THE BENEFITS OF URBAN NATIVE PLANT GARDENING

AN ANNOTATED COMPILATION OF PEER-REVIEWED LITERATURE

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Access

The articles included in this resource may not all be fully accessible. If you have trouble accessing the articles there are a number of actions you can take:

1. Check the author's website, some academics post full access links to their publications.

2. Reach out to authors and request access, authors are often willing and happy to share free versions of their literature.

2. Look up “free journal access” using an online search engine

Photograph on front cover by Erin Minuskin, 2021 in Toronto, Canada.

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Introduction

Urbanization has had and continues to have detrimental effects on the planet. Natural and ecologically-rich lands have been transformed into barren stretches of road and pavement, leading to extensive habitat loss and the replacement of native plants with non-native species (McKinney, 2006).[1] "More than 60 percent of the area projected to be urban in 2030 has yet to be built," therefore with predicted urban expansion the *way* we design cities, towns, and suburbs must change (Convention on Biological Diversity, n.d.).[2] Of critical importance in this shift is native plants. While there are a plethora of interpretations of native plants, a common understanding is that they are plants that have naturally occurred in a region, having adapted to the local environmental conditions and developed deep symbiotic relationships through co-evolution with native organisms over thousands of years. Native plants are the cornerstone of life on land, providing enumerable ecosystem services that ensure human survival. The diverse assemblages of greenspaces in urban areas present opportunities for high levels of biodiversity. Research has shown that historical settlement patterns were located in areas of high biological diversity, meaning cities are biologically rich hotspots (Kühnet al., 2004).[3] The value of urban greenspaces to support biodiversity highlights the need to appropriately and strategically manage these spaces for the sustainability of the planet.

Interest in native plant gardening has grown as numerous campaigns encourage people to plant native and rewild their gardens. Yet, there continues to be resistance to naturalistic gardens with preference for more manicured lawns. Municipal bylaws in a variety of cities across Ontario limit front yard grasses to 20 cm in height. Instances of municipal fines and communities issuing complaints regarding naturalized gardens in Smiths Falls, London, and Burlington highlight a poorly informed and misguided populace (Both, 2022, Khan, 2023, Ramlakhan, 2022).[4] The purpose of this resource is to present peer-reviewed literature on the benefits of native plant gardening to better inform NGOs, municipalities, and citizens of the importance of native plants. These articles provide scientific legitimacy to the planting and preservation of native plant species.

Scope

The objective of this resource is to provide readers with a comprehensive list of peer-reviewed articles on the benefits of native plant gardening. The term 'gardening' is not limited to the typical residential garden, but any opportunity for which people engage with plants - roadside plantings, green roofs, patches of woodland.

The literature in this resource pertains to the Canadian context, and while the research included is not limited to Canada, this project uses the *Level 1 Ecoregions of North America* map as guide to identify regions across North America that share similar characteristics with ecosystems in Canada. This document is a resource for NGOs, municipalities, environmental planners, landscape architects, avid and new gardeners, plant growers, and plant enthusiasts.

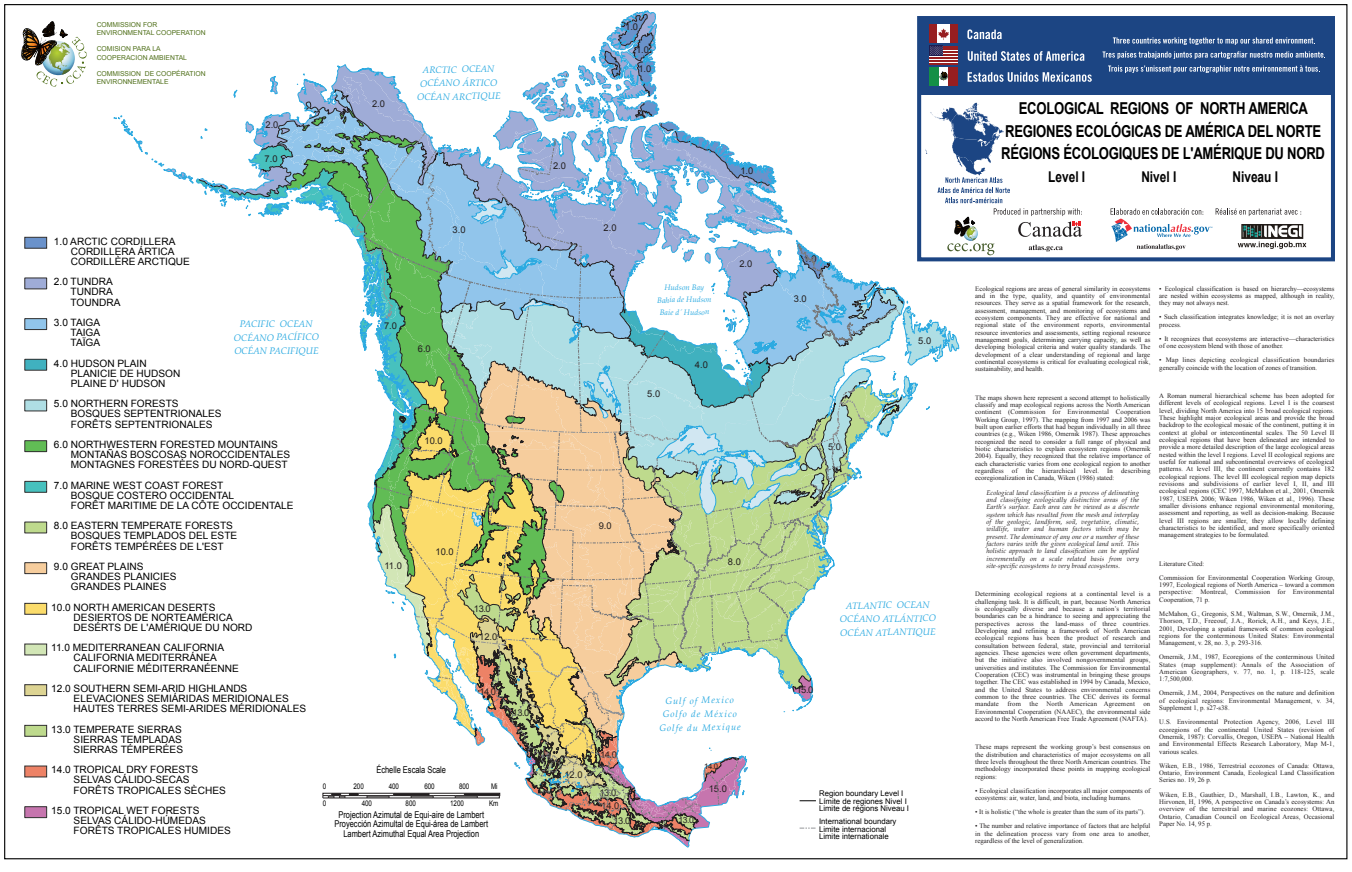

Figure 1: Level 1 Ecological Regions of North America, Commission for Environmental Cooperation

Defining *native*

The classification of native and non-native species is a topic of much debate. A common definition for native species in North America are those that have occurred naturally in a specific ecosystem prior to European settlement. This classification of native species is dependent on the demarcation of a particular time, geographic region, and scale. How do we define these parameters? The articles below explore the layers of complexity involved when defining native species.

origin

native/
non-native

The nativeness and non-nativeness of species

Usher, M.B.

