Tracing an Autoethnography to Identify Opportunities and Challenges of Implementing Backyard Biodiversity Installations in Winnipeg's Residential Spaces

William (Bill) Dowie

A thesis submitted to the Faculty of Graduate Studies of

The University of Manitoba

In partial fulfillment of the requirements for the degree of

MASTER OF ENVIRONMENT

Department of Environment and Geography

University of Manitoba

Winnipeg

Abstract

An autoethnography of a twenty-five-year adult learning journey (formal, non-formal, and informal approaches) is used to trace the processes and dynamics of installing native plants in the City of Winnipeg, Canada. Merging these educational experiences with activities of a homeowner, a horticulture-sector professional, and a researcher gives unique insights and perspectives into adding appropriate biodiversity to the private residential space.

Native plants are an important part of the regional ecosystem as these organisms have co-evolved with other organisms for thousands (and even millions) of years. This helps form the basis of the food web creating a stable and resilient life-giving ecology. Further, native plants provide important ecosystem services such as pollination, food provisions, flood protection, control of pollution, heat regulation, carbon sequestration, and healthy soil. Unfortunately, due to various factors including habitat loss due to urbanization, there is a crisis of biodiversity loss (coupled with climate change). Therefore, this thesis reveals the importance of establishing native plants of all forms in the urban realm. Such plantings are an opportunity for city residents to contribute to the restoration of the local ecosystem by supporting the flora and fauna of the corresponding ecodistrict, ecoregion, and ecozone.

Since design with, and installation of, native plants in the residential backyard is not a widespread practice, the purpose of this thesis is to understand why the planting of native species is not ubiquitous in urban areas. Management models, archival videos, and professional design-build research reflections are part of the analysis that helps sort out the complexity of residential ecosystem.

When keystone woody native plants or modified nativars (trees) are used in purposeful installations, they would benefit a future-forward City of Winnipeg – especially when shifting climate and extreme weather will be prominent. Generally, trees that are suited for the urban forest that can support Lepidoptera larva can also simultaneously contribute to adaptation and mitigation of climate change – one yard at a time.

Acknowledgments & Gratitude

My Advisors and Committee were the best multidisciplinary team I could have assembled. Everyone was exactly what I needed as an adult learner during a graduate program disrupted by a pandemic, faculty strike, and administration turnover. Kudos to Rick + John, Shirley, Nazim, and Erin.

Thanks goes out to all my communities. Support of every measure was given freely and willingly by family, friends, colleagues, fellow professionals, clients, and student-support staff at UMan. Edgar was an emotional rock.

Those that were part of my journey, and helped, will never be forgotten. This graduate program has helped reveal new truths – well beyond my research.

And special gratitude goes out to my mother and my aunt, who
left us during my Program: your compassion for my education
over the years has shaped this moment.

~

Table of Contents

List of Figures & Tables

Figures

Tables

1.0 Introduction – Purpose

The purpose of the research this thesis is to establish ways that the planting of native species can be achieved in urban areas, using the City of Winnipeg as a case study. I believe that private lands in cities have huge potential to become more ecologically congruent – and therefore will contribute to overall urban resiliency. I have added nature to residential spaces to teach people the value of native spaces for decades. For myself, I live in my childhood home which includes biodiverse yard (see Appendix 1 for Google mapping views) that acts as 1) a demonstration landscape; 2) an experiential space to test new materials and techniques; 3) a mental sanctuary of health and activity . Through this yard, I witnessed increase in wildlife, invertebrate and vertebrate. My 25 years as a sustainability design-build consultant was started in my home landscape (self-taught), expanded to building structures, and includes larger residential designs and installations. The knowledge and awareness of the importance of native flora, the dangers of invasive plants, and how fauna can be a blessing or a curse, has all metamorphosized through land-based education; achieved through formal, non-formal, and informal education. My experience found that an ecologically designed garden is designed for non-human species (butterflies, bees, beneficial insects, pollinators, endangered fauna and flora, etc.), as well as the human users for social needs. Finally, my greenhouse gas emissions are lower for several reasons: strategically planted trees moderate seasonal temperatures and wind speeds; heat island effect is minimized due to minimized hardscaping (cementitious materials), and mowing is very quick with only a boulevard and a green (low -mowed turf) path to maintain. (Yard maintenance is with hand tools and rechargeable battery-powered machines.)

I have an education path that exposed me to academic theory and professional frames. My professional accreditations of LEED and Envision (two sustainability frames) as well as studying SITES through the USGBC portal, gives me an advantage to access grey literature and webinar courses that the general public would not easily find. One important note is that adjacent sustainability frames and best practices (WELL, Fitwel, ActiveScore) introduce nature and biodiversity tangentially as part of a wholistic design strategy – especially to enhance physical and mental health. Therefore, I will use my professional learning and continuing educational credits to add new and developing concepts to this thesis.

Having both professional experience and theory allows me to critique civic policy. Therefore, I am confident that my research will inform recommendations specifically for the City of Winnipeg. So, although on the surface my thesis is encouraging native plantings, my research will reach

different audiences: there are eco-centric altruistic desires to protect endangered species (monarch butterflies and established milkweed habitat), and anthropocentric financial reasons re-establish ecological services (water and energy conservation by planting native shade trees). Therefore, a strong opinion is submitted: that the residential landscape context can convince many different stakeholders advocating urban resilience and contribute real-world solutions to mitigate and adapt to biodiversity loss and climate change.

1.1. Overall Approach and Rationale – examining the thesis title

Analyzing the thesis title will allow for a useful rationale for both the reasoning and the structure of this thesis.

> *Tracing an Autoethnography to Identify Opportunities and Challenges of Implementing Backyard Biodiversity Installations in Winnipeg's Residential Spaces*

The autoethnography is an important, albeit non-traditional, qualitative research method when used for environmental research. Usually reserved for psychological, political, or cultural problems or phenomenon [1], there are scholars that are intrigued to use for natural science research, including ecological research and instruction [2]. Further, Murphy, *et al* states that since "… applied fields that involve multiple stakeholders – ecology among them – [with] researchers dedicate[ing] time to building relationships, understanding perspectives and navigating controversy…" an autoethnography allows for reflective and reflexive personal experiences to enrich lessons learned for present and future scholars [3]. Indeed, using purposeful reflexivity, especially when an autoethnography spans decades (the verb tracing), will allow personal judgement, heuristics, expert knowledge, and gut-feeling to be at the forefront of important academic research, rather than an afterthought. There is emerging research that is recognizing expert knowledge in scholarly pursuits, a practice that is common in the closing phase of project management, in particular lessons learned, also found in organizational memory systems [4]. There are always opportunities and challenges within projects (including academic research). Certainly, I do not gravitate to the phrasing of research problems – rather, as a professional consultant, I immediately seek how to create better circumstances for a client and identify opportunities for improvement. This approach to research dovetails into my worldview of pragmatism (described later). Implementing, as a verb, suggests how planning, installation, and maintenance of properties are executed as part of a project and ongoing concern. Backyard is defined as any external part of the outdoor lot that can include all or some of the front (and if

applicable, boulevard), side, back, fence lines, walls, balconies, and roofs. For the purpose of this thesis, scope does not include roof projects. Biodiversity is functionally defined as appropriate and regional fauna and flora that is invited into and possibly celebrated by the resident as part of their property. My ethics (axiology) and landscape design-build experience presses me to skew to a naturalist, ecocentric concentration. Finally, Winnipeg residential spaces are part of the private property realm. This aligns with people residing (residents) in any housing type, (condominiums, apartments, co-ops, duplexes, et cetera), but this thesis will only deal with detached houses that are situated on landscape that can have a variety of plants installed and maintained without interference from city by-law officers or encumbrance by existing infrastructure.

1.2. Significance

This thesis contributes to the academy and industry in that urban ecology has always leaned into nature restoration and native plant use. However, in contemporary academia, concepts of biodiversity and climate are rarely linked (at least not in a pragmatic way). Since residential spaces (houses, yards, car storage) only fall under arbitrary municipal by-laws, unless a resident wants to initiate novel ecoliteracy learning, little is known about native planting strategies as part of a typical house purchase or rental. The social norm of having a default of lawn turf as the landscape groundcover contributes to an ignorance of native plant installation options. Of course, there will always be knowledge gaps, and siloed thinking is another problematic dynamic: when engineers, landscape architects, planners, wildlife biologists, entomologists, botanists, and other important professions do not coordinate biodiversity goals, opportunities are missed to reestablish bioregional ecosystems. Impressively, backyard conservation strategies are already aligned, and when native plants are used optimally, one can mitigate urban challenges such as climate change and biodiversity loss – now and for the future.

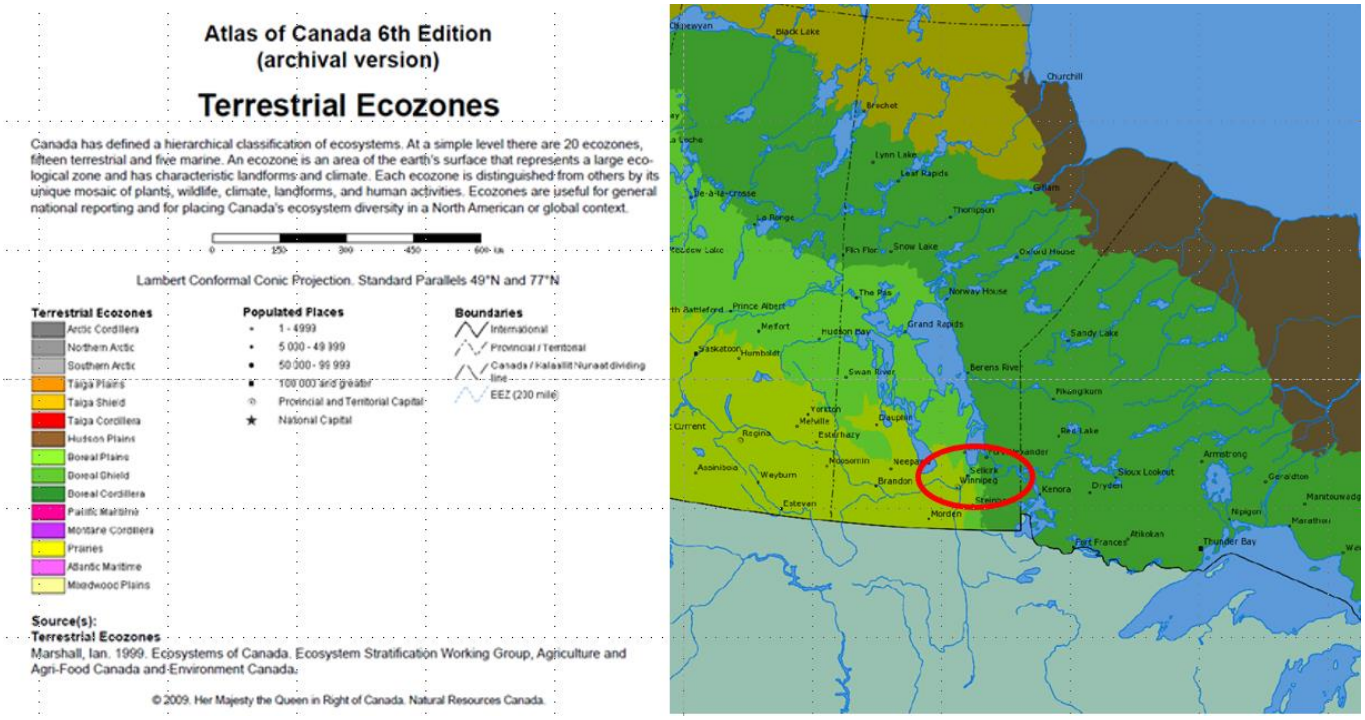
1.3. Study Area and Socio-geographic Context

My study area is the City of Winnipeg, Manitoba (MB), Canada. Winnipeg, MB is a city nestled in the Red River Valley, with a metropolitan regional population of approximately 875,000 and is geographically located in the Tallgrass Prairie region of the zone of the northern plains. According to the Natural Resources Canada (NRCan) map [6] below (Figure One), Winnipeg is located in what is broadly described as the Prairies, just west of the Boreal Plains. Plants and animals have co-evolved together since life started on Earth. The Winnipeg area prairies has had two recent co-

evolution stages: Ice Age sheet deposition and withdrawal occurred over several iterations; the last climate abruption is estimated to be 13,000 and 10,000 years ago (citation needed). Then, animals of all types including mammoths, camels, and ground sloths went extinct with the drier, warmer conditions moving spruce and pine forested areas to become mixed woodlands and then grasslands [5]. Therefore, prairie habitat with mixed woodland, river bottom forests, and nearby boreal forests is functionally the best categorization of geographic / pre-colonial historical reference. With agriculture and urban development, true prairie remnants represent less than 1% of the natural landscape that spanned from Texas to Manitoba (with our province having less than 1/20th of 1%) [7].

There are other contexts that are important to consider for social, ecological, geological, and geographic purposes. Having a good sense of place will contribute to wholistic planning and multi-disciplinary teams to have common ground (pun intended). Other key maps that were a result of my research have been placed in the Appendix and act as strong visuals to used as separate documents for specific project context. As well, having different contexts creates an atmosphere of meta-understanding that can facilitate easier partnership formation with communities, industry, and government. A brief written summary follows after the map to highlight important qualitative research value.

Figure One **Terrestrial Ecozones (Canada)**



1.4. Geographic Context

Whether one wants to deal with general geography or site-specific details, it is important to understand the site. The site can be its own micro-habitat, mirroring many of the same biotic and abiotic , The first thing a person needs to do is to visit the Environmental Protection Agency (EPA) maps of the Ecoregions of North America [8]. For Canada, there are three levels of granularity: the physical scale can roughly align with political jurisdiction, from provincial/state (level I), down to regional area (level II), down to a scale that could encompass an exact city location (level III). Looking at the following maps of Level I, II, and III, one can see which ecoregion encompasses, and what is in proximity to, Winnipeg. Ecoregions maps are essentially differentiated and aggregated patterns of geographically similar natural phenomena and ecosystem functions; this can include: geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology. (For further context, other maps have been placed in APPENDIX 2 – Maps of Ecozones / Ecoregions / Ecodistricts.)

Even if a resident does not need to have formal education in geology or paleontology, having a little history lesson with Manitoba's Ice Age period can aid in design context; the history lesson hopefully will also instill how little geologic time has elapsed since the prairies were revealed. At the same time, if a person cannot fathom what ten to thirty thousand years means in a temporal sense, perhaps a homeowner will be in awe of the co-evolution of plants and insects and will desire to use our bio-regional native plants. Further, a person can become more aware of the power of nature and natural phenomena like overland flooding when you see you are part of the Manitoba *Low*lands. Winnipeg lies within the Red River Plain, shaped by the retreat of ice sheets 11,000 years ago, with flooding, grazing, and natural fires as the dominant disturbance factors. All of which contributes to the co-evolution of plants and insects.

1.5. Winnipeg's Bio-Regional Context – A Story of Specific Place

Every resident should understand the regional landscape in which they live. However, where they live now (and its anthropomorphic from) is not going to be what could be in the landscape – some may even want to say 'should'. This is the concept of historic reference (reference). Living in an urban space can create an even greater disconnection with the landscape. It will be rare that landscapes would remain untouched by development, unless legally designated as a preserve,

easement, or conservation trust. Historically, less than 1% of tall grass prairie now exists now in the Winnipeg regional area, compared to when Europeans started to colonize the area [9]. Winnipeg is located at the junction of the Red and Assiniboine rivers, and historic-geographic references can use as proxy, the Winnipeg region's preserved areas of remnant native lands (prairie, wetlands and riparian habitats) include: Living Prairie Museum (est. 1971), Headingley Grand Trunk Trail, Stony Mountain Prairie Preserve, and the Rotary Prairie Nature Park (est. 1992, a rare wet tall grass prairie preserve). Native woodlands include The Assiniboine Park Forest, containing an aspen-oak mix, wetlands, and tall grass prairie, and the river bottom and oak forest preserve, Bois-Des-Esprits (est. 2003). Detailed information (origin stories, species lists, and management plans) for these, and other ecologically significant natural lands (ESNL), should start with the City of Winnipeg ESNL Strategy, co-written by the City Naturalist and Park Strategic Planner [10].

1.6. Hardiness Zone Context

Nurseries, professionals, and gardeners use plant hardiness zones as a first stage to decide what plants could be purchased. Plant hardiness is generally based on the survivability of a particular plant. This is tricky, as surviving versus thriving needs to be an important distinction for all gardeners. There is also the botanical nuance that although the plant foliage should theoretically survive a winter based on an appropriate hardiness zone, previously set flower buds might have suffered, and no blooms occur. Finally, if there are extreme weather events or patterns that occur (deep soil bed freezing due to lack of snow, late Spring frost, early Fall ice on leaves) all bets are off for the normal growth pattern of many plants – especially fruit trees and shrubs. Natural Resources Canada created their own plant hardiness zone based on a complex formula of variables. Note: in the US system, Winnipeg is listed as within the Red River Valley and labeled as Zone 3b [11]. The NRC website is very useful for past zone maps, methodologies, and projected climate shifts [12]. A municipality location tool in the website lists Winnipeg as zone 4a. (See map, Figure Two below, for relative comparisons with other Canadian jurisdictions; as well, APPENDIX 3 – Maps of Hardiness Zones depicts nearby USA jurisdictions.)

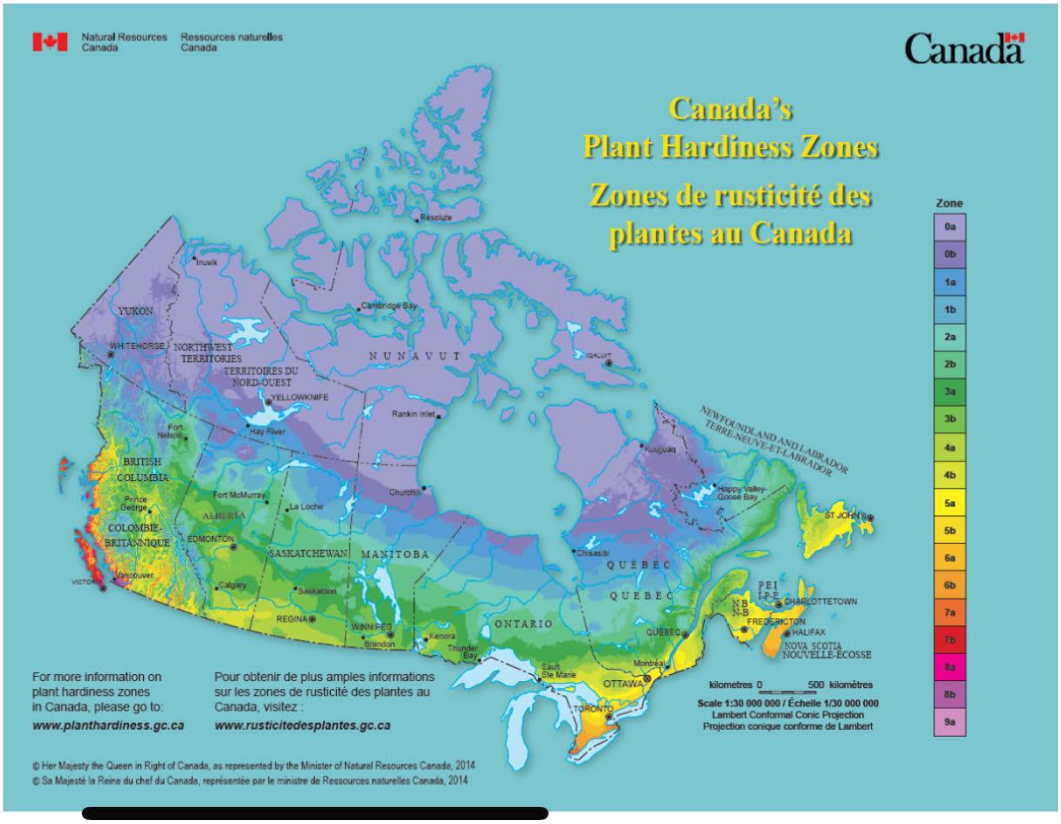


Figure Two **Canadian Plant Hardiness Zones (NRCan)**

1.7. Indigenous Lands Context

Parks Canada has an urban park program, and if an opportunity meets the requirement of "...Reconciliation: e.g., Indigenous-led culture-based activities, places for ceremony, Guardians..." then a national park could be created in an urban centre [13]. Therefore, it is important to identify indigenous land territories for landscape-use purposes. As well, the 2015 Truth and Reconciliation Commission (TRC) report has 94 calls to action [14]. A cursory review of these actions reveal that when dealing with language, education, and land consultations, the following action items will be important to reference: 14,16, 57, 62, 63, 92. With this in mind, an important map [15] is presented below (Figure Three). This shows the locations of indigenous traditional lands and communities that are in, or around, areas of landscape project; in this case Winnipeg is central on the map. Finally, there is a The National Healing Forests Initiative that is "...to honour residential school victims, survivors, and their families, as well as murdered and missing Indigenous women and girls, and children who have been or were removed from their families (including during the Sixties Scoop)." Elders are to be consulted with administrative collaboration with the David Suzuki Foundation and the Royal Canadian Geographical Society [16].

Figure Three **Indigenous Traditional Lands and Communities surrounding Winnipeg**

2.0 Literature Review

An academic literature review revealed that a phrase reflecting the desire to install native plants in a residential space has been coined as *biodiversity in my backyard* (BIMBY; found at [17]. I was first author of the following opinion paper based on this phrase and the author's framework, published by Crimson Publishers in the Biodiversity Online Journal [18].

This following preamble is an article that was published in early 2021 and reflects the exposure I had to concepts of backyard biodiversity until this point. I note that this time period is "during-Covid" (enmeshed within a series of pandemic lockdowns). During the pandemic, there was a surge in backyard recreational activities that was based on citizens (re)discovering nature and the outdoors in general, as a mental health and physical health strategy. Although beyond the scope of this thesis, pre- and post-Covid-19 attitudes towards backyard leisure, including biodiversity, is an opportunity for research in many disciplines. Interestingly, other disruptions such as extreme weather events could have an effect on social behaviour and the outdoors.

2.1. Preamble

The NIMBY (Not In My Back Yard) syndrome, coined in 1980 by the late Nicholas Ridley, symbolized the locally organized objection to (unwanted) human activities near or within sightlines of residential development [1]. Social scientists, and media, have been using this acronym since that time to describe the resistance by stakeholders to controversial facilities and land uses. Given human nature, the NIMBY response is not surprising, but such emotional reactions do little to solve complex environmental problems. We therefore suggest that a more constructive approach to developing acceptable and effective sustainability solutions is to utilize strategies that would embrace complexity and adopt actions within your own property-BIMBY (Biodiversity In My Back Yard) [2]. Most potential developments today can be engineered to ensure that Sustainable Development and its associated 17 Goals [3] can be achieved through novel and creative strategies. Local and pragmatic projects are imperative given the ever-increasing need for humanity to consider new approaches to biodiversity conservation. Scholars suggest that dwindling biodiversity is the greatest challenge facing humanity today [4]. This article provides a case study of how such approaches can be applied to conserving and enhancing biological diversity at the urban backyard-scale.

Although use of the term biological diversity first appeared in 1916 in a Scientific Monthly article written by Harris [5], surprisingly, the concept of biodiversity was not part of modern vernacular

until its resurgence [6]. The term biological diversity has been defined and redefined several times, but the original intent remains the same: “the variety of life in all forms, at all levels, and in all combinations, in a defined area” [7]. Biological diversity can be defined at various hierarchical scales, whether that be the level of genes, species, populations, communities, ecosystems, and/or landscapes. The spatial area within which biological diversity is measured, is human-defined, and varies in size, from an area as large as the Earth itself, to an area delineated as the size of a country, province/state, region, municipality, city/ town/village, or even to an area the size of a puddle in your back yard.

Common environmental challenges that affect biodiversity optimization, as identified by Biswas [8] are industrialization and the accompanying polluting discharges, deforestation, human population growth, invasive species, and climate change. All of these negative sustainability drivers may be mitigated through combinations of environmental policy, architectural and engineering design, and the re-integration of natural processes into a techno-dominant society. These large-scale issues and identified solutions can be daunting for the average citizen to consider, although, adopting a BIMBY philosophy presents a powerful tool for citizen engagement in biodiversity enhancement. As noted by the International Union for the Conservation of Nature (IUCN), most ‘backyard’ landscapes located within the privately held urban realm, offer crucial platforms to amplify and support the important work of nature stewardship. These privately protected areas are identified as an essential component in achieving the Convention on Biological Diversity (CBD) Aichi Biodiversity Target 11 [9].

By embracing the BIMBY mantra, project decisions can be purposeful whereby specified design goals are fulfilled, with biodiversity as a direct output. An individual might simply be ethically bound to ‘save the whales’; however, with our scenario, the BIMBY framework presents opportunity to assist an individual in building and conserving biomes that are species/genera-specific, that help the bees and butterflies (pollinators), songbirds, and small mammals thrive on their property. The psychology of humans adoring and protecting charismatic megafauna (polar bears, elephants, apes), can scale down to micro and meso-fauna-especially if one has an inherent pride of local place that mirrors to caring about global environmental issues.

So how does an individual participate in the social need to optimize global biodiversity-adding new habitats, and restoring landscapes-at the practical, local level? Homeowners (even those that may not own land, but control landscaping design decisions) have several approaches to create ecologically congruent backyards. These approaches range from professionally vetted,

international sustainability standards, to grassroots/non-profit conservation programs. The common thread of any of these approaches is an outcome of biodiversity. All approaches employ a wide variety of human interventions (tips, tools, techniques) that allow for natural stewardship opportunities and backyard biodiversity enhancement. Examples of sustainability frames that would contribute to successful BIMBY implementation are:

LEED - United States Green Building Council's Leadership in Energy and Environmental Design. Mainly used by architects, engineers, and developers to create green and sustainable buildings, the certification process addresses how land, rainfall, and microclimates interact within the property boundary.

SITES - Administered by Green Business Certification Inc., American [Society of] Landscape Architects and other partners, improve in the way the holistic, integrative, and aesthetic design process can be used in the landscape-offering a comprehensive approach embracing interaction with nature.

Envision - created by stakeholders of the Institute of Sustainable Infrastructure (ISI), including the civil engineer discipline, which understands that "...projects have an impact on the natural world around them, including habitats, species, and nonliving natural systems" [10]. ISI approaches sustainability from an ecosystems services lens, allowing monetary values for water, air, food, and extreme weather events to align with traditional triple bottom line models of sustainable development.

RELi - a certification standard recently adopted by Green Business Certification Inc. is a frame that complements sustainability by focusing on the resilience of a community-to deal with the protection of parks and preserves, the productivity of wetlands and habitat, the avoidance of toxins, water, and soil contamination, adverse geology, in order to contribute to healthy and biodiverse landscapes. [ed. note: RELi is no longer associated with USGBC and can be found under the administration of C3 Living Design; for more information on this particular resilience-focused framework see https://c3livingdesign.org/reli/.]

Beyond these professional frames, several types of formal/nonformal education programs exist at local, regional, and national institutional levels that provide backyard-scale conservation guidelines for gardeners (or those that would hire landscapers adept at implementing said guidelines). Program examples include the Canadian Wildlife Federation the National Wildlife Federation and the United States Department of Agriculture's Natural Resources Conservation

Service. As well as being generally wildlife friendly themed, specific animal conservation programs exist that demand a biodiverse landscape that supports different life-stages of a species. For example, The Monarch Way Program promotes the conservation of the inter-generational travels of the monarch butterfly (*Danaus plexippus*), to promote important backyard plantings and highlight the ways in which insect pollinators and songbirds benefit from these purposefully designed habitats.

In the Anthropocene, citizen-led projects, such as BIMBY, are increasingly critical and deserving of ubiquitous uptake, necessitating support and encouragement from the scientific community. Therefore, scientists must adapt and seek out new approaches when communicating with the public, legislators, and corporate decision makers emphasizing why the findings matter, rather than the methodology used. Science for the sake of science is no longer justifiable when dealing with important short-term and long-term issues of ecological sustainability that BIMBY brings to the forefront. Importantly, scientists need to get to know new audiences and appreciate that the way to deliver scientific information cannot be based on a 'one size fits all' approach. This requires a new set of skills, not typically required (or even acquired) in academia or the research lab. With a new willingness to recognize and avoid complicated scientific jargon, scientists should use metaphors and analogies that are relatable for the intended audience [11] in this case BIMBY gardeners.

In order for scientists to best accomplish effective outreach to biodiversity-curious citizens wanting to implement BIMBY strategies, a diverse array of knowledge needs to be shored up to add to their skillsets. These include, but are not limited to, the biological, ecological, and physical sciences, quantitative/analytical tools, humanities and social sciences, communications, policy, administration, and law. There are professional organizations that provide their members with forward-looking, competency-based certifications that demonstrate achievement in a knowledge base involving complex sustainability concepts, including biodiversity. Excellent examples of certification programs that provide assistance are offered by The Wildlife Society the Ecological Society of America, as well as the International Society of Sustainability Professionals.

Scientists, recognizing this shifting paradigm, should participate in outreach work by talking to nature clubs and service organizations and contributing to educational websites as key elements for achieving society's biological diversity conservation goals. An excellent example of scientist-citizen interaction is the popular volunteer Master Gardener programs in the USA and Canada. Here, participants receive advanced education in botany, horticulture, and sustainable land-use.

