Dwelling in Harmony: Mitigating Biodiversity Loss through Ecological Cohabitation

by

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Dalhousie University is located in Mi’kmaq’i,
the ancestral and unceded territory of the Mi’kmaq.
We are all Treaty people.

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Abstract

Though ecological destruction is not an inherent requirement for human habitation, we often design our homes to the detriment of native species. As the human population continuously increases, as does our need for new housing developments, and thus, there becomes an urgency to shift away from our long-upheld anthropocentric design principles which often result in habitat destruction and the spatial displacement of ecosystems. Through the pursuit of ecological cohabitation, our homes can be designed to foster various life forms, and in turn, our dwellings can passively work to preserve and enhance our local biodiversity. Located in Waverly, Nova Scotia, the project focuses on creating habitat opportunities for non-human species throughout the building envelope. By designing a wide variety of habitable spaces within the envelopes of our homes, we can begin to live harmoniously alongside various other species while maintaining the level of biological isolation we have grown accustomed to.

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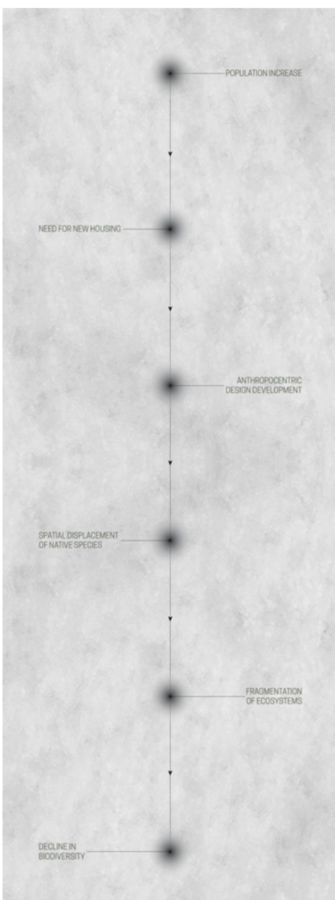
Chapter 1: Introduction

The Issue of Biodiversity Loss

We are currently facing an environmental crisis of an unprecedented magnitude, and it is alarming to learn that we still lack the tools required to understand precisely what we are at risk of losing. With biological diversity declining at a record-high rate (Abe et al. 1997, 277), it is crucial to assess the ways in which humans influence their natural environments. The human impact on any element within an ecosystem can set off a chain reaction, subsequently altering other ecosystems as well. Thus, the condition of biodiversity anywhere cannot be analyzed without the consideration of human influence (Sponsel 2001, 396). The notion that humans are separate from nature is derived from an anthropocentric world view which implies that the damage we cause to our environment is an unnatural occurrence. While every species will impact its environment to some degree (Sponsel 2001, 406), that does not denote their exclusion from the natural world. Though an anthropocentric world view falsely places humans at the center of the world, homo sapiens are typically considered a dominant keystone species in most ecosystems due to their significant influence and impact over biotic and abiotic elements within ecosystems (Sponsel 2001, 398). Given that the majority of damage done to global biodiversity can be attributed to human development (Kilpatrick et al. 2017), the responsibility of mitigating the consequent damage ultimately falls upon the human race. The continued negligence of this fundamental responsibility sustains the endangerment of all forms of life on earth, including that of human beings (Sponsel 2001, 406).



Relationship between increasing human population and biodiversity decline.

Arguments of Biodiversity Preservation

Efforts of biodiversity preservation typically fall under one of two ideologies: the 'aesthetic argument', or the 'utilitarian argument'. The aesthetic argument is an ideological manifestation of ecological egalitarianism; the belief that all species have equal moral standing. In this argument, the preservation of biological diversity is not guided by an agenda of human benefit, but rather as a matter of principle. Unlike the aesthetic argument, the utilitarian argument prioritizes the conservation of certain species based on their impact on humanity. This anthropocentric argument is guided by the perceived promise of services that biodiversity provides to humans (Abe et al. 1997, 277-278). The methods of biodiversity loss mitigation explored throughout this thesis are more closely aligned with the values of the aesthetic argument, though I would argue that the aesthetic approach can be perceived as a more conservative variation of the utilitarian argument. The absence of evidence of interdependency between us and another species does not conclusively signify that such interdependency does not exist. Therefore, it can be argued that the aesthetic argument is more effective in ensuring that humans do not lose out on services that are unknowingly provided to us through biodiversity.