Watsonia I Vol. 23 I 2000
https://archive.bsbi.org.uk/Wats23p323.pdf

This paper describes the "shades of nativeness" within the native/non-native classification through 6 categories established by the Scottish Natural Heritage: native, formerly native, locally non-native, long-established, recently arrived, and non-native. While this study pertains to Great Britain, it provides one of the many approaches to defining nativeness.

origin

cultural

native/
non-native

Perspectives on the 'alien' versus 'native' species debate: A critique of concepts, language, and practice

Charles R. Warren

Progress in Human Geography I Vol 3 Iss 4 I 2007
https://doi.org/10.1177/0309132507079499

This article discusses the native/alien paradigm, exploring its conceptual foundations and seminal works in the field. Key criticisms of the classification include, the arbitrary spatiotemporal distinctions used to define native species and our limited and fragmented understanding of ecological and human history. Warren (2007) further discusses the blurring lines between scientific and cultural values associated with native/alien plants. It is argued that the dogmatic approach of native/alien plants is flawed, and that invasive species should be defined by their potential to cause damage as opposed to their time or place of origin.

cultural

food

Indigenous

British
Columbia

Ecoregion 7

Chapter 3: Nuučaaʔul Plants and Habitats as Reflected in Oral Traditions: Since Raven and Thunderbird Roamed in *Plants, People, and Places*

Marlene Atleo

McGill-Queen's University Press I Ed. Nancy J. Turner I 2020

Marlene Atleo reflects on the role of plants in the everyday life and culture of the Nuučaaʔul, and how knowledge gained from their territory has shaped their lifeways. Through recounting stories, Atleo expresses the role of plants as companions and providers of medicine, food, shelter, clothing, names, and sources of cultural meaning.

city

suburbs

native/
non-native

The role of 'nativeness' in urban greening to support animal biodiversity

Berthon, K., Thomas, F., and Bekessy, S.

Landscape and Urban Planning I 205 I 2021
https://doi.org/10.1016/j.landurbplan.2020.103959

This study provides a comprehensive analysis on the literature and research on the impacts of native plants on animal biodiversity, and how different delineations of *native* are being used in literature. Native plants were found to have positive effects on biodiversity, however preference for urban fauna was determined by the resources the plant provides as opposed to origin.

faunal record

native/
non-native

What constitutes a 'native' species? Insights from the Quaternary faunal record

Crees, J.J. and Turvey, S.T.

Biological Conservation I Vol 186 I 2015
https://doi.org/10.1016/j.biocon.2015.03.007

An examination of the Quaternary faunal record shows the dynamic shifts in species composition over millenniums due to human-induced and natural factors, pointing to the difficulty in defining 'native' species. Crees and Turvey propose a new framework for the native/non-native classification that outlines sub-categories informed by paleontology, zooarchaeology, historical archives, and ancient DNA. These novel classifications are presented along a native to non-native continuum, to refine and expand the existing native/non-native dichotomy.

Urbanization and Species Decline

Cities across the globe are becoming exceptionally uniform. This homogeneity is result of an environment shaped to support the demands of humans. Worldwide, cities have taken on similar attributes and characteristics in the built environment: pavement, roads, and skyscrapers. The homogenization of urban spaces have extended to the flora and fauna, contributing greatly to the decline of species diversity as species that thrive in urban conditions proliferate.

urbanization

Novel urban ecosystems, biodiversity, and conservation

Kowarik, I.

Environmental Pollution I Vol. 159 Iss. 8-9 I 2011
https://doi.org/10.1016/j.envpol.2011.02.022

Through an analysis of current literature, this paper reviews the impacts of urbanization on biodiversity, and native and non-native species. Kowarik (2011) suggests that land managers should look at the entirety of urban nature, integrating strategies to preserve native species along with novel urban ecosystems.

urbanization

urban/rural gradient

Urbanization, Biodiversity, and Conservation
Michael L. McKinney

BioScience I Vol. 52 Iss. 10 I 2002
https://doi.org/10.1641/0006-3568(2002)052[0883:UBAC]2.0.CO;2

A review of the literature on the impacts of urban and suburban expansion on native ecosystems. A number of studies document that along the rural urban gradient, species richness declines and nonnative species increase towards the urban core.

urbanization

biotic homogenization

Urbanization as a major cause of biotic homogenization
Michael L. McKinney

Biological Conservation I Vol. 127 Iss. 3 I 2006
https://doi.org/10.1016/j.biocon.2005.09.005

Across the globe, homogeneous cities have deeply impacted the world's biota, where the uniform nature of urban regions have led to the widespread support of the same "urban-adaptable" species. This paper highlights how urbanization has led to the replacement of native species with non-native species, promoting biotic homogenization.

Opportunities in Human Dominated Landscapes

The increasing expansion of urban areas stress the importance of managing remnant, existing, and new greenspaces to support biodiversity conservation. Cities are composed of a range of greenspaces, including restored native vegetation, backyards, parks, and gardens. The variety of typologies present the opportunity to support diverse species. The articles below highlight the important role that urban spaces can collectively play in biodiversity conservation.

biodiversity

residential gardens

policy

Urban conservation gardening in the decade of restoration
Segar, J., Callaghan, C.T., Ladouceur, E., Meya, J.N., Pereira, H.M., Perino, A. and Staude, I.R.

Nature Sustainability I Vol. 5 I 2022
https://doi.org/10.1038/s41893-022-00882-z

This paper argues that the cultivation of declining native plant species in private and public green spaces is a critical conservation approach to decreasing biodiversity. The authors discuss the ecological and economic arguments supporting urban conservation gardening and the role of social and political mechanisms to promote this approach, including integrating the native seed sector into the horticulture market and conservation gardening labeled species. Urban conservation gardening does not require large-scale change in the existing built environment, but rather is a tangible and cost-effective opportunity that can become an integrated practice of urban living.

biodiversity

green patches

management

The disproportionately high value of small patches for biodiversity conservation

Riva, F. and Fahrig, L.

Conservation Letters I 2022
https://doi.org/10.1111/conl.12881

This study presents evidence that confirms the value of small patches in providing high value for biodiversity, contesting the current conservation emphasis on the value of larger habitat patches over small patches. Results indicate there are more species across several small patches than few large patches of the same total area, and higher extinction risk in small patches does not decrease the cumulative value of small patches for biodiversity. The authors argue that small habitat patches should be part of conservation policy and management.

city

arthropods

The city as a refuge for insect pollinators

Hall, D.M., Camilo, G.R., Tonietto, R.K., Ollerton, J., Ahrné, K., Arduser, M., Ascher, J.S., Baldock, K.C.R., Fowler, R., Frankie, G., Goulson, D., Gunnarsson, B., Hanley, M.E., Jackson, J.I., Langellotto, G., Lowenstein, D., Minor, E.S., Philpott, S.M., Potts, S.G., Sirohi, M.H., Spevak, E.M., Stone, G.N. and Threlfall, C.G.

Conservation Biology I Vol 31 I 2016
https://doi.org/10.1111/cobi.12840

This paper explores the literature on the positive correlations between urban areas and urban bee species diversity, noting that considerable research shows that diverse populations of wild bees live in urban landscapes. The authors urge for a realignment of conservation efforts into urban areas, highlighting their ecological importance and capacity to provide high-impact and high-priority conservation.

city

geology

Germany

The flora of German cities is naturally species rich

Kühn, I., Brandl, R., and Klotz, S.

Evolutionary Ecology Research I Vol. 6 I 2004

The study compares native and non-native species in urban and rural areas in Germany. Results found that both alien and native species richness were significantly higher in urban areas. Geological richness was a key indicator in greater native species. It is argued that German cities, and cities with similar climates and settlement patterns have been preferentially located in areas of high geological heterogeneity enabling them to support high biological diversity.

biodiversity

residential gardens

management

Scaling up from gardens: biodiversity conservation in urban environments.

