For the Birds!

A Rooftop Bird Garden (in Toronto)

by
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Abstract

The design for non-humans has historically been situated in the human dimension where shelter is the unit of measurement. Urbanization has isolated humans from nature, resulting in negative impacts on other species and the fragile ecosystem.

This thesis aims to promote the mediation between species, in this case, birds and humans, in the context of the city. This is initiated through the proposal of a semi-public, forested bird garden atop the roof of an existing parking garage located in Downtown Toronto. The downtown core in Toronto, in particular, poses a fatal threat to migrating birds due to its light pollution and highly reflective glass towers.

By focusing on birds foremost and humans secondly, the design attempts to compensate for the asymmetrical cultural and technological scapes in which architecture has been designed primarily for humans with little regard to other species. The choice of site, though small, does not attempt to be viewed as a 'bird sanctuary' since it does not fit the criteria to be categorized as such. Instead, it offers the possibility in converting other rooftops that together would provide substantial area to make places friendlier to migratory birds along with humans and other species.

For my father, an avid gardener and animal lover, who continues to unconsciously inspire me.

For my mother, a role model for patience, persistence and perseverance.

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Chapter I: Nature vs. Architecture

1.1 Introduction

¹ Raymond Williams, *Keywords* (New York: Oxford University Press, 1985), p. 219

*Nature is perhaps the most complex word in the language.*¹

Nature (noun):

a. The external world in its entirety

b. The phenomena of the physical world collectively, including plants, animals, the landscape and other features...

-Merriam Webster

Nature has been described as the world in which humans exist and culture as the world that is created by humans. The divided relationship between nature and culture has led to debates at defining what architecture - a human product - is in relation to nature.

Architecture was first described to originate in nature by Vitruvius whereby Renaissance and post-Renaissance theorists speculated that caves, huts or tents provided the original model of architecture. The earliest architectural text to develop these ideas are found in Florentine Renaissance architect Filarete's Treatise on Architecture (1460-1464), which proposed that the first buildings were huts built of tree trunks, thus predating the column. However, defining what architecture is in relation to nature was based on contemplating the original model for beauty conveyed by architecture.

Discussion surrounding the idea that beauty in architecture originated in nature is derived by Plato's theory that all things in nature are governed either by numerical relations or by geometry. Architectural applications of this notion were described by Leon Battista Alberti in the mid-fifteenth century in De Re Aedificatoria. Alberti stated, "beauty is a form of sympathy and consonance of the parts within a body, according to definite number, outlines, and

2. Leon Battista Alberti, *De Re Aedificatoria*, [101ms, 1996], pp. 302-3

3. Aristotle, *Physics*, Aristotle [NuVision Publications, LLC, 2004], p. 38.

4. Adrian Forty, *Words and Buildings* [New York: Thames and Hudson, 2000], p. 221.

position, as dictated by concinnitas, the absolute and fundamental rule in Nature.”² He theorized the principle of harmony was derived from the appropriate arrangement between parts in relation to each other and as a whole. This idea followed from antiquity when Aristotle stated, “art partly completes what nature cannot bring to a finish, and partly imitates her,”³ a phrase that would be influential to architectural theorists in the seventeenth century. Nature was, as Alberti believed, “absolute authority of architecture,”⁴ distinguishing art and nature and dominating thinking for the next two centuries.

By the seventeenth and into the eighteenth century, the idea that beauty originated in natural proportions were challenged by French theorist and architect Claude Perrault. He argued that beauty was the construct of the viewing object, marking a shift on architectural theory in the succeeding centuries. In the beginning of the eighteenth century, nature was culturally held to represent the virtue of what is free and unaffected. Based on the philosophy of John Locke, these sentiments were described by British philosopher Lord Shaftesbury in *The Moralists* (1709), where he used nature as a symbol of universal order and represented the ‘natural’ rights of liberty and freedom of speech. Gardener Alexander Pope advocated these concepts in the design of English picturesque gardens, which had its origins in Chinese landscapes. These aesthetics are implemented in William Kent’s Elysian Fields at Stowe in Buckinghamshire in the late 1730s. The landscaped gardens imitated the asymmetry of natural scenes (a shift from the formal geometries of the French garden that dominated European design for over a century). The picturesque ideals found in these landscaped gardens represented a sort of utopia, “a place where humanity’s own natural morality rejoined the natural realm...”⁵ suggesting that human virtue lay in nature.

5. Barry Bergdoll, *European Architecture [1750-1890]* [USA: Oxford University Press, 2000], p. 75.

This notion of recreating the 'picturesque' would be used a century later in American parks and gardens by Frederick Olmsted. Through designs such as Central Park, created in 1857 in New York City, Olmsted introduced the garden to the city. He integrated structures within carefully constructed natural surroundings with walks and paths flowing through the landscape meant for the purpose of enjoyment of the scenery. His picturesque designs also extended in city planning in the layout of suburb of Riverside (1869), which linked to downtown Chicago. The aesthetic qualities of both projects reflected Olmsted's view of parks as places of harmony: an escape from the 'unhealthy' conditions of the urban environment in which he strove to bring landscape as close to the urban population as possible.

⁶ Adrian Forty, *Words and Buildings* (New York: Thames and Hudson, 2000), p. 228.

⁷ Edmund Burke, *A Philosophical Enquiry into the Origin of our Ideas of the Sublime and the Beautiful* (Library of Cattalonia: J. J. Tourneisen, 1792), p. 149.

Following Locke's theory on nature as the basis for liberal politics, British philosophers further theorized nature lied in the perception of one's mind. In 1757, it was Scottish philosopher, David Hume who stated, "beauty is no quality in things themselves: it exists merely in the mind which contemplates them."⁶ Architecture was conceived to recreate the sensations one would experience from the natural; this came to be the aesthetic qualities of the "sublime." The gradual influence of this aesthetic philosophy on architecture was expressed by Irish philosopher Edmund Burke, who wrote in 1757: "natural objects affect us, by the laws of that connection which Providence has established between certain motions and configurations of bodies and certain consequent feelings in our minds...architecture affects us by the laws of nature, and the laws of reason."⁷ Burke's description of the sublime revealed, similar to Perrault, his rejection that beauty relied on the proportions in nature and more on the human experience of natural objects through the senses. The governing idea that the creation of architecture could serve to produce effects similar to one's experience of perceiving

nature.

8. Adrian Forty, *Words and Buildings* (New York: Thames and Hudson, 2000), p. 228.

By the early nineteenth century, philosophical notions describing architecture as “second nature”⁸ were adopted. This began with German philosopher Goethe developing the idea that the study of nature (rather than the study of art), as a whole to its parts, guided the understanding of art. Nature seen as a living actuality was a fundamental shift from the notion that nature was a rational construct that paralleled architecture. The amphitheatre in Verona is the first Roman building in which Goethe viewed ancient architecture originating from the same processes found in organic nature. This theory was further developed in the writings of German architect Gottfried Semper and English critic John Ruskin despite their very different temperaments. Semper was adamant that the origins of architecture did not lie in nature and that nature served no more than an analogy in the formation of architecture. Similarly, Ruskin stressed that the art of architecture relied on the translation of ideas in the transformation of raw materials. However, unlike Semper, who favoured technology, Ruskin had a disdain for the industrial processes that revolutionized methods of production. Ruskin viewed machine produced products as “dishonest,”⁹ disrupting the natural processes of life and praised the dignity craftsmanship brought to labor.

9. John Ruskin, *The Seven Lamps of Architecture* (1849), *Second Edition* (1880), (New York: Dover Publications, 1989), p. 22.

Concurrently, Goethe’s influential ideas extended to American garden design and architectural thought. The philosopher Ralph Waldo Emerson, one of the prominent figures behind American Transcendentalism, viewed nature as the resistance or cure to the artificiality of culture. Emerson encouraged American architects to seek inspiration directly from nature and the everyday. The notion is evident in Louis Sullivan’s career. Sullivan implemented organic decoration, a signature element, in designs such as

10. Frederick Albert Guthrie, *In the Cause of Architecture*, Frank Lloyd Wright: *Essays* (Michigan: Architectural Record, 1975), p. 86

Fig. 1.1 Le Corbusier, man, architecture and nature: diagram of Unité d'Habitation.

11. Adrian Forty, *Words and Buildings* (New York: Thames and Hudson, 2000), p. 238.

12. Leo Marx, *The Machine in the Garden* (USA: Oxford University Press, 2000), p. 64-65

the detailing of the writhing green ironwork covering the entrance canopies of his Carson Pirie Scott Store, built in 1899. Similarly, influenced by American transcendentalism and Sullivan's 'organic' ornament, Frank Lloyd Wright believed, "nature furnished the materials or architectural motifs out of which the architectural forms as we know them have developed."¹⁰ Both Sullivan and Wright produced work free of cultural convention. Natural motifs were an argument against the limits of classicism.

By the end of the nineteenth century, modern architecture sought to reconcile man with nature and enable the extension of the landscape through innovations. On one hand, Ruskin had provided an influential critique in outlining the sense of human alienation from the 'natural'. On the other hand, advancing technology and a desire to create new kinds of cities left architects to reconsider the role of nature in modern life. Le Corbusier sought "to restore to man the relationship with nature that he had lost as a result of urbanization."¹¹ The notion is prevalent in his architecture manifesto, Five Points of Architecture (1926), a set of principles that dictated that the ground occupied by the building be replaced on top as a roof garden. Le Corbusier embraced technology that allowed for innovated building construction methods and viewed buildings as machines for living.