The Human Impact

As we navigate through our current environmental crisis, the way in which we choose to inhabit the earth requires careful reconsideration. One of the primary drivers of global biodiversity loss is the destruction of natural habitats. This destruction often takes the form of clear-cutting forests, draining wetlands, water pollution, and the overexploitation of natural resources (Singh et al. 2021, 12), all of which are continuously fueled by our anthropocentric housing developments.

Aside from complete habitat destruction, habitat fragmentation also plays a crucial role in the decline of global biodiversity. One of the many ways humans contribute to the fragmentation of ecosystems is by dividing large areas of natural land into smaller parcels for proprietary reasons, which often entails the creation of physical boundaries (Singh et al. 2021, 13). In the natural world, boundaries are defined by a change in elements, such as from land to water. Contrastingly, humans tend to rely on built structures, such as walls and fences, to define spatial boundaries (Yeang 1995, 12-13), which leads to the physical fragmentation of ecosystems and the spatial displacement of native species. This results in the isolation of animal communities, which ultimately diminishes opportunities for genetic diversity to occur (Singh et al. 2021, 13).

The extent of the damage humankind has caused to the environment suggests two things: we have little to no regard for the well-being of species outside our own, and we believe we possess the ability to reverse the damage we cause before it can negatively impact us, However, neither of these statements hold true. First, it is in human nature to respect and care for our natural surroundings. In *Are All Species Equal?*, David Schmidtz states “If we do not care, then we are missing something. For a human being, to lack a broad respect for living things and beautiful things and well-functioning things is to be stunted in a way” (Schmidtz 2002, 63). Second, how can we claim to possess the ability to reverse the damage we are causing when we still struggle to understand the magnitude of it? Scientists today are already struggling to predict exactly how ecosystems will respond to our current global environmental crisis over time (Abe et al. 1997, 283).

Ultimately, our declining global biodiversity is a result of the impact mankind has had on the natural environment (Singh et al. 2021, 13), and our fundamental human beliefs are partially to blame. In *Critical Condition: Human Health and the Environment*, the authors state, “In the anthropocentric view of the world, man is the most important of all the species and should have dominion over nature. Most humans believed that any harm we do we can undo, with ingenuity and technology, and that our individual and collective impact on the environment will result in only imperceptible changes” (Chivian et al. 1993, 3). Though prominent, this belief is simply not true. Further, humanity is not immune to the consequences of the environmental damage we have caused, and the loss of global biodiversity continues to threaten our health and overall well-being. A hypothesis named ‘the amplification effect’ states that a decline in biodiversity within an ecosystem will lead to an increase in overall disease risk (Kilpatrick et al. 2017). Consequently, two of the most crucial steps in preventing human illness are the protection of our physical environment and the perseveration of ecosystems and species diversity (Chivian et al. 1993, 1). Tackling the issue of biodiversity loss through methods of habitat conservation and/or restoration will positively impact the overall well-being of humanity (Kilpatrick et al. 2017).

Methodology

Ecological Cohabitation

Throughout history, human habitation has often taken place at the expense of other species. We continuously develop natural lands to meet our housing requirements with little to no consideration of how our presence will impact native species and local ecosystem functions. This typically results in the fragmentation of ecosystems and the spatial displacement of native species (Singh et al. 2021, 13). As our population continues to increase, our subsequent rising need for housing poses a threat to species around the globe (Pidgeon et al. 2014, 1292). We are increasingly encroaching onto natural areas while studies have shown a negative association between housing development and species diversity (Pidgeon et al. 2014, 1291). The systemic trajectory indicates that initially, the presence of new housing on a site positively impacts the local biodiversity due to the new resources being introduced, such as seeds and water, which work to attract other species. However, as the density of housing increases over time, the local biodiversity becomes negatively impacted, typically due to the addition of infrastructures such as roads and power lines (Pidgeon et al. 2014, 1292). A significant takeaway from these studies is that housing type made a difference in the provision of ecosystem services (Tratalos et al. 2007, 308), which suggests that a change in the way we approach housing design could positively alter this systemic trajectory.

