# Urban Biodiversity:

## *Why it matters and how to protect it*

A public discussion paper prepared for the City of Edmonton by

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## Author Biographies

Colleen Cassady St. Clair is a professor of biological sciences at the University of Alberta.[1] Her research focuses on the movement of animals in fragmented habitat and on ways to reduce conflict between humans and wildlife. Michael Clark completed an M.Sc. on plant ecology this spring and is active in several initiatives designed to increase sustainability and biodiversity in Edmonton. The other authors are members of Colleen's lab. Marie Tremblay recently completed a Ph.D. on the diversity and movement of birds in urban areas and now works for Parks Canada on species at risk. Maureen Murray is a current M.Sc. student studying coyotes in Edmonton. Forrest Gainer recently completed a B.Sc. and is currently an NSERC summer research assistant. Adam Cembrowski is a current B.Sc. student and is also a summer research assistant.

***Summary.*** Biodiversity is a comprehensive concept, encompassing every form of life on Earth and all of the ecological processes associated with life. Biodiversity provides clean air, water and soil, which together support the plants that sustain the rest of the 10-50 million species that now inhabit the Earth. For our own species, biodiversity also supports spiritual and psychological health. Biodiversity is especially important in cities because they house the majority of the human population and because most cities are built on sites of high ecological diversity and productivity. Unfortunately, cities provide many threats to biodiversity, most of which involve the loss, degradation, and fragmentation of habitat. Fragmentation caused by barriers of unsuitable habitat prevents the movement of organisms among habitat patches, which is essential for population persistence. Edmonton is fortunate to have a highly connected river valley and ravine park system, but only 2% of the protected areas are in the upper 'tableland' habitat. We have an important opportunity now to save the few remaining

natural areas in the tablelands and to connect them to the ribbon of green in the river valley. Individuals can help to protect and enhance biodiversity in Edmonton by supporting the retention of natural habitat, increasing the abundance and diversity of native plants on both public and private lands, decreasing demand for suburban neighbourhoods and roads that remove and fragment habitat, and getting informed about and engaged in the promotion of biodiversity in Edmonton.

***What is Biodiversity?*** Take a moment to consider what that word means to you. Most people imagine familiar species of animals and plants that they can see inhabiting the air, water and land. Some people may make a distinction between species that are native to their area (e.g., chickadees) versus those that have been introduced from elsewhere (e.g., house sparrows). A few people would consider insects, fungi, soil microbes, and viruses. Some others may add the processes of natural selection and evolution, which generate the wealth of species on Earth. Not many of us would also consider the processes of pollination, decay, competition, extinction or any other ecological process. Yet all of these are components of biodiversity. In this, the International Year of Biodiversity,[2] there is a wonderful opportunity to consider this concept more fully, along with the effects of biodiversity on our planet, our city, and ourselves.

Biologists typically define biodiversity as the variability among living organisms from all sources and their associated ecological relationships.[3] This definition includes diversity at the level of molecules, genes, populations, species, communities, and ecosystems. Such an expansive definition is difficult to visualize and that is why it is so common to think of biodiversity simply as the number of species in an area. This shorthand is helpful, but potentially misleading. Counting species makes their loss seem unimportant when we consider that 99.9% of the species ever to inhabit Earth have already gone extinct. The loss of a few species also seems trivial in comparison to the estimated 10-50 million living species[4] larger than 1 mm. But if we lose 20% of these species by 2050, as some have predicted,[5] our world will change dramatically. This would mark our era as the 6$^{th}$ major extinction episode in the 3.5 billion year history of the Earth, and with those species we'll also irrevocably lose many of the ecological processes on which our own lives depend.

More important than counting species is a focus on the health of ecosystems. This is harder to measure, but more pertinent to our own health and the legacy of biodiversity we will leave to our children and grandchildren. Healthy ecosystems support local biodiversity whether the species count is relatively small, as it tends to be in the higher latitudes, or enormous, as it tends to be in the tropics.[3] One of the advantages of ecosystem health as a measure is that it does not increase with the introduction of species from other parts of the world, as a count of species can. Many of these introduced species (e.g., pigeons, cockroaches, rats) thrive

wherever cities occur, causing global homogenization of urban biodiversity.[6] In this essay, we emphasize ecosystem health to describe how Edmontonians benefit from biodiversity, identify the impediments to conserving it, and suggest some things we could do as a society and as individuals to protect and enhance biodiversity in our city.