The advance of technology in the natural landscape would face growing criticism during the 1960s as well as a concern for environmental protection recurred in diverse forms, in different parts of the world. The dialectical tension between nature and machine was identified by American historian Leo Marx in The Machine and the Garden (1964). He describes the sudden and shocking intrusion of technology in the pastoral scene in which the "artificial resides within the natural,"¹² reiterating similar notions of American

Transcendentalism in the nineteenth century. The book examined the contradictory attitudes in American culture towards rural happiness and the drive for productivity, wealth and power. It served as a precursor to addressing the negative impacts that arose out of the urbanization of cities and industrial processes.

In reaction to unprecedented air pollution and industrial chemical discharges as a result of the consumption of coal and other fossil fuels emitted by factories, the environmental movement emphasized that nature and culture were not separate categories but part of a single system. In the United States, the beginnings of the movement can be traced as far back as 1739 in a petition to stop waste dumping and remove tanneries from Philadelphia's commercial district. The movement expanded in the 1800s with concerns for protecting the natural resources of the West by philosopher Henry David Thoreau, who was interested in people's relationship with nature.

Public awareness to the need for protecting land was enhanced by journalistic photography in the 1950s, 1960s and 1970s, leading many to feel that people were on the edge of environmental catastrophe. In 1970, the United States Environmental Protection Agency formed under President Nixon with the purpose of protecting human health and the environment by writing and enforcing regulations based on laws passed by congress. During the 1980s, the growing awareness of global warming and other climate change issues brought environmentalism into greater public debate. Advance technologies were developed to address environmental issues of climate change and unnecessary energy usage through green roof technology and focused on the effects that buildings had on the delicate ecosystem. This led to architecture being seen as a practise with influence over the future of life on the planet.

The shifting relationship between nature and architecture throughout the centuries reveals the divided connection between humans and nature. This has resulted in negative impacts on the environment and other species. It is these impacts that reveal humans need in the past to build, develop and advance without the integration of nature. The following sections describe the historical human attempt at using technology to control as well as preserve natural things in plants and other species for scientific discovery and public spectacle.

1.2 Gardening, Greenhouses, Zoos

Garden (noun):

a: a plot of ground where herbs, fruits, flowers, or vegetables are cultivated

b: a public recreation area or park usually ornamented with plants and trees

-Merriam Webster

Forest gardening, a plant-based food production system is the world's oldest form of gardening. It originated in prehistoric times in the wet foothills of monsoon regions. It was a process in which tribes identified and protected useful tree and vine species while eliminating undesirable species. As humans formed civilizations, gardening served the purpose of offering beauty and pleasure from nature and therefore evolved to be more concerned with aesthetics and recreation, differing from farming which focused on food production.

Ornamental gardens were known in ancient times. The Hanging Gardens of Babylon were believed to be located in desert, known today as Iraq, to provide pleasure from nature. In ancient Egypt, gardens were used for their shade by wealthy people and associated trees with gods who were believed to be pleased by gardens. Gardens in ancient Rome were known by their statues and sculptures and were laid out with hedges and vines that contained a variety of flowers. While gardening faced decline during the Middle Ages, Islamic gardens were built after the model of Persian gardens, enclosed by walls.

It was not until the late thirteenth century that Europeans

began to grow gardens for leisure and medicinal purposes. European gardening experienced a rediscovery through the description of antique Roman villas and gardens which led to the creation of a new form of garden: the Italian Renaissance garden in the late fifteenth and sixteenth century. By the seventeenth century, European gardens developed with a more classical appearance that were more symmetric, proportioned and balanced around a central axis.

A separate gardening tradition had arisen in China that, by the eighteenth century, shaped the development of the English picturesque garden, with influences in asymmetry, concealment and naturalism. English gardens went from formal rows of trees and flowers beds to placing trees, plants and other garden features in irregular ways to create interesting compositions. Simple or 'natural' nature were favoured over the highly formalized geometric gardens of Versailles in France. This shift had reflected current cultural representation of nature as free and liberated. By the end of the nineteenth century, European parks contained picturesque Chinese pagodas, pavilions or bridges, in attempts to imitate the subtle aesthetic of the original Chinese garden.

It was during the nineteenth century that Frederick Law Olmsted adapted these European styles of gardening for North America, especially influencing public parks, campuses and suburban landscapes. One of his most well known works is Central Park created in New York City in 1857. It was inspired by examples of idyllic, naturalistic landscapes and set the standard for urban parks in cities. The park combined modern technologies and methods such as using steam-powered equipment and transporting more than 18,500 cubic yards of topsoil from New Jersey since the original soil was not fertile enough to sustain the amount of trees, shrubs and plants in the design. It exemplifies the great lengths

13. David M. Scobey, *Empire City: The Making and Meaning of the New York City Landscape* (Temple University Press, 2003), p. 20.

taken to recreate natural scenery for aesthetics and according to Olmsted, represented “great importance as the first real Park made in this country - a democratic development of highest significance.”¹³ His influence would extend well into the 20th century in landscape architecture and city planning.

14. Kenneth Frampton, *Modern Architecture* (London: Thames & Hudson, 2007), p. 226.

In the early twentieth century, Le Corbusier, with the aimed at “reconciling man with nature.” He developed his set of architectural principles in the *Five Points of Architecture* (1926). In them, he proposed that “the roof garden, restore the area of ground covered by the house.”¹⁴ This notion of restoring the landscape became fully integrated in systems of modern architecture. The idea of rooftop gardens which can also be categorized as green roofs, have a centuries long history, with modern green roofs incorporating modern technologies. Similarly, technology has enabled humans the sense and act of control over nature.

Greenhouse (noun):

A structure enclosed (as by glass) and used for the cultivation or protection of tender plants

- Merriam Webster

From recreating natural scenes for pleasure through gardening, there has always existed the notion of control or containing nature for spectacle and scientific advancement. This is seen in greenhouses and zoos which eventually leading to preservation and protection in wildlife reserves.

The methodical approach to the study of plants emerged during the Renaissance in which the first botanical garden was built in Pisa in 1543. These early gardens were primarily used for

medicinal purposes and would lead to serve as display of exotic and new plants from distant lands, linked to international trade and commercial exploration. The concept of greenhouses spread to the Netherlands and then England. French botanist Charles Lucien Bonaparte is often credited with building the first practical modern greenhouse in Holland to grow medicinal tropical plants. The science of botany caused greenhouses to spread to universities such as the Leiden University Botanic Garden, founded in 1587. The garden functioned as an “environmental machine producing plants.”¹⁵

15. John Hix, *The Glass House* (London: Phaidon Press, 1974) p. 13.

Experimentation with the design of greenhouses continued during the seventeenth century in Europe as technology produced better glass and improved construction techniques. Through elaborateness and size, the sheltering of plants is exemplified in the Versailles Orangerie, a royal garden built by Jules Hardouin-Mansart between 1684 and 1686. The large building, measuring to more than 150m long, 13m wide and 14m high, served to house and protect thousands of precious orange trees and shrubs, an exotic food, during the winter. The trees would then be put outdoors during the rest of the year.

The structure of greenhouses allowed for greater control over the growing environment of plants such as temperature, levels of light and shade, irrigation, fertilizer applications and atmospheric humidity. They improved food production in marginal environments and enable certain crops to be grown throughout the year, making them increasingly important in the food supply of high-latitude countries. Greenhouses became more educational in function later in the 18th century in the gardens at Hartekamp, Netherlands, owned by George Clifford. It contained gardens, hot houses, a library and herbarium which demonstrated the latest plant classifications of that time.

16. Tom F. Peters, *Building the Nineteenth Century* (Massachusetts, MIT Press, 1996), p. 206.

British advancements were symbolized in greenhouse construction. This appeared most notably in Joseph Paxton's Crystal Palace, originally built in Hyde Park, London to house the Great Exhibition of 1851. The building situated in a park consisted of 92,000 m² of exhibition space for more than 14,000 exhibitors from around the world to display the latest technology developed in the Industrial Revolution.¹⁶ Inventive glass making methods allowed the creation of large sheets of cheap but strong glass. Reflecting early prefabricated systems at time, Crystal Palace was composed of cast and wrought iron, wood, and glass. To Paxton, the Crystal Palace served as a metaphor of structure which juxtaposed landscape with industry, with the gardener and engineer. Ruskin, on the other hand, wary of technology, viewed the building with derision.

The history of the greenhouse reveals the concept of human "control" of nature and the use of machines for scientific discovery. This history of control is extended to include non-human species in the form of zoos that sought to contain 'wildlife' for study as well as public spectacle.

Zoo (noun):

a : a garden or park where wild animals are kept for exhibition

b : a collection of living animals usually for public display

- Merriam Webster

17. "Zoo." Encyclopædia Britannica. Encyclopædia Britannica Online. Encyclopædia Britannica Inc., 2013. Web. 09 May. 2013. <<http://www.britannica.com/EBchecked/topic/657894/zoo>>

The term zoological garden refers to zoology, the study of animals.¹⁷ The number of major animal collections open to the public around the world exceeds 1,000 with 80 percent in cities. Relatively new terms for zoos are 'conservation park' or 'biopark' (1980s), a strategy used by some zoo professionals to distance their

institutions from the typical ideas on zoos inherited from the nineteenth century. The predecessor of the modern zoological garden is the menagerie, a form of keeping common and exotic animals in captivity that dates back from the ancient world, Egypt, 3500 BC to modern times. Zoos along with aquariums and aviaries provide the public a viewing spectacle that allow humans to interact with species in circumstances they would normally not encounter.

Different forms of zoos that mainly serve for public viewing include open range zoos in which animals are confined with moats and fences rather than cages. Safari parks allow visitors to drive through them and come in close contact with animals. Public aquaria which is the aquatic counterpart of a zoo houses living aquatic specimens for viewing. Roadside zoos are found throughout North America, particularly in remote locations. They are small, unregulated and for-profit zoos notorious for instances of neglect and cruelty. Petting zoos, also called children's farms, features a combination of domestic animals and wild species that are docile enough to touch and feed. Animal theme parks are a combination of an amusement park and a zoo, mainly for entertaining and commercial purposes.