Master Gardening programs, focuses on promoting healthy environments with sustainable gardening practices, green waste reduction, and water conservation all practical techniques that applies to the successful implementation of BIMBY. This newly learned ecological literacy spins greater understanding for the importance of biodiversity in the backyard, expanding to more environmental stewardship curiosity.

In society (and its scientific media voices) we should avoid breathing too much life into confrontational messages like NIMBY (Not In My Back Yard) and start actively endorsing proactive, imaginative, and future-forward approaches to the general public, such as BIMBY (Biodiversity In My Back Yard). The latter will emphasize a synergistic methodology intended to meet the needs and goals of conserving Earth's ecological goods and services that is personal and individually motivated. In short, BIMBY presents local, practical solutions that uplift realistic and achievable frameworks for future generations to be sustainable, resilient, and regenerative.

(Embedded List; [x]) **References from Original Article**

1. Lewis J (2009) NIMBY desert dwellers are equal-opportunity naysayers. Los Angeles Times, USA.
2. Beumer C, Martens P (2014) Biodiversity in my (back)yard: towards a framework for citizen engagement in exploring biodiversity and ecosystem services in residential gardens. Sustainability Science 10(1): 87-100.
3. United Nations (2016) Take action for the sustainable development goals, USA.
4. Seddon N, Georgina M, Shahid N, Joseph A, Alex L, et al. (2016) Biodiversity in the Anthropocene: Prospects and Policy. Royal Society Publishing 283: 1-9.
5. Harris J (1916) The variable desert. The Scientific Monthly 3(1): 41-50.
6. Michael E, Bruce W (1980) Conservation biology: an evolutionary-ecological perspective. Oxford University Press, USA.
7. Berg LR, Hager ME, Goodman LG, Baydack RK (2010) Visualizing the environment, (1st ed.), Wiley Publishers, Toronto, Canada.
8. Biswas R (2018) Challenging factors influencing biodiversity. Biodiversity Online J 1(1): 1-2.
9. IUCN (2020) Privately protected areas and nature stewardship, Switzerland.
10. Institute of Sustainable Infrastructure (2020) Use Envision, USA.
11. Pearson David L (2020) Biodiversity in the Anthropocene. Journal of Insect Conservation 24: 1-3.

2.2. Literature Review Addendum – post-journal article research

Since the publishing of this journal, a BIMBY approach continues to be my focus in my personal residence. Moreover, plans for my property have been to try and *restore* parts my southern-exposed yard into mixed prairie – specially designed as a host and pollinator edge garden. However, this goal has been challenging to implement; I am also trying to *conserve* the native maples, the established ornamental eastern cedars and spruces, as well as self-seeded small fruit trees. So, with a landscape of trees and shrubs, I try and find areas to create edges for native prairie plants. This is challenging, given that edges are naturally more species-rich through succession of these trees (seed drop). There are also unwanted weeds of various growth habits that will move into the space and takeover. It is here that I am the most frustrated as a homeowner: maintenance of this area will need to be a new ongoing practice to establish valuable pollinator forbs and ensure a weed-free ecotone. These landscape changes will allow me to make plans for re-design, installation, and maintenance. Although this will occur over the next few years, this thesis will be an integral part of my renovated landscape.

2.3. Literature Review – ensuring scope + focus

For my study, I will concentrate on existing homes that are surrounded by a plot of land that can be turned into an ecologically designed landscape. My own property will be central, with backyard, front yard, and neighborhood properties as part of the discourse. Findings should be able to be transposed and applicable to any landscape, no matter the maturity of the neighborhood. A trans-disciplinary approach used to create analysis and identify opportunities for further research is mirrored by the composition of my thesis committee (and past mentors): sustainability policy and governance, ecosystem management and ecology, wildlife biology, biosystems engineering, with city planning, urban design, permaculture, and landscape architecture. As part of my scoping and research process, and reflecting on my adult learning, I created a graphic below (figure four) depicting the knowledge domains that eventually lead to the specific thesis problem, native plants in the urban residential yard. This is a useful exercise, as I can visualize my realization that hundreds of variations of theses could be created depending on how one *funnels down or sidetracks* from the very wide origin concept of sustainability. After the graphic there is a summary of each domain which completes my literature review.

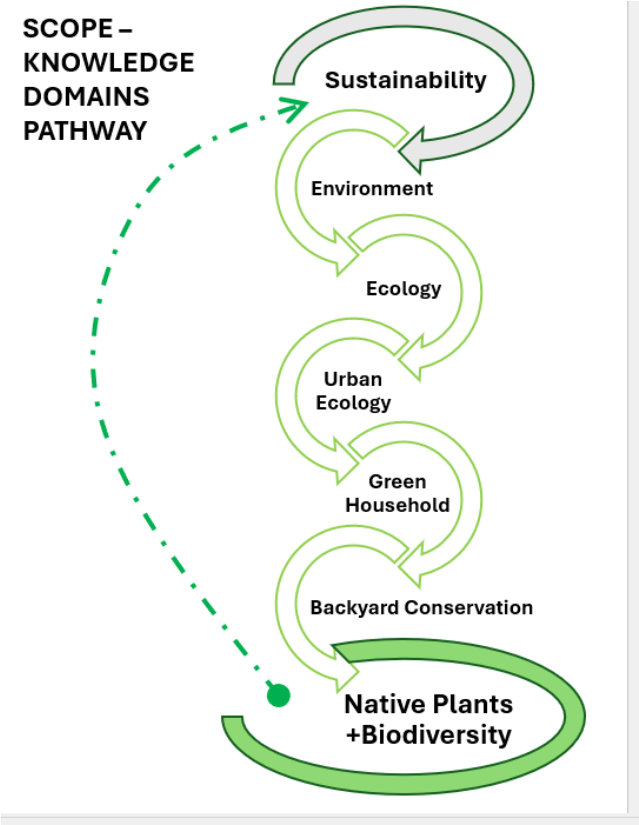


Figure Four **Description of Knowledge Domains (Thesis-Focus Tool)**

2.4. Sustainability (+ Resilience, Regeneration)

Sustainability, to me, is not restricted to the seemingly default "environmental sustainability". I appreciate, at least, the triple-bottom-line approach of environment, economy, and society. I would rather extend this to include a comprehensive model that takes into consideration many aspects such as political, economic, social, cultural, and environmental. I subscribe to the ecological environmentalist Herman Daly's influence of a nested model of the environmental / ecological sphere containing a human-contrived social system, with the economy being a sub-system [19].

2.5. Environment (Sustainability Aspect)

When I worked at Atomic Energy Canada Limited (AECL; Pinawa, circa 1995) we worked on different corporate aspects to minimize direct and indirect environmental impacts. I still favour this federal environmental stewardship approach which addressed: energy, water, air, materials,

fleet management, green procurement, and land. I note that green / healthy building certifications (LEED / WELL) list similar aspects as categories or sub-categories for design-build-maintenance guidance. The latest greening government strategy [20] can function as a pragmatic list of aspects to model (especially if environmental sustainability and funding requirements are to be aligned).

2.6. Ecology (Biodiversity and Ecosystem Context)

The terms ecology, biodiversity, and ecosystem are ususally conflated by the general public. For this thesis, ecology will use a functional definition from an ecology and field biology text book: "Ecology is the study of the structure and function of nature. *Structure* includes the distributiion and abundance of organisms as influenced by the biotic and abiotic elelments of the environment; and *function* includes all aspects of the growth and interaction of populations, including competition, predation parasitism, mutualism, and transfers of nutrients and energy among them" [21] [itallics added for emphasis].

Today, society must be concerned about biodiversity loss as an exestential threat to life on the planet; as well, new scales of biodiversity are "...being viewed more expansively, to include genes, species, populations, communities, ecosystems, and landscapes" [22]. Therefore, everyone and anything can be affected by biodiversity loss. In 1985, an auspicious title appears in a scientific journal by E. O. Wison [23]: *The Biological Diversity Crisis – Despite unprecednted extinction rates, the extent of biolgical diversity remains unmeasured*. Evidently our preoccupation with leg-warmers, music videos, and New Coke distracted us from realizing that an insect apocalypse was around the corner [24].

Lastly, another article that was prominent in The Gaurdian, exclaimied that the world's insects are hurtling down the path to extinction, threatening a "catastrophic collapse of nature's ecosystems", according to the journal Biological Conservation [25]. Retroactively, this seems typical of many environmental issues, as the boiling frog syndrome aptly describes; creeping normality, shifting baselines, and landscape amnesia are more technical terms of the social phenomenon of ignorance while eco-existential threats accelerate unnoticed. More general information about biodiversity in Canada can be found at [26].

Biodiversity, and the interactions of species within the residential space, although relatively small in size, is part of a greater regional-scale – and more importantly, is part of an interconnected ecosystem. Ecosystem processes that are present even in a small residential yard will include decomposition, nitrogen cycling, pollination, seed dispersal, energy capture, food webs, and pest issues like insect outbreaks, diseases, herbivory damage, and wildlife predation (on domestic pets).

2.7. Urban Ecology (City Scale)

Framing cities as a type of ecosystem that should encourage embedding more healthy ecosystems within the already built environment, must allow nature back into the urban realm. Ian McHarg's Design with Nature (1969), Richard Forman's Urban Ecology – Science of Cities (2014), and Timothy Beatley's Biophilic Cities (inspired by E. O. Wilson's 1984 book, Biophilia) are all linchpin books for the relatively recent establishment of urban ecology as a professional discipline. (These books are not arbitrarily chosen; they were used as reference texts in UManitoba's City Planning graduate program – specifically the course, CITY 7460, Urban Ecology and Environmental Management.) Further, Allen, referencing many prominent practitioner-scholars of ecology (Dramstad, Olson, Forman, Odum, McHarg, *et al*) concludes that when landscape ecology and conservation biology principles are merged there is "…a seamless quilt of planning and implementation across scales and jurisdictional boundaries…" [27].

As the urban residence and backyard are obviously located within a city, it is important to understand the relative scale of the various urban systems for sustainable urban design (SUD). Figure Five, below, is a valuable sustainable urban design (SUD) framework shared by a colleague, an urban ecology professor, Nico Larco. From a textbook, this table is column-organized by physical scale and row-categorized by common sustainability aspects of the built environment.

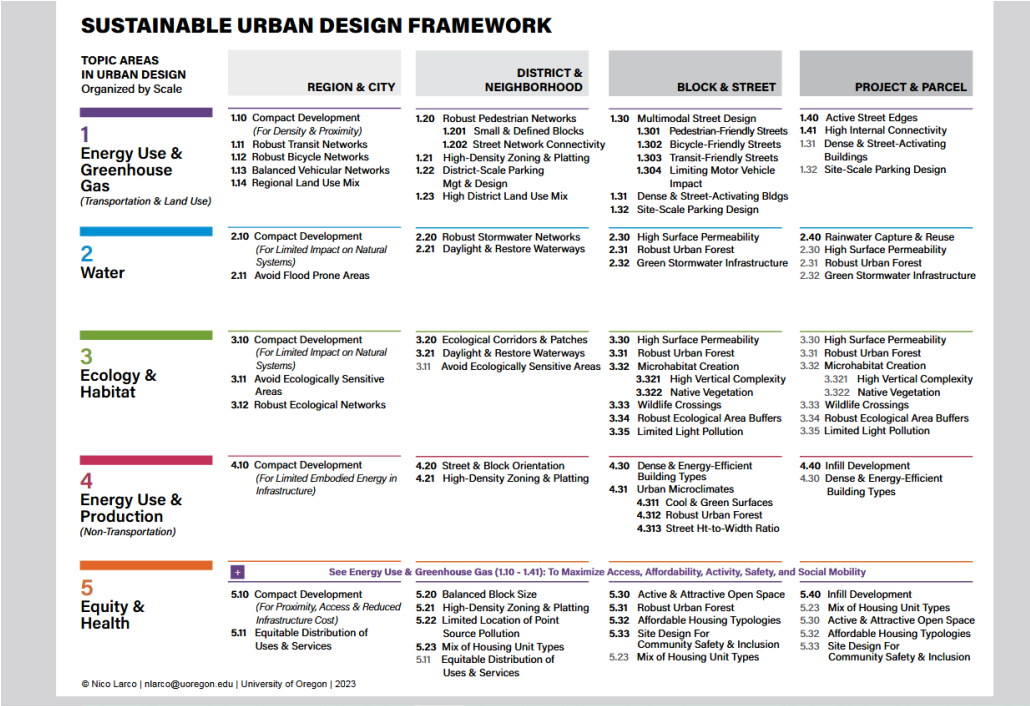


Figure Five **Sustainable Urban Design Framework** [28]

The important scope aspect of this table is the third row, Ecology & Habitat. Note the last column's scale is down to the parcel size (residential yard). All elements in this cell are applicable for an urban residence. Element 3.322, Native Vegetation, is the focus of this thesis. Larco's book details that biologists, ecologists, and arborists should help to "...identify site-appropriate native species, and use site observation to confirm which native species are thriving in similar urban conditions" [29].

Principals of landscape ecology can be employed to create close-proximity biodiversity islands, ecological corridors, complimentary ecotones (abutted to natural spaces. There could even be fruit trees for enhanced wildlife habitat or for a tended orchard. Certainly, permaculture principles [30] can be borrowed and act as a foundational design guide and food growing system employed in an urban space (but this is beyond the scope for this thesis).

2.8. Green Households (practicing various conservation initiatives)

Residents of houses can participate in many eco-responsible practices. Building maintenance can include energy conservation, less toxic cleaners, air purification, battery and electronic drop-offs, blue-bin recycling and subscribing to a kitchen-organics pick-up service. Switching away from fossil fuel usage for heating and hot water, as well as investing in innovative technologies like

heat-pumps and architectural fenestrations (Energy Star rated windows). Transportation choices (transit, electric vehicles, off-set carbon credits for airline travel) and retail purchasing patterns are also part of a green household.

2.9. Backyard Conservation (eco-measures outside of the house)

Yard maintenance can involve potable water conservation, rain-water capture, no pesticides, zero-emission tools, and minimized non-permeable hard surfaces. On-site composting with kitchen organics and leaves creates a semi-closed nutrient cycling loop (a fully closed loop if growing your own food from seed). Grass-clippings in paper bags during summer are arranged to be taken from neighbors' yard (prior to city pick-up) to import nitrogen into the yard for extra compost; bagged leaves will bring in extra carbon in the Fall. For more information, composting techniques can be found at the Green Action Centre [31].

2.10. Native Plants + Biodiversity (woody and herbaceous plants)

The ultimate focus of this thesis is an analysis of the importance, challenges, and opportunities of installing native plants in a residential yard. Native plants can be herbaceous (forbs and grasses) or woody (trees, shrubs, and vines). Rick Darke and Doug Tallamy in the book The Living Landscape [32; p 93] define 'native' as *"…a plant or animal that has evolved in a given place over a period of time sufficient to develop complex and essential relationships with the physical environment and other organisms in a given ecological community'*. These plants can also be categorized as groundcovers, understory, canopy, herbaceous, or woody.

Native plants are proven to be an effective resource for native insects within the urban built environment. The Guardian, reporting on a scientific study, states that "…[s]mall patches of wildflowers sown in cities can be a good substitute for a natural meadow… [where] bees and hoverflies like them just as much." [33].

My experience will be driven by a bias towards woody plants in this thesis – especially trees (After all, I was a former arboriculture Instructor in the Prairie Horticulture Certificate program [34] for more information about this education opportunity.) Using an arboriculture reference book, a 'tree' is described as: "…a woody perennial plant that grows to a height of at least 4.5 meters."

This includes cone-bearing plants (Pinophyta) and flowering plants (Magnoliophyta), which can also be broken down as conifers (generally associated as evergreen / softwoods) or broadleaf (generally associated as deciduous / hardwoods) [35].

2.11. Research Opportunity

This section addresses what many identify as the research questions or the gaps in literature. However when no obvious questions or gaps are easily evident, thinking about research opportunities can allow a researcher to move forward with a study of important social issues. In this thesis, the opportunity can be expressed in terms of a mantra: *if native plant installations were easy to install in a residential space, then everybody would be doing it*. Not to be glib, but this is an important statement that aligns with the thesis objectives of backyard biodiversity importance, the opportunities and challenges, and what solutions can be implemented. If the converse of the mantra is explored, then the thesis research opportunity, by way of a thesis assertion, reveals itself: we should make native plant installations easier for the residents (of Winnipeg).

2.12. Purpose + Objectives

The purpose of this thesis is to establish ways that the planting of native species can be achieved in urban areas, using the City of Winnipeg as a place of context. The work was guided by the following three objectives:

1. describe why native plant installations are important for urban residential spaces (referencing the twin crises of biodiversity loss and climate change)
2. outlining select opportunities and challenges that I have experienced when executing design-build projects of landscape installations. Using management models and other analysis, three roles are examined: as resident (house-dweller / homeowner); as professional (consultant / horticultural employee); and as researcher (academic instructor / graduate student / professional development)
3. Identify a hypothetical case-study that the City of Winnipeg could incorporate to make native plant installations more common – using an urban forestry lens.

2.13. Interpretive Framework – my worldview of pragmatism

Creswell and Poth [36; pp26-27] describes pragmatism in several ways with words and phrases like “freedom of choice”, “multiple qualitative approaches”, and the emphasis on results and solutions (the “what” and the “how”), without much regard for specific methods and stringent analysis.

Many readings about pragmatism all seem to emphasize the focus of the outcomes of research, and not the methods needed to get to the results. As I became more aware of academic research, and the different worldviews, paradigms, and interpretive frameworks, I immediately gravitated towards pragmatism – this seemed to be a solutions-based approach that married up to consulting and industry approaches. I appreciated the exposure to other frameworks such as those of the postpositivists, the social constructivists, the transformativists, the postmodernists, and others. Knowing other perspectives and theories exist to underpin serious academic research gives me a more wholistic and patient viewpoint with respect to philosophy and dealing with other scholars and practitioners. From a personal stand-point, this exploration of worldview lends itself to beneficial self-awareness that goes beyond the academy.

2.14. Philosophical Assumptions

My positionality (declared social identity) is as a privileged middle-class, third-generation white, euro-ethnic Canadian, that is a heterosexual cisgendered male, and who is also neurodivergent. These, and other intersections shapes my philosophical assumptions. Although constantly working towards allyship through various equity education paths, I still must check my biases and strive to understand and work with other viewpoints. The following are the associated philosophical beliefs that are generally coupled with pragmatism [37; p 36]:

> **Ontology –** Reality is what is useful, practical, and “works”.
>
> **Epistemology –** Reality is reflected through tools that allow research to be formed from deduction and induction (objective and subjective evidence).
>
> **Axiology –** knowledge reflects all stakeholders’ views; this shapes the values held about their realities, their observations of phenomena, and their interpretation of research.

As I can play many roles as a well-educated professional, I would still insist that I be described as a naturalist, with a strong eco-centric decision-making frame. This means that I respect (and wish to understand) all life forms (organisms) and their habitats, as well as pay attention to the abiotic

processes and artifacts that compliment the fauna and flora in question. Further, I have built a graphic to help depict how traditional ecosystem and land management practices also play a part in the conducting of my research – and by extension, my landscape design-build projects. This visual model can also be used by me as my own ethical meta-confirmation of my values. Refer to the section titled: Axiology as a Landscape Project Choice Tool.

3.0 Methodology – a fuzzy form of autoethnography

Creswell and Poth [38] describe methodology as "the procedures of qualitative research" as the methodology, and that the researcher depends on inductive logic, rather than top-down theory. Since researcher and their experiences inherently shape methodology, I gravitated to the idea of using autoethnography as the narrative inquiry-research. Creswell and Poth [39] summarize several scholars to describe autoethnography as "the idea of multiple layers of consciousness, [including] the vulnerable self, the coherent self [that involves] critiquing the self in social contexts".

This aligns to the worldview of pragmatism and justifies autoethnography as a special case of ethnographic research – whereby I am the single person being studied. I have lived the life of several characters, and played many roles over the last few decades, and have demonstrated that I care deeply about general environmental issues and specifically about biodiversity loss.

Finally, Creswell and Poth [40] state that (auto)ethnography can take two popular forms: the realist and critical ethnographer in order to collect data from groups. Since the critical ethnography is a "value-laden orientation", I am comfortable in the role as researcher that will be "empowering people" and "challenging the status quo". I appreciate recent scholars recognizing the usefulness of autoethnography as a way to create more robust research, as well as memorialize the processes involved to achieve successful research especially in "…applied fields that involve multiple stakeholders – ecology among them – [where] researchers dedicate time to building relationships, understanding perspectives and navigating controversy" [41].

One strategy I will use to allow an autoethnography to operate effectively as a research narrative is to deem myself as a group of people being analyzed, and not just oneself. By categorizing myself into a group of different characters, I essentially help myself (by way of this thesis) to sort out the stories and unique experiences involving biodiversity in residential landscapes. This ultimately informs how to make native plant installations easier for Winnipeg residents – my thesis assertion. This next section will summarize my different roles that are underpinned by adult learning. (Since this could be replicated by other scholars to understand their own autoethnography, the adult learning triad model presented can be considered either as a tool for sorting methodology, or as a method of analysis for the thesis.)

3.1. Adult Education Modes

I had a mix of formal, informal, and non-formal education, that I purposely sought out, once I was made aware of the importance of backyard biodiversity. As I continued to learn more and more aspects, intricacies, and concepts of urban ecology through various learning venues (institutional, experiential, videos, catalogues, etc., I gained more perspective to understand how native plants are important for the urban residential space. As I kept learning, and gaining more knowledge, I repeated the education process – with my learning journey culminating with the ultimate in professional development education: a graduate degree program.

3.2. The Adult Education Triad Model (a tool for sorting experience)

In adult education, one way to describe my particular learning experience is a triad model of education: formal, informal, and non-formal. Although a simple way to explain a complex and very personal human endeavour, this roughly describes my experience: formal = institutional with examination; non-formal = non-profit, self educated; and informal = learning by doing with successes and failures (inspired by grandfather and grandmother, Ukrainian railroaders / farmers). There are overlaps and debates about terminology [42] but these three categories will be useful to help sort out the autoethnography for this thesis.

I am privileged to have experienced all three of these approaches through many institutions, professional organizations, non-profits, and businesses. Along with an autoethnography spanning 25 years, data will be based on analysis of current horticultural discourse (contemporary literature, archived videos, public library books), printed and digital catalogues of Manitoba nurseries, and direct website references. Personal experiences include hands-on planning and design-build work with existing residential and public landscapes (my own, friends' and clients' properties), lateral learning from professional accreditation training, and working as an employee with local plant nurseries installing and selling herbaceous and woody plants.

Figure Six, below, is depicting these three adult learning approaches as the triad input. There is a nebulous and fuzzy learning process (and since this is not an education thesis, this shall remain as a sort of 'black-box'), and then an output knowledge mix. A mixture of integration, cross-fertilization, and co-produced ideas and concepts can create new opportunities to implement. A

feedback loop is added to identify that knowledge mixes could inspire new educational pursuits, and then new outputs to solve complex problems.

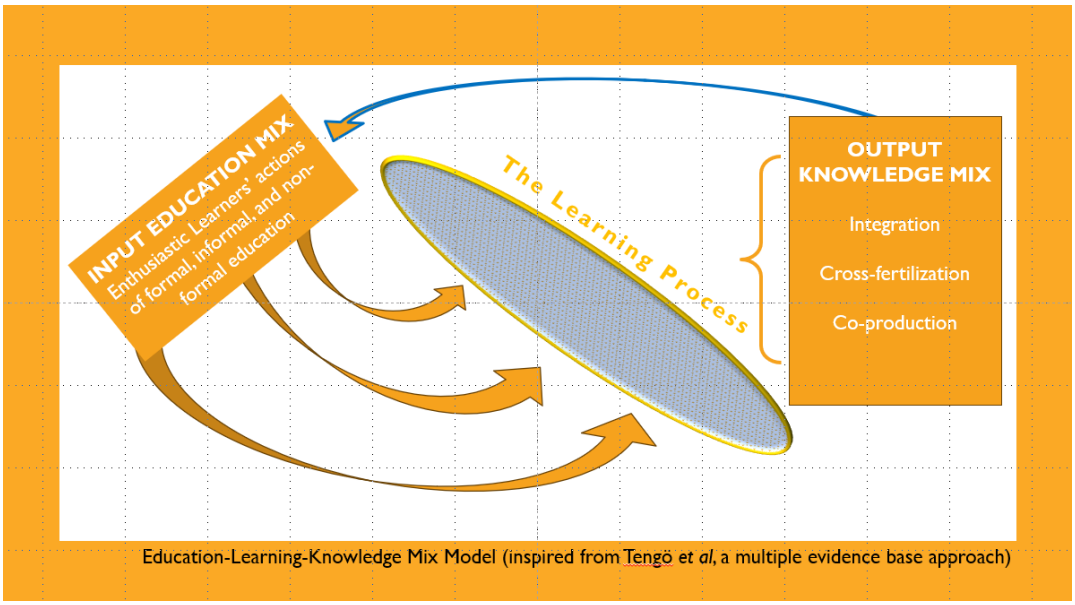


Figure Six **Education-Learning-Knowledge Mix Model** adapted from [43]

3.3. The Resident (House-dweller | Homeowner)

To be inclusive, I have named this character in two ways to identify that citizens can own or rent residential landscape elements, or they could rent. With renters (and sometimes even with associated house owners), there might be restrictions in how and where plants can be installed. Although many native plants such as herbaceous forbs could be placed in portable containers, and they can grow and bloom and be a caterpillar host plant or flowering pollination plant, the scope of my experience is garden plot and yard placed installations. I was lucky to have total creative and design control.

3.4. The Professional (Consultant | Employee)

By definition, a professional is a person that is paid income for service rendered. This can be done through self-employed income, or T4 pay cheques from an employer. As self-employed, I was a design-build consultant that helped homeowners design, install, and maintain their landscapes. Many of my client interactions were to provide 2 – 3-hour long walk-abouts and give immediate impressions and suggestions of how their land could work for their needs – with the right plants chosen. A lot of my practice follows the practices of landscape architecture, and from a professional perspective The Sustainable SITES Initiative (SITES) is a framework specifically created for striving towards ecologically congruent landscapes, with or without a built structure as part of the property. As part of professional development and to gain deeper, specialized

knowledge, I aspire to become a SITES-AP (exam to be taken after a 28-day prescribed study schedule in 2025), to advance my landscape architecture and sustainability knowledge with an industry recognized credential. SITES is popular in the USA as a way to create high performance landscapes, with professional landscapers using this frame as a metrics tool and best practices guide. (All certifications are further explained in later sections.)

As an employee of the horticulture sector**,** I continued to learn in many ways – mostly self taught by involving myself with learning product knowledge, reflecting on academic courses in the architecture faculty and the master gardener courses. I was able to converse with plant nursery owners, fellow employees, and continued to guest lecture at in-person workshops during special customer appreciation days. Conversing confidently with this newfound knowledge, I was asked to help out at the nursery and was hired as a retail associate – acting as their internal subject matter expert internal consultant in the tree and shrub section (arguably the most impactful and expensive plants to purchase for a landscape). Of course, as an associate, I was exposed to all the selling of fruit, vegetables, and ornamental perennials and annual flowers. This expanded my knowledge-base in all plants that would be installed in a backyard landscape.

During this experience, I was exposed to many different customers' needs and wants. I was primarily in charge of helping customers in the tree and shrub section. This employment stint was a multi-pronged learning experience: my product knowledge increased; I was exposed to many different planting scenarios (problems that needed solutions); as well as being exposed to the food production side of plants (fruit and nut). Further, since I was selling several different sizes of plant stock, I learned about different planting techniques (how to dig a hole, how to secure from wind damage, how to prune, etc.).

3.5. The Researcher (Academic | Professional Development)

Traditionally, formal education is recognized as taking place in an institutional, professional setting. My learning about native plants, and horticulture in general, was greatly enhanced when I participated and completed in arboriculture and urban ecology classes within the faculty of architecture, University of Manitoba (UMan). Also, being exposed to structured curriculum and reading courses in the engineering faculty allowed me to gain another perspective through a biosystems / civil engineering lens. Last, I was lucky to participate in a two-week summer course that was held in rural Manitoba (Clear Lake) and learned theory and practice in permaculture principles, based on the original Australian model of agro-ecology, a popular international

movement in gardening and landscaping (mostly based in food production using natural cycle principles) [44].

Further, I simultaneously was pursuing professional development opportunities and achieved accreditation in various sustainability frames that were and are popular in the architecture, engineering, construction, and planning (AECP) sector. Over the years I obtained professional accreditations that all helped me with learning and teaching in the following frameworks: LEED (green building), WELL (healthy building), Envision (sustainable infrastructure), ActiveScore (active transportation), Fitwel (healthy building), a Master Gardener Certificate, and a Certificate in Adult Continuing Education (CACE).

Finally, due to the combination of my practical knowledge, accreditations, and post-baccalaureate special-student courses, I qualified to teach Arboriculture as an Instructor through the University of Manitoba Extended Education faculty. This was a great experience, as I was able to learn while I taught; I created exercises for the participants to do independent research on woody plant diseases, as well as create their own designs for landscape needs.

