% of white birch surveyed were given a rating of 3 or less. This percentage was the highest seen amongst all

species in the health category of 3 or less. Common health defects seen in these birch were dying branches, failing crowns, and damaged trunks. These observed health defects lead to suspicions of these trees being infested by the bronze birch borer, a pest that has been killing birch trees within Thunder Bay (City of Thunder Bay n.d.). The bronze birch borer was not seen on the course however it is suspected that it is present. Figure 5 below shows the health rating distributions of the park.

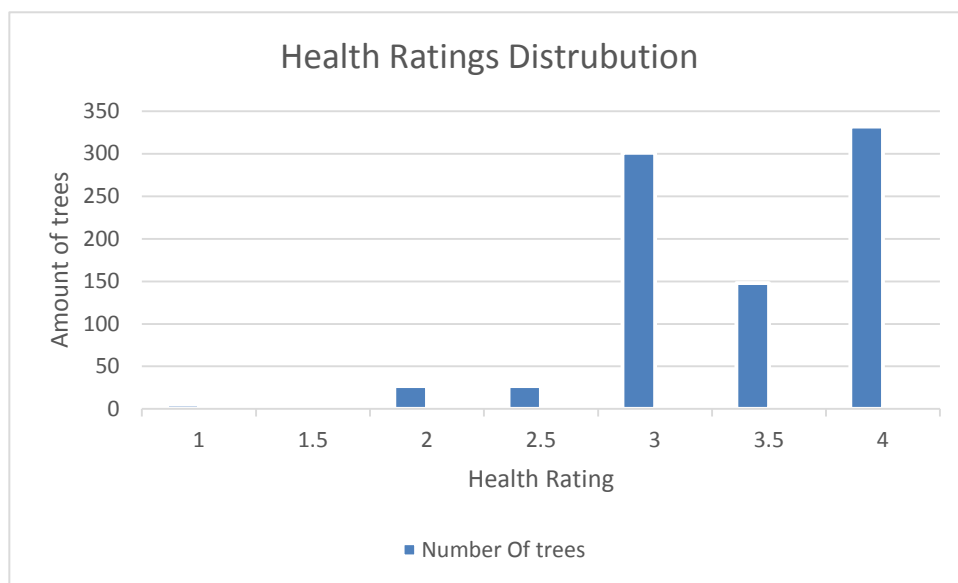


Figure 5 Health ratings distribution

Health ratings between 4 and 3 were the most common amongst the trees in the inventory. This suggests that most of the trees in the management area are relatively healthy. There were, however, trees that showed signs of declining health. Out of the trees with health ratings of 3 or lower the most common health problems were associated with damaged branches (33%), damaged trunk (28%), poor form (12%), and frost cracks (7%). Also on the course there was a suspected bronze birch borer infestation and tomentous infection. Tomentosus root rot was not seen on the course during the study

however it was identified by an experienced forester. The damage to trunks can be attributed to discs, which is unavoidable on a disc golf course.

UTILITY LINE ISSUES

A total of 8 trees were identified as having existing or possible conflicts with utility lines. Out of the 8 trees, 5 are mature trees that will require management action in the near future. Figure 6 shows the trees that are an issue within the park.



Figure 6 Trees in conflict with infrastructure

PRISM PLOTS

A total of 9 plots were conducted in three densely wooded groves of the course. The groves contained mainly early successional shade intolerant species. The most dominant species observed in the stands was poplar. The results for the prism sweeps is presented in table 3 below, it is shown how poplar is the most dominant species within these groves followed by white birch.

Table 3 Species composition by basal area

Species	Average Basal Area (m ³)
Grove 1	
Poplar	30
White Birch	6
White Spruce	2
Grove 2	
Cherry	2
Poplar	6
Grove 3	
Ash	2
Elm	2
Poplar	10
White Birch	10
White Spruce	2
Grove 4	
Poplar	17
White Birch	8
White Spruce	2

DISCUSSION

PLAN PRINCIPLES AND OBJECTIVES

This plan was created to aid in the management of the BPDGC, by promoting the sustainable use of the area. The plan provides recommendations for management actions to deal with challenges that are apparent on the course. Aspects such as tree health, park maintenance, public outreach and stewardship are highlighted. The plan also recognizes that the park area is found within the Robinson Superior treaty on Fort William First Nation traditional land.