Goddard, M.A., Douglii, A.J., and Benton, T.G.

Trends in Ecology and Evolution I Vol 25 Iss 2 I 2009
https://doi.org/10.1016/j.tree.2009.07.016

Goddard, Dougill, & Benton express the importance of private gardens in urban biodiversity conservation. Unpacking the opportunities, constraints, and gaps in residential garden conservation, the authors stress the need for an ecological management approach where private gardens should not be viewed as separate entities, but rather as interconnected networks of green space.

Biodiversity

The articles in this section explore the importance of native plants to support biodiversity. Considerable research has shown the critical role native plant species play in insect reproduction, where Bernays & Graham (1988) predict that "up to 90% of all species of insect herbivores can successfully reproduce only on plant lineages with which they have shared an evolutionary history." Insects are a food source for many bird species, indicating the significance of native plants for higher trophic levels and the sustainability of the planet.

arthropods

birds

suburbs

Midwest US

Ecoregion 8

Assessing a Reconciliation Ecology Approach to Suburban Landscaping: Biodiversity on a College Campus

Bouma, C., Huizenga, E., & Warners, D.

The Great Lakes Botanist I Vol. 52 Iss. 3-4 I 2013
http://hdl.handle.net/2027/spo.0497763.0052.305

This study found that small patches of restored native habitat can support higher trophic levels in suburban areas. By examining the presence of plants, insects, birds, and small mammals in four habitats, restored woodland, open lawn, treed lawn, and forest in a suburban campus, it was found that the native woodland supported greater insect diversity, larger insects, and greater bird and small mammal activity.

city

bees

British Columbia

Ecoregion 7

Bee diversity and abundance in an urban setting

Tommasi, D., Miro, A. Higo, H.A., & Winston, M.L.

Canadian Entomologist I Vol. 136 Iss. 6 I 2004
doi:10.4039/n04-010

This study compared bee diversity and abundance of bees in different urban conditions in Vancouver, B.C. Traditionally managed landscapes (typical flower beds and sites cultivated with ornamentals - petunias, pansies, tulips, roses) had lower bee diversity and abundance than ecosystem-oriented urban landscapes, highlighting the opportunity for urban greenspaces to support bee species. Key factors influencing bee abundance and diversity include landscape management practices, where mowing and the application of herbicides resulted in lower bee richness, and habitat heterogeneity.

bees

climate change

Midwest US

Ecoregion 9

Can native plants mitigate climate-related forage dearth for honey bees (Hymenoptera: Apidae)?

Zhang, G, St. Clair, A.L., Dolezal, A.G., Toth, A.L., & O'Neal, M.E.

Journal of Economic Entomology I Vol. 115 Iss. 1 I 2022
https://doi.org/10.1093/jee/toab202

This article documents the foraging behaviour of honey bees in Iowa, USA during periods of high temperature and drought. Findings showed that when non-native clover abundance declined during extreme heat, honey bees switched to

more drought-tolerant native species. These findings present the potential for native plants to support honey bees with increasing extreme weather events due to climate change.

birds

butterflies

suburbs

residential

Northeast US

Ecoregion 8

Impact of Native Plants on Bird and Butterfly Biodiversity in Suburban Landscapes

Burghardt, K. T.,Tallamy, D. W., & Shriver, G. W.

Conservation Biology I Vol. 23 Iss. 1 I 2009
https://doi.org/10.1111/j.1523-1739.2008.01076.x

This study addressed the role of native landscaping in suburban gardens to reduce biodiversity loss and support bird and butterfly species. Native gardens were observed to support significantly more caterpillar species and consequently support greater bird abundance, highlighting the importance of homeowners' landscaping choices in affecting insect and bird populations.

city

bees

birds

trees

Australia

Increasing biodiversity in urban green spaces through simple vegetation interventions

Threlfall, C. G., Mata, L., Mackie, J.A., Hahs, A. K., Stork, N.E., Williams, N.S.G., & Livesley, S.J.

Applied Ecology I Vol 54 Iss. 6 I 2017
https://doi.org/10.1111/1365-2664.12876

This study examines the impact of 3 features of urban greenspaces - large native trees, volume of understory, and percentage of native vegetation - on 5 animal groups: bats, birds, bees, beetles, and bugs. Complex understory vegetation and native plants were key drivers for greater biodiversity, where an increase of 10-30% of understory volume led to 30-120% higher occupancy of bats, native birds, beetles, and bugs. Additionally, 54% of species responded to increases in proportion of native plants (p.1880).

city

bees

residential garden

Ontario

Ecoregion 8

Local plant richness predicts bee abundance and diversity in a study of urban residential yards

Gerner, E.E., & Sargent, R.D.

Basic and Applied Ecology I Vol. 58 I 2022
https://doi.org/10.1016/j.baae.2021.11.004

This study examines the impacts of urbanization, tree canopy, and the diversity and abundance of locally flowering plants on bee communities. Results found that urbanization and tree canopy only accounted for a small fraction (less than 1%), whereas floral richness and abundance were far greater predictors of bee abundance and diversity.

arthropods

suburbs

Northeast US

Ecoregion 8

Plant origin asymmetrically impacts feeding guild and life stages driving community structure of herbivorous arthropods

Burghardt, K. T., & Tallamy, D. W.

Diversity and Distributions I Vol. 19 Iss. 12 I 2013
https://doi.org/10.1111/ddi.12122

This study compares non-native species in novel ecosystems to the native species that they have replaced in their ecological value and capacity to support terrestrial food webs. Results indicate that non-native plants reduce diversity and abundance of arthropod herbivores, impacting arthropod-derived ecosystem services, such as food for higher trophic levels pollination and seed dispersal in human-dominated landscapes. It was found that "non-native species are not the equivalent of native species when assessed by comparing their effectiveness at supporting terrestrial food webs" (p.1562).

bees

residential

Midwest US

Ecoregion 8

Native plants are the bee's knees: local and landscape predictors of bee richness and abundance in backyard gardens

Pardee, G.L. & Philpott, S.M.

Urban Ecosystems I Vol. 17 I 2014
https://doi.org/10.1007/s11252-014-0349-0

This study examines bee diversity in urban backyard gardens in Northwestern Ohio, looking at the impacts of garden characteristics, surrounding landscape, and the presence of native plants. Results found greater bee abundance in native gardens than in non native gardens. Bee species composition differed in non-native and native gardens, indicating that native plant gardens attract bees that are not found in non-native plantings.

arthropods

birds

residential

Northeast US

Ecoregion 8

Native plants improve breeding and foraging habitat for an insectivorous bird

Narango, D.L., Tallamy, D.W. & Marra, P.P.

Biological Conservation I Vol. 213 Part A I 2017
https://doi.org/10.1016/j.biocon.2017.06.029

This study presents findings on the negative impacts of non-native species in reducing habitat quality for the Carolina chickadee by limiting the insect food available for breeding. Findings suggest human-dominated landscapes should increase native and arthropod producing plant species to support insectivorous birds.

Culture

The cultural importance of native plants cannot be undervalued. Native plants are an integral part of Indigenous lifeways, used in ceremonies, craftsmanship, for nutrition, medicine, and utility. Plants connect us to ourselves, our homes, family, places, memories, and experiences. The deep connection between plants and people are explored in this section.

residential

sociocultural

A New Garden Ethic - Chapter 2: More Than Native Plants

Vogt, B.