3.6. Analysis and Data Gathering Methods

Analysis that uses my experiences as a homeowner, professional, and academic researcher (the chosen autoethnographic approach) will provide insights into the challenges and opportunities of improving urban biodiversity through the planting of native species. In tracing an autoethnography (design-build planning stories, landscape observations, client and employment memories, *in situ* experiences with landscape, past and ongoing adult education), which in my case spans more than 25 years, there needs to be a process that sorts how to reflect on and examine that sort of lifelong experience. The adult learning triad model presented above is a good foundation to differentiate my learning approaches. (This could be useful in considering future ecoliteracy education programs.)

Further, I realize that there were numerous phases of learning that I went through to understand where, and why, a plant is installed in a residential landscape. Thinking on my autobiographical timespan (Spring 1999 through Fall of 2024), I reflected on concepts that loosely flowed three main phases:

1a) understanding what planting conditions are needed: sun, soil moisture, mature size of plants (based on purposeful observation)

1b) what USDA / Agriculture Canada plant zone they belong to. Winnipeg is technically 3b, although various parts of the city, and the way houses are oriented forming micro-climates), zone four plants are able to thrive, potentially long-term. Revisiting this concept is important, as extreme weather starts to create nuances of root, bud, and flower hardiness. Further, climate change and its tendency to shift hardiness zones northerly, will change what (ornamental) plants can be grown.

2) expanding on the concept hardiness zones, a 'collector' mentality can take over a gardener's thoughts. I used Lois Hole's Favorite Trees & Shrubs book [45] as a sort of plant 'bible' and sought out to install every single species. Although this book was geared to the prairies, I soon found out from personal experience that polar vortices and a sopping wet springtime can soon ruin a collection – no matter how much tender loving care and protection you lavish on the plant specimen.

3) after learning more and more about the concepts of food web, biodiversity loss, and the importance that invertebrates have with the interactions of ecosystem services, my plant choice decision making has dramatically shifted to the idea of 'host plants' – especially keystone plants.

Tallamy has pioneered an aggressive educational outreach program called the Homegrown National Park. This will be discussed later in thesis.

4.0 Findings and Discussion

4.1. Reflecting on my holistic experience of backyard biodiversity and native plants

Although I am capable of reconstructing a 'before and after' biological comparison of my own particular yard (from turf to present, with all the iterations in-between), I feel it is more important to detail how my knowledge has metamorphosized over 25 years using formal, non-formal, and informal education and practices. My reasoning for this approach is that it is a given that biodiversity will increase *de facto* by changing from a traditional turf landscape with a few ornamental trees. It is identifying the opportunities and challenges of how to install and plan a native plant landscape that is important, Further, how does one gain this knowledge and keep up, enthusiastically, with how your landscape can continually improve – ecologically. Essentially, my experience as a house dweller, a consultant, and a researcher will inform my thesis and demonstrate why native plants are key to contribute to urban resiliency – and contribute to solutions addressing biodiversity loss and climate change. The following sub-sections are important findings that I can use in my design-build consulting practice; these should be classified as *new knowledge* that built on previous experience gained through adult learning activities.

4.2. The Usefulness of the Linnaeus Taxonomy Hierarchy

Sometimes looking at the lineage of an organism is very important to understand diversity planning relationships that involve habitat needs and disease risks. There are many levels in the Linnaeus taxonomic system (inaugurated the binomial system in 1753) that a biologist or botanist can utilize; it is still useful from an ecoliteracy standpoint for homeowners and design professionals to use, though they might only need to utilize some of these levels. Working from species upward, or family downwards, patterns can be seen between species comparisons by noting the taxonomic intra-relationships. For example, realizing that monarch butterflies are closely related to cabbage moths allows one to gain perspective that perhaps pesticides used to protect vegetables might negatively affect more charismatic butterflies. Extending this reasoning, one could also understand that Lepidoptera in general might benefit from the same habitat-building design principles. So, realizing that plants of the same genus might offer similar forms and functions, someone that appreciates the taxonomic system can feel more empowered in how to work with nature. The following are three examples of organisms that have been observed or

exist in my Winnipeg residential space (see Table One, below). The Integrated Taxonomic Information System (ITIS) [47] search engine (a new discovery for me) was used. One can search in Kingdoms using common name, scientific name, or taxonomic serial number. The ITIS is a top-notch, comprehensive database, that, by way of strategic partnerships, provides "…authoritative taxonomic information on plants, animals, fungi, and microbes of North America and the world".

Monarch Butterfly	**Blue Jay**	**Manitoba Maple**
Kingdom – Animalia Phylum – Arthropoda (invertebrates) Class – Insecta Order – Lepidoptera Family - Danaidae Genus - *Danaus* Species – *Danaus plexippus*	K – Animalia (animals) P – Chordata (chordates) Sub-P – Vertebrata (vertebrates) C – Aves (birds) O – Passeriformes (perching birds) F – Corvidae (crows & jays) G – *Cyanocitta* S – *Cyanocitta cristata*	Kingdom – Plantae (plants) Infrakingdom – Streptophyta (land plants) Division – Tracheophyta (vascular plants) Subdivision – Spermatophytina (seed plants) Class – Magnoliopsida Order – Sapindales Family – Sapindaceae (soapberries) Genus – *Acer* Species – *Acer negundo*

Table One **An Example of Taxonomic Breakdown**

4.3. Horticultural Vernacular (the start of a mini glossary)

There is a botanically functional spectrum of plant categories that is not discussed in the myriad plant catalogues: consumer-based horticulture literature is very "beauty" oriented, with customers willing to pay exorbitant sums for speciality plants. A comprehensive catalogue from a commercial nursery will usually describe a plant's hardiness zone, ideal growing conditions (sun exposure, soil moisture tolerance), mature dimensions, growth habits (shape, flower timing), seasonal colour. There might be a quick reference to the plant being a good wildlife plant, but this can be problematic: some growers do not want to explicit remind consumers that bees, wasps, squirrels, and other animals will be supported by such a plant. Human fear, even if irrational, is a powerful marketing concept. On the other hand, a plant that is called a butterfly attracter or a pollinator plant can be a value-added statement, and a better seller; retailers in this case are betting on a consumer being aware of the importance of pollination and wants the bonus experience of witnessing beautiful, winged insects.

Unless a nursery is selling to well-informed consumers that understand ecosystem dynamics, descriptions about being specific insect food (being a larval host plant), or as a native bee specialist plant are usually left off any labels. (There is an assumption that the propagator or nursery has entomology and wildlife biology knowledge.)

Hopefully, plants that home gardeners and landscape professionals can soon choose from can have self-explaining descriptors that identify how a plant might contribute to a resilient ecosystem. Plants being marketed for the residential yard are an excellent opportunity to educate the general public that there are important design considerations that goes beyond a monoculture of turf grass (or worse, ornamental, aesthetically-pleasing invasive plants sold and inadvertently being allowed to flourish in a plot of land with blissful ignorance).

4.4. What is a Native Plant?

Simply, a native plant is one that is indigenous to an area; a caveat is usually added that it is a "species that occurred in the province before the time of Euro-American settlement" [47, p 22]. Native plants are sometimes referred to as a 'true' or 'straight' species of that plant name. Sometimes a native plant definition emphasizes the geological history and identifies it as the flora that have been co-evolving with the fauna for hundreds, thousands, or even millions of years at a regional scale (using a mapped Ecozone reference).

It is also important to *functionally define native plants* and the alternatives that residents would be offered for their yard. A useful reference that is ecologically linked to Winnipeg and its Tall Grass Prairie roots is from the Native Plant Society of Saskatchewan:

> "Prairie landscape evolved to include a wide variety of plant and animal species adapted to these environmental conditions. The open grassland interspersed with lakes, ponds, creeks, river valleys, shrubs and Peoples and wildlife including, huge herds of grazing animals and a myriad of birds and insects. These age-old plant communities dominated by grasses are what we refer to as native prairie" [48].

It is the co-evolution of the insect-plant interactions that gives us the ecosystem service of pollination. Many do not realize the importance of pollination for the food that we eat. Yes, there are some agro-systems that exist that employ a managed hive system to aid in crop pollination, but for simple backyard pollination, there is the wind and there are insects.

As Tallamy emphasizes: "insects pollinate 90% of our flowering plants. Without insects, we'd lose these plants, which collapses the food web (amphibians, reptiles, birds, mammals)…" [49]. Biodiversity loss is an important socioecological phenomenon that does not seem to be in everyday public discourse, even if the related crisis of climate change is in mainstream media (and only now if there is a devastating extreme weather event). An award-winning essayist (the Berggruen Prize) points out that this dire lack of communication creating large gaps in social awareness regarding the multiple existential crises that the world faces today is in itself a crisis. Plus, there are human-specific social conundrums whereby our own brains trick us into simplifying matters. For instance, Swanigan points out the *availability heuristic* "…which leads us to skew our thinking toward the most easily seen and understood events at the expense of ineffable impacts, like ecological and climatic disturbance" [50]. I, too, believe that an awareness-education-action marketing strategy should be part of successful landscape installations: residents and professionals will not know what they do not know. Leaders in the ecology / horticulture / landscape sector *must* realize the imperative to explain to the general public why it is important to move towards installing native plants in the private residential space, even if challenging.

Placing the term native plants into horticultural historical / attitudinal context is reflected here: not long ago this term was essentially unknown within a traditional gardening conversation. For instance, in the 1970 book The Prairie Gardener [51] "native plant" is not listed in the index. This author-designer offers examples of traditional cultivated trees, shrubs, and perennial border plants, with a whole chapter dedicated to various roses. This is still true to this day, as sheer volume of cultivated varieties overwhelms commercially available native species selection. As an aside, the same book indexed "insects" as infestations, and casually, with confident advocacy, refers to the use of toxic pesticide brands such as Malathion, Kelthane, Aramite, and Black Leaf 40 (nicotine sulphate). This menagerie of chemicals was easily obtained at most garden shops; my Baba (Ukrainian grandmother) might still have an impressive, boxed collection in an old shed. The point is: understanding native plants, their co-dependent insect relationships, and zero-toxic horticulture is relatively new discourse in research, practice, and retail spaces.

4.5. Nativars

A portmanteau of native and cultivar; where a true native species plant has been intentionally modified by a human to create different traits. This also can occur through natural cross-breeding in the wild. There is a small, but important, amount of research being done on quantifying the effectiveness of how nativars' resources interact with animals in the garden. Resources such as nectar and pollen resources, vegetative food sources (foliage), and habitat opportunities (nesting, protection, camouflage at all life stages) can be disrupted by manipulation as the co-evolution traits could be eliminated or severely hampered.

There is new university lab and PhD student research that is helping understand the complexities of native / nativar plant interactions with insects. For example, "...genetic diversity is the foundation for biodiversity, which is the foundation for healthy ecosystems. Open-pollinated, straight species natives provide this genetic diversity; native cultivars do not. Finding locally grown straight species natives, is another key to supporting local ecosystems -- Annie White, a PhD student in Ecological Landscape Design at the University of Vermont. Under the guidance of Dr. Leonard Perry, White is comparing what she calls "true open-pollinated native wildflowers" to native cultivars..." [52].

In recent graduate research, I have learned that modification of plants is an art and a science. For example, because many know of echinacea's medicinal properties, many consumers will gravitate to these plants and enthusiastically purchase for their garden. Then, when you see that a Manitoba native plant listing includes *Echinacea purpurea* you think you are purchasing a beneficial plant – for nature and it is a landscape beauty. I did. For a long time. Unfortunately, the first part of the botanical Latin name of a plant (genus) is hardly ever a way to compare plants for overall biological function. Only through seemingly random video research did I become aware that some nativars are a close match to the ecosystem services function of the true species. However, there are highly modified plants that are basically botanically useless. Important referenced descriptions of nativar complexity follows:

> "The Grow Native! program recognizes that some or perhaps many "nativars" (a cultivar or genetic variant of a straight native species) may have as high an ecological value as native species, but in many cases, this is conjecture and is not absolute. In fact, there are few studies comparing the nutritional value of straight native species to cultivars/nativars" [53]

"Mt. Cuba [in northern Delaware] aims to better understand and quantify the horticultural and ecological value of native plants and related nativars in order to better understand the various ecosystem services these plants provide. In collaboration with academic institutions in the region, popular nativars are established and grown under similar conditions to those experienced in the yards of your average gardener" [54].

4.6. The non-native plants: ornamentals – aliens – exotics

Who does not love beautiful flowers? I am an ecological landscaper, with a strong ecocentric-naturalist ethos, and have been practicing urban permaculture since 1999, yet I was gobsmacked by the colourful annual ornamental display in the raised beds at the nearby hospital (the closest Tim Horton's coffee shop). Figures Seven & Eight, below, are great examples of ornamental public display; these are mainly annual flowers, with some ornamental shrubs for structure.

Figure Seven

An Example of Ornamental Public Display #1

(Photo Credit Bill Dowie Summer 2024)

Figure Eight

An Example of Ornamental Public Display #2

(Photo Credit Bill Dowie Summer 2024)

If the who are humans, not many; if non-humans, a lot! Many insects need more than nectar (sugar) for survival of their entire life cycle, pollen (protein) is important. This is especially true for native bees that can be classified as pollen specialists.

4.7. Cultivated Varieties (cv)

Another portmanteau combining the words cultivated and variety. Essentially this is the constant work of a plant breeder to create modifications of plant form and function. (Whether the modifications are beneficial, benign, or detrimental is up for debate.) Arguably, the cultivation of many, many different varieties of plants drives the economic model of the horticultural industry. Psychologically speaking, humans are always looking for something different: think about clothes fashion or the automobile industry. As a noble pursuit, cultivars are pursued to produce disease resistant plants. This has been important pursuit to protect backyard plants from casual disease – where a tree or shrub that is a featured specimen would be sorely missed by the resident. Generally, in a private urban landscape there is no grove of plants where a few dying will not impact the entire stand – notwithstanding novel introduced diseases (pathogens, pests) that can wipe out entire urban forest systems (see Dutch Elm disease, Pine Bark beetle, and Emerald Ash Borer beetle).

4.8. Plants are part of the entire insect life cycle

Researchers are finding that many ornamentals are useful for resources of animals (insects). They found that some insects and "…non-native plants were well integrated into butterfly nectar diets (83% of foraging observations) and that visitation to non-natives increased later in the season when native plants were no longer flowering" [55].

4.9. Invasives – the anti-ecosystem plants !

Invasive plants are introduced plants that disrupt the ecosystems that they are able to thrive in; this is a serious issue for biodiversity and ecosystem stability. Winnipeg residents can access information about invasive plants through a provincial government unit (though very agricultural-focused [56]; as well as some ENGOs that strive to create education and awareness to the general public. Even as an environmental consultant for decades, and through my formal and non-formal horticulture education experience (landscape architecture and master gardening, respectively),

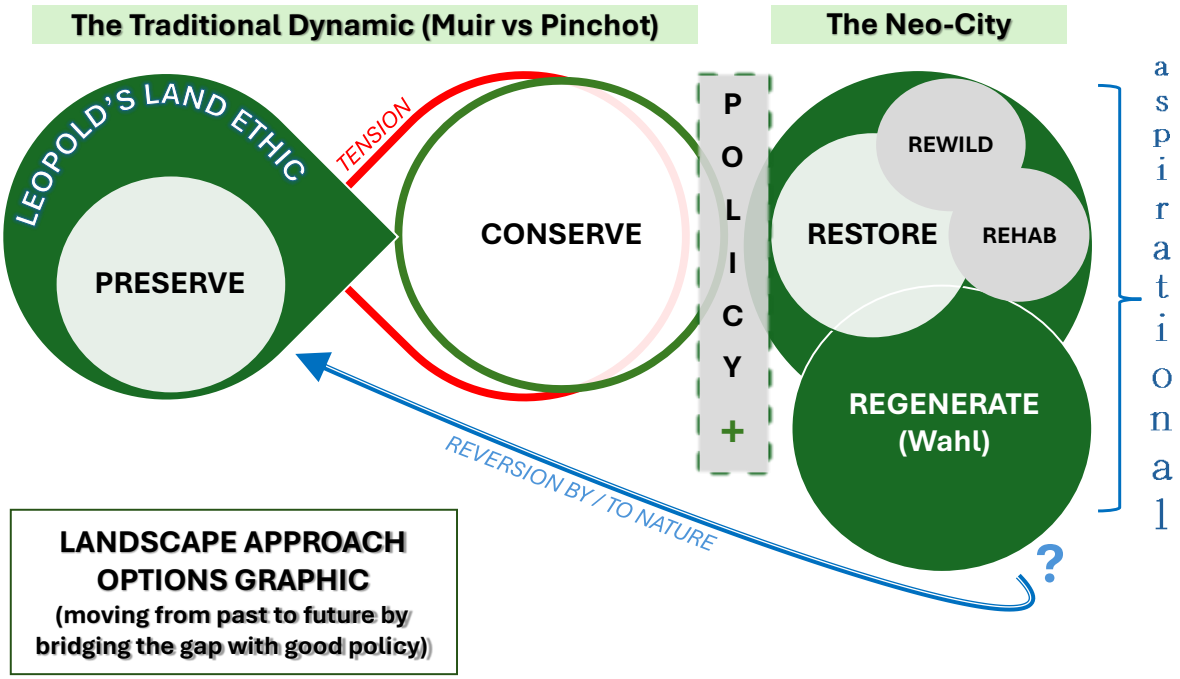
I was not really exposed to invasive plant knowledge (or at least it did not leave an impression of urgency or importance). Only until I attended a live presentation by the Canadian Coalition for Invasive Plant Regulation [57] here in Winnipeg (hosted by the Manitoba Master Gardeners Association, April 1st, 2023) did I realize how invasive plants are really an *anti-ecosystem* component.

However, I still grapple with the tension between some of these plants acting as an important food source for bees – in my case, I have observed prolific and consistent usage by the bumble bee (*Bombus* spp). Two plants that I have in my yard are: creeping bell flower (*Campanula rapunculoides*) and Himalayan balsam (*Impatiens glandulifer*). These plants are summarized by the MMGA as either invasive or aggressive [58].

These particular plants, by gaining a foothold, are described as an ecological nuisance as they push out / push away (displace) native plants from establishing into a landscape. But as I mentioned above, this is a conundrum in my mind: if there was *only* a monoculture of lawn turf, defined by some as ecological desert [59] are these listed invasive plants serving an ecological function by providing a food source to insects? However, I am aware that if invasive plants successfully move out of an urban yard (even if surrounded by a concrete jungle), they can dominate a suburban natural area, then an exurban area, then a rural area (a quickly moving domino effect). Is this an over-generalization, or a rule to heed?

4.10. Axiology as a Landscape Project Choice Tool

Figure Nine **Landscape Approach Model Based on Ethics**



This graphic (figure nine) depicts that enabling policy (and other governance mechanisms) can bridge the gap between the traditional (preservation in tension with conservation) and the aspirational "new city" that is designed around principles of restoration and regeneration. So, stakeholders / actors (including my pragmatic self) can utilize various landscape approaches that can compliment declared values while reflecting and integrating a land ethic (see Aldo Leopold [60] and other frameworks like ecosystem restoration [61], permaculture [62], and Wahl's reflective and summarizing work on regenerative cities [63] can be used to help inform project approaches.

Figure Nine also symbolizes the classic tension between preservation and conservation (the Muir-Pinchot origin story), as well as moving towards more aspirational restoration and regeneration modes. This is where humans *live with the land* and push to create situations where there is holistic harmony with nature. Ideally, this is also contributing to net positive benefits – ecosystem services (pollination, flood control, heat mitigation, soil health) or sustainability aspects of the built environment (energy, carbon, materials, water, nutrients, air quality).

Lastly, the graphic indicates that there is always a chance that even aspirational land approaches can go awry and could be taken over by natural succession to an original preservation state; there is also a possibility that a preservation state might be desired after a re-wilding or rehabilitation project is successful. I add these dynamics into the axiology section as patience, understanding, and temperament are values required by any number of stakeholders or actors. (Indigenous land claims, post-industrial development, come to mind here.)

Further reference to the model above a residential lot owner can make landscape choice, despite their land ethic. The model depicts three realms of choice, moving toward implied, aspirational, socioecological progression: preservation, or conservation, or restoration / regeneration. This model presented suggests that there could be tension and gaps between landscape design-build project choices. Stakeholders traditionally choose a project as either preservation or conservation – mirroring the ecological philosophies of Pinchot and Muir [64].
Preservation is by definition, ideal and pristine, with little or no human intervention. *Conservation* is usually constrained by resources (time and money), and can fall under government jurisdiction (bylaws, regulations), thus the linkage in red (marked tension). There is a distinct gap between a present sustainability strategy of conservation and a newer, third cluster: the *restoration / regeneration* goal. The model's gap does symbolize that well-informed policy (the grey rectangle) can bridge this gap between a pre-determined *status quo* project and an aspirational future-designed project. The policy rectangle can include many management tools: consistently followed best practices, life-cycle planning through all project stages (especially on-going maintenance), financial incentives or penalties, strategic partnerships with community, and awareness and education programs. When policy implementation is successful, ecological restoration (or better) can be realistically achieved. (Note: conservation outcomes can involve human interventions with landscape designs that range from beautifully emulated natural states like a modified and manipulated prairie plot (see Oudolf [65] for highly celebrated landscape designs; to a biologically impoverished reclamation site (brownfield) [66], that is scarred from post-exploitation activity (mining, forestry, industrial contamination.)

Any ecosystem project should try to be informed by the ecological (historic) reference state [67] (before anthropogenic disturbances). This can be done by re-visiting the preservation stage – understanding that the 'true' past-state could be significantly different than the design intent of the project – with timeline and budget constraints threatening stakeholders' goals. For instance,

re-wilding projects [68] need to have clear goals of the achievable ecological states that are wanted by informed and active stakeholders.

Most spaces in Winnipeg have an ecological reference point that originates to when the Pleistocene ice age sheets retreated in Manitoba. 10,000 years ago, Winnipeg would have been tall grass prairie with prehistoric forests shrinking to only the wetter riparian tree and shrub zones, and with a large bioregionally proximate boreal forest to the east. Coincidentally, a short walk from my family home, there is a 13-hectare remnant prairie nature preserve, Living Prairie Museum (year of inception1968), within the corporate structure of the City of Winnipeg [69]. The tall grass prairie, the representative ecosystem (ecological reference state) at LPM, is an endangered ecosystem – one million square kilometres has been whittled down to less than 1% of the original tall grass system. Therefore, a residential space in the proximity of LPM would ideally emulate a tall grass prairie ecosystem. This, however, assumes two important factors: 1) that the geomorphological conditions are the same; 2) that the resident is accepting of this design. These are not trivial factors; they are make-or-break if one is aspiring for true, ecological referenced restoration projects.

If a resident decides to want to mitigate biodiversity loss, understanding the terms and definitions of plants is important, even if at a rudimentary level. Lesson one should be: do not be intimidated by botanical Latin as the name of a plant; common names are shared throughout the world with many countries and cultures and can be vastly different plants – not even sharing the same genus. The second lesson is to really know the difference between a native, a cultivar, or an invasive plant. This is not an academic exercise as consumers need credible and valid options to make an informed decision regarding their landscape. A landscape should be a long-lasting, enjoyable, and valuable part of your property; if biodiversity can be added (or at least not degraded), then it is win-win for you and Nature. I recommend the webinars and video features for more context [70].

4.11. Biodiversity and the Food Web (The Tallamy Tenet)

> *"In the past, we have asked one thing of our gardens: that they be pretty. Now they have to support life, sequester carbon, feed pollinators and manage water."* ~ Doug Tallamy, co-founder HNP

The Homegrown National Park (HNP) program is an important umbrella organization that strongly advocates using keystone plants to support larval stage Lepidoptera insects [71].

The program's research strongly advocates that in order to mitigate biodiversity loss and restore ecosystem balance, the food web must have a strong foundation of woody host plants for Lepidoptera. This is what I will coin the Tallamy Tenet. The larval stage of this family, the caterpillars of butterflies, skippers, and especially moths, are the ideal food source for the adult birds to rear their young. These are soft-bodied insects which chicks can easily eat, as opposed to hard-shelled (chitin) beetles, crickets, and grasshoppers.

Physical scales that CoW involves itself with can vary from small private yards, to district ecological corridors, to vast regional parklands. The Homegrown National Park® [72] program encourages biodiversity in the backyard by using a specific approach as landscaping for Lepidoptera by planting keystone trees. Although this program is not as prescriptive as other backyard programs, it does create awareness of what is a truly native tree; a tree that is a "powerhouse plant" that bolsters the food web [73].
Biodiversity is being lost, too quickly, which concerns an important professional sector organization – the American Society of Landscape Architects (ASLA). When amalgamating various key ASLA videos from seminars and symposiums [74], several reasons are given for this accelerated crisis: habitat loss and fragmentation (urbanization); invasive species (flora and fauna); overexploitation (hunting and fishing); pollution (air, water, soil); climate change (global warming). So, given that urbanization is a listed problem, there should be an urban-centric solution – keeping the issue in a city context.

The urban yard is strongly touted as a biological functional space by the entomologist-ecologist Doug Tallamy in the 2019 book, Nature's Best Hope: A New Approach to Conservation That Starts in Your Yard. Leaning on E. O. Wilson's work that biodiversity loss is real, Tallamy proposed that with native plants dwindling with development, wildlife was fast disappearing as well. The solution: Tallamy proposes to plant native keystone plants in urban settings. Every yard has space for some sort of plantings, especially if a resident starts to replace lawn turf with various forms of native plants. Tallamy and others strongly suggest that on top of the eliminating most of traditional turf, a biological dead-end, there are important keystone plants that will allow larval lepidoptera to feed, creating a basis for an ecosystem-based food web. The food web is important in many ways: clutches of birds must be raised on thousands of soft moth caterpillars. Specialist pollinators, such as solitary (native) bees are able to access pollen and nectars (also contributing to pollination services). Natural population control of pests by beneficial predation creates balance and drastically eliminates the need for pesticides – both at the yard, and neighborhood /

district scale. Tallamy envisions grassroots conservation approaches – how homeowners everywhere converting their yards into conservation islands can provide habitats for wildlife (and perhaps if enough yards participate, these habitat islands can form corridors and networks, linked to existing natural features).

Since learning about Tallamy's approach, I have evolved as a designer in a philosophical and practical way. I am now utilizing important maps from various organizations (government and ENGO) to search for keystone and ecologically important flora to plant in my yard. Further, my scientific definition of biodiversity has evolved, moving away from me thinking that a large variety of non-native ornamental plants (a collector's mentality) is contributing to the local ecosystem. Surprisingly, being a plant collector of many genera is not optimal as I learned about new foundations of botanical science investigating co-evolution and mutualism. (I started to learn that leaf & petal colour plus flower structure shifts the genetic and molecular make-up of plants, disrupting and deterring insect visitation; a term I harshly dub as a *biologically useless* plant.)

I have realized the power of duo-purpose for decades – I just was not aware that I was simultaneously addressing biodiversity and climate issues when I planted a native tree to the south-west of my house. But this is the opportunity of homeowners when understanding the power of plants.

5.0 How *Professionals* Can Learn About Native Plant Installations

Professionals, especially the architecture, engineering, construction, and planning (AECP) professions are key stakeholders and can leverage effective change when dealing with residential landscapes. Park, *et al* advocates that stakeholders must band together and "...design diverse landscapes and restore plant communities that mimic nature in both functional diversity and complexity of structure. These design strategies enhance insect, bird, reptile, and mammal biodiversity..." [75]. This is the same as many of the ENGO programs mentioned previously.

There are many professional certification systems that add sustainability value and focus to built-environment projects. These have origins in green building construction, with the AECP sector using these certificates to improve their own industry's best practices, and can directly or indirectly add guidance to use native plants through biodiversity loss mitigation in landscape projects. Three frameworks were identified in the literature search and will be re-explored here: LEED, SITES, and Envision.

5.1. LEED + SITES + Envision (revisiting the literature review)

"The U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) rating system and the Sustainable Sites Initiative (SITES) are used as examples of how performance-based site design can be incorporated into the design process" [76].

The preceding quote demonstrates that the AECP sector has the support, and the desire, to utilize internationally respected and professionally utilized frameworks that directly (or indirectly) involve biodiversity and nature (using native plants as a focus). Hopefully, as these organizations and their frames evolve, the more accessible the intent and outcomes will be for the general public.

The latest versions of **LEED** introduce more progressive aspects of sustainability as distinct elements, such as location & transportation (to deal with the climate change effects of one-car commuting usage), as well as regional priority, and quality of life. The traditional aspects (called categories) were: Innovation; Energy and Atmosphere (EA); Materials and Resources (MR); Indoor Environmental Quality (IQ); Water Efficiency (WE); and Sustainable Sites (SS). Now, LEED is attempting to address environmental aspects from a social-policy lens that includes issue-based concepts such as carbon emissions, climate risk assessment, health, resilience, and equity.

USGBC states that "… [when surveying the] LEED credits, 35% relate to climate change, 20% directly impact human health, 15% impact water resources, 10% affect biodiversity, 10% relate to the green economy, and 5% impact community and natural resources [77]. Note that biodiversity and climate change are explicitly used as general sustainability aspects.

LEED 4.1 for Residential Single Homes [78] is an obvious certification that a homeowner would pursue if trying to obtain a USGBC accolade. However, like in the commercial building spaces the SS category contains only limited sustainability aspects. These include dealing with heat island reduction, outdoor water use, rainwater management, and nontoxic pest control. Certainly, if one understands landscape design, then native plants could (and should) be utilized for more effective rainwater management, as well as needing less pesticides. Unfortunately, native plants in this case are not explicitly called for in the intent or the requirements of any credits.