***Why should we care about urban biodiversity?*** Recently, Dearborn and Kark[7] provided a comprehensive list of the benefits of conserving biodiversity in cities, which we summarize and expand on here. First and foremost, biodiversity provides the ecosystem services on which all life depends. This term, ecosystem services, is popular with economists as a way of describing and quantifying the value of things we all acknowledge to be important, but tend to take for granted: drinkable water, breathable air, arable soil, etc. But there are many other more subtle services provided by biodiversity, even in cities. For example, even small wetlands, like storm water retention ponds, absorb contaminants and buffer surrounding areas from flooding. Urban natural areas produce many of the pollinators needed to support both native vegetation (e.g., prairie bluebell) and familiar garden species (e.g., apple trees and heritage tomatoes) within the city. Indeed, an estimated 35% of the world's crop species are dependent on animal pollinators,[8] many of which are threatened by agricultural intensification. Urban trees absorb pollutants to improve air quality and reduce the effects of greenhouse gases and, in some cases, they may do so three times more effectively than adjacent exurban forests.[9] Urban-adapted species, like coyotes and songbirds, eat many of the invasive pest species, like house mice and insects, that multiply so readily in cities. Urban biodiversity can also provide sentinels, such as aquatic stonefly larvae, whose presence is an indicator of water quality.

Additional benefits of biodiversity also accrue to humans in less tangible ways. Because so many of us live in cities and seldom leave them, urban biodiversity is essential to providing the experiential learning that shapes individual values and, by extension, civic policy. Abundant evidence now links access to biodiversity with improved human health and well-being, both physical and psychological.[6,10] Natural biodiversity provides a source of aesthetic inspiration and numerous forms of health-sustaining recreation. In the US, where statistics are more readily available, over 20% of the adult population (48 million people) enjoy bird watching, while spending $38 billion dollars annually and generating over 600 thousand jobs.[11] Without experiencing the benefits of biodiversity directly, a person cannot value them, no matter how important they actually are. We are especially at risk of creating such a 'nature deficit'[12] in our children, who spend an average of only a half hour per day outdoors.[13] Another way that biodiversity sustains people is through its link to spirituality, evidenced by the frequent reference to it in many of the world's religions.

In addition to the benefits to people biodiversity provides, it is worthy of protection for its own sake. Because of their unique characteristics, cities can sometimes harbour populations of species that are rare and threatened in other areas. A flagship example of the kind of win-win ecology[14] that can occur in cities is their use by previously-endangered peregrine falcons, which nest on office towers in Edmonton and other cities, and prey on hyper-abundant introduced pigeons. Natural areas in cities can also provide a connection to larger protected areas in the surrounding landscape. Even small natural areas contribute to this ecological function to counter one of the most important impediments to global biodiversity that is posed by cities: the destruction and fragmentation of habitat.

There are two benefits of urban biodiversity that cannot be replicated elsewhere. First, enduring immigration from rural to urban areas means that approximately 70% of the global human population will live in cities by 2050.[15] As a result, billions of people, particularly the 40% of the world that lives in poverty,[16] will only have access to the biodiversity found in cities. A second crucial feature of urban biodiversity is that cities tend to occur in areas that are biologically rich and ecologically diverse,[17] such as river valleys and flood plains. The youthful city of Edmonton has a rich biological heritage and the largest city-owned forest in the world.[18] This magnificent resource was the product of a far-seeing city council, which passed a bylaw in 1915 to protect the river valley and ravines for recreation, thus ending an era of aggressive resource extraction.[19] Indeed, the sustainable use of surrounding natural resources is a reliable predictor of the longevity of city states throughout history.[20] The unusual intactness of Edmonton's urban forest means that is it still possible to find elusive species like moose, barred owls, and yellow lady slippers within a few km of the city centre.

***What are the impediments to biodiversity in Edmonton?*** In spite of the richness of its biological heritage, Edmonton's natural areas are at risk to many threats. Between 2000 and 2007, 31% of its designated natural areas were permanently lost to development.[21] This rate of loss exceeds the rate at which other natural areas have been protected at a ratio of 5:2. Natural areas outside the river valley and ravines, the so-called tablelands, are most at risk. Only 2.3% of the protected areas in Edmonton fall into this category.[22] Wetlands are also at considerable risk with few protected sites[23] and no policy of preventing net loss of wetlands, in contrast to Calgary.[24] The most important contributor to biodiversity is the retention of natural habitat and the window is closing on Edmonton's opportunity to protect what remains.

Among the natural areas that remain in Edmonton, most are degraded in a variety of ways. Some of these include illegal activity, such as off-trail mountain biking, the picking of rare flowers, and the dumping of toxic wastes. More often, potential natural habitat is degraded by procedures like mowing and pesticide application to support human activities or traditional

aesthetic values. In the US, over 80% of US households apply fertilizer to their lawns and about 65% apply pesticides.[25] In Edmonton, mowed parkland has dramatically fewer small mammals and bird species than grassland habitat that is not mowed.[26] Additional degradation of habitat occurs passively through the spread of noxious weeds, competition with aggressive urban-exploiting species, and the insidious effects of climate change. One of the most prevalent forms of habitat degradation is seldom acknowledged; it is caused by the dissection of natural areas to support the transportation network. This problem is already prevalent in the city core, but it is rising rapidly on the fringes of the city to support the sprawl of residential neighbourhoods.