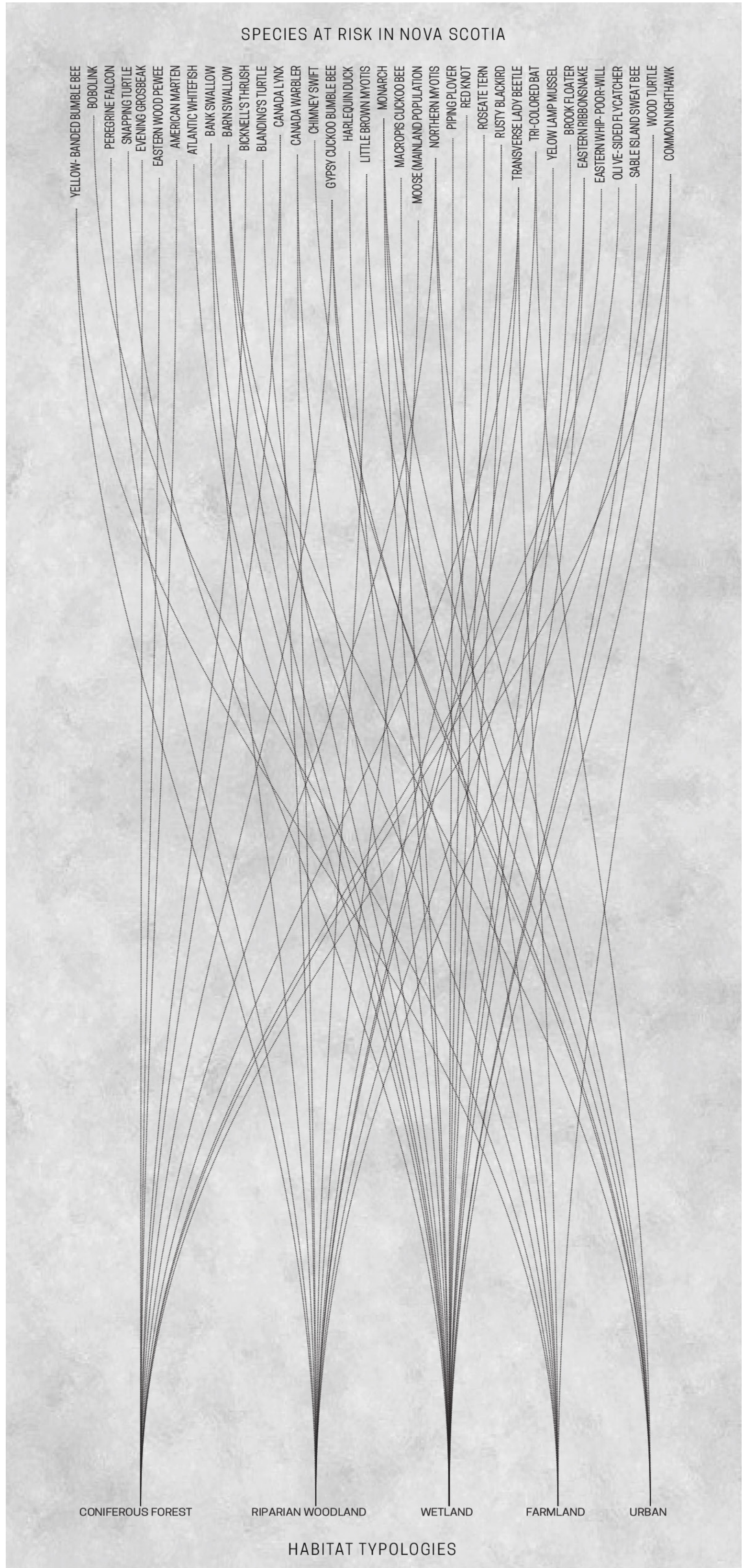
While some believe that the physical presence of any man-made structure on a site will inherently conflict with the local ecosystem (Yeang 1995, 20), I believe there is a way to design our dwellings to achieve a harmonious coexistence between humans and other species. Ecological cohabitation refers to the condition of humans sharing their dwellings with various other species. Through ecological cohabitation, our homes can be designed to foster various forms of life, and in turn, our dwellings can passively work to preserve our local biodiversity. The intention is to form a mutualistic symbiosis between us and the species native to our land through housing design to create an incentive for people to cohabitation. The result will be a new housing typology that addresses the habitat requirements of other species through the design of the building envelope, while simultaneously accommodating human habitation through the design of the interior space. These symbiotic dwellings will be guided by habitat-specific design principles to ensure their provision of ecosystem services, and to avoid disrupting the natural landscape. The symbiotic dwelling will function as the center of a new ecosystem, fostering a harmonious coexistence amongst species through the addition of artificial habitats to the building envelope. By designing homes suitable for ecological cohabitation, we give ourselves the opportunity to evolve past the notion that human habitation must occur at the expense of other species' habitats, and ultimately proving that we live better together than we do apart.