On the other hand, the LEED 4.1 Cities and Communities: Existing Cities [79] (beta version 5 is being piloted) includes a takes a fresh look at nature and biodiversity categories (that serves as macro-proxies for potential native plant installations). These are important additions as sustainability lenses for LEED and is a superior approach to the traditional sustainable sites category. In addition to the traditional credits listed above, LEED for Cities includes a whole category called Natural Systems and Ecology (NS).

This NS category lists the following credits with an ecosystem assessment prerequisite: green spaces; natural resources conservation and restoration; light pollution reduction (important for many animals and plants); and resilience planning. The NS category includes using sophisticated tools such as the IUCN Species Threat Abatement and Restoration (STAR) metric [80].

The most recent category addition to the LEED suite of products is Cities and Communities (known also as LEED for Cities; LfC). Here we start to see much broader environmental and *social* aspects of sustainability. More policy driven than technically prescriptive, this frame will be attractive to administrators and regulators more so than engineers. Within LfC, there is a major category of Natural Systems and Ecology [81].

The frame is useful to guide an entire city and also down to the community level. Although the following is geared to inform policy at these larger scales, a resident with the financial resources, can transpose down to the yard scale: A required Ecosystem Assessment (which is onerous for a homeowner, but has possibilities to create a partner-program with ecologists); Green Spaces; Natural Resources Conservation and Restoration; Light Pollution Reduction; and Resilience

Planning (where climate extreme weather events, insurance risks, and food security can be considered).

SITES is the landscape architects and naturalist pathway to native plant use. Since the LEED frame was widely thought to emphasize the engineering of energy and focused mainly on the interior of the building – with only a small sustainable sites category to address outdoor property concerns. Thus, Sustainable SITES Initiative was created. (For historic context and insights into the new SITES for Existing Landscapes Program that launched a pilot in 2022, visit their website [82] There are four aspects that the present SITES v 2 uses to ensure a comprehensive, holistic and sustainable design: water, vegetation, soils, and materials and resources [83].

Envision "…has been used successfully to respond to a broad range of sustainability criteria — encompassing social, environmental, economic, and resilience factors — on Landscape / Environmental projects. Public agencies and their private sector partners can use the framework to align a variety of projects in this sector with identified sustainability objectives. These areas include: Public realm, Parks / campgrounds, Ecosystem Services, Natural / Green Infrastructure, Environmental remediation / restoration" [84].

When a framework like Envision is leveraged appropriately, there can be scaled benefit for biodiversity enhancement or restoration. Also, good planning and designs utilizing nature, including native plants, can simultaneously contribute to solutions towards urban climate change adaptation and mitigation challenges. Since Envision is a sustainability framework that was devised specifically to guide the AECP sector to create infrastructure in a socially responsible, environmentally congruent, and economically sound ways, it is not surprising to find credits that involve native plants and can be directly tied to residential spaces – existing or new neighborhoods. (Further summary is provided in APPENDIX 5 – The ISI - Envision sustainability framework and rating system.)

5.2. Other Industry Professionals

Arboriculture Lens –

a discipline that focuses mainly on woody plants, trees and shrubs, and how these plants interact with the surrounding environment. The International Society of Arboriculture (ISA) an accrediting body for tree experts exists so that "…professionals, allied professionals, public officials, and consumers worldwide recognize the economic, environmental, and societal benefits and values of trees…"[85]. There is an education wing of ISA called TreesAreGood.org where consumers can obtain valuable information about trees – selection, planting, and on-going care [86].

Trees are impactful plants in the landscape. Pruning is a dangerous task needing training and practice. ISA arborists are the most qualified to help a homeowner deal with their woody plants, no matter the size. In Winnipeg, searching the ISA database on Nov 2024, there are twenty-nine (29) certified arborists registered with one (1) Master Arborist. Disease identification and management is another specialty that advanced companies can help with; an important service with an uncertain future of climate shift allowing new pests into Winnipeg's ecodistrict.

Nursery Industry Lens –

There are newly established programs by Canadian nurseries and landscape firms to understand native plants. The Canadian Nursery and Landscape Association (CNLA) has provided a national plant list available throughout the country [87].

This is a valuable resource to cross-list native plants and other valuable ecosystem plants for a biodiverse landscape. Although there is no explicit resource referring to native plants, the CNLA does celebrate how plants, in general, can "…clean the air, provide shade, cool the surrounding area, reduce noise and absorb excess rainwater from storms" [88].

Manitoba Hydro Utility Lens –

As the electrical aerial lines can come into conflict with trees and large shrubs, Manitoba Hydro, along with professional advice, created a guide for homeowners: Right Tree – Right Place [89].

Landscape Industry Lens –

Landscape architecture is a powerful discipline that can use landscape architects to design with nature, so communities can be kept cool, safe, and healthy. Landscape architects, when designing with nature, can achieve a sustainable, resilient, and bountiful future for everyone (paraphrased from a webinar video series) [90]. As a recent student member of American Society of Landscape Architects (ASLA charges no dues while in university), a researcher can access biodiversity-themed webinars for free. One recording, *Biodiversity by Design: Latest Research and Strategies* (recorded 09/25/2024) references SITES as a way to improve biodiversity. ASLA further advocates for biodiversity metrics to be strongly embedded into both LEED and SITES, amplifying that there are professions that depend on third-party certification systems to ensure best practices [91].

There is an opportunity for formal education institutions to expand on the idea of ecosystem stacking: when native plants, incorporated into well-planned designs, can serve the simultaneous duo-purpose of mitigating biodiversity loss and climate change. This could be foundational for a

newly acknowledged sub-discipline theory and praxis in landscape architecture and horticulture – ecological landscaping.

I have noted on LinkedIn that organizations such as Landscape Ontario have created education sessions on ecological landscaping, due to public demand. If there is a new demand in this special class of professional, non-profits and industry-led organizations such as the Ecological Landscape Alliance (ELA) exists. Established in 1992, ELA's mantra-definition is well positioned to guide an industry: "ecological landscaping is a method of designing, building, and maintaining landscapes that considers the ecology of a site and creates gardens that enhance the surrounding environment for the benefit of humans and all other life in the ecosystem" [92].

There are other professional certification programs offered by independent, regional ENGOs. One example is the education-based ecological landscaping certificate program "Grow Native!". The Grow Native! program was launched by the Missouri Prairie Foundation (MPF) in the year 2000 "...with the goal of changing conventional horticulture and other landscaping applications to embrace the beauty and many values of landscaping with native plants"[93].

5.2. Leveraging Extreme Weather Event Prevention

As abstract socio-political concepts like individualism and government interference become more and more dominant in public discourse, there will need to be a communication strategy to counter that type of rhetoric. This usually includes wholesale anti-environmentalism, especially given the backdrop of political divisiveness and turmoil in America. For instance if a resident is approached with questions regarding sustainability and altruistic global goals, an environmental advocate may very well be rebuffed. Although there can be debates about how communication strategies should occur, and to whom, there is one common element that all residential biodiversity projects share: local self-reliance.

Leveraging individualism and self-reliance is strategic for single-lot residential approach using ecological landscaping; it is smart as long as biodiversity and native plantings are strongly coupled to the prevention of extreme weather events (EWEs). Hypothetically, if a strong individualistic resident is approached with questions such as: how is your air-conditioning and electricity bill budget, how many times did you experience a power brown-out, are you able to sit in your own backyard in the summer in the recent heat-wave, or did your basement flood in the recent thunderstorm? These questions strike home. A person knows, first-hand, that these

(sustainability) issues impact family bank accounts, personal comfort, and (with the vulnerable) health and safety. Certainly these concepts can be construed as city-scale resilience opportunities, but that is the point: when planting biodiversity installations, many private residents are (unknowingly) aggregating mitigation strategies for the entire neighborhood and district. An entire city could benefit if enough private residential properties embrace landscaping designs using native shade trees, native ground covers, native plant borders, lawn-turf minimization, green walls, shade pergolas, and (if possible) green roofs.

In August 2024, NOAA reported that in the USA alone, there had already been nineteen 1-billion-dollar disasters involving weather or climate, and that the "...U.S. has sustained 395 weather and climate disasters... [costing over] $2.770 trillion" [94]. Further, it is not only humans that suffer from these extreme weather events: most animals cannot adapt to heatwaves, extreme cold, and drought, pulling animal ethics into the spotlight [95]. These are all visceral phenomena that strikes home, specially if a loved one is vulnerable to such extremes.

Invariably, as a consultant, I reflect on environmental research ideas, and always try to make them tangible and relatable. I still have no idea what a tonne of CO2e means in the context of climate change discourse with peers, let alone casual conversations with friends. I fully understand the science of the green house effect (I recall that concept from grade school), but the swings, the magnitudes, the day-to-day measures, I haven't been able to link *those* to my limbic brain. An EWE, however, are much more relatable to the human experience than that of the abstract concept as climate change.

As people in Winnipeg that are bound to life survival by the weather – especially during the cold temperatures of the winter season – I am very easily swayed in relating to climate change by using the proxy of EWEs. I feel that many City of Winnipeg (CoW) staff and elected officials would also engage in reflection on the importance of preparing for all kinds of disasters that are directly or indirectly linked to climate change. If that is the case, then the intimately related threat of biodiversity loss can be tethered to this thinking process. Therefore, native plant installation opportunities, that can help alleviate biodiversity loss at many trophic levels, has been logically (yet gently) introduced to the CoW discourse by way of EWE management. I emphasize "gently" as it is my experience when important sustainability conversations need to be started with administrators that are under-staffed and overwhelmed, it is wise to slowly convince the stakeholders that they have buy-in. Weather-related disasters can cost billions of dollars in

damage and include drought, flooding, extreme freezing of soil, severe storms, wildfire, and winter storms.

There are two aspects that I will highlight how native plants can be part of a comprehensive disaster management plan: extreme heat and excess water. (I will note, though, that extreme wind as well as wildfire risks should be part of future contingencies in Winnipeg; both are recent phenomena that needed to be dealt with by city services. Native plant selection will need to be prudent with these risks, as the wrong plants can exacerbate fire and wind damage incidents [96].

EWE management is embedded in the governments of Winnipeg and Manitoba have emergency measures departments and disaster management plans [97].

There is an opportunity to add a biodiversity strategy: planting shade trees and using vegetative mitigation measures (as ground covers; as vertical structure coverings; etc.) is not part of this list. This can be remedied with cross-referencing with various civic and provincial entities, like the department of Urban Forestry.

That being said, the provincial government created a checklist, the Natural Disaster Preparation Residential Checklist [98], that does reference using plant material (and other landscape techniques):

- Raise and slope land away from home (basement flood mitigation)
- Plant deep-rooted native vegetation that can withstand flooding and drought
- Create a rain garden for [overland] flood water
- Plant shelterbelts to decrease blowing snow accumulation around your home
- Plant trees for shade
- Install shade structure like… pergolas [ideally with vines]
- Avoid watering your lawn, or water deeply, infrequently and between midnight and 10 a.m.
- Use rain [capture and storage] barrels for lawn and garden

Ambient Temperature and Radiant Energy Lens – here is where the weather channel issues heat warnings in order to protect the public health. Even if an ambient temperature does not seem too extreme, humidity and radiant energy accelerates risk. Think about when you are wearing a black shirt on a sunny summer day (blackbody radiation is a scientific laboratory measurement). The same phenomena occurs when the sun is shining down on materials like brick, concrete, asphalt, metals. Surfaces can be vastly hotter than the surrounding ambient temperature – placing risk on animal, plant, and infrastructure life. For instance, I do not know if it is fun, or tragic, when a park ranger goes viral cooking banana bread on the dash of a vehicle [99].

More seriously, when roads are buckling, and railway steel twists due to extreme heat, this is an important and grave warning to the animals that live in the city – extreme heat can be deadly. I concur: with extreme cold, we can put on more clothes and deal with better sources of heat; however, you cannot become more naked when it comes to heat. Related, in the winter, heat island effect can be beneficial in a northern latitude city. That cold winter day (without wind) seems much warmer when it is a sunny day, especially when a large wall is a backdrop, and you are wearing a dark coat. To this end, going back to the Middle Ages, northern Europeans recognized this phenomenon and grew (sub-tropical) fruit trees by planting them up against courtyard walls in espalier form [100].

Ironically, taking advantage of these micro-climates might cause people to try out-of-zone (non-hardy) ornamental plants. If successful, finances and aesthetic satisfaction could be diverted away from native plant installation. I have tried (and have succeeded) at establishing several trees and shrubs that are neither Zone 3 nor native plants.

Tree Equity [101], coupled with Heat Health, are two concepts that American Forests is championing for the mitigation of extreme heat and lack of shade. This program is to allow for scientific data to identify tree installations in cities – especially in disenfranchised areas that are subject to heat-health risks.

There are some jurisdictions that offer incentives for residential lots to install native trees and shrubs; this can create shade and transevaporation to lessen temperatures in the immediate vicinity. Ideally if a residential lot is in proximity to areas that are natural woodlands, or could be enhanced with more woody specimens, a federal Canadian urban park program grant [102] could be applicable. This program drives partnerships with Parks Canada with the goal to create an *urban* network of national parks.

5.3. Biodiversity Adjacent (healthy buildings lens)

The Covid-19 pandemic created at least two new insights for the AECP sector, realizing that public health is an integral part of the built environment: indoor air exchange rates with filtration, as well as mental health utilizing nature. Although the following sustainability frameworks are adjacent to frames that directly have design-build implications with nature, nonetheless, WELL and Fitwel should be briefly acknowledged as another way to introduce native plants into the landscape.

Again, the origin of these frames is commercial buildings, but they are slowly transposing into the residential spaces.

The importance of connection with nature through windows, or easy access to outdoor walking paths, has been linked to mental and emotional health [103]. Forest bathing is a social-health movement, originating in Japan, that has found popularity in North America. A mixture of mental and spiritual health through physical visitation into an actual forest, forest bathing (shinrin-yoku) "...is... bridging the gap between ourselves and nature through our five senses" [104].

Much like how LEED has categories of various environmental sustainability aspects to create green buildings, the International WELL Building Institute's WELL standard is a framework to guide designers in the AECP sector to create healthy buildings. Out of ten categories there is one that deals with mental health, Mind, and embraces the broad concept of biophilic design as an important part of everyday occupant experience [105]. The comprehensive category, Mind, has an explicit feature, Nature and Place, as a precondition for designers to ensure the "...support [of] occupant well-being by incorporating the natural environment throughout the project..." [106]

WELL even gives designers an opportunity to create enhanced experiences and prescribes baselines that include: coverage by plants; tree canopy area, and proximity to green / blue spaces[107].

Fitwel, another healthy building framework, also integrates nature into its design guidance; greenery, trees, and water are all mentioned as part of its Workspaces-Views of Nature sub-category [108].

As more buildings throughout the modern city strive to be high performance (simultaneously green and healthy), the AECP sector will need to adjust designs for new and existing buildings. This should include native plant installations as part of revamped aesthetic and . Further, as people have adjusted their work occupancy time to spend significant time at home, as opposed to various off-site locations, nature and corresponding views from the office window will become an important work-from-home amenity that will become commonplace.

6.0 How *Residents* Can Learn About Native Plant Installations

Cities can support pollinators of all types. Therefore, residential spaces can greatly contribute to restoring pollination opportunities for all sorts of animals – especially insects. "The study confirmed that areas sown with wildflowers, usually of small area, concentrate pollinating insects and have a similar value for pollinators as larger areas of natural meadow. Sown wildflower meadows, if properly cared for, can ensure the richness of melliferous plant species and thus positively affect the diversity and number of pollinators"[109].

6.1. ENGO frames – examining my own residential experience

The city can be rewarded with fiscal savings and easing of risk by having a more resilient city by mitigating and adapting to climate change through the installation of bioregional native plants. Mitigation and adaptation projects, leveraging proper design with nature, combines the beauty of native plants in all forms with the ecosystem services of the same plants. This is leveraging the simultaneous multiple uses of native plants to address both biodiversity loss and climate change.

There are many different environmental non-government organizations (ENGOs) that exist to direct and indirectly support wildlife, native flora and fauna, and backyard conservation in general. I have registered my yard over the decades with ENGOs as an "official backyard conservation space". Due to the COVID lockdowns, other ENGOs were directed to move in-person meetings onto webinars. This created a burgeoning video archive collection. This exposed me to new organizations that were only accessible as local or regional gardening and landscape clubs and extension services. This spurred me to register my yard with more conservation and stewardship programs. In fact, I will have a new signage collection mounted near my front sidewalk for an awareness campaign starting in 2025. I advocate that due to the ease of ubiquitous webinar technology, the City of Winnipeg should embrace the responsibility to create awareness, ensure education, and encourage the practical implementation of biodiversity in my backyard (BIMBY).

Simply, there are two general ways that you can approach backyard biodiversity: a *whole yard approach* or concentrating on one particular insect, or family, or order of animals (or its function, such as all pollinator-friendly plants). Here is where taxonomical knowledge is useful, previously referenced. This simple delineation can breakdown quickly, as the functions of a particular bee (like the rusty patch bumble bee, a favorite of gardeners trying to help) can be described as a

pollinator – yet this function is shared by butterflies (another possible approach). Moreover, certain wildflowers that attract adult bees and butterflies will be attractive to hummingbirds (yet another type of garden approach), where that can be part of gardening for birds (advocated by the Audubon Society). You see what I mean?

Other ways can include approaches from: a *habitat perspective* (layers, structure, complexity) and wait for all fauna and flora to eventually show up in your yard; or *species-based perspective* which immediately addresses needs-based design such as being a steward for the monarch butterfly and planting its ultra-specialized milkweed host-plant (*Asclepias* spp) to attract egg-laying females and completing its life-cycle. Finally, the most comprehensive conservation strategy is the *ecosystem approach*. Programs are usually guided by ENGO-sponsored certification books, guidelines, or pamphlets (now, all digital registration). Conservation programs like these have all the outdoor sustainability aspects brought together in a checklist / recommendations format. Adding native plants for biodiversity and ecoservices enhancements is just one part of habitat provisioning (food, water, shelter, space). The other aspects will give tips and tricks regarding composting, water conservation, tree planting for energy conservation (shade, wind), erosion control are some other aspects that urban dwellers can incorporate into the landscape. The following are screenshots of slides from conference presentations that I have consistently used to raise awareness of BIMBY ENGOs. (Other ENGOs that I have registered for are summarized in APPENDIX 4 – Personal Property Conservation Certifications.)

Fort Whyte Alive's Naturescape Program

Figure Ten **Yard Certification Example - FWA**

Canadian Wildlife Federation

Figure Eleven **Yard Certification Example – CWF**

The National Wildlife Federation

Figure Twelve **Yard Certification Example - NWF**

6.2. Ecological Restoration approach

The Global Biodiversity Standard (TGBS) [110] strives to protect and restore biodiversity, use the knowledge of trusted local and international experts, be objective and independent and be accessible and equitable. Although international in context and regional in scale, the fact that "…TGBS promotes the restoration of degraded landscapes and supports sustainable development by conserving and restoring the biodiversity that underpins the delivery of ecosystem services…." is a comprehensive grassroots certification scheme to duplicate at scale.

6.3. Urban Forestry Approach (using keystone trees)

The powerful ENGO, American Forests, advocates the importance of residential-scale biodiversity, and echoes the Tallamy Tenet of the Homegrown National Park program. However, even if "…backyard landscaping [can be a] boon to biodiversity… [the] average American house is

surrounded by lawn and nonnative plants — two major problems for urban ecosystems" [111]. A side note: an advocate should archive statements of ENGOs; the more credible an organization, especially one that does well respected, pragmatic community work, the better the odds that civic government administrators and politicians will listen to policy options for biodiversity actions from that entity.

6.4. Habitat (Behavioural) Approach

How a plant or animal behaves is another approach, as alluded to above, such as pollination. The one caveat for this approach is to really strive to emulate nature. Most certifications and programs will strongly advocate for "messy" – in direct tension with a manicured, contrived aesthetic. This is the operations and maintenance (O+M) phase of the yard, since most of the construction will have been put into place as part of the original design.

This is where it gets difficult: aesthetically, and manual labour-wise: this is NOT your "mow, blow, and go" yard work process. Indeed, as part of my own continuous improvement of landscape knowledge, I did not know many of these enhanced habitat techniques (like leaving stems up for cavity nesting bee habitat) until 2023 (decades after the start of my backyard naturalization journey). For sure, one must try and strike a balance between biodiversity and aesthetics. Concepts to take into consideration is the neighborhood's personality, the style of house, and the existing landscape property form (is it flat, wide, vertical, treed, other). This becomes more of a design exercise of form and function and is beyond the scope of this thesis; my question: "how should the landscape fit in / be adjusted this season?" certainly was, and still is, dealt with continuously in my yard.

6.5. The Homegrown National Park program (Landscaping for Lepidoptera; aka The Tallamy Tenant)

After reading various books with themes involving nature in the city, landscape design should involve the whole life cycle of the pollinator. Traditional butterfly and bee gardens concentrated on providing nectar-rich, beautiful flowers. These flowers were of different forms to attract different flying insects. This approach, however, neglected a safe place for the females to deposit its eggs, and more importantly, where its larval offspring can thrive. Plants that support the caterpillars that

become adults through the chrysalis metamorphosis are the foundation for a healthy pollinator garden. As Tallamy declares: "A plant that has fed nothing has not done its job" [112, p 96].

This gardening style involves *host* plants; host plants that are the vegetative food source for the caterpillars to grow through their instar stages before pupation. Therefore, it is key to identify the bioregionally valid flora and fauna the co-evolved in the ecoregion.

In Benjamin Vogt's book, a new garden ethic – Cultivating Defiant Compassion for an Uncertain Future [113] there are several rallying calls to use the residential garden as a place to allow wildlife to thrive, ecosystems to fully function, while creating a pleasing aesthetic. Rooted in Aldo Leopold-isms, Vogt asks an important question that we all should ponder: "What happens to our world when we start learning from its complexity instead of teaching it how to be simple and one-dimensional?".

As theory and practice of ecological landscaping and permaculture was uncovered, pollinator gardening became a more prominent design direction. Pollinators include many different insects: butterflies, moths, bees, wasps. Immediately, there is a tension that appears in this short list: people will admire the fluttering beauty of butterflies, appreciate the mostly unnoticed nocturnal moths, but could trigger immense trepidation when confronted by bees and wasps. This is unfortunate, as most bees and wasps are non-aggressive, and the native species are solitary (no hives or colonies). Certainly, in recent years, wasps have been challenging with respect to the numbers of paperback wasps stinging unsuspecting people outdoors; there are people that are highly allergic, and a sting could be life-threatening [114].

These stories and first-hand bad experiences contribute to the misinformation that all bees and wasps must be feared. Even movies and television create apocalyptic dramas starring killer bees as dangerous and deadly natural protagonists. So, given primal fear, pollination gardens might be immediately quashed in a residential design. The horticulture industry followed suit and created flowering crabapple fruit trees with sterile flowers; cv names are 'Spring Snow', 'DurLawrence', and 'Sunsterile' [115].

If a plant is bred to bear no fruit, that is fruit that can no longer fall on the ground, rot, and attract wasps and flies. However, fruit is an important food source for wildlife, especially migratory birds. Obviously, we see a trade-off here: biological function for flying insects and wildlife or aesthetically pleasing flowers without botanical use.

Further, expanding beyond just pollinators, beneficial insects and arthropods such as spiders are accounted for in designing an ecological landscape. Again, fear of bugs and spiders will cause pause. People do not understand that these creepy-crawlies are an integral part of the ecosystem and need to be embraced as helpful residents in the yard. Helpfulness can be defined scientifically as inhibiting garden pests (predation) and facilitation of detritus (decomposition). These insects are key to keeping balance in the residential landscape.

Finally, encouraging meso-fauna like birds, chipmunks, squirrels, amphibians, and reptiles requires special niche habitats. These habitats can all be integrated into a residential landscape – the trick is to create an aesthetic style that is both useful for the animals, and not ugly for the occupants.

6.6. Herbaceous (prairie) vs Woody (trees)

I have been trying to establish a prairie edge planting area of native herbaceous plants for years now. This area is a sunny southern exposure, but is located under some tall, large canopy, deciduous maple trees, as well as an ornamental green spruce. Therefore, conditions are not optimal, but not terrible. Further, some aggressive weedy plants seem to easily find a home in this space – burdock, elm and green ash seedlings, and the occasional thistle.

I have been tempted to just "let it go wild", but this would allow aggressive plants, and potentially some listed invasives forbs, to dominate the space. This would be a waste of a sunny exposure, poorer choices of nutrition (pollen, nectar) for insects, and an opportunity lost for a prairie swath to delight the senses with a strong aesthetic view. Therefore, slowly but surely, I will develop new restoration designs to establish a valuable native-dominated ecotone, and practice more consistent maintenance practices to eliminate encroaching and spontaneous weeds. This will absolutely involve meticulous spot painting of glyphosate products on targeted weeds (avoiding soil disturbance so as not to trigger the seed bank to germinate more unwanted plants). Perhaps there might be a naturally raised

If someone did not have the knowledge or the patience to take on a small prairie plot restoration project, then creating a shrub border is a reasonable compromise. There have been many times that messy, weedy, and unattractive places in clients' landscapes are transformed with the following process: 1) chopping all plants in-place to save biomass to compost *in situ*; careful Round-Up (glyphosate) treatment of all leftover, freshly cut green stems and applying herbicide liquid (painted with a small brush) directly on woody stems and its freshly exposed cambium [116]; 3) bring in some new compost & soil mix, depending on the

site conditions; 4) cover the entire area with thick cardboard (which was collected over the days or weeks after the initial design consultation, which means do not skimp!); 5) cover the cardboard with a 3-5” depth of chocolate brown wood mulch (depending on budget); plant ornamental shrub border and establish with proper watering (as the cardboard is smothering the weeds and not allowing rain to penetrate until the following season). This six-step technique has proven incredibly effective at successful establishment and offers relatively ‘instant’ curb-side appeal. The ornamental shrubs and small trees should be as many true-species native woody plants as possible, plus add wildlife beneficial cultivars. I am especially inclined to advocate for (and personally install) this landscape design-build approach now that I am aware that the Tallamy Tenet mitigates biodiversity loss through re-establishment of the food web using keystone plants.

7.0 Putting it all together – an urban forestry lens case study

As a pragmatist, it is common for research questions to shift during data analysis and more research questions come to light. This next section is a rudimentary exploration to create a process and show the background of an interdisciplinary consultant's thinking to pick ecologically beneficial trees for residential landscapes.

The **premises** that spawned this idea are: 1) the Tallamy Tenant states that a top priority for restoration and rebuilding of ecosystems (mitigation of biodiversity loss) is to install keystone plants that are based on landscaping for Lepidoptera; 2) Tallamy's research, coupled with NWF databases show that for most of North America these keystone plants are woody plants and mostly trees (with the Quercus genus always a top-three performer); 3) every ecoregion / ecozone / ecodistrict has unique native trees; 4) the propagation and sale of true native plants, especially native trees, is a constrained activity; 5) the nursery and landscaping industry have been creating and distributing nativar plants for decades; 6) new research shows that some nativars (at least in flowers) can be as ecologically beneficial as the original true species that co-evolved with the animals, plants, and other organisms that are supposed to be present in the landscape (forming a stable and resilient ecosystem); 7) there are finite resources in the horticulture industry to conduct research into nativars.

Meta-proposal / new research question: government at all levels funds research to create urban-resilient nativar trees that are ecologically similar in benefit to their keystone tree cousins.

7.1 Case Study (an urban nativar tree experiment)

With an urban forestry approach, the CoW could have a targeted incentive plan for residents at the yard-scale, the neighborhood scale; this can lend itself to create high levels of connectivity. Stakeholders of the City of Winnipeg administration recognize the importance of private lands to ensure a successful urban forestry strategy. One of the opinions: "I have observed great residential places for a city tree; when I see a private front yard with lots of space, especially when an adjacent city boulevard is too small or can't accommodate due to existing infrastructure (traffic layout, overhead wires, underground system constraints)" ~ paraphrased from a public education webinar [117].

As an installer of many types of plants, biodiversity in my yard was a consistent goal since 1999. At one point, the landscape had over 200 different species of plants. Certainly, the genera was much

lower, but nonetheless, a "collector's mentality" allowed for a variety of plants – in terms of woody versus herbaceous, floral versus vegetative, tall versus groundcover. Most of plants were perennial, with a few annuals usually reserved to planters. Therefore, I thought, the numbers (abundance) and differences (variety) of plants must have created a healthy ecosystem – at least in my slice of the world. Or so I thought.

Once I was made aware, understood, and enthusiastically accepting of the Tallamy Tenet, myself (and gardeners world-wide) are converting much of their landscapes and clients' projects to install native keystone plants that optimize landscaping for Lepidoptera. This does not mean that biodiversity need to be 100% native trees. When contributing to the urban forest, your yard is important to be resilient by utilizing all sorts of plants. I appreciate the following rule of thumb where "…an urban forest should be no more than 10% of the same species, 20% of the same genus and 30% of the same family" [118].