As the course is on public land, it is important to be managed appropriately to benefit all users. Consultation is an integral aspect of this process, keeping the public informed and addressing their concerns. The popularity of the sport of disc golf in Thunder Bay has expanded; a management plan is therefore needed to continue the progression of the course in a safe and sustainable manner. The planning period is for the next 5 years and it is recommended that it is reviewed after this period.

CHALLENGES & RECOMMENDED MANAGEMENT ACTIONS

Soil Erosion and Compaction

Erosion was found in areas of high traffic like along fairways, near tee pads and around baskets. This high traffic damages the ground vegetation and limits any potential new growth. Erosion is often an issue on disc golf courses due to repetitive high traffic in the same locations (Trendaflova & Waller 2011). Erosion is a primary factor limiting plant growth in urban soils

(Trendaflova & Waller 2011) and can be reduced or minimized on the BPDGC through the application of woodchip mulch.

Throughout the course there were apparent areas showing clear signs of erosion and compaction. On hole 9 there is an erosion issue. The location for the proposed new tee pad is on a slope where erosion has already begun. The new tee pad should be engineered to accommodate for this. Gravel can be used as a base for the tee pad to prevent erosion. Further, hole 14 also has erosion issues. Similarly the tee pad should be engineered to prevent this. However, just beside this pad, work was done by the city to an underground water line and now the ground surface is exposed dirt. Grass seed should be placed on top of this area and be flagged off to allow for the grass to properly grow and prevent further erosion. In terms of compaction, the areas located near the original hole 1 and basket 2 are very compacted sites. This should be the location for the first application of woodchip mulch.

Approximately 6 inches of woodchip mulch should be spread around in areas of high traffic (Trendaflova & Waller 2011) Mulch can help to retain moisture, increase organic matter, reduce maintenance and provide a buffer for trees from mowing equipment (Hutchison 2016). An efficient way of obtaining the woodchip mulch could be from trees removed from the park, as they could be chipped on site. Woodchip mulch should be applied along walkways on the fairway, around baskets and around newly planted trees. Annual assessments can identify areas of concern with high erosion and compaction that could use woodchip mulch.

Management of Existing Trees

There are many trees showing signs of poor health. Health issues found include, frost cracks, broken branches, exposed roots, damaged crowns, disease and pests. Poor form is also seen on the course in both juvenile and mature trees, with many mature trees showing signs of declining health.

There is a need for the removal of trees within the park; over 35 trees were identified that should be removed within the next five years (Figure 7). Removing trees should be done in a proactive manner to ensure safety of all park users. Removal should be done during the winter months when there is less traffic on the course. Removal during the winter months can reduce rutting and compaction from heavy equipment (Agherkakli et al. 2014). Further, deciduous trees such as white birch and poplar can reproduce asexually after removal. This should be considered when deciding on when to remove deciduous trees. If asexual reproduction is desired then the trees should be harvested in the winter, if not, then trees should be harvested in the summer (Fraser et al. 2002). It is important that tree removal is done in a safe and responsible manner. After removal the city should use a stump grinder to remove all stumps to prevent tripping hazards. In the future, trees needing removal should be identified during each annual assessment.



Figure 7 Trees needing removal in the near future

Mulching of trees can be done on site after cutting trees and spread out through areas of high traffic, and around newly planted trees. In specific cases of white spruces suspected to be infected with tomentosus root rot, all timber should be removed after being cut to prevent further spread of the disease. As trees are removed new trees are needed to maintain the forest within the course. Appropriate species selection ensures that the correct trees are chosen for the site and growing location. Factors like the amount of shade, wind protection and elevation all affect species choice (Hutchison 2016).