Approach

The project is based in Nova Scotia, and as a starting point, the provincial list of species at risk was analyzed. The list features species of both flora and fauna organized into three categories of varying severity: vulnerable, endangered, and threatened. For the purposes of this project, only species of fauna are specifically addressed, and a special focus is placed on pollinator species such as bees, bats, and butterflies. Addressing the habitation concerns of pollinator species allows us to passively address the population concerns of flora at risk. Pollination is a crucial process in ensuring the survival of plant species, and so the loss of pollinator species heavily impacts the well-being and biological diversity of an ecosystem. Globally, the decline of pollinator species can be attributed primarily to human activity. More specifically, practices of human expansion disproportionately affect pollinating species due to the fragmentation of nectar corridors and hive destruction (Allin 2011, 134). Though pollinators are quite small, they play a major role in the web of life. The loss of a single pollinating species can lead to the extinction of various species of plants, which then contributes to the loss of more pollinating species. In the *Encyclopedia of Environmental Issues*, Craig W. Allin states, “As the plants disappear for lack of pollinators, animals such as birds, small mammals, and lizards that eat the fruit, nuts, and seeds produced by pollinated plants will also begin to starve. This effect will ripple through the food web until it reaches larger animals, including human beings” (Allin 2011, 135).

By closely researching the habitat requirements of each individual species of fauna, the list was diluted to reveal five habitat typologies: the coniferous forest, the riparian woodland, the wetland, the farmland, and the urban. By addressing these five habitat typologies, we address the habitat requirements for every species of at-risk fauna in Nova Scotia. The intention is to offer an alternative housing typology that is holistically designed to accommodate ecological cohabitation in each of these five environments. By doing so, we can ensure that the habitats of these vulnerable species are not only protected from our future housing developments but are also able to benefit from them.

The following chapters establish a set of design guidelines for habitat-specific symbiotic homes. Each of the five habitat typologies offers its own set of unique architectural constraints and challenges, but they also provide different opportunities for the symbiotic home to interact with the pre-existing ecosystems. The goal is to establish a minimally destructive way for us to coexist alongside other species on these ecologically rich sites through an ecocentric design approach. After establishing the design guidelines for the five habitat typologies, the project will expand on the guidelines established for the wetland habitat. Wetlands are amongst the most ecologically diverse ecosystems on Earth, so there is a greater urgency to protect them from our destructive developments. The result will be a home designed through an ecocentric lens to prioritize the needs of native and at-risk fauna over those of the human inhabitants.



Habitat typologies discovered through analysis of provincial species at risk.