So, we need to start identifying native keystone trees *and* existing nativars that may be ecologically beneficial. When a comprehensive review of a vegetation sections of ecodistricts is completed identifying keystone trees, the woody plant candidates (using botanical Latin and common names) should be cross-referenced to these to local nurseries ideally for straight species availability. Although the flora found might not be to historical reference – most of Winnipeg (excluding riparian areas) was prairie forb / grass dominant. Here is where we must remember the premise: *it is more important to first plant woody plants that support Lepidoptera caterpillars to (re)build a food web as part of a resilient urban ecosystem*.

The NWF needs to be the first stop for the researcher so they have an idea what group of plants should be investigated in the first place. The Keystone Host-Plant Genera [119] in Great Plains (GP) region NWF - Ecoregion 9 section, states that a "…genus is a taxonomic category of plants that contains one or more species of plants with similar characteristics. Species within each genus have adapted to local conditions and are the appropriate native species or varieties suited to a specific ecoregion". This needs to be a touchstone statement and is the basis for premise two.

Therefore, there is an underlying premise that native trees and nativars might actually be part of a "designer ecosystem" strategy that are deliberately tailored for the urban realm; this is its own research problem and needs a SWOT analysis for this approach to be acceptable and free of unintended consequences.

Related to horticulture academic and industry nativar research, there is serious effort within the forestry sector to conduct both *in situ* trials and controlled experimentation in seeing what trees can be purposely moved out of a natural growing zone, and into another area. This work is under the concept of *assisted migration* [120] and is being debated (see unintended consequences comment above) as a potential conservation tool to anticipate climate change and adaptation opportunities. This research should be dovetailed into this proposal.

Figure thirteen below shows the three categories of assisted migration, where "…human-assisted movement of plants or animals to more climatically suitable habitats…" [121]. Research should be carried out with careful thought, and speedy purposefulness, to deal with potentially devasting consequences on native deciduous trees by rapidly changing climate.

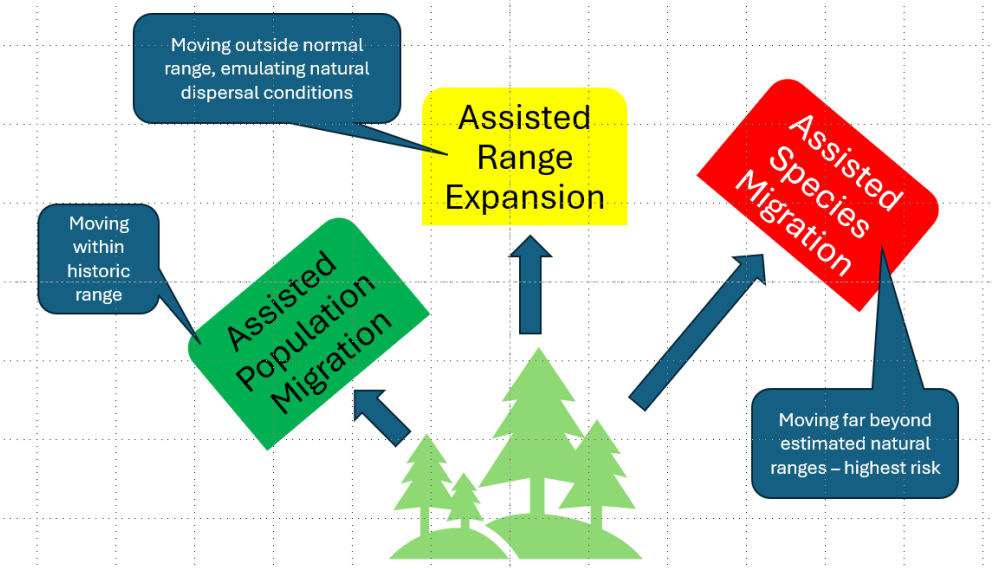


Figure Thirteen **Depiction of Various Forestry Practices**

Climate change has been modelled to show an increase in species richness, with favourable conditions in the northern prairies; this will allow for a wide variety of tree species that are not currently in that ecozone [122]. Therefore, plant buyers could be buying today's zone 5 stock as a normal landscape choice, as opposed to a collector plant. (At present, big box stores could sell zone 5 plants of eastern Canadian origin, and an unsuspecting gardener, without the proper plant labels, would see this plant die-off.) Of course, it is much more complicated than just hardiness zones (soil, hydrology, fungal relationships, etc. all play a part in healthy plant establishment) but understanding NRCan / USDA hardiness zone maps (see appendix) can be another planning tool and guide a gardener to hedge towards rapid climate change. In Winnipeg's case, according to a

Prairie Climate Centre infographic, there will be wetter springs, drier late summers; much warmer winters; with many hot days (with more 20C+ nights) [123].

The Winnipeg urban forestry program [124] has a strong presence within the municipal administration as citizens realize, and demand, that trees in the city are maintained and an integral part of streets and green spaces. Perhaps the people are appreciating trees beyond the aesthetic – that they understand the critical ecosystem services that trees (and the urban forest) provides. The City of Winnipeg has issued several tables that are comprehensive guidelines for administrators and professional contractors follow for boulevard and residential developments. These follow *purposefully in the body of the thesis* as these tables are much more than data results, or worse, supplemental information to buried in an appendix: these are the start of the tree choosing process and is an important constraint to use as a vetting tool.

Table Two, below, is labeled Acceptable Tree Species for Planting on City-Owned Properties – Natural Area and Forest Habitat Trees [125]. As mentioned above should be a starting point to guide professionals and citizens for the planning and designing of landscape projects using species of trees that are deemed foundational for naturalization and habitat restoration [126]. This list can complement an ornamental tree list (Table Three) that immediately follows. This is what CoW uses for boulevard replacement that they deem as suitable for public land-use (such as boulevards). This is important: proven performance is taken into consideration based on expert opinion regarding different urban conditions such as soil, hardiness, weather resilience, and other factors.

Table Two **City of Winnipeg Acceptable Tree Species for Planting on City-Owned Properties – Natural Area and Forest Habitat Trees**

Large Sized Trees (mature height 15 m or greater) – Deciduous

Species	Common Name
Acer negundo	Manitoba maple
Populus tremuloides	Trembling aspen
Populus balsamifera	Balsam poplar
Populus deltoides	Cottonwood
Populus grandidentata	Large-toothed aspen
Quercus macrocarpa	Bur oak
Salix amygdaloides	Peach-leaved willow
Tilia americana	Basswood or American linden
Ulmus americana	American elm

Medium Sized Trees (mature height 9 m to 15 m) – Deciduous

Species	Common Name
Celtis occidentalis	Delta hackberry

Small Sized Trees (mature height less than 9 m) – Deciduous

Species	Common Name
Amelanchier alnifolia	Saskatoon
Cornus sericea	Red-osier dogwood
Corylus americana	American hazelnut
Corylus cornuta	Beaked hazelnut
Crataegus chrysocarpa	Hawthorn
Prunus americana	Wild plum
Prunus pensylvanica	Pincherry
Prunus virginiana	Chokecherry
Viburnum lentago	Nannyberry
Viburnum rafinesqueanum	Downy arrowwood
Viburnum trilobum	Highbush cranberry

Table Three **City of Winnipeg Ornamental Trees Acceptable for Public Use (excerpt)**

Small Sized Trees (mature height less than 9 m) – Deciduous

Species/cultivar name	Common Name	Special note
Acer ginnala	Amur maple	Tree form for boulevards
Acer ginnala 'Embers'	Embers Amur maple	Tree form for boulevards
Acer ginnala 'Ventura'	Ventura Amur maple	Tree form for boulevards
Acer tatarica 'GarAnn'	Hot Wings Tatarian maple	Tree form for boulevards
Crataegus x mordenensis 'Snowbird'	Snowbird hawthorn	Better suited to parks and green spaces
Crataegus x mordenensis 'Toba'	Toba hawthorn	Better suited to parks and green spaces
Prunus maacki	Amur cherry	
Prunus maacki 'Goldrush'	Goldrush Amur cherry	
Prunus x 'Ming'	Ming Amur cherry	
Pyrus x 'DurPSN303'	Navigator ornamental pear	
Sorbus aucuparia 'Rossica'	Russian mountainash	Limited use for boulevards
Sorbus decora	Showy mountainash	Limited use for boulevards
Syringa reticulata	Japanese tree lilac	
Syringa reticulata 'Ivory Pillar'	Ivory Pillar Japanese tree lilac	
Syringa reticulata 'Ivory Silk'	Ivory Silk Japanese tree lilac	
Malus x adstringens 'Durleo'	Gladiator rosybloom crabapple	Narrow columnar crown
Malus x adstringens 'Kelsey'	Kelsey rosybloom crabapple	
Malus x adstringens 'Pink Spires'	Pink Spires rosybloom crabapple	Narrow columnar crown
Malus x adstringens 'Selkirk'	Selkirk rosybloom crabapple	
Malus baccata 'Jeflite'	Starlite flowering crabapple	Very small fruit
Malus baccata 'Spring Snow'	Spring Snow flowering crabapple	No fruit

Small Sized Trees (mature height less than 9 m) – Coniferous

Species/cultivar name	Common Name	Special note
Juniperus scopulorum 'Medora'	Medora upright juniper	Parks and green spaces only
Thuja occidentalis and specific cultivars	Eastern white cedar pyramidal tree-form and pyramidal tree-form cultivars	Parks and green spaces only

Now, the following Table Four, identifies woody plants as vegetative host plants (and sometimes as a floral pollinator plant). Both aspects are noted to identify woody plants that can serve as duo-purpose, thereby creating a higher value choice priority – could have several simultaneous ecosystem service and aesthetic attributes.

Table Four taken from [127]

Manitoba Host Plant List – Selecting Plants for Pollinators (from Pollinator Partnership Canada)

Common Name	**Botanical Latin** (alphabetically)	**Caterpillar Host Plant**	**Pollinator Source**
Saskatoon serviceberry	*Amelanchier alnifolia*	X	X
red-osier dogwood	*Cornus sericea* [stolonifera]	X	X
trembling aspen	*Populus tremuloides*	X	X
pin cherry	*Prunus pensylvanica*	X	
chokecherry	*Prunus virginiana*	X	X
bur oak	*Quercus macrocarpa*	X	X
beaked willow	*Salix bebbiana*	X	
shining willow	*Salix lucida*		X
American basswood, American linden	*Tilia americana*	X	**?**
American elm, white elm	*Ulmus americana*		
American (high bush) cranberry	*Viburnum opulus* var. *americanum* *Viburnum trilobum* var. *americanum*	X	X

The following, Table Five, is a summary of the Great Plains ecoregion identified by the NWF (with research coordination from Tallamy, *et al*) following the premise of larval lepidoptera as the foundation for the urban food web [128]. The ranking is based on number of species of caterpillars that are supported by the woody plant.

Table Five **Great Plains Ecoregion Plant List (identified by the NWF)**

Top 10 Ranking | Woody Plants (Trees & Shrubs)

for Lepidoptera **Genus-**Common Name-(Species**)**	no. species use as a host plant (count of different types of Lepidoptera larvae; caterpillars)
1 **Quercus** Bur oak (*Quercus macrocarpa*), Post oak (*Quercus stellata*), Blackjack oak (*Quercus marilandica*)	**253**
2 **Prunus** American plum (*Prunus americana*), Chokecherry (*Prunus virginiana*)	**222**
3 **Salix** Peachleaf willow (*Salix amygdaloides*), Sandbar willow (*Salix interior*)	**214**
4 **Betula** River birch (Betula nigra), paper birch (*Betula papyrifera*)	**189**
5 **Populus** Eastern cottonwood (*Populus deltoides*)	**180**
6 **Alnus** Tag alder (*Alnus serrulata*)	**164**
7 **Malus** Prairie crabapple (*Malus ioensis*)	**162**
8 **Carya** Shagbark hickory (*Carya ovata*), Bitternut hickory (*Carya cordiformis*)	**153**
9 **Vaccinium** Sparkle/Deerberry (*Vaccinium arboreum*), (*Vaccinium stamineum*)	**146**
10 **Acer** Box elder/MB maple (*Acer negundo*), Silver maple (*Acer saccharinum*)	**145**

All these lists are important to first qualify the ecological (historical) reference state for the woody plants of the bioregional Winnipeg ecosystem that is within, and surrounds, the urban centre. Using this information, one can verify commonalities between government and non-profit lists (robust research) and then confirm which genus and species are important as Lepidoptera host plants. Combining this information into a table, spreadsheet, or database can then help to cross-reference with local nurseries' inventory (by way of physical or digital catalogues).

Recalling the premises of this proposal, that straight species (true natives) must be the first inquiry and if native plants are hard to source then available nativars are to be confirmed to be botanically useful (ecologically beneficial) as a host plant for larval insects (and as we added during this research process, having complementary benefits such as floral resources for adult insects).

If availability of existing true natives is scarce (inventory in any given planting season), then an opportunity presents itself to explore the following cultivars listed below (Table Six). This starts to become relevant for this plant choosing process as nurseries may have inadvertently developed "useful nativars" – biologically functional woody plants (trees) that emulate key aspects as keystone native plants in the food web. These plants listed below have been developed and brought to market over the last 40 years. This is encouraging as an already established propagation program can be expanded. Propagators can carefully create hybrids that will provide several (ecological) benefits: food sources for insects (foliage and floral); be disease resistant; have aesthetically pleasing qualities; and are climate change / extreme weather event ready.

Following all the charts below, at first glance, the top three Manitoba native trees that are of high inventory, are the maples, apples, and cherries. (Specific plant cultivars are given.) If these types of trees can meet benefits beyond moth caterpillar food, then we have real candidates to plant on a wide-scale. Test plots could be created in appropriate areas of the city; specific situations that emulate the conditions of a future Winnipeg. This is the crux of this hypothetical case-study.

Figure Fourteen (page 74) is an attempt at capturing the vetting process: balancing lists regarding the Tallamy Tenet, confirming keystone plants near and at Winnipeg, checking on native plant and propagation nurseries for availability, cross-checking for pollination (floral) resources as an extra benefit, and arriving at a top 3, 5, 10 plant list depending on the landscape choices of the human occupants.

This balancing act reveals more complexity and constraints – a buffer to biodiversity loss. However, more research is needed to see if the same trees would result if the running scenario was climate change.

Table Six **List of Manitoba Available Tree Cultivars** (adapted from [129])

Genus	**species 'cultivar'**	
Acer	*ginalla*	'JefUM'
A.	*saccharum*	'Jeferno'
A.	*saccharum*	'Jefselk'
A.	*saccharum*	'Jefcan'
A.	*saccharum*	'1515'
A.	x *freemanii*	'Jefcel'
Betula	*platphylla*	'Jefpark'
Fraxinus	*americana*	'Jefwis'
Malus	x 'Jefwall'	
M.	x *adstringens*	'Jefgreen'
M.	x *adstringens*	'Jefspire'
M.	x *adstringens*	'Jefnite'
M.	*baccata*	'Jeflite'
Populus	x 'Jefguard'	
P.	*deltoides*	'Jefcot'
Prunus	*maackii*	'Jefdike'
P.	*maackii*	'Jefspur'
P.	*virginiana*	'1903'
Quercus	x 'Jefcen'	
Q.	x *jackiana*	'Jefmir'
Tilia	x 'Jefhouse'	
T.	*cordata*	'Golden Cascade'
T.	*mongolica*	'Harvest Gold'

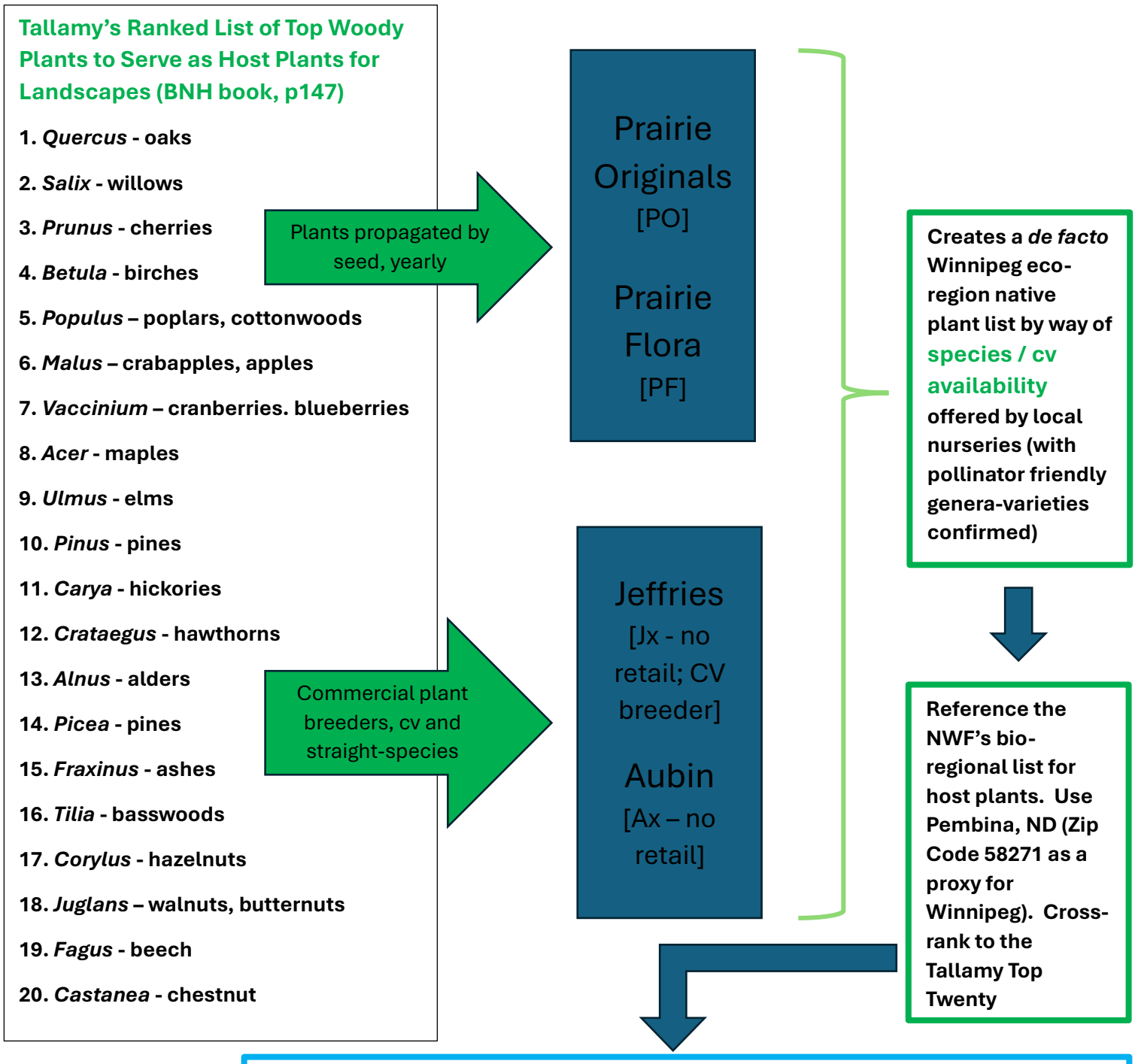
Table Seven **Existing Native and Nativar Trees Inventory – Local Manitoba Nurseries**

Manitoba Nurseries - Native (and Related Cultivars) Tree and Shrub List

Rank Prairie Eco-Region (ND/GP)	Tallamy Rank – top 20 woody host plants (widely researched list) Latin - Common Name (Genera) Field Guide – (native) Trees of Manitoba	Botanical description / cultivated varieties (cv)	Sources in Manitoba – # of (near) native plant choices	Avail. (varieties) # of choices	Avail. (varieties) Rank
5 / 1	Quercus - oaks *Quercus macrocarpa*	*Quercus macrocarpa*; Q spp 'cv'	At x1; Jt x4	5	13
2 /3	Salix – willows * *Salix amygdaloides*	*Salix* spp. 'cv'	At x5; As x10; Jt x6; Js x4	25	4
1 / 2	Prunus – (choke)cherries, plums *Prunus americana* (* black knot disease, depending on cv !)	*Prunus virginiana* 'cv'; P. spp.; P. spp 'cv'	PO x3; A x13; As x4; Af x20; Jt x7; Js x2; Jf x17	66	2
4 / 4	Betula - birches *Betula papyrifera*	*Betula papyrifera*; B. spp. 'cv'; B. spp	At x8; As x2; Jt x7	17	7
3 / 5	Populus – poplars, cottonwoods *Populus balsamifera / P. deltoides / P. grandidentata / P. tremuloides*	*Populus balsamea; P. tremuloides; P. deltoides 'Jefcot'; P.* spp. 'cv'	At x12; Jt x10	22	6
? / 7	Malus – crabapples, apples	*Malus* spp. 'cv' (crabs); M. spp 'cv' (apples)	At x11; Af x23; Jt x10; Jf x24	68	1
? / 9	Vaccinium – low bush cranberries, blueberries	*Vaccinium* 'cv'	Af x4; Jf x4	8	11
6 / 10	Acer – maples, box-elders *Acer negundo*	*Acer spicatum*; *A. negundo* A. spp. X 'cv'	PO x1; At x13; As x3; Jt x16; Js x1	34	3
8	Ulmus - elms *Ulmus americana*	*Ulmus americana* 'cv'; U. spp. 'cv'	At x6; Jt x7	13	9
?	Pinus – pines *Pinus strobus / P. banksiana / P. resinosa*	*Pinus strobus* + P. spp. 'cv'	Ac x7; Jc x5	12	10
9	Crataegus - hawthorns	*Crataegus chrysocarpa*; C. x mordenensis 'Snowbird'	PO x1; At; Jt x2	3	15
7 / 6	Alnus - alders	*Alnus rugosa*; *A. hirsutus* 'Harbin'; *A. incana* ssp. *tenuifolia*	PO x1; At x1; As x1; Jt x1	4	14
?	Picea – spruces *Picea glauca / P. mariana*	*Picea glauca* + P. spp. 'cv'	Ac x12; Jc x11	23	5
n/a	Carya - hickories	**No availability – eco-zone**	n/a	---	
10	Fraxinus – ashes *Fraxinus nigra / F. pennsylvanica*	*Fraxinus pensylvanica*; F. spp cv	At x4; Jt x3	7	12
12	Tilia – basswoods, lindens *Tilia americana*	*Tilia americana*; T. spp 'cv'	A x8; Jt x9	17	7
15	Corylus - hazelnuts	*Corylus americana*	PO x1; As x1; Js x1	3	15
?	Juglans – walnuts, butternuts	*Juglans nigra*	At x1; Jt x2	3	15
n/a	Fagus - beeches	**No availability – eco-zone**	n/a	---	
n/a	Castanea - chestnuts	**No availability – eco-zone**	n/a	---	

Legend: PO = Prairie Originals (straight species by seed); Ax = Aubin Nursery (digital catalogue), Jx = Jeffries (digital catalogue; distributes their *Northern Garden Collection* plants c/o local nurseries), t = trees, s = shrubs, c = conifers, f = fruit trees and shrubs; * = pollen specialist bee plant

Figure Fourteen **Decision Chart of Native Woody Plant Choices – choosing true-species and nativars (cv)**



8.0 Further Research Opportunities Collection

8.1. PESTEL – a tool to sort out further challenges and opportunities

Environmental sustainability issues, especially in a dynamic and ever-changing urban realm, are complex. The way that different sustainability domains and aspects are categorized in the thesis therefore borrows from the world of strategic management. Scanning for opportunities and challenges uses a management tool to sort out possible analysis approaches, data gathering, and future research. Using an established management model that was created to describe aspects of political, economic, social, technological, environmental, and legal (PESTEL) is useful. The PESTEL model is also replicable in other jurisdictions and can be transposed to various physical scales. PESTEL has its origins in strategic management [130].

As an acronym that parses out an analysis of several aspects, PESTEL can be used as a categorization tool, as well as a reductive way to start to deal with a multi-aspect issue – all too common in the world of environmental sustainability, urban ecology and biodiversity. This allows conversations to start amongst different stakeholders to seek novel and transdisciplinary enhancements and solutions to complex problems.

The PESTEL Model – a brief background of the sorting process

I was grappling with trying to piece together seemingly disparate story-elements (education-learning-knowledge process) of twenty-five years of ecological landscaping experience. The question I struggled with for a few years during thesis research: how do I sort this out ? Creswell [131, p. 11] outlines several aspects of the pragmatic worldview (which is what I strongly subscribe to; this is described more fully under the section, interpretive framework / worldview), including how "[p]ragmatists agree that research always occurs in social, historical, political, and other contexts."

Ecological landscaping involves having access to many different knowledge domains, skills, and approaches. Therefore, describing a complex and multidisciplinary aspects of native plants installations is challenging – from a personal standpoint, as well as trying to translate the concepts to 'city administration-friendly' language. PESTEL is an important management tool to help identify external threats in a strengths, weaknesses, opportunities, and threats (SWOT) exercise. I feel this can be transposed to the residential scale – both physically and practically.

The following sub-sections will explore each PESTEL aspect and treat then as further research questions, gaps, or opportunities. Some of the research presented has already been completed (original song creation for a past urban forestry conference) whereas other research (No Mow May) is aspirational to become a stand-alone article that contributes to public awareness regarding the dynamics of disease, weeds, and native plant displacement.

8.1.1. Political – Native plants are important to Install in Residential Spaces

Transnational government organizations, scholars in the academy, and practitioners in industry have identified, without hyperbole, a socio-ecological existential threat that is like a two-sided coin – the twin crises of biodiversity loss and climate change [132] (The Convention on Biological Diversity (CBD) and the United Nations Sustainability Development Goals (UNSDGs) are two important global policy frameworks that can allow a top-down approach to inform local policies that affect residential biodiversity. When biodiversity is significantly lost, regional climate can be affected, which can trigger a domino effect globally. The deforestation of the Amazon Rainforest and other jungles are examples where rain patterns can be changed thousands of miles away [133].

These are big policies that have evolved from international, national, or sub-national scales and perspectives when dealing with climate change and biodiversity loss (as well as materials waste, air pollution, ozone depletion, endangered species trading, nano plastics, endocrine disruption and carcinogen contamination). All of these have highly bureaucratic organizations trying to create big solutions for big problems. Many large cities are part of organizations that are aligned with such big policies and progressive administrators strive to match its corporate-city goals to these frameworks. However, I would suggest that these complex scientific and social issues are too abstract and unrelatable to the general public.

Reflecting on world-wide elections around the world (circa 2024) most incumbent governments have lost ground due to the economic pressures of real-life microeconomic inflation. These were dubbed “kitchen table issues” – where people can immediately relate to impacts and understand implications to themselves and their family. In my opinion, personal autonomy will be the leverage tool that is needed for biodiversity enhancements at the residential scale, by way of native plant installations. That being said, these international protocols and policies should not be abandoned. They should, however, be given close attention by civic administrators and politicians to transpose and become relatable to the neighborhood and residential scale. If

biodiversity and climate change affects us all, then we need to communicate such existential matters to the everyday taxpayer. (Communications will be explored under the Social aspect of the PESTEL model, later in this thesis.)

The following is a collection of important "big picture" concepts that should be researched by urban policy makers and translate into accessible language for citizens:

Convention of Biological Diversity | Montreal, December 2022
https://africa.iclei.org/wp-content/uploads/2023/05/Summit-Report-Final-High-Res.pdf

Millennium Ecosystem Assessment (MEA) | (ch. 27, p. 808): Ecosystems and human well-being : current state and trends : findings of the Condition and Trends Working Group / edited by Rashid Hassan, Robert Scholes, Neville Ash. (The millennium ecosystem assessment series ; v. 1); ISBN 1-55963-227-5 © 2005 found at:
https://www.millenniumassessment.org/en/Condition.html#download

Cities and Biodiversity Outlook | https://www.cbd.int/authorities/doc/cbo-1/cbd-cbo1-summary-en-f-web.pdf
key quote: "Ours is an increasingly urban world. The twenty (20) ambitious Aichi Biodiversity Targets set by the CBD for 2020 cannot be achieved without coherent governance at global, regional, national, sub-national, and local levels. The habits of **urban dwellers** will largely determine the health of our ecosystems and the survival of biodiversity. Cities—their inhabitants and governments— can, and must, take the lead in fostering a more sustainable stewardship of our planet's living resources."

CitiesWithNature program | https://citieswithnature.org/what-is-citieswithnature/
key quote: "All cities, large and small, critically depend on healthy interconnected ecosystems within and around them, so it is essential that nature is fully integrated into urban planning and development."