The position of most modern zoos in Australasia, Europe and North America, particularly those with scientific societies, is that they display wild animals primarily for the conservation of endangered species, as well as for research purposes and education, and secondarily for the entertainment of visitors. This position is disputed by critics such as animal rights organization PETA who allege that most zoo research is geared toward finding new ways to breed and maintain animals in captivity. Andrew Linzey, director of the Oxford Centre for Animal Ethics, argues that zoos make a "minuscule contribution to conservation."¹⁸

18. Tom Geoghegan, "What are zoos for?" BBC News 8 January 2008.

Although these built environments served to stimulate the relationship between human and non-human species, they were designed within the context of confinement for viewing pleasure or scientific research according to the human environment. Similar to greenhouses, zoos were used for scientific research as well as public display. It would appear to be a human effort to integrate nature and wildlife within human society and allowed for scientific advancement, however, it was still within the measurement of human scale with little regard to the ethical issues concerning captivity. In 1993, in an attempt to dispel stigma, the New York Zoological Society changed its name to the Wildlife Conservation Society and rebranded the zoos under its jurisdiction as “wildlife conservation parks.”¹⁹

¹⁹ William G. Conway, *New York Zoological Society* (1995), pp. 259-276

Natural reserves with the main purpose for protecting wildlife have existed since antiquity. A nature reserve (also known as a bioserve) or wildlife sanctuary are areas for wildlife, flora, fauna or feature of geological or other special interest protected from hunting, predation or competition. They are created by government legislation, reserved and managed for conservation and research. The earliest sanctuary was declared in the 3rd century BC by King Devanampiya Tissa of Sri Lanka. Antiquity reveals various cultural practises that maintain reserved areas for biota, usually for religious reasons such as the ‘evil forest’ areas of West Africa that were forbidden to humans and threatened with spiritual attack. In this case, humans were driven out of areas occupied by other species.

The first modern day nature reserve is credited to the National Trust in England in 1899 and the first major nature reserve designated as an international bioserve was Yellowstone National Park in Wyoming, USA in 1976. Today, there are several national and international organizations that have taken the responsibility of

supervising numerous systems of non-profit sanctuaries and refuges. These 'sanctuaries' whose main purpose is to protect wildlife reveal humanity's attempt in redeeming their actions through government legislature.

While human effort has been made in preserving lands reserved for other species outside the cities, boundaries do not exist or are not perceived by wildlife such as birds. A well known bird sanctuary is located in Toronto called Leslie's Spit which is located very near Toronto's glass covered skyline which has been shown to cause many deaths in migratory birds flying through the dense urban core. This thesis seeks opportunities to maintain a level of preservation for other species within the fabric of the city. The following section briefly looks into the variety of uses that rooftop development has offered as an alternate public realm in the city.

1.3 Rooftop Development

Drawing on the previous histories of the relationship between nature and architecture, as well as the human's 'control' of nature for scientific discovery, this chapter seeks an alternate scale to the city in rooftop development and the opportunities to reestablish humanity's connection to nature. Rooftop development is typically viewed as unusual or exclusive in North America. Yet there have been a varied history of uses and functions throughout the world.

Fig. 1.2 Hanging Gardens of Babylon

The use of roofs - as spaces of leisure in the city - can be traced back to the ancient world of the Hanging Gardens of Babylon in the 6th century. Resembling a theatre, thriving gardens draped over the sides of an ascending terraced brick structure. They served as a relief or connection to nature in the middle of the desert (believed to be in modern Iraq). According to legend, King Nebuchadnezzar of Babylon built the gardens for his wife as a reminder of her homeland. The gardens placed atop terraced roofs were for people to take pleasure or escape from afar or within against the desert backdrop.

Similarly, the Old Testament cites the roof as a platform for various everyday activities. There is evidence in utilizing the roof for farming where "the roof of the house provided extra accommodation which was often utilized in the summer. The family would sleep there, and use it as a living room during the day, as well as a storeroom, where raisins, figs, flax, etc. were spread out in the sun."²⁰ As a site for spectacle, "men and women on the roof watch[ed] while Samson performed."²¹ Descriptions from ancient periods and in the Bible suggest that the roof facilitated a connec-

20. J. D. Douglass, D. Guthrie, N. Hilyer, F. F. Bruce, A. R. Millard, *The New Bible Dictionary* (InterVarsity Press, 1994), p. 544.

21. Doris W. Rikkers, *Scofield Study Bible: New King James Version* (Vol. 1), (Oxford University Press, 2002), Judges 16:27

tion between humans and nature, one of either pleasure or sustenance.

Fig. 1.3 Santorini, Greece

Practical applications to the use of rooftops can be seen in response to warmer climates in South America, Asia and Africa where rooftop structures are crucial to the economy and culture. Areas in the Mediterranean use the roof where individual dwellings situated on varying levels are connected by walls and terraces to create communal activity yet still provide reasonable privacy. The roof terraces in Santorini, Greece are comprised of steep slopes on which houses sit, connected through interlocking terraces and winding paths. Providing structural strength as well as generating a greater sense of community shows the use of the rooftop as essential to the daily life of the people of those regions.

Fig. 1.4 Roof garden, Villa Savoye by Le Corbusier (1931)

The rooftop garden has been part of the modernists' ideal image of healthy outdoor space especially in Le Corbusier's Five Points of Architecture, a set of architectural principles described in his architecture manifesto in 1926. These principles served to guide him throughout his life. To compensate for the ground that is consumed by the building, Le Corbusier proposed a roof garden. His Villa Savoye (1931) is representative of the bases of his manifesto with a functional roof, serving as a garden and terrace, "reclaiming"²² for nature the land occupied by the building. Unité d'Habitation (1952) was designed with rooftop communal facilities. In both projects, the roof was addressed as a site of programme.

²² Kenneth Frampton, *Modern Architecture* (London: Thames & Hudson, 2007), p. 226

Structurally, there have been different strategies in implementing rooftop additions in new or existing projects where the roof serves an alternative function or contributes to the overall form.

A common perception of rooftop development is that it is merely a topping up method for construction. This resulted in a more intensive use of land and created a negative view of rooftop construction due to the construction being expensive and disruptive. However, building on the roof can go beyond topping off and add another dimension or function to the building and neighbourhood. In a 2004 competition to design Les Halles in the centre of Paris, Jean Nouvel proposed a large raised park to compensate for the lack of greenery and the large building volume required for the site. Horizontal differentiation was incorporated in buildings such as Manuel Gaua's housing completed in 1998. Building projects emerged with seemingly autonomous layers such as the apartment complex in Sittard designed by Neutelings Riedijk Architecten. The building form is clearly broken in three; the plinth, the intermediate apartment and the sculptural penthouses on the roof. The Basket bar by NL-architects on the campus of Utrecht University incorporates a basketball field on the roof of a bookshop and café. Similarly, in Germany, Aisslinger's Loft cube provided a fast and efficient solution in assembling prefab structures for the 'urban nomad'. When there is no space inside the city limits for two thousand homes needed in Hereweg, Groningen, MVRDV investigated a strategy of dismantling buildings and then rebuilding them in a stacked form. For this project they designed a large apartment block in which the monumental building on the existing site was to be dismantled and reconstructed on the roof of the new building.

An example of roof top development as extension on an existing building would be the redevelopment of Lingotto complex by Renzo Piano. The Fiat plant in Turin, Lingotto was built in the 1920s and closed in the 1970s but was turned into a multifunctional complex. It now houses an auditorium, an exhibition space, part of the university, a shopping centre, a hotel, and a cinema. At the roof

sit a glass bell-jar that is intended as a conference room and literally hangs above the industrial complex.

Rooftop extensions are often described in architectural literature as parasitic constructions. Yet Parasitism is defined by which the host organism is “harmed”²³ (to some degree) by the guest organism giving a negative connotation. The result is regarded as an isolated architectural object.

23 Ed Melet and Eric Vreedenburgh, *Rooftop Architecture* (NL: NAi Publishers, 2005), p. 78.

Mutualism or symbiosis, rather than parasitism, in which both organisms benefit from the association, can characterize the advantages of rooftop development. Pioneer’s House by John Kormeling in Rotterdam completed 1999 shows how extension can have influence on their surroundings. However, today’s rooftop developments have yet to provide more than just an addition to the existing structure below or offer beyond a singular function.

The last decade has seen a growing trend in green roofs and rooftop agriculture in North American cities such as New York City to meet the needs of fresh produce for homeowners and restaurants in downtown. Brooklyn Grange is the world’s largest commercial rooftop vegetable garden situated atop a 40,000 square foot warehouse in Long Island City, Queens that provides the locals with fresh, organic produce. Toronto’s Royal York Hotel rooftop is host to a bee yard and herb garden.

With this episodic outline of rooftops as sites for programs and connections to nature, this thesis argues that existing buildings offer the opportunity for an alternate public realm to the city. As more people migrate to cities and cities densify, is it possible to reconnect nature and wildlife to humans within the urban fabric through the use of rooftops? The next chapter seeks to understand

the history of the development of Toronto and the opportunity that rooftops can offer to enhance ecology, and in particular, support migrating birds within the fabric of the city.

1.4 Urban Parks, Green Roofs, Toronto

There is growing interest in rooftop development. This comes in response to the lack of park space and environmental issues that have arisen from the urbanization of cities. The following section looks at how Toronto developed into a metropolis and its current initiatives in rooftop development.