Trees should be planted in similar areas where trees have been removed to maintain the same structure of the disc golf course. The sites for removal are typically found on higher ground within the course and based of the existing

species composition both coniferous and deciduous trees should be planted. As seen in figure 7, there are many trees needing removal surrounding the parking lot, this should be a focus area for newly planted trees for the next 5 years. A new parking lot is currently proposed for the summer of 2017, planting should not occur till after this is done. It is recommended that the Birch Point Disc Golf Association (BPDGA) advises the City on planting sites to avoid conflicts with flying discs.

All planting should occur in the spring to allow for a full growing season. Newly planted trees should have woodchip mulch placed around their bases and be staked to help with stability. Stakes should be removed 2 years after being initially placed. These newly planted trees should be fertilized and water bags should be installed for the first growing season.

Plastic guards can be used on the trunks of mature trees to protect them from flying discs. Trees along fairways that are identified within the annual assessment that show poor health and damage to trunks should be protected. These guards are only necessary on trees where the lowest branches are high enough to leave the trunk exposed.

The watering and fertilization of newly planted trees can drastically improve tree health (Hutchison 2016). Water bags should be used on newly planted trees to efficiently ensure they are properly being hydrated. The City's park division can fill water bags as necessary however during the summer

months they should be filled bi-weekly. These bags should be removed after the first growing season.

When planting new trees one of the most important decisions is which species to plant. Diversity should be one of the main goals. A variety of species increases the resistance to any possible outbreaks of disease or pest (Hutchison 2016). The existing species composition of the course should be considered to maintain the structure of the park. Currently the dominating species composition is mainly white spruce, balsam poplar and white birch. It is important to maintain a mix of conifers and deciduous trees in order to protect this original character and function of the BPDGC. Spruce should be avoided as there is the presence of tomentosus root rot on the course. Red Pines, Jack Pines, and Balsam Fir can be planted on the course as they seem to grow quite well on the site and are more resistant to tomentosus root rot. Additionally, white birch, silver maple, Norway maple, linden, and elm should be planted as they can thrive in the urban setting.

Proper Signage

As there are some risks involved in disc golf there is a need for proper signage throughout the course. Signs will help to ensure that people who are not playing the sport are aware that they are entering a disc golf course and to be cautious of flying disc. These signs can also include information for disc golfers, encouraging responsible and safe play while respecting all park users. Signs should give a proper warning that park users are entering a disc golf course and some sort of illustration to aid with this warning. Large signs should

be placed along the recreational path upon entering the disc golf course from both boundaries, also signs should be placed at both parking lots that are found within the course. The proposed locations for these signs can be seen in the figure 8 below, the black and yellow boxes represent the signs.



Figure 8 Proposed sign locations

Park Maintenance

Ideally the best way to carry out tree maintenance is to use a proactive approach. This would be where annual inspections of trees are done and maintenance occurs before problems occur. However due to financial resource constraints, maintenance needs to be done following a reactive approach. A reactive approach assesses problems after they occur, this is a less desirable

approach however it is a reality due to the lack of proper funding available to the urban forestry division of Thunder Bay.

A serious issue within the course is damage to trees from grass cutting by employees of the City. As this course is found within a municipal park the grass is cut by City employees. Often the bases of trees are damaged by weed whackers causing stress and leading to tree mortality.

Problems should be identified within the annual assessments and the five-year intensive inspection. Proper pruning techniques should be applied and trees should be removed and planted where necessary. It is also important that park maintenance is aware of the trees on the course. When mowing the grass within the park, there is a need for sufficient time and care to be taken in close vicinity to trees.

An annual pruning cycle can be very beneficial for the urban forest. Returning annually ensures that trees are growing properly and can eliminate future issues. Newly planted trees should be structurally pruned annually for at least five years after being planted (Hutchison 2016). Structural pruning should be practiced on these trees to train them to be strong and resilient. Trees that are growing around utility lines can also be pruned to prevent future conflicts.