New Society Publishers I 2017

Benjamin Vogt explores the importance of native plant gardening for ecosystem health and our role as humans and gardeners in shaping the environmental, social, and cultural landscape.

cultural

food

Indigenous

British Columbia

Ecoregion 7

Cultural Keystone Species: Implications for Ecological Conservation and Restoration

Garibaldi, A., & Turner, N.J.

Ecology and Society I Vol. 9 Iss. 3 I 2004
http://www.ecologyandsociety.org/vol9/iss3/art1/

This paper proposes the concept of *cultural keystone species,* "a metaphorical parallel to ecological keystone species" that alternatively calls for conservation efforts on species that have a large influence on cultural identity (p.1). Highlighting the inextricable connection between ecological and social systems, Garibaldi and Turner argue that the application of cultural keystone species has the potential to not only support cultural restoration, but simultaneously ecological restoration.

cultural

Indigenous

food

British Columbia

Ecoregion 7

Restoring Camas and Culture to Lekwungen and Victoria: An interview with Lekwugen

Penn, B.

Focus Magazine I Vol. 9 Iss. 3 I 2006
http://www.ecologyandsociety.org/vol9/iss3/art1/

This interview explores Cheryl Bryce's work to reinstill the traditional practice of camas harvesting, a practice that the Lekwugen people have undertaken for thousands of years. Bryce speaks to the significant cultural value of camas harvesting in fostering a deep reconnection between traditions and the land, as well as its importance for food sovereignty and ecosystem health.

Food Security

Climate change has led to considerable decline of pollinator species threatening food security and the agricultural industry where 75% of the leading global food crops depend on insect pollination (Klein et al., 2007). Native plants can play a critical role in peri-urban spaces and agricultural lands to combat the impacts of climate change and support greater pollinator species.

arthropods

cost

food

pollination

Maximizing arthropod-mediated ecosystem services in agricultural landscapes: the role of native plants

Isaacs, R., Tuell, J., Fiedler, A., Gardiner, M. and Landis, D.

Frontiers in Ecology and the Environment I Vol. 7 I 2009
https://doi.org/10.1890/080035

This article explores the opportunities for native perennial plants to enhance arthropod-mediated ecosystem services, including biological control of insect pests and pollination of crops, by providing pollen, nectar, and shelter to beneficial arthropods. The use of native plants has the potential to increase farmer profit and reduce dependency on chemical pesticides.

bees

climate change

food

pollination

Northeast US

Ecoregion 8

Native bees buffer the negative impact of climate warming on honey bee pollination of watermelon crops

Rader, R., Reilly, J., Bartomeus, I. and Winfree, R.

Global Change Biology I Vol. 19 I 2013
https://doi.org/10.1111/gcb.12264

This study predicts that climate change will change pollination services, and highlights the importance of native diversity in buffering the impact of climate warming through response diversity. With predicted declines in honey bees (the main pollinator of agricultural crops) due to climate change, wild bees become increasingly important to stabilize ecosystem services and food security.

food

Indigenous

sociocultural

British Columbia

Ecoregion 7

"Where our women used to get the food": cumulative effects and loss of ethnobotanical knowledge and practice; case study from coastal British Columbia

Turner, N.J., and Turner, K.L.

Botany I Vol. 86 Iss. 2 I 2008
https://doi.org/10.1139/B07-020

The encroachment of western knowledge systems, residential schools, loss of land, and urbanization have led to a loss of traditional food systems that have deeply affected Indigenous lifeways, culture, knowledge, and food sovereignty. This article explores five important native food plants to Northwest Coast First Peoples, identifying their cultural, ecological, and social significance. Opportunities to renew food traditions and reinforce Indigenous knowledge are explored to revitalize cultures, languages, and botanical knowledge.

Green Roofs

While native plants are often chosen for their hardiness, benefits to biodiversity, and adaptations to local climates, the environmental conditions of green roofs are far different from the climate at the ground level. Green roofs face extreme heat in the summer, cold in the winter, and are prone to rapid soil drying. Due to these harsh conditions and shallow substrates many native plants are not suitable for green roofs. The articles below present opportunities and constraints involved with including native plants on green roofs.

green infrastructure

prairies

Midwest US

Ecoregion 8

A comparison of bee communities of Chicago green roofs, parks, and prairies

Tonietto, R., Fant, J., Ellis, K., & Larkin, D.

Landscape and Urban Planning I Vol. 103 Iss. 1 I 2011
https://doi.org/10.1016/j.landurbplan.2011.07.004

This study looked at the potential for green roofs to act as habitat for native bees by comparing green roofs with urban parks (both natural areas and turf lawns) and tallgrass prairies (a reference natural habitat) in Chicago, Illinois. Native bees were observed on green roofs, but were represented by fewer species and individuals than in natural park areas and prairies. Results showed that the green roof planted with native prairie species and with the highest plant diversity contained the greatest number of bee species. This article demonstrates that while green roofs may support less bee species than ground-level natural urban areas, they have potential to support native bees if planted with native species.

green infrastructure

Ontario

Ecoregion 8

Air temperature cooling by extensive green roofs in Toronto

MacIvor, J.S., Margolis, L., Perotto, M., & Drake, J.A.P.

Ecological Engineering I Vol. 95 I 2016
https://doi.org/10.1016/j.ecoleng.2016.06.050

This study, undertaken in Toronto, Canada, analyzed the impacts of irrigation, substrate, and vegetation type (*Sedum* and a 'meadow' mix) on roof cooling. *Sedum* was observed to cool the roof significantly more than meadow vegetation, however irrigated meadow mix performed as well as unirrigated *Sedums*. Results indicate the importance of *Sedums* to improve green roof cooling and the opportunity to combine *Sedum* with wildflower and grasses to support other benefits, such as habitat value, aesthetics, and water capture.

green infrastructure

Midwest US

Ecoregion 8

Establishment and Persistence of *Sedum* spp. and Native Taxa for Green Roof Applications

Monterusso, M. A., Rowe, D. B., & Rough, C.L.

HortScience I Vol. 40 Iss. 2 I 2005
https://doi.org/10.21273/HORTSCI.40.2.391

This study evaluates the survival of 18 native plants and nine *Sedum* spp. over 3 years on green roofs in Michigan, US. All nine species of *Sedum* were observed

to be suitable, while results showed only four of the native species were suitable for unirrigated extensive green roofs (*Allium cernuum L., Coreopsis lanceolata L., Opuntia humifosa L. , and Tradescantia ohiensis L*).

green infrastructure

Atlantic Canada

Ecoregion 5

Performance evaluation of native plants suited to extensive green roof conditions in a maritime climate

MacIvor, J.S. and Lundholm, J.

Ecological Engineering I Vol. 37 Iss. 3 I 2011
https://doi.org/10.1016/j.ecoleng.2010.10.004

This study evaluates the survival, cover, roof cooling, and stormwater retention properties of 15 native plant species in Atlantic Canada. Analysis suggests that plants native to maritime coastal areas can outperform common non-native green roof plants in this region.

green infrastructure

Native plant enthusiasm reaches new heights: Perceptions, evidence, and the future of green roofs

Butler, C., Butler, E., & Orians, C.M

Urban Forestry & Urban Greening I Vol. 11 Iss. 1 I 2012
https://doi.org/10.1016/j.ufug.2011.11.002

Through an analysis of literature in scholarly journals and papers presented at the annual North American green roof conference, this article highlights the growing interest in the application of native plants on green roofs. The authors explore the complexities of native plant green roof application, examining who is promoting the use of native plants and the scientific evidence supporting native species use on green roofs. This paper highlights the need for further research on native plant performance on green roofs.

green infrastructure

Northeast US

Ecoregion 8

Sedum cools soil and can improve neighboring plant performance during water deficit on a green roof

Butler, C. & Orians, C.M.