Toronto is the largest city in Canada. Formed in the late eighteenth century and developed as a modern metropolis similar to New York City and Chicago during the Industrial Revolution in the nineteenth century, Toronto grew quickly during the postwar decades. Refugees from war-torn Europe and Chinese job-seekers, as well as construction labourers from Italy and Portugal arrived. Toronto's population grew to more than one million by 1951 and doubled to two million by 1971. In 1967, the seven smallest municipalities of Metropolitan Toronto were merged into their larger neighbours, resulting in a six municipality configurations to include the old City of Toronto, East York, Etobicoke, North York, Scarborough and York. The metropolitan government was dissolved in 1998 by the Provincial Government and all six municipalities were amalgamated in a single municipality, creating the current City of Toronto.

Today the population of Toronto is 2,615,060 based on a 2011 census. The city covers an area of 630 square kilometres, the city's borders are formed by Lake Ontario to the south, Etobicoke Creek and Highway 427 to the west, Steeles Avenue to the north and the Rouge River and the Scarborough-Pickering Townline to the east.

One of the things Toronto is known for are its skyscrapers. The first skyscraper to be built was in 1894 starting with the construction of the Beard Building, a seven storey, iron-framed structure designed by E.J. Lennox. The city experienced its first building boom in the late 1920s and early 1930s. However, between 1932 and 1964, only one a single building above 90m was built due to the depression and war.

Toronto experienced a second and what would be an explosive building boom between 1967 and 1976 due to major economic growth. Many international and domestic businesses relocated to Toronto and created massive new skyscrapers in downtown which included the TD Tower, Commerce Court West and First Canadian Place. Thus began the rise of Toronto's modern skyline that formed along the northwestern shoreline of Lake Ontario. After the mid-1970s, the pace of the boom slowed down considerably but continued onto the early 1990s with Scotia Plaza and TD Canada Trust Tower, Canada's second and third tallest buildings.

After a lull in construction from 1993 to 2004, the city's largest high-rise construction boom began with the completion of One King Street West and continues unabated ever since. Currently, there are nearly 50 planned, under construction or recently built buildings over 150 m tall. By 2015, Toronto is expected to have 44 buildings over 150 m and become known to have the most high-rise structures under construction in the Western hemisphere.²⁴

²⁴ Canada Grows Taller
<http://www.ctbuh.org/Publications/Journal/InNumbers/TBINCANADA-Rising/tabid/4080/language/en-GB/Default.aspx>
 Dec 2012.

Some of the developments in Toronto include the waterfront and Yorkville Village. However, the negative effects of these building booms have been the reduction of parkspace available for residents and the community and loss of habitat for other species. As cities like Toronto developed into metropolis, the connection

between the community and nature were strained which were attempted to be solved in the development of urban parks.

Urban Park (noun):

An Urban Park is a park in cities and other incorporated places to offer recreation and green space to residents of, and visitors to, the municipality.

- Wikipedia

In an effort to maintain a connection to nature, urban parks developed within the metropolis in an attempt to satisfy the need of green space for residents and visitors. The history of urban park design in America is understood in four phases. In the late-nineteenth century, large tracts of land on the outskirts of cities were purchased by city governments to create 'pleasure grounds' that consisted of semi-open, landscaped areas whose purpose was to city residents and workers to relax in "nature."²⁵

25. Galen Cranz, *The Politics of Park Design: A History of Urban Parks in America* (Cambridge, Massachusetts: MIT Press, 1982), p. 25.

As urban areas grew to surround these parks, recreational programs were introduced such as zoos, golf courses and museums that drew visitors around the region and came to be known as regional parks. In the early 1900s, neighbourhood city parks were developed with swimming pools, playgrounds and civic buildings with the intention of 'Americanizing' the immigrant residents. After the World War II, new parks were designed with the focus on outdoor and indoor recreation such as ball fields and gymnasiums while green space became a second priority. As urban land prices increased in the 1960s, urban parks were reduced to small pocket parks that provided greenery, a place to sit outdoors and often a playground for children.

Fig. 1.5 Central Park by Frederick Law Olmsted New York City, NY 1857

Due to the increasing limited amount of space available

for buildings and parkspace, cities have been looking for alternate solutions in offering . One innovation has been the installation of green roofs and Toronto has been a leading city in taking initiatives to promote this construction. In an effort to encourage future developments to be more environmentally friendly and bio-diverse, Toronto has taken several initiatives to compensate for the negative effects that buildings impose on the environment and other species.

Benefits of a green roof

A 2005 report prepared by the City of Toronto, in partnership with EETech with a team from Ryerson University, researched quantifiable benefits associated with green roof construction. The study included storm water flow reduction, improvement in air quality, reductions in direct energy use and reduction in urban heat island effect. This data was calculated on the assumption that 100% of available green roof area would be utilized. Qualitative benefits include aesthetic improvement of the urban landscape, increases in property values, use of green roofs for food production and increased biodiversity.

Fig. 1.6 Layers of a typical green roof

Rooftop gardens help to insulate buildings, decreasing rooftop temperature from 60 degrees to about 25 degrees. A reduction in air condition use translates into savings in electricity. Studies have shown that 150 square metres of 'plant surface area' produces enough oxygen for one person for a day. Rooftop gardens help reduce the amount of water lost to evaporation and run-off, with plants absorbing much of the rainfall, thereby alleviating the pressure on the city's network of sewers. Gardens, whether they be rooftop gardens or traditional planting beds, help to evoke a sense of community and contribute to reducing external and internal stresses.

Fig. 1.7 Typical green roof assembly on conventional roof

Green Roofs in Toronto

A green roof is an extension of an above grade roof built on top of a human-made structure, that allows vegetation to grow in a growing medium and which is designed, constructed and maintained with the Toronto Green Roof Construction Standard. A green roof assembly includes, as a minimum, a root repellent system, a drainage system, a filtering layer, a growing medium and plants, and shall be installed on a waterproof membrane of an applicable Roof.

Toronto is the first city in North America to pass a bylaw that requires and governs the construction of green roofs on new development. It was adopted by Toronto City Council in May 2009 and the bylaw applies to new building permit applications for residential, commercial and institutional development made after January 31, 2010 and new industrial development on April 30, 2012.

The Bylaw states green roofs are required on new commercial, institutional and residential development with a minimum Gross Floor Area of 2000 m². Green roof coverage depends on the size of each new buildings. The table below shows how the requirement ranges from 20-60 per cent of "Available Roof Space"²⁶ for commercial, institutional and residential development. Available Roof Space is defined as the total area minus areas designated for renewable energy, private terraces and residential outdoor amenity space. Residential buildings less than 6 storeys or 20m in height are exempt from being required to have a green. The Green Roof Bylaw also applies to industrial buildings or additions to industrial buildings where the Gross Floor area is 2000m² or greater and the application was made on or after April 30, 2012.

²⁶ City of Toronto URL: <http://www.toronto.ca/greenroofs/what.htm>

Fig. 1.8 Available Roof Space for commercial, institutional and residential development

Gross Floor Area * (Size of Building)	Coverage of Available Roof Space (Size of Green Roof)
2,000 - 4,999 m ²	20%
5,000-9,999 m ²	30%
10,000-14,999 m ²	40%
15,000-19,999 m ²	50%
20,000 m ² or greater	60%

There are three main types of green roof systems:

- Complete systems where all the different components including roof membrane are an integral part of the whole system
- Modular systems that are positioned above the existing roofing system
- Pre-cultivated vegetation blankets that consist of growing medium and plants that are rolled onto the existing roofing system with drainage mats and root barriers as required.

Intensive green roof have a deep growing medium that supports a variety of landscape design and growth. They are accessible and used as recreational space. Extensive green roofs have shallow growing medium and the landscaping is designed to be more self-sustaining, requiring less maintenance than an intensive system. They are also less expensive since they require less structural support and maintenance.

Green roofs can be installed on existing buildings as a retrofit. An example of a retrofit is the intensive 704m² green roof on ESRI Canada Ltd. 12 Concorde Place. It covers 100% of available roof space on a commercial building, and it hosts 52 plant types including sedums, grasses, flowers, herbs, shrubs and trees.

In a complete green roof system, all parts of the roof are designed to support vegetation growth. These systems provide the

most flexibility in terms of the type and nature of growing medium, drainage and protection layers and type of vegetation. Complete systems vary in thickness and weight from as low as 50mm to 75mm (2 to 3 inches) in depth and 60 to 90 kg per sq. m, (12 to 18 lbs per sq. ft.) in weight. They can be installed with a variety of waterproofing membrane types.

Green roofs can also be installed through modular systems which are essentially growing medium that are grown off-site and simply placed on the roof to achieve complete coverage. They are available in different depths of growing medium ranging from 75mm to 300mm but the variety of vegetation is typically more limited.

A pre-cultivated vegetation blanket is a pre-grown interlocking green roof tile, available in a variety of system designs. The most versatile system contains 25mm of planting substrate, resulting in a lightweight system. The majority of vegetation is made up of several varieties of Sedum, a succulent plant tolerant to extreme temperatures and requiring little or no irrigation and very little maintenance. They are cultivated at ground level, then rolled and transport as a complete system on pallets or by crane.

In 2009, the City of Toronto launched the Eco-roof incentive Program that is designed to promote the use of green and cool roofs on Toronto's existing commercial, industrial and institutional buildings with a gross floor area of less than 2,000m². The program's aim is to assist Toronto's business community to take action on climate change.

Biodiversity (noun):

The biological diversity in an environment as indicated by numbers of different species of plants and animals.

- Merriam Webster

Aside from the environmental benefits of green roofs, the last few years have seen more attention on the opportunity for green roofs to create habitat and enhance biodiversity which was not traditionally viewed in North America. A discussion paper, *Using Green Roofs*, prepared for Toronto City Planning in April 2010, uses biodiversity as a driver for green roof policy, attempting to follow the European view of green roofs as more ecologically focused. For example, the UK Biodiversity Action Plan supports “the use of green roofs as important linkages between habitat fragments to facilitate dispersal and additional habitat for rare and protected species.”²⁷ As part of Basel’s overall biodiversity strategy, new buildings are required to implement green roofs in the design.