The City Biodiversity Index (CBI); Singapore Index on Cities' Biodiversity; 2021 Handbook; tech. report 98 |
key components: native biodiversity, ecosystem services provided by biodiversity, and governance and management of biodiversity Chan, L., Hillel, O., Werner, P., Holman, N., Coetzee, I., Galt, R., and Elmqvist, T. on the Singapore Index on Cities' Biodiversity (also known as the City Biodiversity Index). Montreal: Secretariat of the Convention on Biological Diversity and Singapore: National Parks Board, Singapore.
70 Pages https://www.cbd.int/doc/publications/cbd-ts-98-en.pdf

ICLEI (Local Governments for Sustainability)
CityTalk blog | https://talkofthecities.iclei.org/building-the-legal-backbone-for-net-zero-cities-insights-from-cop29s-korea-pavilion/
key theme: Residents' engagement is key to policy success

Kumming-Montreal Global Biodiversity Framework (KMGBF) | https://www.cbd.int/gbf
key takeaway: world's masterplan to halt and reverse biodiversity;
bringing 30% of the degraded ecosystems under effective restoration by 2030

Nature, Health, and Resilience in Cities, and Urban Climate Finance; **COP 29**
https://iclei.org/news/urban-sectors-front-and-center-in-the-third-ministerial-meeting-on-urbanization-and-climate-change-at-cop29/
key themes: High-Level Roundtables, focusing on Green Construction and Buildings, Urban Transport and Infrastructure

Aichi Biodiversity Targets
Strategic Goal A Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society
Strategic Goal B Reduce the direct pressures on biodiversity and promote sustainable use
Strategic Goal C To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity
Strategic Goal D Enhance the benefits to all from biodiversity and ecosystem services
Strategic Goal E Enhance implementation through participatory planning, knowledge management and capacity building
key takeaway: August 21st, 2024 is a refresh date for the 2022 COP 15's call to action for reversing and restoring biodiversity loss
https://www.cbd.int/sp/targets/default.shtml

IPBES Invasive Alien Species Assessment: Summary for Policymakers
key theme: The severe global threat posed by invasive alien species is underappreciated, underestimated, and often unacknowledged
https://www.ipbes.net/IASmediarelease

Canada's biodiversity goals (30% by 2030)
https://www.canada.ca/en/environment-climate-change/services/biodiversity/2030-nature-strategy.html
and https://www.canada.ca/en/environment-climate-change/services/biodiversity/canada-2030-nature-strategy.html

Referencing these listed international protocols, the City of Winnipeg has an opportunity to align or improve their sustainability policies, climate resilience goals, plus any and all biodiversity / ecological plans and programs (such as urban forestry). There is definitely a prospect for the City and academia to partner to create progressive and imaginative policies and programs that can position Winnipeg as a world leader.

8.1.2. Economic – supply and demand challenges

The micro-economics of native plants is an interesting dynamic: on one hand, we celebrate the perseverance of a small, locally-owned business that is a supplier of hard-to-find bioregional plants; on the other hand, it is this small scale that constrains the supply of these valuable plants.

There is not a wide marketing of native plants in Winnipeg, so the demand is artificially supressed. If, through effective incentive programs homeowners start to order more native plants, there will be a supply problem.

For example, when I worked at a local plant nursery: there were very few, if any, true native plants sold. Yet, since there were still consistent requests from their clients on how to landscape responsibly and sustainably, the owners assigned me the task of being their 'designer-in-residence' and give in-house consultations to appointment-only customers. My knowledge of native plants aligned with their interest in natural gardening (ecological landscaping). While the local native plant nurseries (LNPN) were referred to as a source for flowers, unfortunately, even to this day, a LNPN rarely has enough inventory – especially in quantity or variety of shrubs or trees. Out of necessity, I would source the ornamental nursery's tree stock for landscape designs. My biodiversity strategy was to be sure to recommend a variety of genera, to hedge against diseases and pests – a risk if designing with only similar species. (Black Knot disease, *Apiosporina morbosa*, that essentially wiped out most of the Schubert chokecherry, *Prunus virginiana* 'Schubert', tree stock in Winnipeg is an infamous example of depending on the same species for different landscape design scenarios.)

An important policy consideration for the city would be to try and eliminate this supply constraint: for residents and ecological landscapers there must be easy and consistent availability of bio-regionally 'grown-from-seed' native vegetation.

Perhaps cities in Canada could tap into financial programs that are driven by internation efforts like The Economics of Ecosystems and Biodiversity (TEEB) [134] – an international concern that strives to allow ecosystem services and biodiversity — appropriately referred to as "natural capital"— as part of normal governance and management at the city level. When city administrators make a direct connection to how nature's services (natural capital) can impact the bottom line of taxpayers' needs, finances "of" and "with" nature become embedded in a city budget. A city has the opportunity to use financial mechanisms in several ways. Two ways involve a punitive (issuing fines) or supportive (offering incentives).
Much like energy and water conservation measures, some North American jurisdictions have financial mechanisms such as rebates and cash-back incentives for native plant installation and grass turf removal. For example, the state of Minnesota has a very good program called *Lawns to*

Legumes: Your Yard can BEE the Change. This program is based on a cost-share funding model. As of summer 2024, up to $400 USD of eligible expenses can be reimbursed to homeowners.

There are orientation guides and YouTube videos available on their extensive website. The funding is handled in partnership with an ENGO called Blue Thumb, with Metro Blooms as an advertising channel. After reviewing and participating in many ENGO backyard conservation programs, in my opinion, this is an exemplar – of information, outreach, and professionalism. More information can be found under the Minnesota Board of Water and Soil Resources [135].

There is an opportunity for the 50 Million Tree Program [136], of Forests Canada, to be able to adjust its funding model from "only large-scale projects" to allow money to flow into projects that are residential. If there are minimum numbers of trees required, the city could guarantee the amounts needed and take on the responsibility to distribute to strategically identified neighborhoods.

There are ENGOs that are investing hard dollars through grants and incentives to encourage native plant establishment. Nature Manitoba [137] has several programs like the Nature Manitoba Native Habitat Grant and the Manitoba Bluebird Fund that are geared to help residents purchase native trees, shrubs, and herbaceous plants to encourage bird habitat (and hopefully increase populations of songbirds).

Another approach that CoW could use are legal and financial mechanisms that involve rewarding the use of native plants or punishing those that violate water-use restrictions. CoW can look to decades-long rules and programs from other jurisdictions. These have tended to be many arid climate cities that have incorporated water restrictions into their city bylaws. Phoenix and Las Vegas have all had strict enforcement processes that ensure water conservation – even having a patrolling "water police" to monitor lawn irrigation use. Consequently, landscape form and function adjusted to meet these new mandates. Native plants in those climates include cactus, yucca, and other xeric plants as these use little or no potable water since they have created various adaptation survival strategies over thousands of years. Whether a carrot or a stick approach is used, these plants (that were "of that place") became common and aesthetically pleasing and displaced unsustainable plants like grass turf.

8.1.3. Social – neo-communication strategy: it's not education, it's inspiration (a poem, a song, a message)

Inspiration, Not Just Education

"With the best of intentions, people think that simply explaining the facts will gain them support. Sadly, this is rarely true. More important is the way in which facts are presented and how they relate to the things that matter to the intended audience" [138]. The preceding quote was inspirational and a main theme at a presentation that a colleague and I used as a theme for the Canadian Urban Forestry Conference (Winnipeg, 2024). At an instinctual level I knew that BIMBY and native plants could be a useful tool and mental health strategy for people to rest, relax, and recharge. As mentioned earlier, WELL and Fitwel recognize the importance of nature and views.

There are different ways to explain a deeply personal reflection. When it comes to speaking to various stakeholders about environmental issues, one needs to understand that an "…audience will consist of a majority of non-scientists, which means that the wording and the methods that are used to communicate will be critical to the overall communication process. Presently, common communication media that are being used to promote… conservation include the use of video, visual art/photography, performance art/music, infographics, social media, speaking/public outreach, press/popular media, blog, and curriculum…" [139].

The following is a project that reflects my experiences sitting and reflecting amongst my own backyard urban forest stand.

An Example of Non-Traditional Messaging – song writing | Poem –> Song
(created for a national urban forestry conference; Wpg 2024)

The Environmental Musician (Emily Thoroski) performances, including conference song "Canopy", can be found on YouTube

https://youtube.com/@theenvironmentalmusician?si=68HYmQx1pdSN4g7k

https://youtu.be/P_e7MdPMBe8?feature=shared

"Canopy"
Music & Lyrics by Emily Thoroski and William Dowie © 2024

Big and small creatures bound
Under the Canopy there's stillness of sound

In and out of the green
Alighting on the brown

All the wondrous animals sideways, up, and down

Why am I frozen in reflection of the things that have passed me now?
Ouuu, Ouuu, Ouuu

Trees talk to me but I'm not listening
Trees tell me to be but I'm still wandering
The Canopy sways to and from
Beating wings, crawling feet
A melody ripples through the leaves
Like a peaceful memory
Scared, yet protected underneath
Our breath's in synchrony
Distracted by the fast pace around me
I feel safe under my friend, this tree
Ouuu, Ouuu, Ouuu

Trees talk to me but I'm not listening
Trees tell me to be but I'm still wandering
Why can't I see the world the way the trees see?
Why does the tree know better than me?
Know me better than I know myself
Feel connected to all that surrounds
Can I create a safe space for this tree?
The way it does for me?
Will we ever see?

Big and small creatures bound, under the Canopy there's stillness of sound

Trees tell me to be but I'm still wondering

8.1.4. Technology – Appropriate Integrative Pest Management

As mentioned earlier, describing a technique of installing a shrub border in trouble-spots (weeds and saplings) I advocate using Round-up responsibly. This is by targeted spot painting and generally not wide-area spraying. The techniques that I use without depending too much on pesticide (glyphosate only) applications include: smothering using cardboard (somewhat controversial depending on the plants and planting schedule) and adding mulch made from chipped, recycled pallets; solarization to overheat plants and soil (which disrupts the biota and would need replenishment) using clear or black poly-plastic sheets (if bought brand-new, a petroleum product with high carbon cost); paying close attention to protection of woody plants by mechanical protection (metal wire mesh) rather than chemical applications to prevent herbivory.

Other technologies that I would be interested in researching post-thesis would be incorporating underground silva-cells to install larger trees in small residential lots – a technique that is being incorporated under sidewalks and public plazas to support the native tree urban forest (by creating healthy root zones).

Lastly, permeable paving systems, generally reserved to high budget private installations, should be a new land and building code for cities: this could dramatically allow using water collected on-site for native tree support, rather than hard impermeable surfaces shunting valuable stormwater into sewers or water bodies.

[ed. note: there are numerous commercial booklets and industry literature that can be accessed directly from leading companies involved in the manufacturing, design, and installation of green technologies that would assist growth of native plants in a city environment.]

8.1.5. Environmental – an example of complexity | good intentions, bad results?

[ed. note: this is an aspirational article – to find a publisher in 2025 after reviews]

Say No to No Mow May Month?

Is No Mow May helpful for biodiversity? Postponing mowing lawns is marketed as enhancing urban habitats for pollinators by delaying cutting turf for a month in spring. The rationale is that No Mow May allows non-turf plants in the lawn's ecosystem to feed bees and other pollinators. To discover whether this practice promotes biodiversity is being challenged. By looking at No Mow Mays origins and impact on native and non-native plants and pollinators we explore whether the claims of biodiversity offer promise.

No Mow May origins

The No Mow May Movement originated in the United Kingdom. The United Kingdom's "Plantlife" organization called for people to temporarily not cut the grass on their lawn for No Mow May every year (Plantlife, nd). Europe originated the concept of well-manicured, short grasses as a status sign to demonstrate respectability and status. The concept of both mown lawns and not mowing lawns temporarily is the native home of the dandelion and European honeybee. The goal of the event is to "Provide a feast for pollinators, tackle pollution, reduce urban heat extremes, and lock away atmospheric carbon below ground" (Plantlife, nd). With over 23 million lawns in the UK, the smallest grassy patches are deemed to add up to protect nature, communities, and the climate in a big way.

The No Mow May expanded to North America. This event was parachuted across the Atlantic to Appleton, Wisconsin to become the first North American city to adopt No Mow May in 2020, with calls to "save the bees" by temporarily not mowing lawns (Smith, 2024). This No Mow May practice quickly spread to most of North America, including Canada, without any adaptation to the landscape or consideration of native plants or biodiversity (Smith, 2024).

Most lawns lack biodiversity and is not a sustainable or healthy ecosystem. The perfect turf grass lawn is a monoculture, kept short and green. To keep a perfectly green grass, pesticide, synthetic fertilizer, and turf maintenance practices are common residential practice. This unnatural lawn requires a lot of work and expense but is reinforced as the norm by media advertisements and often city by-laws. For example, Winnipeg's city by-law states that lawns should be no more than six inches (Winnipeg, nd). Native species of plants are what is needed for healthy ecosystems.

Most flowering plants on city lawns are non-native. Dandelions (*Taraxacum officinale*) are the main non-native plant found on lawns in Canada (Hodgson, 2022). Dandelions are not native to Canada and did not evolve with the native bees and pollinators. Dandelions suppress wildflowers through the allelopathic properties of their pollen, roots, and tissue by reducing seed production in other plants. Dandelions were introduced by European settlers to Canada, as a food and medicine but now are considered weeds and signal an unkept lawn (Hodgson, 2022). Dandelions colourful yellow and broad-based florette leaves are one of the first flowers of spring and thrive in disturbed areas like lawns, if untreated with pesticides. As the preferred green lawns are monoculture, broadleaf herbicides, that do not harm turf grass, are typically applied to kill dandelions. This chemical treatment poisons the soil's complex ecosystem and can seep into water through runoff or groundwater.

The dandelions and other non-native species in non-native lawns attract non-native species of bees. The European honeybee are non-native species (Xerces society, nd), which compete with the many native bee species. MacInnis, Normandin, & Ziter, (2023) found honeybees negatively impacted native bee populations and species diversity. The lead author Dr. MacInnis in an interview stated: "We found that the sites with the largest increase in honeybee populations across sites and years also had the fewest wild bee species" (Concordia, 2023). Disease associated with honeybees threaten wild pollinators (Fürst et al., 2014). Deformed wing virus, for example, can be passed from honeybees to bumble bees—and can also amplify and distribute diseases within a bee community.

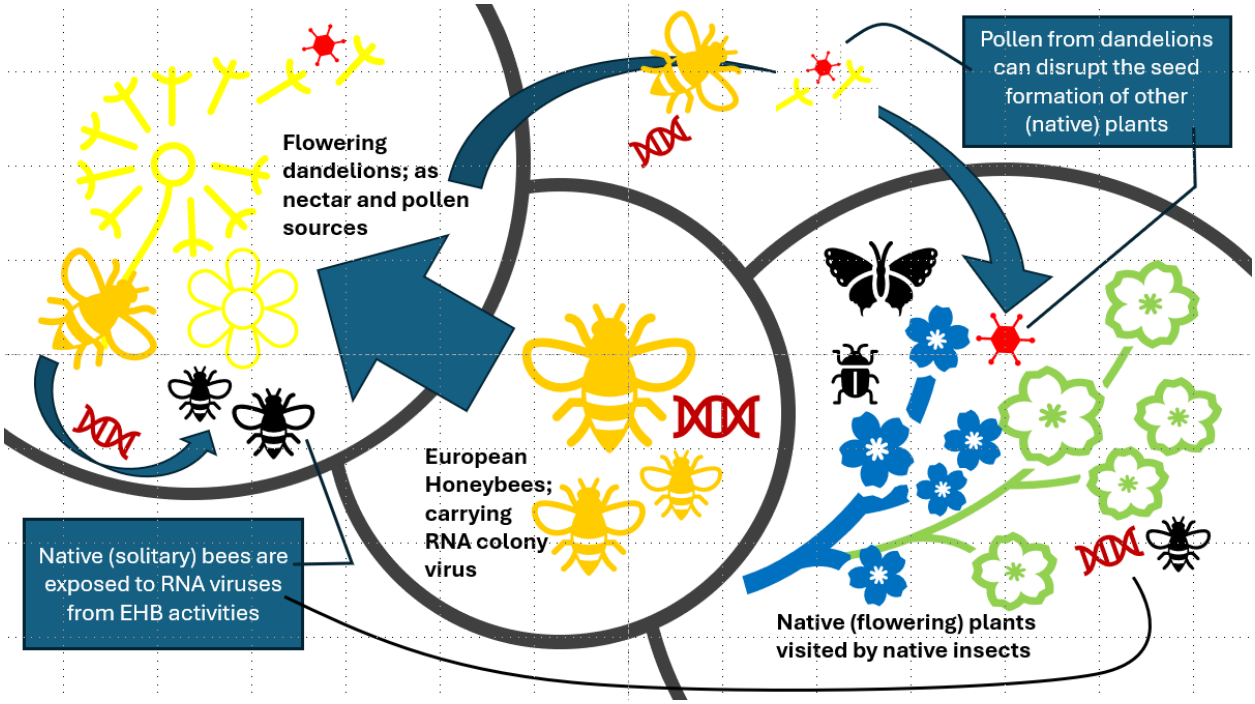
Honeybees cause ecological harm by pollinating non-native plants. Honeybees are adapted to pollinate non-native plant species. Figure Fifteen shows the negative impacts of dandelions and honeybees on native plants and bees. These plants include invasive species, furthering their reproduction and spread (Xerces Society, nd). However, native plants need native bees. Native bees coevolved with native plants and often have behavioral adaptations that make them better pollinators than honeybees. For example, buzz-pollination, in which a bee grasps a flower and shakes the pollen loose, is a behavior at which bumble bees and other large-bodied native bees excel, and one that honeybees lack.

Non-native honeybee hives are being introduced in many cities and crowding out native pollinators. Hatfield and Shepherd (2023) state: "Managed honeybees are domesticated livestock, and their very presence has the potential to harm native species." A single honeybee hive means 15,000 to 50,000 additional bees to feed often in areas with limited flowering

resources. This raises the energy cost of foraging for native bees, to outcompete them. Over a three-month period, a single hive collects as much pollen as could support the development of 100,000 native solitary bees !

Domesticated honeybees are outcompeting native species. The popularity of beekeeping in cities creates abundant honeybee populations which overwhelms other species competing for the same resources (Lejtenyi, 2023). Urban honeybee hive densities are often too high and cannot be supported by plants, without competing. MacInnis, Normandin, & Ziter, (2023) found the number of species of native bees found in an area decreased when the number of honeybees went up in Montreal (MacInnis, Normandin, & Ziter, (2023). In Britain, the London Beekeepers Association found that some parts of that city had four times as many hives as the city's gardens and parks could support. The conservation organization Buglife recommends creating two hectares (five acres) of habitat for each hive, several times the size of an average residential lot in the United States.

Figure Fifteen **Impacts of Dandelions + Honeybees on Native Plants and Bees**



Honeybees are sub-par pollinators. Honeybees groom their pollen for carrying in neat pollen cakes, which are less likely than native bees to contact the stigma of another flower and pollinate it. Thus, honeybees interacting with flowers contribute little or nothing to pollination. Honeybees are "nectar robbers" of many plants, accessing nectar by biting a hole in the base of the flower, which does not pollinate the plant. By contrast, many native bees carry pollen as dry grains, often all over their bodies making pollination of the plant more likely.

Conclusion

Not mowing dandelions on manicured lawns that attract honeybees is the opposite of biodiversity. The focus of No Mow May on maintaining a monoculture lawn most of the year and allowing non-native species to bloom for one month to attract non-native honeybees that compete with other wild pollinators is misdirected. Furst et al. complains (2014) stating: "…honeybees are least in need of saving. Media attention disproportionately covers them over native pollinators, and murky messaging has led many citizens—myself once included—to believe they are doing a good thing for the environment by putting on a beekeeper's veil" but they are not (Furst et al., 2014, p. 4). Rather than focusing on non-native bees we should focus on native habitats with native plants and native pollinators. With large urban areas being manicured lawns are an opportunity to shift to native plants to create habitats in lawns, gardens, balconies and window boxes that can support native pollinators and wildlife. Individually these may be small but together they cover massive areas. Clearly, No Mow May was against the science findings of biodiversity and so misguided. The good news is that the popularity of No Mow May, shows people are ready for action on biodiversity. Through asking them to restore native plants to their lawn, they can make a positive difference, rather than the negative impact of No Mow May.

[Ed Note: This is a good case study related to communication and social behaviour. Although only indirectly dealing with the narrower scope of native plants, this case study analysis does suggest that BIMBY activities are complex with respect to general ecology. This complexity might offer up more confusion and conflicting messages to the broader topic of the environmental value native plants.]

(Embedded List; APA) **References**

Fürst, M., McMahon, D., Osborne, J. *et al.* (2014) Disease associations between honeybees and bumblebees as a threat to wild pollinators. *Nature* 506. https://doi.org/10.1038/nature12977

Hodgson, M. (2022). A Dandelion with That? The Laidback Gardener. https://laidbackgardener.blog/2023/05/07/a-dandelion-with-that/?amp=1

Lejtenyi, P. (April 26, 2023). Abundance of urban honeybees adversely impacts wild bee populations, according to new Concordia research: The explosion of beekeeping in cities may be overwhelming other species competing for the same resources. Concordia News. https://www.concordia.ca/news/stories/2023/04/25/abundance-of-urban-honeybees-adversely-impacts-wild-bee-populations-according-to-new-concordia-research.html

MacInnis, G., Normandin E., Ziter, CD. (2023). Decline in wild bee species richness associated with honeybee (Apis mellifera L.) abundance in an urban ecosystem. *PeerJ* 11:e14699 https://doi.org/10.7717/peerj.14699

Plantlife. Nd. Your No Mow May Lawn Guide. https://www.plantlife.org.uk/campaigns/your-no-mow-may-lawn-guide/

Smith, A. (2024).There's Little Science Behind 'No Mow May'. *UnDark*. https://undark.org/2024/05/13/little-science-behind-no-mow-may/#:~:text=In%202020%2C%20the%20Wisconsin,other%20insect%20pollinators%2C%20proponents%20claimed.

8.1.6. Legal – by-laws and bureaucracy
(sterile aesthetics versus nature in city)

There is an underlying tension between being able to landscape how you desire and what the city requires of you and your property. Of course, there are reasonable limits that a municipality can impose, such as for issues of safety (sightlines), maintenance (litter and trash caught up in planting beds), and even ensuring of planting compliance so as not to violate an up-to-date, urban invasive plant list. However, when there seems to be arbitrary rules such as height of vegetation of grass and non-purposeful flower beds, a resident might fear reprisal of a city bylaw officer. At the very least, imaginative designs using biologically important native plants would give way to the status quo approach of turf lawn with a few sterile, compact globe, dark colour foliage ornamental shrubs – an unfortunate circumstance for all well-meaning arthropods.

This idea of autonomy, that of a self-regulated garden, is poignant. Dave Goulson [140], a well-known British naturalist, writes in his book regarding ordinances and fines in the USA if grass is not cut: "…to the immense frustration of US Wildlife enthusiasts and conservationists. There is a certain irony that, in the 'land of the free' where one can legally purchase a sub-machine gun, one is not free to let the grass grow" .

In Canada, there have been publicized cases where residents of yards with native plants run afoul with their municipal by-law enforcement officers. Featured in Canadian Geographic (Can Geo), the Sinclair couple in Smiths Falls, Ontario were cited by the city "…for everything from their habitat logs, which were classified as "timber and lumber debris," to their "grass and weeds being in excess of 20 centimetres," to their compost heap — purposely built to provide airflow — not being properly covered." This property had backyard conservation certification from the Canadian Wildlife Federation, and yet the aesthetic tensions (battlefield as described in the article) became a serious legal matter [141]. While Can Geo reflects on the complexity of biodiversity, and that "[s]cientists and Knowledge Keepers know native plants are foundational for ecosystems", they also importantly summarize important Canadian precedents of note such as Sandy Bell 1996 and the City of Toronto [142], as well as the 1997 Etobicoke case with Douglas Counter [143].

Not being a lawyer, I still have a gut feeling that the City of Winnipeg (CoW) is out of step with the ethics of native plants, as well as the legal implications of certain bylaw officers opposing them. I

wonder if a hypothetical case study could be created based on an actual yard, and develop recommendations on how to clarify, change, edit, modify the language of the CoW's Livability By-law [144]. By identifying arbitrary, non-scientific phrases (questions: what are "vermin"; what is an "infestation"; what is "harbourage") one can analyse and demonstrate how established 3rd party backyard conservation programs conflict with by-laws. This vagueness could be issue across North America, and absolutely in Canada (as Professor Nina-Marie Lister, Toronto Metropolitan University states): "...municipalities... rely on vague and aesthetics-based terms to describe potential violations... [where] ...a subjective statement... has no qualifier [with] no basis for defence in court" [145].

Instead of a punitive focus, there really should be jurisdictions that are encouraging of biodiversity installations into private residential spaces. These could be incentive programs with financial compensation, in-kind design support, or building codes that are ahead of the regulatory curve and prescribe climate resilient design. The city's administrative professionals would require ecological literacy (addressed later in thesis) to understand how backyard conservation uses established AECP techniques to responsibly install bioregional native plants.

8.2 Driving ecoliteracy leads to more native plant use

Needing common biodiversity language amongst stakeholders

As my learning journey has demonstrated, being exposed to different professional disciplinary languages through the various accreditation processes of different sustainability certification systems is an invaluable ecoliteracy experience. Ecological Literacy (ecoliteracy) is broadly defined as being well informed with various aspects of environmental knowledge domains; where "…the ability to understand the principles of organization of ecosystems… [and] principles in everyday life to create sustainable communities" [146].

The premise is that ecological awareness and biodiversity loss mitigation actions can occur after educating established (or soon-to-be established) AECP professionals using an infrastructure frame developed by the engineering community that focuses on sustainability, equity, and resilience. This frame is called Envision and is under the auspices of the Institute of Sustainable Infrastructure (ISI) in the USA.

8.2.1. Professionals should learn Envision

Far-sighted and sustainability-focused jurisdictions across the world are incorporating Nature-Based Solutions (NbS) [147], Nature-Based Climate Solutions (NbCS), Green Infrastructure (GI), Low Impact Development (LID), and other engineering and architecture technologies, techniques, and tools to meet the twin crises of climate change and biodiversity loss head on. Many frameworks accommodate different scenarios using nature and working with nature in the built environment.

Professionals that work at the CoW already have continuing education requirements could also explore for further adult learning opportunities with sustainability education – for city staff and the public. However, in my opinion, Envision is by far the best framework that can accommodate many scales and better deals with the social aspect of sustainability. That being said, the next section will perform a rudimentary analysis on how native vegetation can be part of, and contribute to, the successful sustainability certification of *new housing developments*. Then a process will be provided that helps professionals and landowners choose native trees and shrubs that can form the foundation of a healthy and resilient local terrestrial ecosystem.

In the early 2000s the City of Winnipeg administration realized that there needed to be internal knowledge and competencies in sustainability and energy conservation when the green building

movement started to integrate into new and existing corporate building policies. To this end, since some well-established sustainability frames such as the Leadership in Energy and Environmental Design (LEED) were being adopted as a default reference for new construction and existing building standards, the LEED accredited professional (AP) was a natural extension to train and educate city staff [148]. I recall a rush to study for the LEED exam in 2008-9, as the professional requirements to become a LEED-AP were to be more onerous; many of us in Winnipeg sustainability circles successfully passed the exam and were now officially in a non-formal education system in green building construction and operations.

This same sort of education journey should be revitalized by the City of Winnipeg (CoW), but for nature-based infrastructure and biodiversity. The framework of Envision fits this approach nicely. Although borne out of the civil engineering field, the Envision framework is suitable for other disciplines such as "…planners, architects, procurement professionals, general sustainability practitioners, CFOs, CEOs, students, [and] professors…" [149]. Since Envision has the inherent credibility of the engineering – a profession that is a linchpin in city construction and operations – there should not be resistance to exploring the professional credential associated with Envision. The non-formal education outcome is the Envision Sustainability Professional (ENV SP). Therefore, Envision can be an effective sustainability framework to 1) inform policy of integrating biodiversity into new development residential landscapes; 2) to educate professionals within the AECP disciplines of CoW's many departments and units.

As opposed to the LEED-AP credentialling process, which requires hundreds of hours of study, a high exam fee, and a 3rd party proctored exam, the ENV SP learning process can be achieved over a weekend, with a lower exam fee, and is an open-book, online exam in the comfort of your home. Certainly education scholars can debate the differences of professional development approaches and the accompanying outcome-effectiveness, but my point is this: being exposed to many different vernaculars, disciplinary approaches, and schools of thought with respect to all things 'sustainable' is the value of ecoliteracy. The more we know about nature, the more we can learn to live with Nature.

There is a 192-page long manual on Envision. There are two intertwining purposes for such a comprehensive manual: 1) to educate an adult learner about the Envision Framework – of which there is a meta-educational outcome of general ecological literacy that includes sustainability, resilience, and equity; 2) to act as a guide for already accredited professionals to utilize the Envision Framework to certify infrastructure projects. Since such a process already exists, there is

no need to expend time and money creating an in-house green infrastructure policy and training process.

8.2.2. Public Ecoliteracy – led by CoW, supported by an ENGO consortium

CoW should consider an external policy to raise awareness, build expertise, and market the importance of biodiversity in the urban realm to the general public. Envision [150] is a ready-made adult learning process (content, examination, and continuing education credits) that is managed very professionally by the Institute for Sustainable Infrastructure (ISI), USA and Canada offices. Therefore, I believe there would be a likely appetite for a general-public partnership option for sustainability education. As this sustainable infrastructure certification gains more widely accepted status throughout Canada, fellow AECP professionals (with accreditation in Envision) could form regional chapters (officially or loose networks). Activities of these chapters could consider a guest lecturer outreach program for high school students needing sustainability / civil engineering education. This allows for even greater learning opportunities within the AECP sector, and beyond, which could spillover into other professions and sectors.

Other sectors that could benefit from various sustainability professionals participating in k-12 education, could be already established ENGOs based in Winnipeg. Green Action Centre [151], the Manitoba Master Gardener Association (MMGA) [152], and The Wildlife Society (TWS) [153] are strong candidates that could be approached as partners. This sort of scenario could create more expanded learning opportunities beyond the generalities of the Envision guidelines. GAC and MMGA are already experienced in public education programs.

For native plant landscape topics, Living Prairie Museum offers in-person and virtual seminars on various horticulture topics [154]. For more advanced topics could be embedded into a public education program that has participants "…acquiring… [ecological design] skills is the landscape horticulturist apprenticeship program at Red River College Polytechnic" [155].