When pruning a tree, no more than 25% should be removed on a yearly basis (ISA n.d.). Exceptions to this are if the tree has significant defects, or is highly vigorous (Pokornyn n.d.). Pruning should be done in winter months after leaves drop and before bud's flush (Pokornyn n.d.). Pruning in the winter

decreases damage to the trees as they are in dormancy. If trees are showing good form and appear healthy then pruning is not required (Pokornyn n.d.).

The implementation of a pruning cycle can be introduced to the disc golf player tree committee. This pruning cycle would follow an annual schedule. Pruning should be done annually in the early winter, when trees are entering dormancy to ensure minimal damage is done. There are 173 juvenile trees that will require pruning, these trees can be seen in Figure 9 on the next page.

In addition to the pruning of juvenile trees, there is a need for mature trees to be pruned to remove branches from the way of flying discs. Along the fairways of holes 1, 2, 3, 10, 11, 16, 17 and 18 there are conflicting trees along the fairways that would greatly benefit from pruning. Also there are 8 trees that are conflicting with power lines. They can be seen in figure 6 in the Utility Line Issues section. These trees should be pruned within the next 5 years along with juvenile trees on annual pruning days.



Figure 9 Juvenile trees requiring pruning

Pests and Disease

White spruce trees are suspected to have tomentosus root rot *Inonotus tomentosus* within the course. The disease was not seen during surveying; however, it has been identified by an experienced forester on the course. Tomentosus root rot is a root disease that can cause mortality to spruce trees. Symptoms that a tree is infected include short needles, abnormal curling of branches, and mushrooms that are produced in the fall or late summer after periods of high rain fall (Guyon 2006). Tomentosus root rot can be managed by the removal of infected trees and planting of resistant species (Guyon 2006). The pathogen can remain persistent in sites for extended periods within woody materials, so it is important that all infected timber including roots from

infected trees are removed from the area (Guyon 2006). A further survey should be done in the fall by the disc golf tree committee to identify which white spruce trees are infected and forward recommendations for removal to the City. White spruce trees showing poor signs of health and suspected to be infested with tomentosus root rot can be seen in figure 10 below.



Figure 10 White Spruce trees showing poor health

The Bronze Birch Borer *Agrilus anxius* was not found on the course, however it is suspected to be present because many of the white birches within the City of Thunder Bay are infested with the pest (City of Thunder Bay n.d.). Exit holes were not observed on any birch trees however, many were showing health defects like dying branches and failing crowns which can be an indication of infestation (Hutchison 2016). Birch trees that were identified with a poor health rating should be continually monitored within the annual assessment. Trees that are stressed due to poor health are more susceptible of infestation (Hutchison 2016). Failing crowns and D-shaped exit holes on the

trunk should be a clear indication that trees are infested. Figure 11 shows birch trees on the course that should be monitored for Bronze Birch Borer.



Figure 11 White Birch trees showing poor health

Birch is an aesthetically pleasing tree and grows well in the urban setting, as a result it is often planted within communities. Unfortunately, birch trees are highly vulnerable to the bronze birch borer. The borer typically attacks stressed trees as they are easier to infest. The females lay their eggs underneath the bark of the birch tree, these eggs hatch into tiny grubs which tunnel into the inner bark (Hutchison 2016). These grubs create galleries underneath the bark that can girdle the tree cutting off the flow of the sap (Hutchison 2016). Trees that are infested by the pest, will have branches that are dying, and have D-shaped exit holes on their trunks (Hutchison 2016). However, watering and

fertilization can increase a trees resistance to infestation (Hutchison 2016).

Trees that are infected can be treated with multiple applications of the chemical insecticide Bendiocarb or Chlorpyrifos (Hutchison 2016). Application of the insecticide should be done by professionals and injected into the trunk and branches. Trees that are identified as infested with the Bronze Birch Borer should be removed.

The emerald ash borer *Agrilus planipennis* (EAB) has been found within the City of Thunder Bay (City of Thunder Bay n.d.), although the pest was not found during surveying, the ash trees found on the course are still vulnerable to infestation. As there are approximately 6 ash trees on the course as seen in figure 12, EAB should not be as high of a management priority as the Bronze Birch Borer and Tomentosus root rot.