²⁷ Beth Anne Currie and Brad Bass, *Using Green Roofs* (Toronto: City of Toronto 2010), p. 9.

In early 2013, the City of Toronto released guidelines for biodiverse greenroofs. This development comes in the wake of several issues brought to light concerning the danger that urbanization of Toronto poses on not just the environment but on wildlife.

One of these issues was described in a New York Times article, printed on October 28, 2012, that singled out Toronto’s urban centre as a fatal threat to migratory birds. One of the main reasons is due to the fact that Toronto lies in the middle of a major route for migrating birds. Yet the city’s sea of highrise glass towers act as barriers for birds flying over the downtown core.

It is estimated that one to nine million birds die every year from collisions with buildings in Toronto, according to the Fatal

Fig. 1-9 Casualties of Urban Skies
The New York Times, October 28, 2012.

Light Awareness Program. FLAP is a non-profit Toronto based organization that has existed for 20 years by volunteers who scour the grounds of Toronto Downtown to rescue injured birds or collect the bodies of dead ones.

Although Toronto is cited as one of the major threats to birds, the city also leads in North America in addressing the issues through newly established bird protection policies and legislature. According to the article the threat is still “rarely considered by architects and developers.”²⁸ In an effort to bring awareness and change, FLAP is currently participating in two legal cases to prosecute the owners of two buildings that are notorious for a high number of deaths of migratory birds. The cases are being prosecuted by Ecojustice, a non profit environmental law group. FLAP has also worked with the City of Toronto Planning Department to present design guidelines for new and existing buildings that pose threats to birds.

²⁸ Ian Austen, *Casualties of Urban Skies*
(The New York Times, October 28, 2012), p. 11.

These initiatives and guidelines have assisted in reducing numbers of deaths. Still, can more be done in turning urban centres into friendlier places for birds and other wildlife? The following chapter looks into understanding this phenomena, as well as explaining the biology of migrating birds by remapping Toronto from a “bird’s eye view” to reveal areas that offer opportunities to make urban centres friendlier to birds.

Chapter II: A Bird's Eye View

2.1 Bird Migration

Bird Migration

The regular seasonal journey undertaken by many species of birds in response to changes in food availability, habitat or weather.

- Wikipedia

Fig. 2.1 Atlantic flyway routes for migratory in relation to Toronto

Toronto is located in the middle of the Atlantic Flyway, which represents several major migratory routes for many species of birds. The Atlantic Flyway generally follows the Atlantic Coast of North America and the Appalachian Mountains. The main end-points of the flyway include the Canadian Maritimes and the region surrounding the Gulf of Mexico. Toronto is known to be a stopover location for thousands of migratory birds every year. Key reasons include its location between the wintering and breeding grounds of numerous temperate and neotropical migrants, the availability of greenspace in the city, and its proximity to Lake Ontario. Yet the large buildings in downtown Toronto pose threat to birds heading south from the northern wilderness.

Birds cannot perceive glass as an object; therefore the reflection of sky and trees against the highrises of Toronto deceives many into believing the reflections are real and leads to fatal collisions. Also, many birds migrate during night, navigating by the light of the stars with an internal magnetic compass when it is overcast. However, the strong light given off from Toronto downtown office buildings disorients them; they are known to circle around powerful light sources until morning, facing exhaustion and sometimes death.

Fig. 2.2 This shows 2000 birds collected by FLAP during a single migratory season in fall 2003. The display was available for public viewing in order to raise awareness.

Although some species of birds have been known to adapt to urban conditions, such as the pigeon, skyscraper cities have become a growing concern to bird-friendly organizations such as FLAP (Fatal Light Awareness Program), a Toronto-based, non-profit organization that volunteers to raise awareness of the threat that Toronto's buildings pose for the birds. According to FLAP, collisions with buildings are the leading cause of bird deaths, second only to habitat loss. Volunteers go out early in the morning in Downtown Toronto to search for birds that have fallen victim to collisions with glass or light pollution. The birds are collected and frozen in which FLAP annually displays the collected bodies at the Royal Ontario Museum (ROM) for public viewing to raise awareness to the issue. The bodies are then donated to the ROM for display or for research purposes.

2.2 Bird Biology

Fig. 2.3 Birds migrate during spring and fall.

The methods birds use to navigate dictate the differences between those who travel during the day or at night. For most migratory species, the time for laying down fat reserves to use as fuel on the journey occurs in late summer, where they will also change their feathers and improve the power of their flight muscles.

There are several different types of flight techniques used by different types of birds species according to their size, body weight and wing span. Large bird species such as birds of prey, cranes and storks for example use thermal soaring. As the ground warms up in the morning sun, more energy is absorbed by some features than others. This causes the air locally to heat up, forming an invisible, rising bubble. As it rises, more air is sucked in and heats up and it too rises. Thermals often become visible as tufts of cloud when they reach a certain height, allowing birds to pinpoint where the next one may be found.²⁹

²⁹ Christopher Perrins and Jonathan Elphick, *The Complete Encyclopedia of Birds and Bird Migration* (Edison, New Jersey: Chartwell Books, 2003), p. 18.

Other birds with long wingspans use dynamic soaring. The technique takes advantage of the friction created by the wind over water, causing air to slow down. The bird climbs into the wind to gain height; then, when it can generate no more lift, it turns and glides with the wind, losing height but gaining ground. Birds not specially adapted to soaring move forward in one of three ways: continuous flapping; bouts of flapping interspersed with periods of gliding with wings outstretched; or flapping and ballistic flight, with wings closed, known as bounding flight.³⁰

³⁰ Ibid., p. 30.

Birds with a relatively high weight compared to their wing

Fig. 2.4 Weather radar technology allows the tracking of bird migration during night over the City of Toronto and surrounding area.

area practise continuous flapping. Their strong wings allow them to swim under water. Birds with a body weight of 5 ounces or more alternate between periods of flapping and gliding, in which the bird gains height and speed with continuous flapping flight to allow for periods of gliding which uses less than one-twentieth of the energy needed for flapping. Small to medium-sized birds, such as warblers, finches and thrushes, use bounding flight. The air passing over an outstretched small, broad wing creates a drag that cancels out any lift the bird would obtain from gliding. Therefore, these smaller birds fold their wings and drop between periods of flapping to generate significant lift and reduce drag.

Birds rarely fly only at night. Since many migrants make ocean crossings, they are forced to continue to fly by day. Most young birds instinctively know their migration route. They also experience an annual biological rhythm that triggers the necessary physiological changes so that they are ready to migrate at the right time which stops when they reach their wintering ground for breeding.

Birds navigate based on a variety of senses indicating that migration is an instinctive activity. Birds are genetically disposed to use the sun and star constellations as well as to detect magnetic fields and visual landmarks for direction.³¹ The migratory paths of birds varies from linear to nonlinear (circular) motions to follow the flow of wind that help with travel. Bird migration routes have been built up over generations and change is only possible through gradual evolution.

Some tests suggest that the sense of smell may be used by some birds during movements. Birds may use sounds in various ways such as positional clues. It has been speculated that birds can

31. Christopher Perrins and Jonathan Elphick, *The Complete Encyclopedia of Birds and Bird Migration* (Edison, New Jersey: Chartwell Books, 2003), p. 38.

use the echoes of their own calls from the land surface in this way. Studies show that birds may even be conscious of small changes in gravity and are possibly able to detect the Coriolis force (the force produced by the spinning earth) during migration.

Most migrating birds require periods of rest after extensive travelling which are known as migratory stopover locations. Despite their apparent preference for natural areas, migratory birds are known to use smaller patches of habitat within the urban matrix of the city such as backyards and tree-lined streets as places to rest and feed, also known as stopover locations. This is due to a number of factors such as inclement weather, inability to find adequate food and or rest, relating to habitat scarcity and fragmentation (habitats becoming smaller and farther apart). The success of bird migration depends on the accessibility of these “stopover locations”³² to complete their migratory journeys. However, the direct or indirect result of human activities that humans have engineered to the world's climate and environments have led to habitat loss and obstacle that negatively impacts migrating journeys.

32. Christopher Perrins and Jonathan Elphick, *The Complete Encyclopedia of Birds and Bird Migration* (Edison, New Jersey: Chartwell Books, 2003), p. 32.

33. Longcore, Rich; Mineau, MacDonald; Bert. *An Estimate of Avian Mortality at Communication Towers in the United States and Canada* (PLOS ONE, 2012), p. 1.

The earliest reports of behavioral responses of migrating birds to different lighting systems on tall towers can be traced back to 1886.³³ American naturalist E.A. Gastman reported that nearly 1,000 migratory birds were killed around electric light towers in Decatur, Illinois on a single evening. A century later, a report for World Wildlife Fund Canada and FLAP detailed the hazards of lighted structures and windows to migrating birds.

Fig. 2.5 Savannah Sparrow

Light plays an important role in the migration of birds and research shows how sensitive birds are to light. Some birds, such as the Savannah Sparrows, also use polarized light patterns to help determine the direction of their migratory path. They have been

34. Muheim, Philips, Åkesson, Polarized light cues underlie compass calibration in migratory songbirds 5

Fig. 2.6 Four pigments in a bird's cones (responsible for colour vision in the retina) extend the range of colour vision into the ultraviolet.

35. H. Poot, B. J. Ens, H. de Vries, M. Donners, M.R. Wernard, J. M. Marquenie, Green Light for Nocturnally Migrating Birds, *Ecology and Society* 13, (Ecology and Society 13, 2008), URL: <http://www.ecologyandsociety.org/vol13/iss2/art47/>

known to use polarized light from an area of sky near the horizon to recalibrate their magnetic navigation system at both sunrise and sunset.³⁴

This sensitivity to light mainly indicates that vision is the most important sense for birds. Unlike spherical human eyes, the eye of the bird is a flatter shape, most closely resembling reptilian eyes and has proportionally more light receptors in the retina than mammals. Most birds are tetrachromatic, possessing four types of colour receptors, allowing them to perceive ultraviolet light. Birds can detect rapid movements and slow moving object such as the movement of the sun and the constellations across the skies which are imperceptible to humans.