Habitat fragmentation is a particular problem for natural areas because it compromises the viability of remaining populations, whether they are comprised of trees, insects, fish, birds or mammals. Small, isolated populations are more vulnerable to extinction from chance events like floods, disease outbreaks, and severe storms. Additionally, these populations gradually lose the genetic diversity that promotes the health of individuals.[27] For these reasons, promoting the functional connectivity of populations has become the primary goal of major continental ventures like the Yellowstone to Yukon Initiative.[28] One of Edmonton's best features is the unusual intactness and connectedness of the river valley and ravine system.[17] This resource is tremendously important to the retention of biodiversity. Recent research on birds in Calgary revealed that 71% of all species detected (i.e. 39 out of 55 species) were primarily associated with large natural areas, emphasizing their role as sources of biodiversity. Among the smaller patches of habitat interspersed with urban areas, those that were closer and better connected to the large forested natural areas contained more native birds than locations that were more isolated from such areas.[29]

Fragmentation and other challenges to biodiversity are not unique to Edmonton. These same threats are causing the global extinction crisis forewarned by conservation biologists. Primary treats to global biodiversity include habitat destruction, degradation and fragmentation, introduced species, and overexploitation by humans. Habitat degradation includes secondary effects such as pollution and climate change. All of these threats are caused by human population growth and consumption, which already devours approximately 1/3 of the Earth's primary productivity.[30] It might seem inevitable, then, that as Edmonton grows it must steadily lose its inherent biodiversity and all of the benefits it provides. But actually, there are many things we can do as a society and as individuals to retain what we have and enhance it, even while we grow and prosper economically.

***How can we promote biodiversity in Edmonton?*** We are fortunate to live in a city with visionary councillors who, in 2007, approved Natural Areas Systems Policy, which asserts that

*The City of Edmonton will balance ecological and environmental considerations with economic and social considerations in its decision making and demonstrate that it has done so*. This policy challenges all of us to find ways to live,[31] move,[32] and grow,[33] even while we green.[34] *The way we green* will provide hundreds of suggestions for promoting biodiversity while getting on with our daily lives in a modern, thriving, and liveable city.

Remembering that biodiversity is really about ecosystem health, society must make an enduring distinction between natural areas and green spaces like playing fields, which do not support much more (marcro) biodiversity than parking lots. The cornerstone of protecting biodiversity is the retention of natural habitat and the ecological features it supports. We should be particularly vigilant with the few large areas that remain unprotected and do everything we can to secure them before they are lost. We must also identify the areas that have the greatest potential to connect to existing protected areas. The 2009 decision by council to allocate additional funds and permit borrowing of funds for land acquisition is a very helpful step in this direction. Equally important is the recent establishment of the Edmonton Area Land Trust, which is a non-profit organization that encourages the protection of natural areas on private land.[35] Additional opportunity to connect natural habitat at a regional scale is provided by the creation of the Capital Region Board,[36] which strives to integrate land use planning among 25 participating municipalities.

Such an integrated approach to identifying, enhancing, connecting and protecting natural areas is emphasized by the City's 2008 Natural Connections Strategic Plan.[37] This document demonstrates the critical role of habitat connectedness and shows how it can be both structural and functional. Structural connectivity is provided by the connectedness of natural habitat we can see on maps, such as the ribbon of green that exists along the river valley.[17] Functional connectivity, which supports the movement of species,[38] is provided by these features as well as by less obvious forms of connection, such as the stepping stones created by individual trees, naturalized yards, storm water ponds, and small natural areas that are near enough to others to benefit from and contribute to the movement of organisms.

Despite the pivotal importance of large and connected natural areas, habitat patches need not be large or entirely natural to contribute meaningfully to urban biodiversity if they are functionally connected. The best way to create functional connectivity in any landscape is to increase the size and abundance of natural habitats and make the matrix, the area that surrounds these habitats, as accessible to native species as possible. Matrix quality can be increased by reducing land use intensity, increasing native plant abundance and diversity, and protecting or creating patches of semi-natural habitat.[39] Reducing the width of roads and mitigating them with wildlife crossing structures can dramatically reduce the barrier they

provide to wildlife movement.[40] Natural areas, both large and small, provide the building blocks of biodiversity, but we can further enhance its retention with every choice we make that reduces the degradation of natural areas and enhances the naturalness of our built environments.[41]