Figure 12 Ash trees found on the course

The pest attacks ash trees by laying eggs in bark crevices or bark cracks, and these eggs hatch into larvae (Hutchison 2016). These larvae chew through the bark to the cambium to feed. The larvae create serpentine galleries between bark and sapwood of ash trees, trees usually die one or two growing seasons after infestation (Hutchison 2016). Monitoring for EAB can be done by wrapping ash trees with sticky green prism traps and baiting with ash leaf volatiles (Hutchison 2016). Ash trees located along Current Avenue can be monitored as they are easily accessible. Trees that are infected can be injected with TreeAzin™ an insecticide that can combat the pest (Hutchison 2016). It is important that if infected trees are removed, the lumber is properly handled to prevent the spread of the pest. Continual monitoring on the ash trees for EAB

should be done, and if discovered, trees should be considered for insecticide treatment.

The continual monitoring of pests and diseases can occur through the annual assessments and 5-year intensive assessments. Preventative tree care can aid in increasing trees' resistance to diseases and pests. Trees that are infected should be evaluated to determine if they should be treated or removed. If a potential epidemic threatens to break out prompt and affective action needs to be taken.

OTHER RECOMMENDED MANAGEMENT ACTIONS

Public Consultation Events

As the BPDGC is found within a public park, it is important to hold consultation events to hear from all park users. An annual consultation event should occur within one of the City's community centers, where citizens can attend to listen to current management objectives, voice any concerns and identify any values found within the park. These consultation events could be run by the City, along with representatives of the disc golf association of Thunder Bay.

As consultation is an important aspect of the management plan, all concerns that are raised should be considered when amendments are being made to the management plan. The management plan will follow an adaptive approach being able to change according to current social and environmental needs. It is important that if values are identified that they are properly

managed long into the future. Properly addressing feedback from consultation is important in maintaining a public recreational space

Outreach using Public Websites and Social Media

Through the use of social media, the City can communicate to and educate the public about information pertaining to the park. Social media is a very useful tool that can be used to reach many different members of the public (Moreno et al. 2013). Information such as the tree inventory, the management plan and map of the course should be made available on the City's website and through the Thunder Bay Disc Golf Association's Facebook page in pdf format. Currently there is a closed Facebook group for disc golf players, however, it is recommended that an open group is made for the BPDGC. Upcoming events, promotions and educational information can be posted to assist with promoting the sustainability of the park. Once created, the public BPDGC Facebook group can regularly post information and be used as a platform for public to raise their concerns.

Identifying Values

Through consultation, values throughout the park can be identified. These values should be addressed within the plan and accommodated for. The BPDGC is also used as a space for walkers, picnickers and an open space for outdoor activities. There are many benches throughout the course that people regularly use. It is important to identify these specific values, and manage for them appropriately to avoid conflicts among park users.

Disc Golf Player Tree Committee

It is recommended that the BPDGA establish a disc golf player tree committee for the health and sustainability of the park. As disc golf players are regular park users and are interested in the overall health of the park, the committee could be a very useful tool for continual stewardship of the park. Committee members could be trained as citizen pruners by the City. Once trained, the committee could conduct annual pruning days throughout the course. Also the committee could advocate best practices and educate others within the disc golf community.

Annual Assessment

It is recommended that the members of the disc golf player tree committee conduct an annual assessment to evaluate the success of the management plan. It is important to have current monitoring of the park area to determine if management objectives are being met, and take corrective action to ensure they are. The assessment should be done twice throughout the year during late spring and fall. By performing this assessment twice a year, issues that arise at different seasons can be observed for. The annual assessment can consist of a walk throughout the course looking at all trees. As doing a full inventory is time consuming, this annual assessment will be more of a specific problem assessment (Hutchison 2016). This type of assessment is less intensive than the original inventory of the course. The main concern of this type of inventory is looking for seriously damaged trees. It is a more efficient approach of surveying, where not all trees are surveyed just trees that are visibly damaged

or have apparent issues. Surveyors should be looking for signs of declining health, assess newly planted trees and any other obvious issues. By performing this annual assessment, the City will be able to keep up to date information on the health of trees, identify what trees need to be removed and whether or not objectives are being met.