Scientific journals report that a nocturnal migratory bird's magnetic compass is wavelength dependent. While migratory birds require light from the blue-green parts of the spectrum for magnetic compass orientation, certain colours of light can disrupt it. Research showed that on overcast nights, birds were disoriented and attracted by red and white light (containing visible long-wavelength radiation) while clearly less so by blue and green light (containing less or no visible long-wavelength radiation).³⁵

Bird Friendly Development Guidelines

It has been recommended by a 2009 report on Migratory Birds in the City of Toronto to further support migratory bird conservation in city by:

- A. Providing stopover habitat for the diversity and abundance of birds observed that continue to use the City and
- B. mitigate potential hazards to these migratory birds here ever possible.

Four strategies that have been recommended are:

- A. Protect and, where feasible, improve existing stopover habitat,
- B. reduce or remove known hazards to migrating birds,
- C. Pursue supportive education and awareness programs, and
- D undertake focused scientific studies to fill key data gaps.

In addition, green roofs have been observed to contribute a significant area of habitat to the urban matrix. It is estimated that 21% of the total land area in the City of Toronto is covered with roofs; 8% of the total land area is covered with roofs that are suitable for green roofs.³⁶ Crucially, green roofs can provide stopover habitats and protect birds from potential dangers such as cars and predators.

36. D. Banting, H. Doshi, J. Li, P. Missios, A. Au, B. A. Currie, and M. Verrati. Report on the Environmental Benefits and Costs of Green Roof Technology for the City of Toronto. [Toronto: October 31, 2005.], p. 1-2.

In 2005, Toronto City Council adopted Motion J(17) regarding the "Prevention of Needless Deaths of Thousands of Migratory Birds in the City of Toronto."³⁷ This led to the adoption of Migratory Bird Policies in January 2006. As part of those policies, the City of Toronto Green Development Standard issued a bird-friendly development guidelines booklet in 2007. The booklet lists the a number of design-based development strategies for bird friendly buildings:

37. City of Toronto. Bird Friendly Development Guidelines. [Toronto, March 2007], p. 4.

Creating visual markers and muting reflections in the first 12 metres above grade. For buildings that are close to a natural area such as a ravine or woodlot in which the vegetation is generally higher than 12 metres, glass treatment should be applied to the height of the top of the surrounding vegetation at maturity. Visual markers can consist of features or patterns on glass where the denser the pattern the more effective it becomes as a solid object to birds. Visual markers can be created by incorporating patterned or 'fritted' glass, using film products or externally applying patterned decals

with clear spaces of no more than 28 cm. Strategies for muting reflections include angling glass, using internal screens, awnings/overhangs and sunshades.

Strategies for reducing the unnatural brightening of the night sky through excessive and unnecessary light include: eliminating direct upward light, reduce spill light beyond areas that need to be lit for safety and security while optimizing useful light that is used to illuminate urban areas that need to be lit for safety. Since office buildings usually keep lighting on while cleaning is performed in the evening, thus increasing light pollution, the guidelines advise to schedule cleaning during the day which in turn reduces energy consumption and results in cost savings. Another strategy is to implement motion sensitive lighting systems to minimize lighting levels.

Interior plants, large and small, are discouraged since it is common for greenery to be placed at front lobbies (near clear glass fenestration) that are brightly lit at night. Bird friendly ventilation grates with a porosity with no than 2x2cm prevent birds that have collided to fall through and become trapped if attempting flight. The use of transparent noise barriers that are constructed with clear polymethyl methacrylate panels pose the same dangers as glass towers and so similar strategies should be applied for birds to perceive them as objects.

UV Reflective Glass

Recent advances in technology have allowed the development of UV reflective glass in order to be visible to birds. Birds have the ability to see the full spectrum of colour, including UV

Fig. 2.7 What Humans See vs. What Birds See

38. Inspired by a spider's web with UV reflective properties, specialized glass that contains a UV reflective coating allow windows to be visible to birds but appear clear to humans.
<http://www.ornilux.com>

light, which is invisible to the human eye. The German company Ornilux has developed a type of glass with a UV reflective coating that will make windows visible to birds and decrease the risk of head on collisions. The development is still being monitored and studied but shows promise in the development of bird friendly buildings materials.³⁸

The attention of these issues, following the needs of birds, assists in environmental education and awareness to promote values on the respect of nature and the fragility of ecosystems.

By primarily designing for birds, this thesis attempts to integrate a species other than humans that inhabit this world and maintain a rightful place in the land. Promoting the coexistence of birds and humans, this thesis hopes to assist in the mediation between different species that define a whole ecosystem.

Are there opportunities above existing buildings in the densest urban center in Canada to design a mixed-use public space that will offer migrating birds a soft spot to rest and feed during their long journey?

2.3 Bird Mapping

To determine potential sites that would provide benefits to birds, Toronto has been remapped by placing attention to the specific characteristics relevant to a migratory bird's journey in regards to food, rest and shelter. Working from large to small scales, remapping Toronto is intended to provide a better understanding to the world of birds within urban context. The following categories are illustrated below:

North American Migration Flyways and Dangerous Cities

Open Space

Parkspace

Power lines

Major and Minor Water Regions

Green Roofs

Downtown Building Heights

Most Dangerous Buildings

Areas with Current Building Construction

Fig. 2.8 Migrating Flyways and Open Space

Fig. 2.9 Power Lines and Parkspace

Major and Minor Water Regions

Source:
2012 datasets from DMTI Spatial
Toronto boundary from City of Toronto

Green Roofs

Source:
City of Toronto 2009
Toronto boundary from City of Toronto

Fig. 2.10 Water and Green Roofs

Most Dangerous Buildings

Source:
Fatal Light Awareness Program 2010
Toronto boundary from City of Toronto

Downtown Toronto Building Heights in Metres

Source:
2012 Datasets from City of Toronto
Data classifications based on Jenks optimization method
Toronto boundary from City of Toronto

0.21 - 19.57
19.58 - 51.61
51.62 - 108.92
108.93 - 553.00
None No Data

Fig. 2.11 Most Dangerous Buildings
and Downtown Building Heights

Areas with Current Building Construction
Source:
<http://urban.toronto.ca/press/development>
CTBUH Canada, Globe, Tablet, December 2012

Fig. 2.12 Areas with Current Building Construction

2.4 Site

Fig. 2.13 Site at 50 Cumberland Street, Toronto

The space selected to develop a rooftop bird garden is on top of a 7 level parking garage located at 50 Cumberland Street in Yorkville, Toronto. It is situated east of Bay Street, which is considered an area in transition with several high rise building projects currently being completed. The property of the parking garage that (still in use today) has recently been purchased and is set to be demolished in place of two additional high rise condominium buildings. The proposed design in this thesis serves to critique the future proposal, which will only add to the threat posed to migrating birds.

The garden will also serve as a semi-public park for humans to address the lack of parkspace in Downtown Toronto. The following diagram illustrates the benefits to the surrounding area and community by applying a 400m radius (a common benchmark) around the proposed site.

Fig. 2.14 Benefits to Surrounding Area

Total population of dessimation areas:

Current (2012): 22,132

Projected (2016): 24,874

The projected population for the area surrounding the proposed site is intended to increase, thereby increasing the number of people the proposed park would benefit.

Source:
Envionics Analytics Group, Inc.

A common benchmark for adequate distance between a dwelling to greenspace lies between 250m to 400m, therefore a radius of 400m is applied to the proposed site.

Source:
2012 datasets from DMTI Spatial

Jessum Ketchum Park
Open space with a few
trees and grass

Open space with trees
and grass

Monocultured garden
mainly used by workers
and residents

The proposed site would add to existing nearby parks that lack diversity in plant species. The design would enhance ecology for surrounding area.

Offering green space to any downtown core in a city would benefit birds and other natural life. 'Green P' parking lots are owned by the City of Toronto, which makes acquiring land more feasible and provides easy public access to the rooftop through stairwells. By having the site on a roof, predators such as cats are less likely to reach it. Providing green space downtown offers migrating birds a place to rest and feed when they have no other options and a soft spot to land if they survive head on collisions or spend the night circling light sources until early morning.

This project seeks to use the roofscape as an alternate urban realm. Rather than serving merely as a cover, existing roofscapes are given a programmatic scape, in this case a bird garden open to the public. The aim is to reconnect humans with other species and ultimately nature. The design is to be seen as a prototypical project. When applied to numerous rooftops, it will present a significant amount of green area making Downtown Toronto friendlier to birds.

Fig. 2.15 Rooftop of existing parking garage

Chapter III: Feed

3.1 Native vs. Invasive Plant Species

Native plants are species of wildflowers, shrubs and trees growing in a region in which they have evolved prior to European settlement in North America around 1600 AD. Plants evolve over time in response to local climate and soil and interactions with other species inhabiting the community. They possess certain traits that allow them to adapt to local conditions. By adapting to local soil and climate condition, they have also evolved with local bird, mammal, butterfly and insect populations.