Ecological Engineering I Vol. 37 I 2011
https://doi.org/10.1016/j.ecoleng.2011.06.025

Butler and Orians (2011) examine the capacity for *Sedum* species to reduce soil temperatures and increase the survival of neighbouring plants on green roofs. It was found that *Sedums* reduced the growth of adjacent plants in the summer during wet conditions, but increased performance of species during periods of drought. These results indicate that *Sedums* can provide opportunities for more diverse plants on green roofs.

Invasive Species

Urban areas are prime locations for invasive species. Globalization has rendered cities as centers for novel species importation, and these disturbed urban lands provide suitable conditions for exotic species. With the unregulated growth of cities, it is undeniable that invasive species will be present. The articles in this section explore the potential for native plants to combat exotic species' encroachment.

evolution

genetic diversity

management

Coevolution between native and invasive plant competitors: implications for invasive species management

Leger, E.A. and Espeland, E.K.

Evolutionary Applications I Vol. 3 Iss. 2 I 2010
https://doi.org/10.1111%2Fj.1752-4571.2009.00105.x

This article examines the factors that allow some native and invasive species to cohabitate, and explores management actions that can support native species to evolve improved abilities to compete with invasive plants. Leger and Espeland apply an evolutionary perspective for controlling invasive specie suggesting, "Management actions that maintain genetic diversity in native species while reducing population sizes and genetic diversity in invasive species could promote the ability of natives to evolve improved competitive ability" (p. 169).

Western US

Ecoregion 6, 10

Intra and interspecific competition among invasive and native species during early stages of plant growth

Mangla, S., Sheley, R.L., James, J.J., and Radosevich, S. R.

Plant Ecology I Vol. 212 I 2011
https://doi.org/10.1007/s11258-011-9909-z

This study examines the intensity of intra and interspecific competition of two invasive species (*Bromus tectorum* and *Taeniatherum caput-medusae*) and two native species (*Pseudoroegneria spicata* and *Poa secunda*) during early stages of plant growth and with different levels of nitrogen. Results indicate that competition intensity varies depending on life stage, and that with increasing nitrogen, invasive species become more competitive than native species. To support native plants during the first few weeks of germination, density, species proportion, and their spatial arrangement should be altered to minimize intraspecific competition among native species and maximize interspecific competition against invasive annuals (p. 540).

prairies

Great Plains

Ecoregion 5, 9

Using ecological restoration to control biological invasion

Bakker, J.D. and Wilson, S.D.

Journal of Applied Ecology I Vol. 41I 2004
https://doi.org/10.1111/j.0021-8901.2004.00962.x

This study demonstrates that native plant restoration can reduce the spread of invasive species, while enabling the establishment of native species. A field

experiment was conducted in Saskatchewan, Canada, examining the invasive grass, *Agropyron cristatum*. It was found that native species in the same functional group (C3 grasses) as *A. cristatum*, more strongly resisted this invasive species than species in a different functional group (C4 grasses). To note, this study took place with native plants that had been established for 2 years, indicating that early plant establishment is a contributor to the reduction in magnitude of biological invasion.

Health

Research has shown the benefits of contact with nature for mental health and well-being, however what is the relationship between native plants and health? The articles below explore the role of native plants for mental and physical health, touching on traditional plant medicines and improvements to mental restoration.

Indigenous

medicinal plants

cultural

Plants, People, and Places Chapter 9: Traditional Plant Medicines and the Protection of Traditional Harvesting Sites

McCune, L.M. and Cuerrier, A.

McGill-Queen's University Press I Ed. Nancy J. Turner I 2020

Through scientific knowledge derived from traditional knowledge, this chapter highlights the importance of medicinal plants in healthcare. It is argued that traditional medicinal plants should be recognized for their application to treat diabetes due to the high levels of antioxidants present in medical plants. Value should be further placed on specific cultural harvesting sites, where certain areas provide conditions that influence antioxidant levels (soil acidity and mineral content, ultraviolet exposure, traditional forms of plant management). The chapter showcases the opportunity for western scientific knowledge informed by Indigenous knowledge to communicate the benefits of traditional medicinal plants to policymakers, and support greater recognition of traditional medicines.

city

green infrastructure

meadow

office

Midwest US

Ontario

Ecoregion 8

'There's a meadow outside my workplace': A phenomenological exploration of aesthetics and green roofs in Chicago and Toronto

Loder, A.

Landscape and Urban Planning I Vol. 126 I 2014
https://doi.org/10.1016/j.landurbplan.2014.01.008

Loder explores the recent trend to mimic native habitat through prairie-style green roofs in two case study cities - Toronto and Chicago. Comparing meadow and *Sedum* green roofs, this study reveals the cultural and contextual factors that influence people's perceptions and acceptance of 'wilder' green roofs. This article further touches on the positive benefits of meadow habitat on green roofs for well-being, creative thinking, and fascination.

Maintenance

Native plants have been lauded for the little maintenance and upkeep required as they are more well-adapted to local environmental conditions. These plants use less water, are not dependent on chemicals and fertilizers, and do not need to be mowed. This minimal maintenance reduces financial costs and can mitigate impacts of climate change through the reduction of carbon intensive mowing practices, and the use of water - a declining resource. The articles below look at the impact of native plantings on maintenance over non-native plants.

arthropod

meadow

Germany

Flower power in the city: Replacing roadside shrubs by wildflower meadows increases insect numbers and reduces maintenance

Mody K, Lerch D, Müller AK, Simons NK, Blüthgen N, and Harnisch M.

PLoS One I Vol. 15 Iss. 6 I 2020
https://doi.org/10.1371%2Fjournal.pone.0234327

This study looked at the conversion of roadside plantings from exotic woody shrubs to native wildflower meadows. Findings showed that regardless of size or isolation of these patches, arthropod density increased by 63%. This study further revealed that maintenance costs were reduced fivefold with the conversion of exotic woody vegetation into native wildflower meadows.

cost

turfgrass lawns

water

Southern US

Ecoregion 8

The performance of native and non-native turfgrass monocultures and native turfgrass polycultures: An ecological approach to sustainable lawns

Simmons, M., Bertelsen, M., Windhager, S., and Zafian, H.

Ecological Engineering I Vol. 37 Iss. 8 I 2011
https://doi.org/10.1016/j.ecoleng.2011.03.004

This article explores the use of polycultures of native turfgrasses as an alternative to the single-species conventional lawn. Referencing ecological theory, it is believed that an assemblage of native species will be more adaptable to urban and environmental stressors and will exhibit greater stability than monocultures. Results found that the weed cover was significantly lower in the native plots compared to the non-native turf. This presents the opportunity for native plants to reduce the need for fertilizers and pesticides to suppress weeds.

Soil

Soil biodiversity plays a critical role in supporting the biosphere, providing a number of ecosystem services including plant health, productivity, nutrient cycling, and storage of soil organic carbon. The articles the role of native plants in supporting urban soil diversity.

city

soil biodiversity

ecosystem services

Soil biodiversity supports the delivery of multiple ecosystem functions in urban greenspaces

Fan, K., Chu, H., Eldridge, D J., Gaitan, J.J., Liu, Y., Sokoya, B., Wang, J., Hang-Wei Hu, He,J., Sun, W., Cui, H., Alfaro, F.D., Abades, S., Bastida, F., Díaz-López, M., Bamigboye, A.R., Berdugo, M., Blanco-Pastor, J.L., Grebenc, T., Duran, J., Illán, J.G., Makhalanyane, T.P., Mukherjee, A., Nahberger,T.U. ...Delgado-Baquerizo, M.