Chapter 2: A Symbiotic Dwelling

An Ecocentric Approach

Anthropocentrism

Throughout human history, architecture and other fields of design have been primarily informed by the human experience. The anthropocentric design paradigm aims to generate a product that is in the best interest of human desire, rarely taking into consideration the implications for other species and/or the natural environment. During the 19th century, the collective objective of human civilization was to conquer the natural world, an objective deeply rooted in anthropocentrism (Acosta et al. 2012, 29). In the present day, anthropocentric design is guided not only by fundamental human beliefs of biological superiority but also by a strong culture of consumerism. Consumerism blurs the lines between human needs and wants, often leading to a liminal category of 'invented needs' (Acosta et al. 2010, 31). In relation to the professional field of architecture, catering to the 'invented needs' of humans can result in unnecessary ecological damage. For example, a client claiming they need a fully paved driveway could lead an architect to compromise the porosity of a groundwater recharge zone, and as a result, alter the local water cycle. Anthropocentric ideology is profoundly ingrained in the majority of human cultures, and as a result, it can be assumed that most humans perceive human lives as inherently more valuable than the lives of any other species (Allin 2011, 76). This ideology manifests itself in every aspect of human design, but especially in architecture. With the architect's canvas being the earth, an anthropocentric approach to design can be detrimental to the natural environment.

Biocentrism

Biocentrism holds that all living beings have intrinsic value regardless of their utility to humanity (Allin 2011, 146). The fundamental differences between anthropocentrism and biocentrism are most evident in arguments for environmental preservation. The anthropocentric view aims to preserve the environment as a means of maintaining the well-being of humanity, while the biocentric perspective aims to protect all biotic components without it being a means to an end (Rottman 2014). There are two separate origins of biocentric ideology; the desire to avoid inflicting harm on sentient beings, and the desire to preserve the purity of the natural world. The former results in a form of biocentrism that regards living beings as individual entities to be protected, while the latter results in a form of biocentrism that is less focused on the individual living beings, and more focused on the larger biotic system (Rottman 2014).

Biocentric ideology can be applied to the field of architecture in ways other than programmatic manifestation. Design decisions such as site and material selection can decentre the human experience to prioritize the well-being of other living organisms potentially impacted by the development. Ultimately, a biocentric approach to design ensures the preservation and accommodation of all living beings present on site, however, it does not necessarily account for the abiotic components within the ecosystem. In the 1970s, an attempt was made by Arne Naess to broaden the definition of biocentrism to encompass living systems as well as living beings, but biocentrists hold that moral standing cannot be assigned to living systems, only to living beings (Allin 2011, 146). This attempt ultimately paved the way for the development of an ecocentric ideology.

Ecocentrism

Ecocentric ideology expands beyond the parameters of biocentrism as it centers both the biotic the and abiotic components within an ecosystem. Ecocentrism prioritizes the health of the ecosphere over the well-being of individual species, including the human species (Rowe 1994, 4), and it holds the potential of being the most viable approach to addressing our current environmental crisis (Washington et al. 2017, 5). In *Ecocentrism and Traditional Ecological Knowledge*, Stan J. Rowe states,

> It seems to me that the only promising universal belief-system is ecocentrism, defined as a value-shift from homo sapiens to planet earth: ecosphere. A scientific rationale backs the value-shift. All organisms are evolved from Earth, sustained by Earth. Thus, Earth, not organism, is the metaphor for life. Earth not humanity is the life-center, the creativity-center. Earth is the whole of which we are subservient parts. Such a fundamental philosophy gives ecological awareness and sensitivity an unfolding, material focus. (Rowe 1994, 4)

An ecocentric approach to design would work to address the ecological reality of the site, assessing the well-being of all organisms yet transcending the needs of a single species in order to address the ecosystem as a whole (Rowe 1994, 4). In the professional field of architecture, ecocentric ideology can be manifested through designed building systems that carefully interact with the local ecosystem according to the collective needs of its biotic and abiotic components. Designing a space where humans are compelled to recognize themselves as symbiotic beings (Acosta et al. 2010, 33) will highlight the entangled interdependencies between humans and their ecosystems. Through an ecocentric design approach, the intention of the symbiotic home is to establish a housing typology that functions as the center of a new ecosystem through designed modes of mutualistic symbiosis.