Invasive plants are non-native species that out-compete native plants and often dominate in natural areas. They have the capacity to spread quickly and easily on new sites and have widespread negative economic, social and environmental impacts. They reduce nesting and foraging opportunities for animals, are sometimes harmful to humans, and removal is resource intensive due to their reproductive survival strategies. Invasive plants in abundance reduce plant diversity, affect wildlife habitat and alter ecosystem dynamics. Research shows that invasive species have become a threat to global biodiversity and are now a major environmental issue for the public.³⁹

³⁹ URL: <http://www.evergreen.ca/en/resources/native-plants/fact-sheets.sn>
Retrieved 2013

However, by selecting plants that are native to the surrounding area, birds are more likely to recognize and approach the plants. Birds have the cognitive ability to recognize habitats in order to perform long-distance migrations. They have been known to follow the changing of plants according to geographical area. These mental maps serve as a wayfinding tool and so native plants or habitats inform and situate the bird during its journey. The ben-

efits of using native plant species include not requiring watering or chemical fertilizers and pesticides in order to thrive. They can thrive in poor soils. Local flora and fauna support them and in turn they provide food and habitat. Growing them improves biodiversity and creates a local seed source. Planting native species and connecting existing green spaces provides migrating corridors for urban wildlife.

While urban gardens cannot replace natural habitats, they can provide needed food and resting spots for many migratory species and offer safe nest sites for others. Therefore a bird-friendly garden will also be inviting to butterflies, bees and other creatures. Increasing biodiversity allows better cross pollination, which is responsible for the production of crops and resources. A list of native plants that attract a variety of birds, as well as butterflies and bees was compiled based on three main sources by Evergreen in Vancouver, Fletcher's Wildlife Garden in Ottawa, and the City of Toronto Green Standard. The list has been narrowed to plants that are shallow rooted and drought tolerant to suit the conditions of a rooftop garden.

The following plant list is organized by graminoids (grasses), forbs (wildflowers) and tree shrubs ranging between 1 and 7 metres. They provide nourishment through berries and seeds as well as shelter. A growth chart displays the time of year that each plant blooms to ensure that food and shelter is available during migrating season.

TREE SHRUBS

SHRUBS

LOW SHRUBS

FORBS

GRAMINOIDS

Fig. 3.1 List of plants suitable to grow in rooftop conditions as well as attract forest based birds

Fig. 3.2 Bloom Time Chart

Source: Evergreen.ca

3.2 Planting Strategy

The following strategy is used for the placement of plants to create a garden suitable to attract a variety of migrating forested bird species. The proposed type of environment is unlikely to attract types of birds such as seagulls or shorebirds, who travel along water and the coast, and pigeons, who have adapted as a species to prefer concrete and urban conditions. The choice of site is less likely to attract breeding birds as they are conservative in their choice of wintering or breeding area due to their genetic basis. Migrating birds are less selective in their stopover locations since they require rest stops along their migrating journey to feed and restore energy, which can offer limited options due to timing and available resources.

1. Designating the four corners of the site for human pavilions maximizes as much space for landscaping as possible where the design begins with the placement of plants.
2. Using the existing column grid as an organizational device, tree shrubs 4-6 metres tall are located above select existing columns for structural support.
3. Shrubs 2-3 metres tall are located along grid lines.
4. Small bushes up to 1-2 metres tall surround the shrubs to form small clusters. The clusters of varying heights serve to attract a variety of bird species.
5. Major and minor paths are derived from the clusters and graminoids and forbes line the edges of the paths, filling in the remainder of available space for landscaping.
6. Diagram showing designated bird and human space.

Fig. 3.3 Plant list displayed in approximate diameter

Fig. 3.4 Using Existing Column Grid

Fig. 3.5 Tree Shrubs 4-6 metres tall

Fig. 3.6 Shrubs 2-3 metres tall

Fig.3.7 Low Shrubs less than a metre tall

Fig. 3.8 Water, Flowers and Paths

Fig. 3.9 Designated Bird and Human Space

Stormwater Management Ponds

Fig. 3.10 Stormwater drains into ponds into controlled output roof drains. The drains filter that rate of flow to prevent over flooding the sewer system.

3.3 Feeders

Birdhouses and feeders provide nourishment and shelter during winter months for birds that remain in the city. The design of the following birdhouses and feeders take in consideration the unique characteristics of a variety of bird species that have been collected by FLAP.

Fig. 3.11 Location of birdhouses and feeders in plan

Black Chickadee
Parus atricapillus

The Black Chickadee sleeps in thick vegetation or in cavities. It bathes in water, dew or snow. They are known to flock together and call out to each other. They eat insects (especially caterpillars) in summers and seeds (including feeder) and berries in winter.

Cage Feeder

Eastern Bluebird
Sialia sialis

The blue bird is a voracious insect eater. It has blue or blue and red plumage. It is attracted to platform feeders, filled with darkling beetle but will also eat raisins soaked in water. It is known to used heated birdbaths in the winter.

Platform Feeder

Blue Jay
Cyanocitta cristata

Toronto's signature bird is known for it keen brainpower and thin screech when perched in trees around the GTA. The blue jay is a year-round dweller of the area.

5 Course Meal

Canada Warbler
Cardellina canadensis

Identified for its yellow chest and black 'sideburns', the Canada Warbler sings with a clear, slashing staccato. The songbird nests in mossy patches beneath dense forest canopies, and is one of the last birds to arrive in the spring but the first to fly south for the winter.

Habitat

Fig. 3.12 Birdhouses and feeders 1-4

Chimney Swift
Chaetura pelagica

The chimney swift is distinctive for its cylindrical body, commonly described as 'cigar with wings' and is an acrobatic flyer that chases airborne insects for food. The existence of the chimney swift is threatened by the loss of chimneys to nest in since people increasingly opt to install gas furnaces.

Artificial chimney

Golden Crown Kinglet
Regulus satrapa

Similar to the chickadee, the golden crowned kinglet with its tuft of golden hair on its head is the most commonly found dead bird by FLAP during migratory seasons. It winters in the southern US and travels up to the northern Canadian provinces to breed.

Folding

Purple Martin
Progne subis

The purple martin is a swallow bird that catches winged insects from the air. It is known to be dependant on artificial houses of wood or aluminium and fake plastic gourds that are supplied by individuals and organizations fond of birds.

Communal Apartment

Ruby-Throated Hummingbird
Archilochus colubris

Measuring at just seven to nine centimetres, the ruby-throated hummingbird is the one of the smallest birds to be collected by FLAP. It is known for its flashing emerald-green plumage and a dash of deep red at its throat. This nectar-eater is the only breeding hummingbird in eastern North America.

Syrup Feeder

Fig. 3.13 Birdhouses and feeders 5-8

Eastern Screech Owl
Megascops asio

The nocturnal bird does not actually emit a screech sound. The eastern screech owl roosts during the day in cavities or near tree trunks. They favour large insects such as beetles, moths, crickets, grasshoppers and cicadas which makes up half of their diet. They are found in residential areas.

Cavity

Tree Swallow
Ichnus alba

The tree swallow is highly social outside of the breeding season is known to form flocks that can reach several thousand birds. It eats berries and seeds but mostly relies on acrobatically catching insects in mid-air with their bill.

Nest Box

Eastern Whippoorwill
Antrozous vociferus

Notoriously hard to spot due to their haphazard grey-brown feathers which helps them blend in with the ground. The nocturnal bird roosts in the ground, eats insects and emits rolling, repetitive sounds.

Camouflage

House Wren
Troglodytes aedon

Known for its effervescent voice, the house wren is a busy forager in low tree branches and shrubs. It eats insects (spiders, beetles, caterpillars, earwigs) and nests inside tree holes or nest boxes.

Singalong

Fig. 3.14 Birdhouses and feeders 9-12

Chapter IV: Shelter

4.1 Design Proposal

Premise:

To design a bird garden with human pavilions for visitors on the rooftop of a parking garage in downtown Toronto. The garden will offer a place to rest and feed for birds during migrating season while allowing visitors to engage in the activity of birding and recreation. The proposal serves as a prototypical project open to adaptation and implementation on other existing roofscapes as well as in similar urban centres that pose the same threat to migratory birds.

Program:

The proposal will contain a significant designated bird space and four human pavilions. The pavilions will consist of a public pavilion that serves as the main entrance, the main office for FLAP (Fatal Light Awareness Program), a city chapter for the International Dark Sky Association, and a greenhouse housing a butterfly garden. The pavilions serve as a networking platform for various organizations to connect in shared interests. The structures are also designed to allow the pleasure of viewing the birds. People remain concealed inside the pavilions or by bird blinds so as not to startle the birds. The facades of the pavilions follow the development guidelines set by the City of Toronto Green Development Standard. Bird furniture such as birdhouses and stormwater management ponds are strategically arranged across the site to provide food and shelter during winter.

4.2 Landscaping

The design starts with landscaping that addresses the needs for migratory birds. The pavilions are added next. The landscaping layers include plants, birdhouses, water, rocks, furniture, and paving patterns.

Fig. 4.1 Site Plan

Fig. 4.2 Landscaping Plan Level 1

Fig.4.3 Landscaping Plan Level 2

4.3 Plans and Sections

Fig. 4.5 Level 3

Fig. 4.6 Level 2

Fig. 4.7 Level 1

Fig. 4.8 Section A
with paving options

Fig. 4.9 Section B with material options

Fig. 4.10 Section C with landscaping details

4.4 Pavilions

1 Restaurant Pavilion with
Public entrance from street level

2 Main office of
Fatal Light Awareness Program

3 Toronto Chapter of
International Dark Sky Association

4 Greenhouse and Butterfly Garden

5 Existing Parking Garage

Fig. 4.11 Axonometric view of site

PUBLIC PAVILION

Fig. 4.12 The Public pavilion serves to be the main entrance for visitors and volunteers arriving from street level. It contains public washrooms and a restaurant at the second level, with an outdoor patio. A beeyard and an herb garden is located on the roof of the restaurant (accessible by a built-in ladder) to provide the restaurant fresh produce. The lower level facade acts as a bird feeding wall with circular openings that contain food for birds coming from outside. Each hole contains a peephole on the interior side for visitors to view the birds and outside for pleasure while still being concealed so as not to startle the birds.