Nature Ecology & Evolution I Vol. 7 I 2023
https://rdcu.be/dhxHt

The value of soil biodiversity in supporting multiple ecosystem functions is well known in natural ecosystems. This study provides evidence that these benefits extend to urban greenspaces. Results indicate that taxonomic and functional soil biodiversity support several ecosystem services in urban areas, including organic matter decomposition, plant productivity, nutrient cycling, water regulation, and microbially driven carbon pools.

carbon storage

city

biodiversity

Germany

Biodiversity maintains soil multifunctionality and soil organic carbon in novel urban ecosystems

Schittko, C., Onandia, G., Bernard-Verdier, M., Heger, T., Jeschke, J. M., Kowarik, I., Maaß, S. & Joshi, J.

Journal of Ecology I Vol. 110 I 2022
https://doi.org/10.1111/1365-2745.13852

This study investigates the effects of plant biodiversity of urban grasslands on ecosystem functioning and services of urban soils. Previous research has reported the positive correlation between plant diversity and SOC storage, however this study indicates that this effect extends to urban areas. While results show both native and non-native biodiversity positively contribute to SOC and soil multifunctionality, non-native plants were observed to have lower positive total effects in comparison to native plant species.

prairies

turfgrass lawns

residential

Midwest US

Ecoregion 8

Impact of Residential Prairie Gardens on the Physical Properties of Urban Soil in Madison, Wisconsin

Johnston, M.R., Balster, N.J. & Zhu, J

Journal of Environmental Quality I Vol. 45 Iss. 1 I 2016
https://doi.org/10.2134/jeq2015.02.0093

This study compares the effects of native prairie gardens and turfgrass lawns on urban soils. Results indicate that the soil beneath residential prairie gardens

had a 10% lower bulk density, 15% lower penetration resistance, 25% greater level of soil organic matter, and 33% greater saturated hydraulic conductivity than turfgrass. Shifts to soil structure were found in the upper levels of the soil, indicating that changes to soil may take decades at greater depths and will provide long-term benefits to homeowners.

carbon storage

turfgrass lawns

residential

Midwest US

Ecoregion 9

Native plant gardens support more microbial diversity and higher relative abundance of potentially beneficial taxa compared to adjacent turf grass lawns

Baldi, D.S., Humphrey, C.E., Kyndt, J.A., & Moore, T.C.

Urban Ecosystems I Vol. 26 I 2023
https://doi.org/10.1007/s11252-022-01325-5

This study compared the bacterial communities within the soils of native gardens and adjacent turf grasses. Native plant gardens were observed to support significantly more bacterial biodiversity than turf grass, and bacterial diversity was positively correlated with greater distance from turf grass. A greater abundance of *Kofleria* and *Gemmatimonas* were found in native gardens, genera that are keystone species for carbon and phosphorus sequestration.

Urban Forest

Urban forests provide critical ecosystem services such as carbon sequestration, habitat provisioning, and cultural benefits. There is considerable research that promotes the use of both native and non-native trees in cities, highlighting the cultural value of non-native trees and opportunities for assisted migration (Chalker-Scott, 2015, Riley et al., 2018, Schlaepfer et al., 2020).[5] The articles included in this section, however, move the focus on opportunities to include more native tree species.

trees

management

native/
non-native

Challenges and future directions in urban afforestation

Oldfield, E.E., Warren,R.J., Felson, A.J., & Bradford, M.A.

Journal of Applied Ecology I Vol. 50 Iss. 5 I 2013
https://doi.org/10.1111/1365-2664.12124

This article explores the current peer-reviewed and published literature on urban native afforestation practices, examining their impacts to the growth, survival, and recruitment of native trees. Analysis of the literature highlights the importance of local seed sources, understanding local site conditions, and strategic planning and management to increase the presence of native urban forests. The authors conclude that while native afforestation should be promoted, it is clear that exotic species will not be eradicated, and that a more realistic future for urban forests is one of co-existence between native and non-native species.

trees

Ontario

Ecoregion 5,8

The role of native species in urban forest planning and practice: A case study of Carolinian Canada

Almas, A.D., & N.J. & Conway, T.M.

Urban Forestry and Urban Greening I Vol. 17 Iss. 1 I 2016
https://doi.org/10.1016/j.ufug.2016.01.015

This article explores the management of native tree species in urban forestry planning across municipalities in Ontario, Canada. While many UFMPs (Urban Forestry Management Plan) are supportive of native tree planting, in practice many municipalities fail to actually plant native species. Topics explored within this article include the discrepancy between municipal plans and practice, municipal foresters' attitudes and priorities, and assisted migration.

trees

management

Northeast US

Ecoregion 8

Restoration treatments in urban park forests drive long-term changes in vegetation trajectories

Johnson, L.R., & Handel, S.N.

Ecological Applications I Vol. 26 Iss. 3 I 2016
https://doi.org/10.1890/14-2063

This study examines the ecological restoration of native forests in New York City over the course of 15-20 years. The restored forest plots were compared to unrestored forests, and were found to have less invasive species, greater native tree saplings, a more complex forest structure, and differing understory composition. While restored plots indicate a successional trajectory to a closed forest canopy, anthropocentric disturbances will greatly influence forest development. The authors suggest a management approach that considers the challenges and disturbances from urban sites and climate change in order to preserve native biodiversity in cities.

Water Management

Native plants have often been considered superior to non-native species due to their adaptation to local conditions. Native plants, unlike exotics, have deeper root systems, supporting greater infiltration of stormwater and reducing erosion. The articles below explore opportunities to include native plants in stormwater infrastructure in the face of growing periods of flooding and drought due to climate change.

green infrastructure

prairie

turfgrass

stormwater

Midwest USA

Ecoregion 8

Evaluation of Turf-Grass and Prairie-Vegetated Rain Gardens in a Clay and Sand Soil, Madison, Wisconsin, Water Years 2004-08

Selbig, W.R., & Balster, N.

Scientific Investigations Report 2010–5077 I U.S. Geological Survey I 2010
https://pubs.usgs.gov/sir/2010/5077/pdf/sir20105077.pdf

This study compared the effectiveness of a rain garden planted with turf grass and one with native prairie species into two different soil types, sand and clay. Results showed that both rain gardens regardless of vegetation or soil type

were capable of infiltrating most of the run-off, however the median infiltration rates was greater with prairie vegetation than turf grass. Results indicate greater pedoturbation, root penetration, biological activity, and soil development in the prairie vegetated clay garden and points to increased capacity to store and infiltrate stormwater than the turf-clay garden.

city

cost

lawn

water

Western US

Ecoregion 11

Outdoor Water Use Conservation through Native Plants

Shapiro, K., Chan, A., Carson, E., & Tayag, R.

Sam Sandoval Research Group I 2012
https://watermanagement.ucdavis.edu/teaching/esm121/termprojects

This report examines the impacts of converting front lawns to native plants on cost and water consumption in Davis, California. The authors found a 60% reduction in water usage with native plants, however, the difference in cost was only $46/year. The cost of converting front lawns to native plants was calculated to be $3960, indicating that residents would not receive a return in their investment for 23 years. This analysis illustrates a lack of financial incentives to encourage homeowners to transition to native plant front yards, where the cheap price of water in Davis is a key limiting factor.

green infrastructure

stormwater

Midwest USA

Ecoregion 8

Potential for Using Native Plant Species in Stormwater Wetlands

Bonilla-Warford, C.M. & Zedler J.B.