There are many international programs that have created excellent public awareness materials to improve ecoliteracy, by way of benefits that nature provides. For an exemplar on urban forestry, and its benefits to city residents, see APPENDIX 6 – United Nations Urban Forestry Awareness Poster.

9.0 Conclusion

Native plant installations of all forms can address challenges of urban resilience. Urban resilience in this thesis was mainly defined to address the challenges of biodiversity loss. Through the addition of bioregional native plant biodiversity at the residential scale, climate change can simultaneously be addressed through mitigation and adaptation techniques. Although biodiversity loss is a global existential threat to humanity, house-dwellers in existing neighborhoods can play a vital role to regenerate local habitats – and contribute to ~~the larger~~ urban resilience. Further, the design-build sector (engineers, architects, and planners) can also play a significant role in reversing biodiversity loss by using professional sustainability frames (accreditation and certification processes). Finally, internationally recognized organizations, exemplary urban jurisdictions, and leading practitioners were identified as entities that are demonstrating solutions-based approaches using native plants on private lands. This suggests that reversing biodiversity loss can be executed by citizens. These actors can immediately participate in an accessible mitigation strategy: design, install, and maintain native plants in their yards. This can be as simple as potted pollinator plants on the entrance stairs or as complex as an ecotone of native mixed prairie with a backdrop of keystone trees.

An autoethnography of a twenty-five-year adult learning journey (formal, non-formal, and informal approaches) was used to trace the processes and dynamics of installing backyard biodiversity projects using native plants in Winnipeg. A simple mantra holds: if it was easy to install native plants, then everybody would do it. Merging various education experiences with being a homeowner, a horticulture-sector professional, and a researcher gives unique insights and perspectives into “why it isn’t easy” to install many native plants.

Native plants are an important part of the ecosystem as these organisms have co-evolved with other organisms for thousands, and even millions, of years forming the basis of the food web creating a stable and resilient life-giving ecology. Important ecosystem services such as pollination, food provisions, flood protection, control of pollution, heat regulation, carbon sequestration, and healthy soil. Unfortunately, due to various factors including habitat loss due to urbanization, there is a crisis of biodiversity loss (coupled with climate change). Therefore, it is important to establish native plants of all forms (groundcovers, understory, canopy, herbaceous and woody) in the urban realm. These plants should be a major component of all landscapes – especially urban, residential yards. This is an opportunity for city residents to contribute to the

restoration of the local ecosystem by supporting the flora and fauna of the corresponding ecodistrict, ecoregion, and ecozone.

Design with, and installation of, native plants in the residential backyard is not a widespread practice, as there are many aspects of human society that present unique challenges and opportunities. Management models can be put into place to sort out the complexity of native plant installations. The PESTEL model offers political, economic, social, technological, environmental, and legal aspects to further understand interesting socioecological scenarios that can aid in establishing residential native plant installations in the city of Winnipeg.
There are variations of woody native plants (nativars) that could become keystone host plants and installed in a future city environment dictated by shifting climate. These are generally trees that are suited for the urban forest and need to support Lepidoptera larva to underpin the food web (helping biodiversity) and simultaneously contribute to adaptation and mitigation of potential extreme weather events (driven by climate change), serving a duo-purpose to make the city more resilient, one yard at a time.

REFERENCES

(IEEE basis with footnote style; all links accessed Dec 17th, 2024)

[1] APA, https://www.apa.org/pubs/books/essentials-autoethnography-sample-chapter.pdf

[2] see David H. Kahl, Jr., International Journal of Communication 5 (2011), © 2011, Autoethnography as Pragmatic Scholarship: Moving Critical Communication Pedagogy from Ideology to Praxis; found at https://ijoc.org/index.php/ijoc/article/viewFile/1018/668

[3] see Applied autoethnography: A method for reporting best practice in ecological and environmental research, by Kilian J. Murphy, Laura L. Griffin, Grace Nolan, Amy Haigh, Tamara Hochstrasser, Simone Ciuti, Adam Kane, First published: 15 July 2022, found at: https://besjournals.onlinelibrary.wiley.com/doi/full/10.1111/1365-2664.14252

[4] For more insights, see: Expert Knowledge: Its Structure, Functions and Limits by Marek Hetmański, Studia Humana, Volume 7:3 (2018), pp. 11—20, DOI: 10.2478/sh-2018-0014

[5] Savage, Candace. 2024. Prairie – A Natural History of the Heart of North America (rev. ed.). Greystone Books, Vancouver

[6] Map source = Marshall, Ian. 1999. Ecosystems of Canada. Ecosystem Stratification Working Group, Agriculture and Agri-Food Canada and Environment Canada. Date of publication: 2010, 6th edition; https://natural-resources.canada.ca/maps-tools-and-publications/maps/atlas-canada/climate-and-environment/26082#a6

[7] https://legacy.winnipeg.ca/PublicWorks/parksOpenSpace/LivingPrairie/default.stm

[8] https://www.epa.gov/eco-research/ecoregions

[9] https://legacy.winnipeg.ca/PublicWorks/parksOpenSpace/LivingPrairie/default.stm

[10] https://legacy.winnipeg.ca/publicworks/parksopenspace/NaturalistServices/PDF/ESNL.pdf

[11] https://www.thegardenhelper.com/map/h zm-nm1.html

[12] https://planthardiness.gc.ca/?m=1

[13] https://parks.canada.ca/pun-nup/politique-policy#section-10

[14] https://ehprnh2mwo3.exactdn.com/wp-content/uploads/2021/01/Calls_to_Action_English2.pdf

[15] https://native-land.ca/

[16] https://www.nationalhealingforests.ca/about

[17] https://cris.maastrichtuniversity.nl/ws/portalfiles/portal/72906417/beumer_2015_biodiversity_in_my_backyard_towards.pdf

[18] https://crimsonpublishers.com/boj/fulltext/BOJ.000512.php

[19] https://theconversation.com/the-inconvenient-truth-of-herman-daly-there-is-no-economy-without-environment-193848 also see https://uwaterloo.ca/sustainability-in-curriculum/toolkit/1-understand-what-sustainability-means/ways-framing-sustainability

[20] https://www.canada.ca/en/treasury-board-secretariat/services/innovation/greening-government/strategy.html

[21] Smith, Robert Leo. © 1996. Ecology and Field Biology, 5th ed. HarperCollins College Publishers: New York

[22] Biodiversity Conservation at Multiple Scales: Functional Sites, Landscapes, and Networks; BioScience, Volume 50, Issue 2, February 2000, Pages 133–146, https://doi.org/10.1641/0006-3568(2000)050[0133:BCAMSF]2.3.CO;2 Published: 01 February 2000; found at: https://academic.oup.com/bioscience/article/50/2/133/321884

[23] The Biological Diversity Crisis by Edward O. Wilson; BioScience, Vol. 35, No. 11, The Biological Diversity Crisis (Dec., 1985), pp. 700-706; Published by: University of California Press on behalf of the American Institute of Biological Sciences; Stable URL: http://www.jstor.org/stable/1310051

[24] https://www.nytimes.com/2018/11/27/magazine/insect-apocalypse.html

[25] https://www.theguardian.com/environment/2019/feb/10/plummeting-insect-numbers-threaten-collapse-of-nature
[26] https://www.canada.ca/en/services/environment/wildlife-plants-species/biodiversity.html
[27] Allen, W.L. Advancing Green Infrastructure at All Scales: From Landscape to Site; Environmental Practice , Volume 14 , Issue 1 , March 2012 , pp. 17 – 25 DOI: https://doi.org/10.1017/S1466046611000469
[28] used with permission from Nico Larco; found at: https://blogs.uoregon.edu/nlarco/sustainable-urban-design-framework/
[29] Larco, Nicolas & Knudson, Kaarin. © 2023. The sustainable urban design handbook. Routledge, New York. ISBN: 9781138945678 (hbk).
[30] https://permacultureprinciples.com/resources/free-downloads/
[31] https://greenactioncentre.ca/composting-resources/
[32] Rick Darke and Doug Tallamy. The Living Landscape (p 93) © 2024 published by Timber Press, Portland
[33] Patches of wildflowers in cities can be just as good for insects as natural meadows – study; The Guardian; found at: https://www.theguardian.com/environment/2024/nov/20/patches-of-wildflowers-in-cities-can-be-just-as-good-for-insects-as-natural-meadows-study-aoe
[34] For more info see https://prairiehorticulture.ca/#Streamsofstudy
[35] Trees in Canada by John Laird Farrar © 1995 (7th impression, 2000) ISBN 1-55041-199-3; Fitzhenry & Whiteside, Ltd., Markham, ON and the Canadian Forest Service (NRCan)
[36] Creswell, J. W. and Cheryl N. Poth (2018). Qualitative Inquiry & Research Design: choosing among five approaches (pp 26-27). Los Angeles: Sage Publications, Inc.
[37] Ibid. paraphrased from p 36
[38] Ibid. p 21
[39] Ibid. p 70
[40] Ibid pp 92-93
[41] Applied autoethnography: A method for reporting best practice in ecological and environmental research. By Kilian J. Murphy, Laura L. Griffin, Grace Nolan, Amy Haigh, Tamara Hochstrasser, Simone Ciuti, Adam Kane. 15 July 2022; found at: https://besjournals.onlinelibrary.wiley.com/doi/full/10.1111/1365-2664.14252
[42] https://infed.org/mobi/informal-non-formal-and-formal-education-a-brief-overview-of-some-different-approaches/
[43] https://pubmed.ncbi.nlm.nih.gov/24659474/
[44] https://www.gardeningknowhow.com/garden-how-to/info/history-of-permaculture.htm
[45] Lois Hole's Favorite Trees & Shrubs book © 1997 Lone Pine Publishing, Edmonton, Canada
[46] https://www.itis.gov/
[47] p22; NatureScape Alberta © 2000 by Myrna Pearman & Ted Pike; ISBN 0-9685765-0-8
[48] https://www.npss.sk.ca/docs/2_pdf/NPSS_SKNativePrairie-TakingStock.pdf
[49] https://phys.org/news/2020-12-powerhouse-bolster-food-web.amp
[50] Pamela Swanigan is the inaugural winner of the annual Berggruen Prize Essay Competition. October 15, 2024. Found at: https://www.noemamag.com/its-time-to-give-up-hope-for-a-better-climate-get-heroic/
[51] 1970 book The Prairie Gardener by H.F. Harp (of the former federal experimental farm in Morden, MB; est. 1915)
[52] https://www.ecobeneficial.com/2014/04/native-cultivars-vs-native-plants/
[53] https://grownative.org/learn/natives-cultivars-and-nativars/
[54] https://www.indefenseofplants.com/blog/2018/2/6/mt-cuba-center-puts-nativars-to-the-test
[55] Flowering phenology influences butterfly nectar foraging on non-native plants in an oak savanna - Rivest - 2023 - Ecology - Wiley Online Library; found at https://esajournals.onlinelibrary.wiley.com/doi/full/10.1002/ecy.4004 also Nature; Herbaceous

perennial ornamental plants can support complex pollinator communities; found at https://www.nature.com/articles/s41598-021-95892-w
[56] https://www.gov.mb.ca/agriculture/crops/weeds/declaration-of-noxious-weeds-in-mb.html
[57] https://www.mgmanitoba.com/event/invasive-ornamental-plants-what-home-gardeners-and-professionals-need-to-know/
[58] Lawn, Garden and Roadside Weeds, by Jeannette Adams, Marilyn Dudek and Teresa Lopata; found at: https://www.mgmanitoba.com/invasive-plants-weeds/#:~:text=Common%20Tansy%20spreads%20by%20rhizomes%2C%20but%20mostly,and%20discard%20properly%20to%20limit%20its%20spread
[59] https://www.cbc.ca/news/canada/thunder-bay/lawn-grass-climate-action-1.6810711
[60] https://www.aldoleopold.org/about/the-land-ethic
[61] https://citieswithnature.org/guidelines-for-urban-ecosystem-restoration/
[62] see Mollison, B & Holmgren, D. (1980). Permaculture One: A Perennial Agriculture for Human Settlement, Corgi Books, London, UK.; and Bloom, J., Boehnlein, D., & Kearsley, P. (2015). Practical permaculture for home landscapes, your community, and the whole earth. Portland, Oregon, Timber Press; and Holmgren, D. (2002). Permaculture: principles & pathways beyond sustainability. Hepburn, Victoria, Australia, Holmgren Design Services
[63] https://medium.com/activate-the-future/regenerative-cities-in-their-bioregional-context-8259d8d65d8e
[64] https://www.neh.gov/article/frenemies-john-muir-and-gifford-pinchot
[65] https://oudolf.com/
[66] R.M. Swab, N. Lorenz, S. Byrd, R. Dick, Native vegetation in reclamation: Improving habitat and ecosystem function through using prairie species in mine land reclamation, Ecological Engineering, Volume 108, Part B, 2017, Pages 525-536, ISSN 0925-8574, https://doi.org/10.1016/j.ecoleng.2017.05.012
[67] Schneider, Richard R. 2019. Biodiversity Conservation in Canada – from Theory to Practice. The Canadian Centre for Translational Ecology, Edmonton, Canada
[68] No Sense of Wild to a Need to Rewild North America by John Miles; found at https://rewilding.org/from-no-sense-of-wild-to-a-need-to-rewild-north-america/
[69] https://legacy.winnipeg.ca/publicworks/parksopenspace/livingprairie/
[70] https://youtu.be/PBy5F7yHjks?feature=shared
[71] https://homegrownnationalpark.org/ also see: Tallamy, D. W. (2009). Bringing Nature Home: how you can sustain wildlife with native plants (updated and expanded). Portland, Oregon, Timber Press; and also Tallamy, D. W. (2019). Nature's best hope: a new approach to conservation that starts in your yard. Portland, Oregon, Timber Press
[72] https://homegrownnationalpark.org/about-us/
[73] https://www.udel.edu/udaily/2020/december/doug-tallamy-native-plants-food-web-insects-birds-survival-earth/
[74] https://www.youtube.com/watch?v=9d6A1T75ksI
[75] Park, S., Ali, Z. & Zhang, P., Landscape Architecture Solutions to Biodiversity Loss: Executive Summary. American Society of Landscape Architects Fund. March 2024. https://www.asla.org/evidence
[76] Toward Ecosystem Services as a Basis for Design; Steven Windhager, Frederick Steiner, Mark T. Simmons and David Heymann Landscape Journal, September 2010, 29 (2) 107-123; DOI: https://doi.org/10.3368/lj.29.2.107
[77] https://www.usgbc.org/leed
[78] https://build.usgbc.org/singlefamilyclean41
[79] https://build.usgbc.org/l/413862/2023-07-28/246vh9s/413862/16905657706biUEe1d/LEED_v41_LFC_Existing_Cities_Beta_Guide_July_2023.pdf

[80] https://iucn.org/resources/conservation-tool/species-threat-abatement-and-restoration-star-metric#3289
[81] https://build.usgbc.org/l/413862/2023-07-28/246vh9s/413862/16905657706biUEe1d/LEED_v41_LFC_Existing_Cities_Beta_Guide_July_2023.pdf
[82] https://sustainablesites.org/measure-impact-sites-existing-landscapes
[83] https://www.sustainablesites.org/certification-guide
[84] https://sustainableinfrastructure.org/landscape-environmental/
[85] https://www.isa-arbor.com/Who-We-Are/Our-Organization
[86] https://www.treesaregood.org/about
[87] https://cnla.ca/learn/national-plant-list
[88] https://www.gcfoundation.ca/our-story
[89] https://www.hydro.mb.ca/docs/safety/right_tree_right_place.pdf
[90] https://www.asla.org/positive.aspx
[91] https://learn.asla.org/products/biodiversity-by-design-latest-research-and-strategies-10-pdh-la-ceshsw
[92] https://www.ecolandscaping.org/about/
[93] https://grownative.org/grow-native-professional-certification-program/
[94] https://www.ncei.noaa.gov/access/billions/
[95] https://www.nature.com/articles/s41559-023-02235-1
[96] For incident examples, see: https://www.winnipeg.ca/fr/node/32153 and https://www.cbc.ca/news/canada/manitoba/power-outages-wind-winnipeg-1.7337919#:~:text=Forceful%20winds%20cause%20power%20outages%20around%20Winnipeg%2C%20impacting%20thousands%20%7C%20CBC%20News
[97] Winnipeg = https://www.winnipeg.ca/services-programs/emergency-public-safety/emergency-preparedness/about-office-emergency-management and Manitoba = https://www.gov.mb.ca/emo/about/index.html
[98] https://www.gov.mb.ca/emo/mitigation/disaster_checklist.pdf
[99] https://www.foodnetwork.com/fn-dish/news/saguaro-national-park-rangers-bake-banana-bread-heat-car
[100] https://hort.extension.wisc.edu/articles/espalier/
[101] https://www.americanforests.org/our-programs/tree-equity/
[102] https://parks.canada.ca/pun-nup
[103] https://www.sciencedirect.com/science/article/abs/pii/S0360132320301372
[104] https://treecanada.ca/article/take-a-bath-in-the-forest/#:~:text=Shinrin%2Dyoku%20%E2%80%93%20or%20forest%20bathing%20%E2%80%93%20has,in%20a%20very%20mindful%20and%20slow%20way
[105] https://resources.wellcertified.com/articles/new-report-or-access-to-nature-and-the-workplace/
[106] https://v2.wellcertified.com/en/wellv2/mind/feature/2?part=1
[107] https://v2.wellcertified.com/en/wellv2/mind/feature/9?part=2
[108] https://helpcenter.fitwel.org/hc/en-us/articles/10312977332372-Views-of-Nature
[109] Barbara, Z., Łukasz, D., Agata, J., Banaszak-Cibicka, W., Kornelia, K., Mikołaj, B. et al. (2024) Sown wildflower meadows: Can they replace natural meadows in urban spaces for bees, butterflies and hoverflies? Ecological Entomology, 1–14. Available from: https://doi.org/10.1111/een.13396
[110] https://www.biodiversitystandard.org/
[111] https://www.americanforests.org/blog/backyard-biodiversity/
[112] p96; Bringing Nature Home – How You Can Sustain Wildlife with Native Plants (updated and expanded) by Douglas W. Tallamy © 2009, Timber Press, Portland, Oregon, USA

[113] Benjamin Vogt's book, a new garden ethic – Cultivating Defiant Compassion for an Uncertain Future [title capitalization variation is author's choice] © 2017 New Society Publishers, Gabriola Island, Canada
[114] https://www.winnipeg.ca/people-culture/our-city-our-stories/skip-being-stung-tips-deal-aggressive-wasp-population and https://www.cbc.ca/amp/1.6943650
[115] Rick Durand; Cold Hardy Tree List (partially from the Western Nursery Growers Group) https://www.prairietrees.ca/wp-content/uploads/2024/02/List-of-Cold-Hardy-Prairie-Trees-February-23-2024.pdf
[116] https://www.oklahoman.com/story/business/2008/09/25/treatment-can-stop-sprouts-from-cut-stumps/61534310007/
[117] a Zoom webinar hosted by MMGA, Nov 20th, 2024 https://www.youtube.com/watch?v=RKU-EN7MYm0
[118] https://www.cityplants.org/wp-content/uploads/2021/09/Ch.-3-Right-Tree-Right-Place-Right-Reason.pdf
[119] found at https://www.nwf.org/-/media/Documents/PDFs/Garden-for-Wildlife/Keystone-Plants/NWF-GFW-keystone-plant-list-ecoregion-9-great-plains.pdf
[120] William M. Twardek, Jessica J. Taylor, Trina Rytwinski, Sally N. Aitken, Alexander L. MacDonald, Rik Van Bogaert, Steven J. Cooke. The application of assisted migration as a climate change adaptation tactic: An evidence map and synthesis. Biological Conservation, Volume 280, 2023, 109932. ISSN 0006-3207. https://doi.org/10.1016/j.biocon.2023.109932. (https://www.sciencedirect.com/science/article/pii/S0006320723000320)
[121] https://natural-resources.canada.ca/climate-change/climate-change-impacts-forests/adaptation/assisted-migration/13121
[122] https://www.planthardiness.gc.ca/?lang=en&m=16
[123] https://climateatlas.ca/sites/default/files/cityreports/Winnipeg-EN.pdf
[124] https://engage.winnipeg.ca/10550/widgets/67282/documents/120884
[125] https://legacy.winnipeg.ca/publicworks/parksopenspace/UrbanForestry/PDF/Acceptable_Tree_Species.pdf
[126] https://legacy.winnipeg.ca/publicworks/parksopenspace/UrbanForestry/PDF/Acceptable_Tree_Species.pdf
[127] https://www.pollinator.org/pollinator.org/assets/generalFiles/LakeManitoba.2017.pdf
[128] adapted from The Keystone Host-Plant Genera in Great Plains (GP) region NWF - Ecoregion 9 section, found at https://www.nwf.org/-/media/Documents/PDFs/Garden-for-Wildlife/Keystone-Plants/NWF-GFW-keystone-plant-list-ecoregion-9-great-plains.pdf
[129] multiple sources:
copied from a one-sheet physical handout at Rick Durand's break-out session, Plant Diversity in a Time of Climate Change, MBNLA's Grow-24 conference, Feb 13th, 2024 https://mbnla.com/grow/speakers-topics/
larger list digitally available as: List of Cold-Hardy Prairie Trees https://www.prairietrees.ca/wp-content/uploads/2024/02/List-of-Cold-Hardy-Prairie-Trees-February-23-2024.pdf
[130] by F. J. Aguilar, "Scanning the Business Environment," MacMillan Co., New York, 1967. https://www.researchgate.net/profile/Manoj-Trivedi-2/publication/363640549_PESTLE_TECHNIQUE_-A_TOOL_TO_IDENTIFY_EXTERNAL_RISKS_IN_CONSTRUCTION_PROJECTS/links/6326de560a70852150026dfc/PESTLE-TECHNIQUE-A-TOOL-TO-IDENTIFY-EXTERNAL-RISKS-IN-CONSTRUCTION-PROJECTS.pdf and https://libguides.libraries.wsu.edu/c.php?g=294263&p=4358409#:~:text=It%20examines%20the%20Political%2C%20Economic,used%20in%20a%20SWOT%20analysis
[131] Creswell (p. 11) Research Design © 2014 published by Sage Publications Los Angelas
[132] https://www.cbd.int/climate/intro.shtml

[133] https://www.climateandlandusealliance.org/wp-content/uploads/2016/02/Effects_of_Tropical_Deforestation_Policymaker_Summary.pdf
[134] Citation: Secretariat of the Convention on Biological Diversity (2012); Cities and Biodiversity Outlook—Executive Summary. Montreal, 16 pages
[135] https://bwsr.state.mn.us/l2l
[136] https://forestscanada.ca/en/program/50-million-tree-program
[137] https://naturemanitoba.ca/nature-manitoba-grants-and-subsidies
[138] Marketing the Urban Forest An Art of Persuasion by James R. Geiger & Hal Voege; found at: https://treeboardu.org/graphics/courses/05-03-04-marketing-the-urban-forest.pdf
[139] MSpace – UManitoba thesis repository
M. Env. thesis excerpt from Emily Thoroski; Why do wildlife matter: transforming interview information into music and video to advance environmental conservation
[140] Dave Goulson (p23), The Garden Jungle or Gardening to Save the Planet © 2019
[141] https://canadiangeographic.ca/articles/our-shared-garden-the-importance-of-native-plants/
[142] http://web.ncf.ca/bf250/charter.html
[143] https://lorrainejohnson.ca/blog/despite-a-court-victory-the-douglas-counter-saga-continues
[144] https://clkapps.winnipeg.ca/dmis/documents/docext/bl/2008/2008.1.pdf
[145] https://www.rewildingmag.com/rewilding-yard-not-illegal/
[146] https://link.springer.com/referenceworkentry/10.1007/978-3-031-17299-1_811
[147] IUCN (2020). Global Standard for Nature-based Solutions. A user-friendly framework for the verification, design and scaling up of NbS. First edition. Gland, Switzerland: IUCN.
[148] https://www.usgbc.org/credentials
[149] https://envisioncanada.com/credentialing/envision-sustainability-professional-env-sp/
[150] https://sustainableinfrastructure.org/credentialing/envision-sustainability-professional-env-sp/
[151] https://greenactioncentre.ca/school-services/
[152] https://www.mgmanitoba.com/ask-an-mg/
[153] https://wildlife.org/certification-programs/
[154] https://legacy.winnipeg.ca/PublicWorks/parksOpenSpace/LivingPrairie/pdf/Environmental-Education-Brochure_2024-25_Nov-update.pdf
[155] https://www.winnipegfreepress.com/arts-and-life/life/2024/12/07/budding-professionals

(Embedded List; IEEE) References within Original “BIMBY” Article - see page 20)

(Embedded List; APA) References within Original “No Mow” Article - see page 88)

APPENDICES

APPENDIX 1 – Google Map Views and Solar Calculator of a Residential Property

By planting native plants and trees in my yard – the abundance and shade provided by trees is visible on Google Maps features.

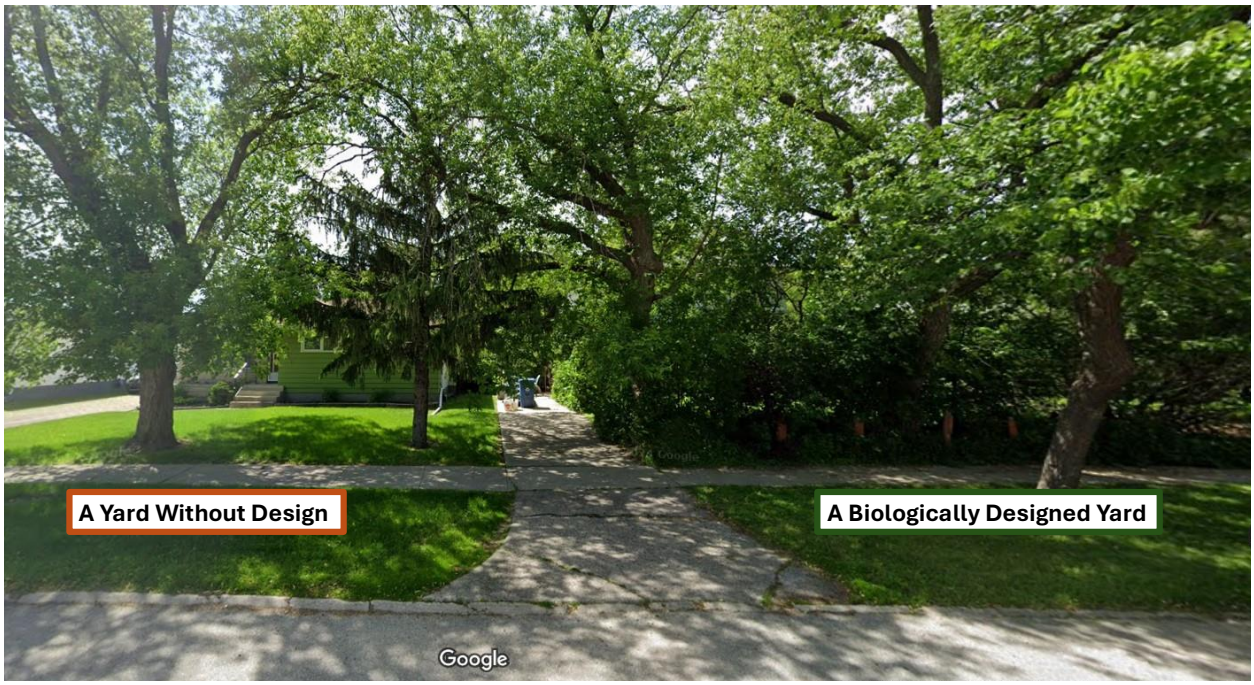


Photo: Google Maps, June 2024

Figure A1.1 June 2024 photo of biologically designed front yard (right) beside manicured neighbour. (Source: Google Maps.)

Figure A1.2 October 2018 Google photo of biologically designed front yard (right) beside manicured neighbour. (Source: Google Maps.)

Figure A1.3 June 2024 photo of biologically designed front and back yard (right) beside manicured neighbour. (Source: Google Maps.)

Figure A1.3 June 2024 (summer-scape) compared to February 2022 (winter-scape) photo of biologically designed back yard showing shading and tree cover layers. (Source: Google Maps.)