Fig. 4.13 The pavilion is made of reinforced light weight concrete. It is connected to commercial and retail at ground level through an existing elevator core and public stairwell access. The second level of the pavilion connects to the large ramp that continues off the internal ramp system of the parking garage. The pavilion also contains bird viewing blinds for visitors and birdwatchers to be concealed as they view bird activity.

LEVEL 3

LEVEL 2

LEVEL 1

FLAP MAIN OFFICE

Fig. 4.14 The Flap main office is connected to the public pavilion through a covered walkway. The pavilion is designed with a bird-friendly facade and roof in which extruding windows and skylights also act as sitting posts for birds to perch on and rest.

Fig. 4.15 The Flap pavilion is constructed with reinforced light weight concrete with bird viewing blinds that also act as structural columns to hold the second level structure holding the offices. The second level also contains a bird room that is used to store the collected bodies of birds that have died from head on collisions with glass facades. The bodies are frozen and are stored until they will be displayed during the annual bird lay-out, an event organized by Flap to raise public awareness of the issue. The birds are then donated to the Royal Ontario Museum to be embalmed for display or for further research.

LEVEL 3

LEVEL 2

LEVEL 1

INTERNATIONAL DARK SKY ASSOCIATION

Fig. 4.16 The International Dark Sky Association pavilion is the only pavilion to be designed under landscaping with protruding skylights. It is constructed in reinforced light weight concrete and contains a multi purpose room that also functions as an exhibit or meeting room. It represents the Toronto chapter and serves to connect to other city chapters around the world. It is a non-profit member organization that serves to educate others on how to preserve the night sky while protecting wildlife, cutting energy waste and stopping light pollution.

GREENHOUSE

Fig. 4.17 The Greenhouse pavilion houses the butterfly garden and contains equipment for landscaping maintenance. It is intended to be open during the day and all year around. It cultivates the grow of plants and provide warmth for visitors during the winter months.

Fig. 4.18 The pavilion is mainly constructed with stainless steel and UV reflecting glass that is manufactured by the german glass manufacturing company Ornilux. The greenhouse is accessible by a ramp that is designed with bird viewing blinds pointed towards the central landscaped bird space. The greenhouse also contains a mezzanine to hold an office. Seating is located in the reception area and on the roof. Along with the beeyard at the public pavilion, the butterfly garden serves to assist in the main pollinator species who are responsible for crop production yet face increasing decline in specie population.

4.5 Conclusion

As more people move to cities, and density in the urban fabric increases with construction occupying more land, roofscapes offer an alternate public realm to the city.

This project seeks to make existing roofscapes into programmatic scapes, in this case a bird garden containing a series of pavilions that are open to the public in downtown Toronto. By green roof technology, buildings have the potential to enhance ecology and biodiversity, bridging the gap between architecture and nature.

In briefly outlining the historical relationship between nature and architecture, this project establishes itself as a garden that takes inspiration from nature. Yet it does not attempt to establish itself as “nature” for several reasons. The project situates itself within the urban matrix atop an existing building, conditions that are human made. Introducing greenspace atop a building requires maintenance and adherence to an existing structural layout (in this case, the roof of a parking garage). Where nature is unmaintained and free to grow, in short, “wild”, a garden by definition is a cultivation of nature by the human hand. The project differs in the ideal perception of a garden from being a ‘pristine’ environment since the clustering of plants and trees attempts to mimic nature, as a forest, that would attract migrating birds. Although the proposal takes inspiration from nature, it maintains the position of being categorized as a rooftop bird *garden* in terms of cultivation and maintenance. It thus attempts to compensate for the lack of ‘nature’ in the city.

Furthermore, the project aims to fit into the larger economy of public and private endeavours, alongside with parks, zoos, and sanctuaries. It attempts to develop into an endeavour that respects wildlife by proposing a new environment integrated rather than segregated or isolated from the urban realm.

Creating a Network

Although the scale of the site is small in relation to the city, the prototypical design aims to add and to create a greater network with new and existing parks or gardens. To foster this network, a guidebook is prepared for city dwellers, buildings owners and, in particular, the bird watching community. *Designing a Rooftop Bird Garden* informs and encourages the public to build rooftop bird gardens by giving a brief overview of the fatal threat urban centres pose on birds, providing a list of plants capable of growing on rooftop conditions, and helpful planting tips. The guidebook also assists serious and amateur birders to foster their appreciation for birds by building their own gardens if they have access to a rooftop.

Fig. 4.19 Selected pages from Guidebook to Designing a Rooftop Bird Garden

A section is devoted to the small list of birds that the plant list will attract which can be further expanded in further development. The guidebook should also include strategies in making facades friendlier to birds. Crucially, the guidebook is meant to help develop city authorities in implementing new and necessary green roof plans.

Can this public awareness not just inform adults but reach younger generations that will in turn influence the way they regard nature in their adult life? Consider the importance given to nature in children's picture books. Children's books often play an important role in socialization by assisting parents to explain social relations and belief systems that exist in their world. The books portray nature by using animals or plants as metaphors for human conditions and emotions in order to illustrate moral 'lessons'. They also assist children in developing an understanding and appreciation of the natural world. The valuable role of nature presented in these books provide learning tools and re-iterate philosophical notions that our human "virtue" lies in our 'natural' side. Children's books are seen to affect the way children see the world and in turn influence the way they understand environmental problems or how they regard other species. Deeply empathetic relations are fostered between children, animals, and nature.

However, studies show that children are becoming increasingly isolated from nature. According to an analysis of the *296 Caldecott Medal Award Winners* from 1938-2008, depictions of nature were shown half as much as manmade environments in children books.⁴⁰ This trend being more pronounced in the last few decades. Factors that have contributed to this isolation include urbanization and access to television, which are believed to have in turn influenced the content of children's books. The decline in biodiversity in cities proves the need for environmental awareness

40. J. A. Williams, C. Pridemore, N. Palmer, P. J. Savadell, and D. Menden, "The Human-Environment Dialog in Award-winning Children's Picture Books," *Psychological Inquiry* 20(2), 82-100, 1999. doi: 10.1111/j.1467-8020.2011.00199.x

41. J. A. Williams, C. Podeschi, N. Patmer, P. Schwadel, and D. Mayler, "The Human-Environment Dialog in Award-winning Children's Picture Books," *Sociological Inquiry* 2012, 82: 145-159. doi:10.1111/j.1475-682X.2011.00399.x

and concern. Research states that 36% of all known species on earth face the threat of extinction.⁴¹ This decline will directly affect humans in terms of food production and sustainable habitat which ultimately determines our very existence. Are there ways through children's books or other mediums for younger generations to cultivate a connection with and an appreciation for nature?

A crucial project that could function alongside *Designing a Rooftop Bird Garden* is developing a children's picture book to assist in learning coexistence with non human species. These books would teach children about the ecosystem as well as the benefits of caring and cultivating plant life.

Feasibility

The project aims to re-establish the connection between humans and non-humans that have historically been divided as a result of notions of control through technological advances and scientific discovery. The prototypical design aims to be adapted to other and larger roofscapes. Taken together, these roofscapes would offer a new sustainable habitat. Here, migrating birds and other non-human species would renew the urban fabric.

The garden has different functions and serves different communities at different times of the year. It would be populated by migrating birds and, at times, the birdwatching community during migrating seasons. It provides food and shelter for those species that end up remaining in the city during the winter. Outside migrating seasons, the garden functions as a park for a controlled number of visitors, (since the site is surrounded by residential and commercial buildings and is a major shopping and tourist loca-

tion). The project may be seen as a prototype given its unique environment and provision of space for humans and non humans to rest, eat and enjoy.

This project assumes that the top level of any parking garage is rarely used due to the time it takes to travel to ground level exits and the fact that users would prefer their automobiles not be exposed to inclement weather. Therefore, it is hypothesized that the multi-functional garden would increase user activity and compensate for the loss of revenue that would occur in replacing the existing parking spaces on the roof. The garden would be maintained by the City of Toronto since it is a “Green P” parking garage which are maintained by municipal regulations.

The garden would require some level of security and a lighting strategy at night since it is located atop a building supports offices for organizations which would not be open after working hours. Given the unique location, it would not be safe for the park to be fully public since it may attract loitering. Special attention would need to be given to lighting since the site requires a need for without powerful illumination that would harmfully attract and disorient birds from above. The garden would still be open to public during the day and functions all year round. As stated before, the project would integrate stormwater managements ponds to respond to heavy rainfall. The stormwater management ponds are designed to have controlled output drains that would filter stormwater gradually so as not to overwhelm the sewer system. These ponds are regarded as environmentally friendly and will also serve to function as temporary bathing or drinking stations for visiting birds.

Future Development

Further development of the project would lead to more focused definition regarding the scope of research and result. Approaching the project from a technological point of view would require further research on greenroof systems applied as modular units to a variety of different roof types. The aim would be to design a system that is applied not only to roofs but to facades of buildings, offering additional solutions outlined in the “Development Friendly Guidelines” prepared by the City of Toronto in making glass more visible to birds.

Approaching the project from a landscaping point of view would require further research into the life cycles of the different plant species and bird species. This would provide a more detailed life cycle of the project as a public endeavour in terms of the different inhabitants that would share the site at different times of the year. Since it has been established that the garden is to be maintained while allowing the natural clustering of plants and trees, the planning of the project would require projected cycles in how it would develop in consistent intervals such as 5, 10, or 15+ years. This would allow a better understanding of how successful the project may be and the future issues that should be addressed.

As a prototypical project, the direction of development that the design can head towards will benefit urban centres and hopefully inspire future solutions or help address the threats imposed on wildlife.

Fig. 4.20

Fig. 4.21

Fig. 4.22 East view towards Public Pavilion

Fig. 4.23 View towards Flap Main Office

Fig. 4 24

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