Inhabiting the Liminal

The building envelope is primarily experienced as the physical barrier between the interior and exterior realms (Derakhshi 2020, 15). In the context of residential architecture, the envelope becomes a separating force between human and other. Historically, this form of biological isolation has been perceived as a desirable characteristic of human shelter despite its negative ecological impact. Over time, the liminality of building envelopes has evolved as humans seek out a closer connection to their natural environment. What was once a heavy load-bearing exterior wall is now often substituted for a light and airy curtain wall system (Derakhshi 2020, 16). This shift towards more transparent envelopes is an aesthetic manifestation of the human desire to feel connected to the natural world, however, it does little to establish a tangible physical connection. The intention of the symbiotic dwelling is to redefine the liminality of the domestic envelope as an opportunity for ecological cohabitation, rather than a mechanism for biological isolation.

Habitable Envelopes

An ecologically inhabitable domestic envelope is a defining characteristic of the symbiotic dwelling. By designing opportunities for non-human species to inhabit the envelope of the human home, the functionality of the house as a shelter can transcend anthropocentrism. Reimagining the domestic envelope as an ecological component allows for a way of merging the interior and exterior realms of the built environment. There is a significant precedent for inhabitable building envelopes designed to accommodate the human experience of architecture. The iwan, the engawa, the vernada, the porch, and the balcony are all examples of liminal spaces carved into the architectural skin to create moments of dwelling and sanctuary for humans (Derakhshi 2020, 37). There are fewer precedents of inhabitable envelopes designed to accommodate non-human species, however. By embracing the liminality of the residential envelope, we can transform that boundary between human and other into a functional ecological component. To inhabit the liminal in an ecological sense is to blend the domestic envelope outwards into the natural realm by allowing it to be utilized for non-human habitation, while simultaneously ensuring the human inhabitant can maintain a desirable level of biological isolation through the interior of the home. The following chapters will outline various habitat-specific residential envelope concepts suitable for non-human habitation.

Functional Biomimicry

The notion of transforming the domestic envelope into an ecological component is heavily dependent on ensuring that non-human species are able to identify the symbiotic home as a space suitable for their habitation. The application of biomimicry in the design process can ensure that architectural elements are able to naturally convey their suitability for ecological habitation to various species. Biomimicry refers to the creation of man-made designs inspired by the natural processes of organisms and ecosystems. This design inspiration can be derived from natural forms, systems, and characteristics, and be applied to the human context of architecture (Jamei et al. 2021). Using biomimicry, the design of the domestic envelope can subtly imitate recognizable characteristics of other species' natural habitat preferences to passively convey that this is a safe and desirable space for them to inhabit.

Architectural design can draw inspiration from nature in three main ways; by mimicking nature, by mimicking natural processes, and/or by mimicking the functional principles of ecosystems (Jamei et al. 2021). By attempting to imitate desirable habitat conditions/characteristics of various non-human species, inspiration can be drawn through all three of these ways. According to Mike Hansell, animals build their habitats with the intention of trapping prey and providing protection from predators and temperature extremes (Hansell 2005, 1). Much like human housing, animal-built structures function primarily to provide control of various conditions within the interior while simultaneously providing a buffer against the dangers of their surrounding environment. These protected structures work to attract other species, which in turn contributes to the rise of local biological diversity (Hansell 2005, 214).

The building envelope can already be perceived as a form of biomimicry due to its functional similarity to naturally occurring skin. Like skin, the building envelope is comprised of distinctive layers that react uniquely to eater, heat, pollution, and noise. These layers work to filter external elements and to maintain a constant condition within the internal space (Jamei et al. 2021). This similarity between the building envelope and the natural skin highlights the potential of an inhabitable domestic skin functioning as an ecological component.

The idea is to mimic the natural habitat conditions of certain organisms by consciously manipulating the temperature, lighting, scale, and patterns within the inhabitable domestic envelope. This includes using patterns from the natural world that are familiar and desirable to certain organisms. By approaching biomimicry from a functional and conceptual perspective rather than a purely aesthetic one that centers around the human experience, the final form of the symbiotic dwelling will be more so informed by ecocentric functionality than by traditional architectural design notions. Through this approach, we can begin to decentralize the human experience in the architectural design process and discover what it would look like to design a human home for non-human inhabitants.