June 2024

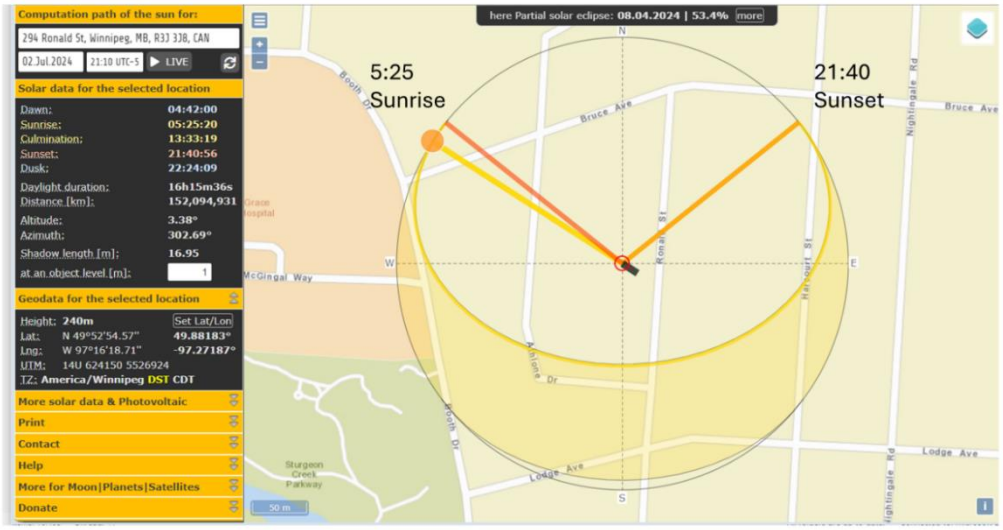


Figure A1.4 Solar map for June 2024

January 2025

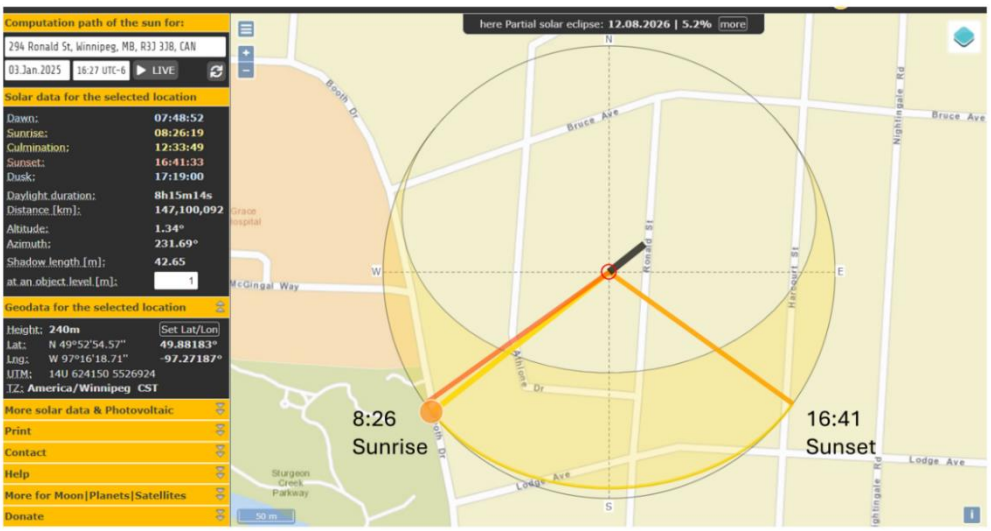


Figure A1.5 Solar maps for January 2025.

APPENDIX 2 – Maps of Ecozones / Ecoregions / Ecodistricts

Agriculture Canada has mapped areas in Canada into various ecological 'levels'. This is similar to the United States Environmental Protection Agency (USEPA) framework in terms of granularity levels. The three levels are described as ecozones (level I), ecoregions (level II), and ecodistricts (level III).

This system is useful to analyze what native plants are present. See Figure A.2.1 where Winnipeg is indicated as the red star in the Winnipeg ecodistrict, within the Lake Manitoba Plain ecoregion, as part of the Canadian Prairies ecozone (area = 9212 km^2). This ecodistrict is nestled beside the Boreal Plains ecozone to the west and the Boreal Shield ecozone to the east. Figure A.2.1 also indicates the adjacent ecodistricts that could help inform landscape plant design choices – especially when these boundaries are dynamically blurred with land use priorities, wildlife movement (seed dispersal), and climate change (species migration).

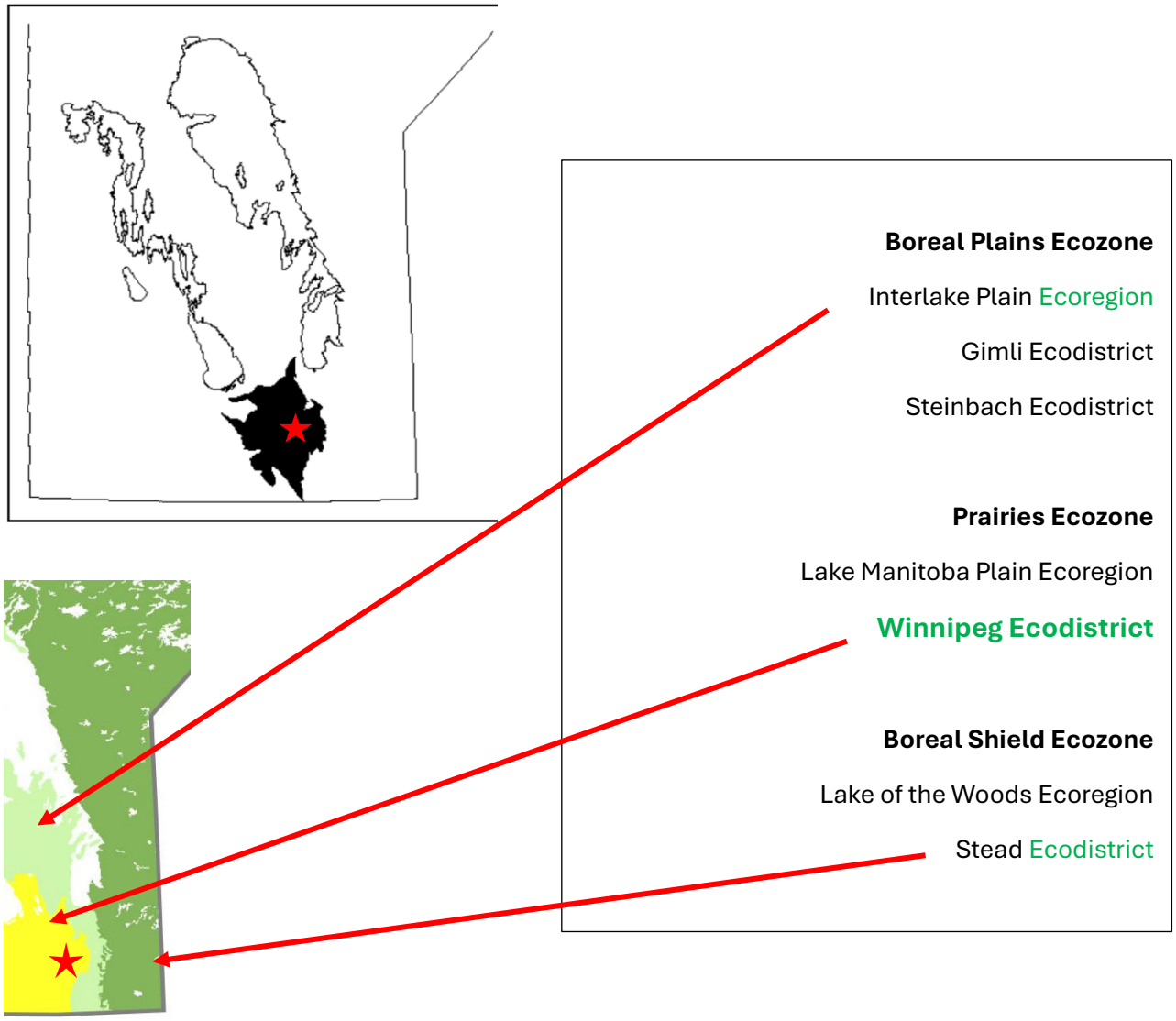


Figure A2.1 Ecozones in Manitoba with Winnipeg shown as red star

Winnipeg, as part of The Great Plains (USEPA, 9.0, Level I)

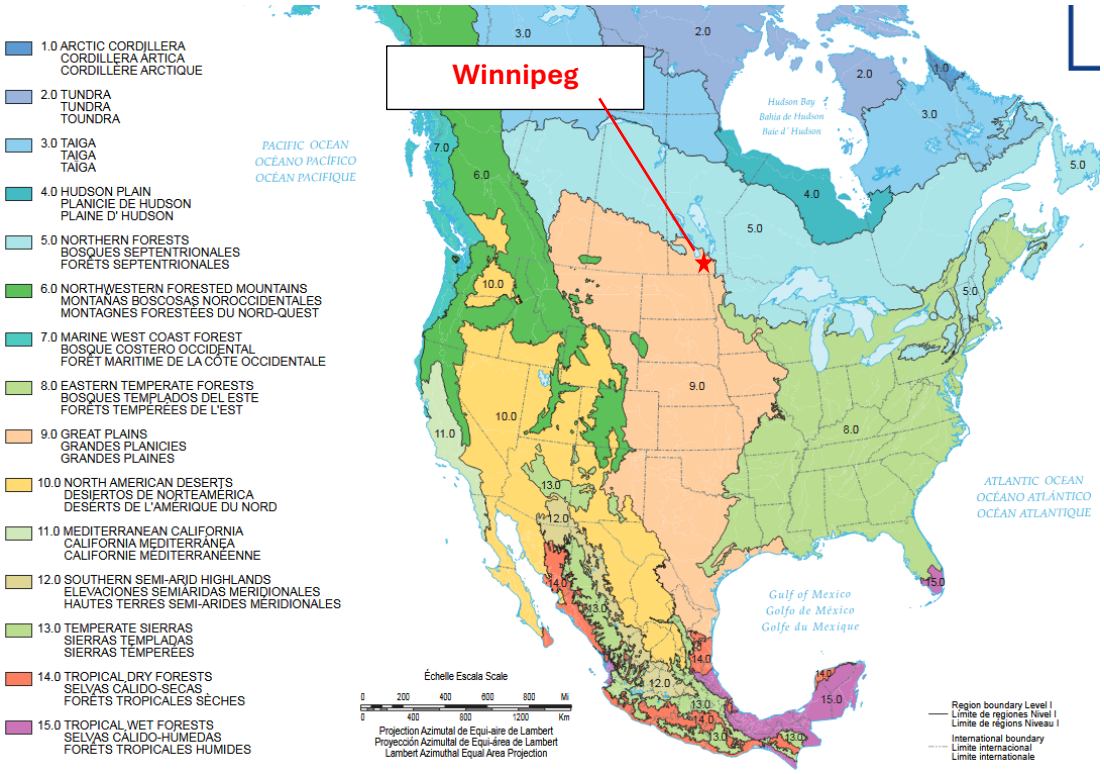


Figure A2.2 Winnipeg ecozones in The Great Plains (USEPA, 9.0, Level I)

Source: EPA, nd.
https://gaftp.epa.gov/EPADataCommons/ORD/Ecoregions/cec_na/NA_LEVEL_I.pdf

At Level I (see Figure A2.2 above), Winnipeg is located within The Great Plains with the Northern Forests just to the east. At Level II (see A.2.3 below), Winnipeg is described as being within the Temperate Prairies with a nexus point to the east of Mixed Wood Shield and Boreal Plain. Finally, at Level III (see Figure A.2.4 below), Winnipeg falls directly within the Lake Manitoba and Lake Agassiz Plain. There is a tri-ecoregional nexus to the east including the Northern Lakes and Forests, the Northern Minnesota Wetlands, and the Mid-Boreal Lowland and Interlake Plain. This geographic overlap could be important for climate-driven assisted migration planning (a controversial and debated landscape adaptation strategy). This is the human-contrived process of native flora purposefully planted away its traditional area, to hedge its future survival (based on climate change scenario models), and consequently, the organisms that depend on the plants ability to adapt and thrive. The three-level ecological regions of the USEPA maps are compiled from various Canadian agencies: Wildlife habitat Canada / Canadian

Council on Ecological Areas / Environment Canada / Canadian Plains Research Center, University of Regina, SK / Agriculture and Agri-Food Canada.

The USA does have a very detailed geographic Level IV, and even level V. These levels of detail for the Winnipeg region can be functionally substituted with on-site surveys, to confirm soil and hydrological conditions. Certainly, when actual planting commences, there is more than enough surprises like buried boulders, moisture pockets, tree roots, and other obstacles that require on-the-spot design-build decisions. Perhaps, with resources, newer LIDAR technology could add a layer of planning certainty.

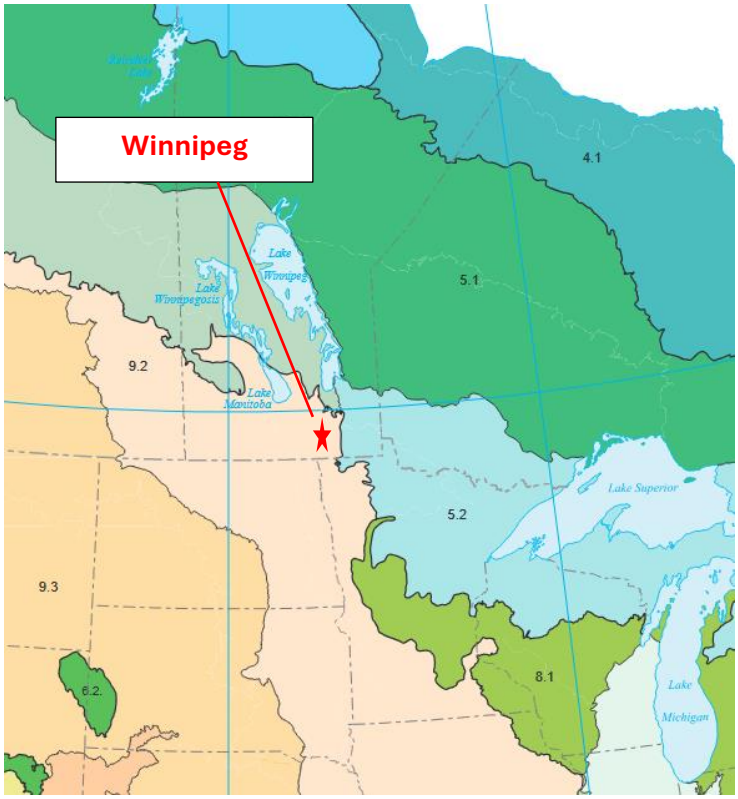


Figure A2.4 Winnipeg, as part of the Lake Manitoba and Lake Agassiz Plain (USEPA, 9.2.2, Level III)
Source; EPA, nd.
(https://gaftp.epa.gov/EPADataCommons/ORD/Ecoregions/cec_na/NA_LEVEL_II.pdf)

Winnipeg (circled in red), as part of the Lake Manitoba and Lake Agassiz Plain (USEPA, 9.2.2, Level III)

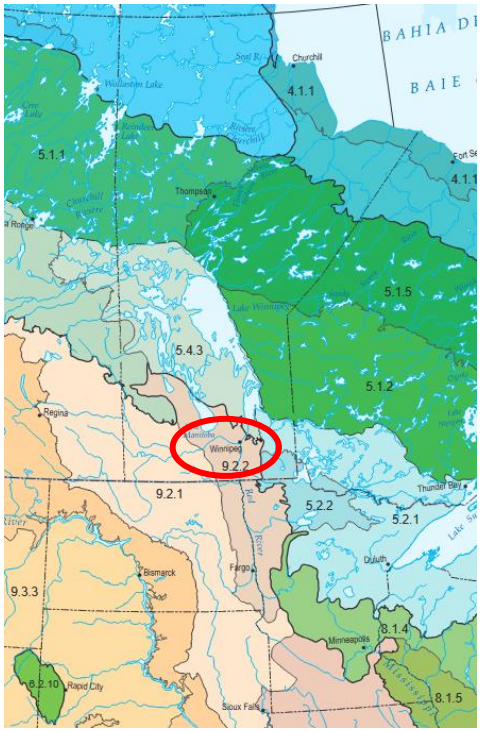


Figure A2.5 Canadian (tri-provincial) map of Prairies Ecoregions
Source: EPA, nd.
(https://gaftp.epa.gov/EPADataCommons/ORD/Ecoregions/cec_na/NA_LEVEL_III.pdf)

To emphasize the ecoregion concept, especially in the context of native plants that support native animals, the Pollinator Partnership Canada program's Prairies Ecoregions map is depicted below in Figure A.2.6. Winnipeg is labeled as belonging to the Lake Manitoba Plain. Note the pockets of Boreal Transition to the west; this, at least, allows for further investigation of opportunities for other useful ecotones, in and around Winnipeg, that could support biologically functional plants.

Canadian (tri-provincial) map of Prairies Ecoregions

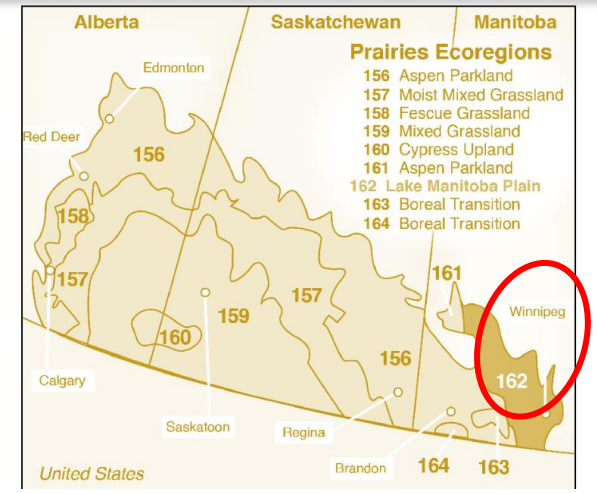


Figure A.2.6 Canadian pollinator map – Winnipeg Area

Source : Pollinator Partnership Program, nd.
(https://www.pollinator.org/pollinator.org/assets/generalFiles/LakeManitoba.2017.pdf)

APPENDIX 3 – Maps of Hardiness Zones

Figure A3.1 below depicts the USDA hardiness zones (based on extreme temperatures) that straddle the US-Canada border area. Winnipeg is part of the Red River Valley and is listed as Zone 3b.

Figure A3.1 Hardiness Zone Map of Northern Midwest United states
(adapted source: https://planthardiness.ars.usda.gov/system/files/ND150_HS.png)

2023 USDA Plant Hardiness Zone Map

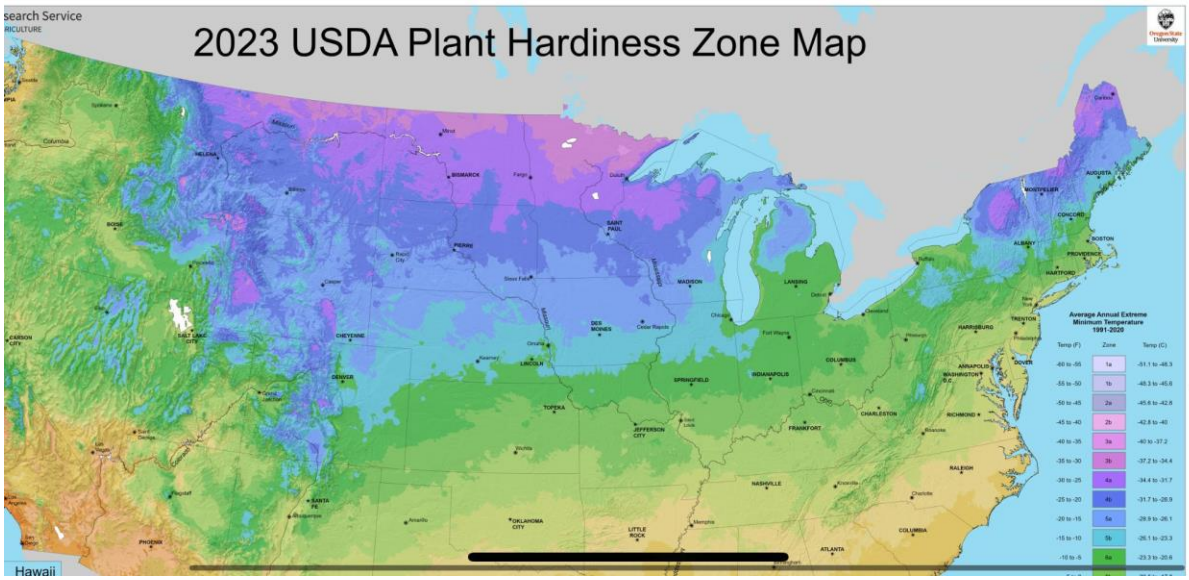


Figure A3.2 2023 USDA Plant Hardiness Zone Map

"The *USDA Plant Hardiness Zone* Map is the standard by which gardeners and growers can determine which perennial plants are most likely to thrive at a location."

https://planthardiness.ars.usda.gov/home

APPENDIX 4 – Personal Property Conservation Certifications

A sample list and brief description of various certifications – environmental nongovernment organizations (ENGOs) – relevant to urban biodiversity that the author registered his property; since 2023, expanding on original certifications dating back to early 2000s.

Pollinator Pathways Project
A non-profit helping to educate the public about pollinators
https://www.pollinatorpathwaysproject.com/

The Bee conservancy program

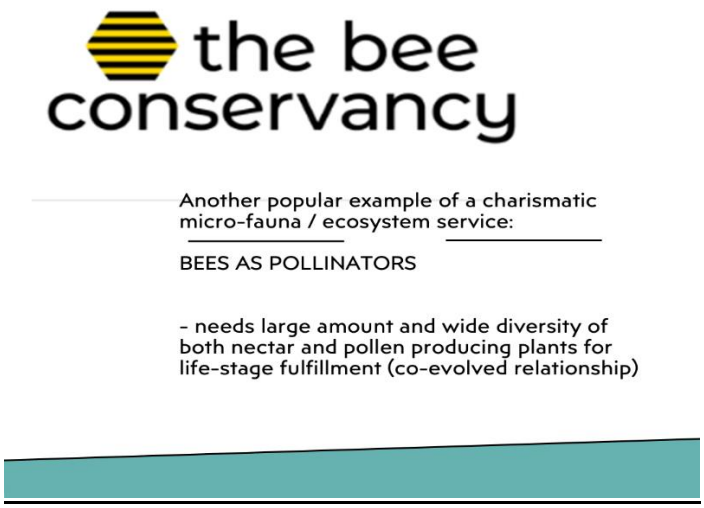


Figure A4.1 The Bee conservancy overview

Xerces Society

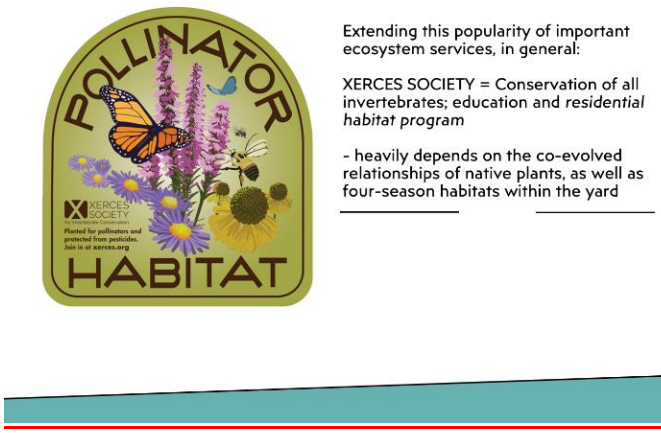


Figure A4.2 The Xerces Society
Xerces Society broadly conserves *Invertebrates*

The Monarch Butterfly Waystation program

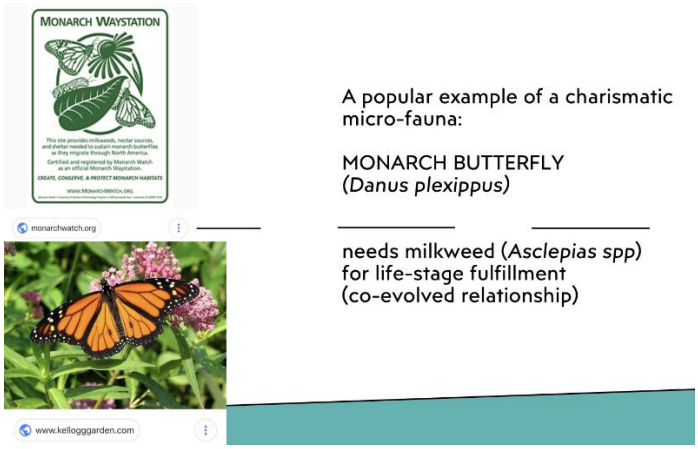


Figure A4.3 The Monarch Waystation

Wild Ones

Figure A4.4 Wild Ones

Animal Taxonomy Approach: vertebrate or invertebrate

There are ENGOs that have categorized their stewardship very broadly: vertebrates or invertebrates. This captures a wide swath of animal orders (refer to Linnaeus taxonomy exercise earlier in thesis).

Vertebrates – the Audubon Society

Bird watching is one of the great hobbies of the world. During the COVID-19 lockdown, since March 2020 , the hobby grew to higher levels of interest with the appreciation of nature in the backyard. https://www.audubon.org/magazine/more-birds-bring-more-happiness-according-science

Bird migration is a natural activity of birds throughout North America. Winnipeg is located on several flyways, including many songbirds. Native plants, as host plants for caterpillars help feed young birds. Fruit trees (in Fall) give the nutrition and energy to help a flock continue a successful flight back down south. In Winnipeg's case, native fruit trees (plus ornamentals and food crops) are important for avian species and small mammals.

mountain ash berries (*Sorbus decora 'Grootendorst'*) visited by various birds throughout the year

Figure A4.5 Showy Mountain Ash Berries
Photo Credit = Wm Dowie, Sept 3rd, 2024

Invertebrates – Xerces Society

As part of the invertebrates, there are the arthropods (a way to capture spiders and insects together, so as to build common habitats). Arthropods are beneficial for the yard and contribute to ecological balance, usually through predator-prey interactions (such as spiders and insects). Without going to deep into ecology theory, arthropods are well known to contribute to the producer-consumer-decomposer cycle of the backyard ecosystem. (Also see slide above for an example of a pollinator program – specialized invertebrate focus.)

APPENDIX 5 – The ISI - Envision sustainability framework and rating system

The Envision rating system uses 64 sustainability indicators, called "credits", to evaluate projects. The system also rewards projects for innovation. The following is a list of the sustainability and resilience indicators (credits that can be earned by the project team); they are divided by five categories. The **bold** lines are credits that can be directly tied to residential spaces – existing or new neighborhoods.

(Source: https://sustainableinfrastructure.org/envision/use-envision/#:~:text=Envision%20includes%2064%20sustainability%20and,Natural%20World%20and%20Climate%20&%20Resilience)

QUALITY OF LIFE

QL1.1 Improve Community Quality of Life 30 QL1.2 Enhance Public Health & Safety

QL1.3 Improve Construction Safety

QL1.4 Minimize Noise & Vibration

QL1.5 Minimize Light Pollution

QL1.6 Minimize Construction Impacts

QL2.1 Improve Community Mobility & Access

QL2.2 Encourage Sustainable Transportation

QL2.3 Improve Access & Wayfinding

QL3.1 Advance Equity & Social Justice

QL3.2 Preserve Historic & Cultural Resources

QL3.3 Enhance Views & Local Character

QL3.4 Enhance Public Space & Amenities

QL0.0 Innovate or Exceed Credit Requirements

LEADERSHIP

LD1.1 Provide Effective Leadership & Commitment

LD1.2 Foster Collaboration & Teamwork

LD1.3 Provide for Stakeholder Involvement

LD1.4 Pursue Byproduct Synergies

LD2.1 Establish a Sustainability Management Plan

LD2.2 Plan for Sustainable Communities

LD2.3 Plan for Long-Term Monitoring & Maintenance

LD2.4 Plan for End of Life

LD3.1 Stimulate Economic Prosperity & Development

LD3.2 Develop Local Skills & Capabilities

LD3.3 Conduct a Life-Cycle Economic Evaluation

LD0.0 Innovate or Exceed Credit Requirements

RESOURCE ALLOCATION

RA1.1 Support Sustainable Procurement Practices

RA1.2 Use Recycled Materials

RA1.3 Reduce Operational Waste

RA1.4 Reduce Construction Waste

RA1.5 Balance Earthwork On Site

RA2.1 Reduce Operational Energy Consumption

RA2.2 Reduce Construction Energy Consumption

RA2.3 Use Renewable Energy

RA2.4 Commission & Monitor Energy Systems

RA3.1 Preserve Water Resources

RA3.2 Reduce Operational Water Consumption

RA3.3 Reduce Construction Water Consumption

RA3.4 Monitor Water Systems

RA0.0 Innovate or Exceed Credit Requirements

NATURAL WORLD

NW1.1 Preserve Sites of High Ecological Value

NW1.2 Provide Wetland & Surface Water Buffers

NW1.3 Preserve Prime Farmland

NW1.4 Preserve Undeveloped Land

NW2.1 Reclaim Brownfields

NW2.2 Manage Stormwater

NW2.3 Reduce Pesticide & Fertilizer Impacts

NW2.4 Protect Surface & Groundwater Quality

NW3.1 Enhance Functional Habitats

NW3.2 Enhance Wetland & Surface Water Functions

NW3.3 Maintain Floodplain Functions

NW3.4 Control Invasive Species

NW3.5 Protect Soil Health

NW0.0 Innovate or Exceed Credit Requirements

CLIMATE AND RESILIENCE

CR1.1 Reduce Net Embodied Carbon

CR1.2 Reduce Greenhouse Gas Emissions

CR1.3 Reduce Air Pollutant Emissions

CR2.1 Avoid Unsuitable Development

CR2.2 Assess Climate Change Vulnerability

CR2.3 Evaluate Risk and Resilience

CR2.4 Establish Resilience Goals and Strategies

CR2.5 Maximize Resilience

CR2.6 Improve Infrastructure Integration

CR0.0 Innovate or Exceed Credit Requirements

APPENDIX 6 – United Nations Urban Forestry Awareness Poster

Figure A6.1 Urban Forest Poster (public awareness exemplar)