There are many ways society and civic planners can support natural habitat in both natural areas and the surrounding habitat. The Edmonton Naturalization Group[42] provides ideas and resources for supporting native vegetation. There is a surprising number of opportunities to create natural habitat even in high-density areas. The downtown Edmonton Stantec building has a green roof comprised of native plants that attracted a successful goose nest in 2009. Native plants and courses about them are available from Bedrock Seedbank,[43] which has a stall every Saturday at the Strathcona Farmer's Market. The Urban Farmer[44] is a landscaping company that specializes in the installation of creation of native habitat in diverse urban settings. Because most of Alberta's plant diversity comes from grasses, wildflowers, mosses and other non-woody plants, there is tremendous opportunity to create meaningful native habitat in school yards, public parks, the borders of storm water management ponds, road verges and boulevards. With higher levels of plant diversity, these areas could significantly support additional biodiversity in the form of insects, birds, and mammals. Even single trees adjacent to bridges can enhance the movement of songbirds in urban areas.[28]

Support for native biodiversity will not come from a passive approach of, for example, ceasing to mow your lawn. Hundreds of invasive species from elsewhere are superb competitors (a defining characteristic of weeds) that will easily choke out native vegetation and the biodiversity benefits it provides. It takes time and patience to identify and remove noxious weed species with non-chemical, biodiversity-friendly methods. The process of doing so provides immense opportunity to enjoy and learn about natural ecosystems. One of most-enjoyed forms of biodiversity, birds, will respond almost immediately to the provision of native trees and shrubs in urban green spaces, and these naturalized spaces will also increase connectivity to natural areas for the benefit of hundreds of other species.

***What can I do to support Edmonton's biodiversity?*** The paragraphs above contained many ideas that can be acted on by individuals, but here we summarize the ones that we think generate the maximum benefits for biodiversity and, by extension, our own well-being. We offer these ideas with a friendly nudge of encouragement and fully recognize that they are not practical for every individual or instance. In the spirit of win-win ecology,[12] we've ranked our list according to the maximum combined benefits to humans and biodiversity.

1. Get informed about the consequences of your actions: what you eat, what you drive, what you wear, how you clean, how you use resources (water, electricity, gas), where and how you vacation and how you spend your leisure time. This provides an excellent, mind-stimulating opportunity for life-long learning and you will discover a surprising congruence between human and ecosystem health.
2. Think about the effects on biodiversity of land use decisions and share your ideas with decision makers. A new school might choose a dramatically larger naturescape and more efficiently planned sports fields, rather than expansive seas of introduced, cropped grass.
3. Seek out local opportunities to support biodiversity. Simple acts, like replacing your lawn or an empty lot with a native prairie, planting a butterfly-attracting perennial, foregoing pesticide use, and preventing house sparrows from nesting in your eaves can significantly enhance the biodiversity around your home. The 2008 Biodiversity Report provides numerous additional ideas and contacts.[22]
4. Increase your awareness, tolerance and compassion for other species. A society that tolerates mosquitoes, wild meadows, magpies, and coyotes, will enjoy the benefits of urban amphibians, heightened insect, mammal and bird diversity, natural forms of pest control, and better ecosystem health. Like children, not every aspect of biodiversity is pleasurable in every moment!
5. Get engaged and share your views. Edmonton offers superb opportunities, such as the Master Naturalist Program,[45] to learn more about biodiversity and participate in its conservation. Diverse clubs[46] and non-government organizations[47] also support biodiversity. Community engagement opportunities, like the Eco-mobility demonstration project,[48] can raise awareness about biodiversity benefits while building community cohesion. City councillors are available at any time to hear your concerns and suggestions about biodiversity in Edmonton.[49]

**Wrapping up**. Galvanizing a society around the goal of retaining biodiversity would require widespread agreement on the benefits and urgency of doing so. Such consensus can only be reached if people understand the impact of a healthy ecosystem on their own quality of life. Can such a view be supported? We have experienced similar paradigm shifts in the past with the mandatory use of seatbelts, the banning of smoking, and the variety of laws that limit the pollutants individuals can release to land, air, and water. Increasing our protection of biodiversity could progress from information to action in the same iterative way if enough people understood and appreciated the immense and diverse value of retaining biodiversity.

In this discussion paper, we have encouraged a more comprehensive view of biodiversity than most of us think about when we hear the word. We've identified numerous advantages of retaining biodiversity for human physical and psychological well-being as a part of healthy

ecosystems. We reviewed the ways biodiversity is lost in Edmonton and elsewhere and we've suggested some things that societies and individuals can do to maintain and enhance urban biodiversity. We hope you have enjoyed reading our essay and we encourage you to participate in the upcoming public engagement opportunities. Each of us can make a significant contribution to biodiversity to benefit ourselves, future generations of Edmontonians, and the other species with whom we share our city.

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[1] More information about this research is available here: http://www.biology.ualberta.ca/faculty/colleen_cassady_stclair/

[2] Read more at http://www.cbd.int/2010/about/

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[45] Read about the City's Master Naturalist program at: http://www.edmonton.ca/environmental/natural_areas/master-naturalist-program.aspx

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