Five-year Intensive Assessment

It is recommended that there be a more intensive assessment every five years, to take a closer look at all trees within the park. This assessment should be conducted by the disc golf tree committee and will include updating the current tree inventory, looking at all pre-existing and new trees. All of the attributes collected in the original inventory can be updated. After this assessment, decisions can be made regarding the removal and planting of trees. By performing an intensive assessment, the City of Thunder Bay will be able to gather more accurate information pertaining to the trees on the course. Indicators such as tree health and amount of erosion can be assessed to ensure management goals are being achieved. Disease and pest monitoring should also occur. Specific species such as white birch, ash and white spruce should be observed for health defects indicating pest or disease activity. Health defects such as dying branches, failing crown, discoloration in trunk and fungal activity are all indicators for further observations (Hutchison 2016). If exit holes are found on the trunks of trees, then it is a clear indication that the tree are infested. After performing the inspection, a report should be created to update the management plan.

Other Course Layout

A possible solution in aiding with the soil compaction issue, would be moving the baskets to an alternate course layout. An alternate course layout can help to reduce constant foot traffic over the same areas. Moving the baskets would allow vegetation to grow back and recover as well as provide a different experience for players maintaining full enjoyment of the course.

As the BPDGC was just recently updated and all the baskets were moved, the old course layout would provide an easy option for moving the baskets. The new course layout and the old course layout could provide two potential courses, allowing players to enjoy a variety of play as well as reducing soil compaction. Determining how often the course will be changed can be done by the City of Thunder Bay in consultation with BPDGC. Club members will be the ones moving the baskets, the BPDGC Facebook page should be used to inform the public of these course changes.

Natural Forest Stands on Course

There are various stands of trees that border the disc golf course. Prism plots were done in these groves to determine the species composition by basal area. These stands were mainly dominated by early successional mid tolerant species such as birch and poplar. These stands will be left to natural processes and will continue to be monitored within the annual and five year assessments.

Recommendations for Future Work

During the development of this management plan, many decisions on approach and implementation were made, and lessons learned. There was no template to follow in the development of this plan, and there are some changes that could be made in the future to improve the quality of subsequent management plans. With the proper resources, surveyors with experience in forestry should be used for data collection to ensure the tree inventory information is accurate. Also when creating the tree inventory, the previous inventory of 2010 was used for GPS coordinates. The previous inventory was missing many trees and it became rather confusing for surveyors when trying to determine if waypoints had to be created or if they already existed. In future, the inventory should be restarted with all trees being added as waypoints.

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APPENDICES

	Species
Balsam Fir	<i>Abies balsamea</i>
Silver Maple	<i>Acer saccharinum</i>
Yellow Birch	<i>Betula alleghaniensis</i>
White Birch	<i>Betula papyrifera</i>
Green Ash	<i>Fraxinus pennsylvanica</i>
Eastern White Cedar	<i>Thuja occidentalis</i>
Tamarack	<i>Larix laricina</i>
White Spruce	<i>Picea glauca</i>
Black Spruce	<i>Picea mariana</i>
Red spruce	<i>Picea rubens</i>
Jack Pine	<i>Pinus banksiana</i>
Lodgepole Pine	<i>Pinus contorta</i>
Red Pine	<i>Pinus resinosa</i>
White Pine	<i>Pinus strobus</i>
Scots Pine	<i>Pinus sylvestris</i>
Balsam Poplar	<i>Populus balsamifera</i>
Pin Cherry	<i>Prunus pennsylvanica</i>
Bur Oak	<i>Quercus macrocarpa</i>
Red Oak	<i>Quercus rubra</i>
Willow	<i>Salix</i>
Mountain Ash	<i>Sorbus aucuparia</i>
Linden	<i>Tilia</i>
American Elm	<i>Ulmus americana</i>

Shapefiles with imbedded tree information for all trees surveyed are copied on the attached cd.