Environmental Management I Vol. 29 Iss. 3 I 2002
https://doi.org/10.1007/s00267-001-0032-0

With little research on the capacity for native plants to tolerate fluctuating water levels and inundation, this article explores the potential use of native *Spartina pectina* in wetland planting. The native grass demonstrated positive results in its growth and establishment in a variety of water levels indicating opportunities for its implementation in stormwater projects. However, further research must be undertaken on the drought tolerance of *Spartina pectina*. The paper concludes with thoughts on opportunities for other native plants to be considered and further researched for their use in stormwater wetlands.

Ottawa, Canada, photograph by Sophie Nito, 2021.

Gaps

Canadian Research

The intent of this annotated bibliography was to compile articles examining the role of native plants in urban areas in Canada, however, this proved difficult. The topic of urban native plants in research is still in its infancy in Canada. Responding to the absence of local research, we expanded the literature search to include regions with similar climates and environmental conditions. This resource uses the *Level I Ecological Regions of North America* to distinguish different areas of similar ecosystems. The articles included in this annotated bibliography are primarily located in Ecoregion 8: Eastern Temperate Forest. This region includes parts of Southern Ontario, Atlantic Canada, and the US, however the articles in this annotated bibliography are primarily located in Northeast and Midwest US. This predominance of articles based in US states in Ecoregion 8 indicate a gap in Canadian research. Within Canada, green roof research is primarily in Toronto, and Indigenous literature was primarily found in British Columbia.

Beyond Survival on Green Roofs

There is considerable research and interest in green roofs in Canada, and particularly in Toronto where the city was the first major North American city to adopt a green roof policy (C40 Cities, 2018).[6] The application of native plants on green roofs is gaining traction, however, current research focuses on the survival of native plants on roofs as opposed to their capacity to support benefits associated with green roofs, such as roof cooling, stormwater management, and biodiversity. Two articles included under *Green Roofs* discuss the opportunities for green roofs to support stormwater retention and cooling, however more research must look at the impact of native plants on these ecosystem services, and furthermore on the impacts to biodiversity (MacIvor & Lundholm, 2011).[7] The literature included in this resource highlight the integral role of native plants for biodiversity on the ground level, however how does this translate to rooftops where the environment is not a natural habitat for native plants? Much research points to the dominant performance of the non-native *Sedums* on rooftops, therefore it is important to explore the value of native plants on roofs to determine best practices and priorities for green roof design (Monterusso et al., 2005).[8]

The Carrot Green Roof & Garden, Toronto, Canada, photograph by Ryan Godfrey.

Mental Health

While there is considerable research on the benefits of greenspace and nature on human health and well-being, peer-reviewed literature focused on the value of native plants to mental health is limited. Studies have shown the benefits of experiencing nature through gardening, exercising and observation, but how does the presence of not just nature, but native species influence health? A study by Fuller et al. (2005) indicated that greater species richness in urban greenspaces resulted in greater psychological benefits.[9] While native plants were not mentioned, the literature presented in this annotated bibliography points to the immense role that native plants have in supporting greater abundance and diversity of species. While it can be inferred that by planting native species, we will see an increase in biodiversity and subsequently observe benefits to health and well-being, there are no scientific journals and articles presenting this information.

Scaling Up

The articles in this resource range from backyards, gardens, green roofs, and individual species interactions. The analysis of these small scale spaces indicates the numerous ecological, social, and cultural benefits of native plants. But, plant species and the animals that use these resources are not constrained to these areas. The availability of multiple habitat patches and corridors are critical for the movement of species and their foraging opportunities. A study undertaken by Riva and Fahrig (2022) highlights the disproportionately high ecological value of small patches in urban areas, where multiple small patches were observed to have greater species than fewer large patches of the same area.[10] While several papers address the importance of urban habitat patches, there is little research on the composition of these patches and more specifically patches composed of native plants. Further research should examine native plants at a larger scale. For example, what is the impact of a entire block or neighbourhood of native plant gardens? These spaces should be analyzed as a collection of interconnected areas for greater biodiversity conservation.

Conclusion

This document provides readers with a diverse breadth of literature on the benefits of native plants in urban areas. While there are a number of articles included, they only represent a fragment of the benefits that native plants offer. More research focused on the role of native plants in cities is critical to support greater acceptance and promotion of native plants in policy, the horticultural industry, and amongst homeowners.

It is projected that 60% of the land that will be converted to urban land by 2030 has yet to be built (Convention on Biological Diversity, n.d.).[11] The expansion of urban regions is increasing at twice the rate of population growth (Walter Kille, 2013).[12] With much of this land yet to be built, as designers, planners, policy makers, citizens and environmentalists we stand at a pivotal point in which upcoming urban expansion can be sustainable, centering biodiversity and adapting to the evolving climate. These articles show that integral role of native plants to support ecosystem health and human survival; it is clear that for a healthy planet, native plants must be incorporated into planning and management of growing cities.

Green roof, Toronto, Canada, photograph by Ryan Godfrey.

Appendix A

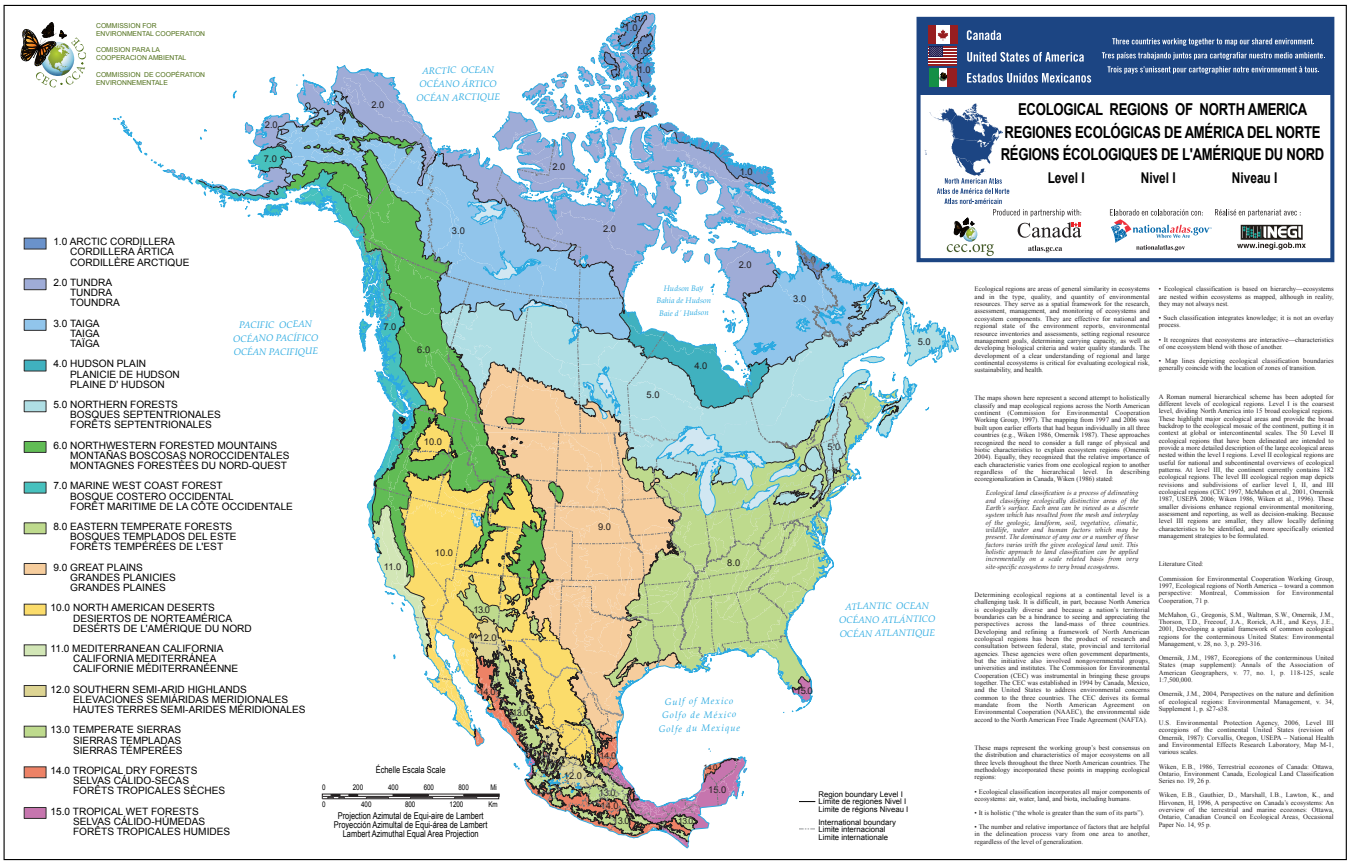

Figure 1: Level 1 Ecological Regions of North America, Commission for Environmental Cooperation

Ecoregion 5

Performance evaluation of native plants suited to extensive green roof conditions in a maritime climate
MacIvor, J.S. and Lundholm, J.

The role of native species in urban forest planning and practice: A case study of Carolinian Canada
Almas, A.D., & N.J. & Conway, T.M.

Using ecological restoration to control biological invasion
Bakker, J.D. and Wilson, S.D.

Ecoregion 6

Intra and interspecific competition among invasive and native species during early stages of plant growth
Mangla, S., Sheley, R.L., James, J.J., and Radosevich, S. R.

Ecoregion 7

Bee diversity and abundance in an urban setting
Tommasi, D., Miro, A. Higo, H.A., & Winston, M.L.

Chapter 3: Nuučaaʔnut Plants and Habitats as Reflected in Oral Traditions: Since Raven and Thunderbird Roamed in *Plants, People, and Places*
Marlene Atleo

Cultural Keystone Species: Implications for Ecological Conservation and Restoration
Garibaldi, A., & Turner, N.J.

Restoring Camas and Culture to Lekwungen and Victoria: An interview with Lekwugen
Penn, B.

"Where our women used to get the food": cumulative effects and loss of ethnobotanical knowledge and practice; case study from coastal British Columbia
Turner, N.J., and Turner, K.L.

Ecoregion 8

A comparison of bee communities of Chicago green roofs, parks, and prairies
Tonietto, R., Fant, J., Ellis, K., & Larkin, D.

Air temperature cooling by extensive green roofs in Toronto
MacIvor, J.S., Margolis, L., Perotto, M., & Drake, J.A.P.

Assessing a Reconciliation Ecology Approach to Suburban Landscaping: Biodiversity on a College Campus
Bouma, C., Huizenga, E., & Warners, D.

Establishment and Persistence of *Sedum* spp. and Native Taxa for Green Roof Applications
Monterusso, M. A., Rowe, D. B., & Rough, C.L.

Evaluation of Turf-Grass and Prairie-Vegetated Rain Gardens in a Clay and Sand Soil, Madison, Wisconsin, Water Years 2004-08
Selbig, W.R., & Balster, N.

Impact of Native Plants on Bird and Butterfly Biodiversity in Suburban Landscapes
Burghardt, K. T.,Tallamy, D. W., & Shriver, G. W.

Impact of Residential Prairie Gardens on the Physical Properties of Urban Soil in Madison, Wisconsin
Johnston, M.R., Balster, N.J. & Zhu, J

Local plant richness predicts bee abundance and diversity in a study of urban residential yards
Gerner, E.E., & Sargent, R.D.

Native bees buffer the negative impact of climate warming on honey bee pollination of watermelon crops
Rader, R., Reilly, J., Bartomeus, I. and Winfree, R.

Native plants are the bee's knees: local and landscape predictors of bee richness and abundance in back-yard gardens
Pardee, G.L. & Philpott, S.M.

Native plants improve breeding and foraging habitat for an insectivorous bird
Narango, D.L., Tallamy, D.W. & Marra, P.P.

Plant origin asymmetrically impacts feeding guild and life stages driving community structure of herbivo-rous arthropods
Burghardt, K. T., & Tallamy, D. W.

Potential for Using Native Plant Species in Stormwater Wetlands
Bonilla-Warford, C.M. & Zedler J.B.

Restoration treatments in urban park forests drive long-term changes in vegetation trajectories
Johnson, L.R., & Handel, S.N.

Sedum cools soil and can improve neighboring plant performance during water deficit on a green roof
Butler, C. & Orians, C.M.

The performance of native and non-native turfgrass monocultures and native turfgrass polycultures: An ecological approach to sustainable lawns
Simmons, M., Bertelsen, M., Windhager, S., and Zafian, H.

The role of native species in urban forest planning and practice: A case study of Carolinian Canada
Almas, A.D., & N.J. & Conway, T.M.

'There's a meadow outside my workplace': A phenomenological exploration of aesthetics and green roofs in Chicago and Toronto
Loder, A.

Ecoregion 9

Can native plants mitigate climate-related forage dearth for honey bees (Hymenoptera: Apidae)?
Zhang, G, St. Clair, A.L., Dolezal, A.G., Toth, A.L., & O'Neal, M.E.

Native plant gardens support more microbial diversity and higher relative abundance of potentially beneficial taxa compared to adjacent turf grass lawns
Baldi, D.S., Humphrey, C.E., Kyndt, J.A., & Moore, T.C.

Using ecological restoration to control biological invasion
Bakker, J.D. and Wilson, S.D.

Ecoregion 10

Intra and interspecific competition among invasive and native species during early stages of plant growth
Mangla, S., Sheley, R.L., James, J.J., and Radosevich, S. R.

Ecoregion 11

Outdoor Water Use Conservation through Native Plants
Shapiro, K., Chan, A., Carson, E., & Tayag, R.

Appendix B

British Columbia

Bee diversity and abundance in an urban setting
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Saskatchewan

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Midwest US

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Western US

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Potential for Using Native Plant Species in Stormwater Wetlands
Bonilla-Warford, C.M. & Zedler J.B.

Europe

Biodiversity maintains soil multifunctionality and soil organic carbon in novel urban ecosystems
Schittko, C., Onandia, G., Bernard-Verdier, M., Heger, T., Jeschke, J. M., Kowarik, I., Maaß, S. & Joshi, J.

Flower power in the city: Replacing roadside shrubs by wildflower meadows increases insect numbers and reduces maintenance
Mody K, Lerch D, Müller AK, Simons NK, Blüthgen N, and Harnisch M.

The flora of German cities is naturally species rich
Kühn, I., Brandl, R., and Klotz, S.

Australia

Increasing biodiversity in urban green spaces through simple vegetation interventions
Threlfall, C. G., Mata, L., Mackie, J.A., Hahs, A. K., Stork, N.E., Williams, N.S.G., & Livesley, S.J.

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