It is important to recognize that there is a difference between creating space for non-human species to make their homes and attempting to create their homes for them. When we attempt to take over the natural processes within an ecosystem, we risk doing more harm than good in the long term. The intention of the symbiotic dwelling is to encourage biological diversity around the human dwelling in a minimally invasive way by creating opportunities for other species to inhabit our dwellings harmoniously alongside us.

House as the Center of Life

The notion of an ecosystem can be conceptualized in three different ways; through technical meaning, through a model, or through a metaphor (Pickett and Cadenasso 2002, 1). Ecosystems refers to the biotic and abiotic components within an environment interacting with each other in a somewhat systematic way. This technical definition can then be translated and abstracted to fit into the three dimensions of the term (meaning, model, and metaphor) (Pickett and Cadenasso 2002, 2). To establish the home as the center of life, it is necessary to first metaphorize the ecosystem of the site. The biotic components would consist of producers (plants, green algae, etc.), consumers (herbivores, carnivores, omnivores, and parasites), and decomposers (saprophytes), while the abiotic components would be water, air, soil, and sunlight. In technical terms, the building envelope would certainly be considered as an abiotic component. However, the intention of the symbiotic dwelling is to allow the domestic envelope to subtly transcend the abiotic realm into the biotic one.

Conceptually blurring the boundary between biotic and abiotic in terms of the domestic envelopes requires a clarification between living skin and skin that makes way for life. The concept of living skin implies that the envelope contains a biotic component, while the latter conveys that the envelope is inherently abiotic. Working off the notion that the envelope is a naturally abiotic component within an ecosystem, the process of blending it outwards into the biotic realm entails the development of bio-promptive design principles and methodology (that is, design elements that function to promote biological diversity). With the domestic envelope functioning to attract, foster, and encourage the growth of non-human species, the house can then become the origin of various life forms within the ecosystem of the built environment. The core objective of the symbiotic dwelling is to design for ecological cohabitation, which in its essence is the harmonious coexistence of various forms of life. It is this harmonious coexistence that will ultimately breathe life into the domestic envelope.

Mutualistic Symbiosis

The transition towards a design methodology that intentionally deprioritizes the human experience will naturally be met with human resistance. Humans have growingly become accustomed to the biological isolation provided by traditional housing developments, and as a result, there is now a certain level of discomfort attached to the notion of sharing our homes with other species. Though the symbiotic home still maintains a degree of biological seclusion, the challenge of ecological cohabitation then becomes recognizing and addressing the issue of human desirability in a way that does not inform or compromise the ecological functionality of the home. In ecology, mutualistic symbiosis refers to a type of interaction in which different species benefit from the existence of one another. The benefits can take the form of various life functions such as nutrition or protection, and as a result of this mutual exchange, these species will often choose to live in closer proximity to each other. The introduction of mutualistic mechanisms into an ecosystem can result in enhanced species diversity, ecosystem function, and overall stability (Hale et al. 2020, 9).

By designing with the intention to form interactions of mutualistic symbiosis, we can then create incentives for humans to choose ecological cohabitation over conventional forms of dwelling. The benefit to humans provided by symbiotic homes could be as simple and abstract as aesthetic pleasure, or as physically tangible as food production. Overall, mutualistic symbiosis is integral to maintaining and enhancing the biological diversity that drives ecosystems (Hale et al. 2020, 2), and it offers a way of addressing the issue of human desirability by generating incentives for humans to cohabitate with non-human species. Further, mutualistic symbiosis could be used as a method of conditioning humans to recognize the interdependencies between themselves and other organisms within their ecosystems. By generating opportunities for humans to benefit from non-human species without exploiting, controlling, or harming them, we can finally begin to make way for ecological harmony through harmonious coexistence. Regardless of this though, the concept of mutualistic symbiosis also offers a way for humans to enhance the role they play within their ecosystems while maintaining a somewhat anthropocentric world view. It allows them to engage in ecological cohabitation simply because they would benefit from it without requiring them to compromise their deeply ingrained beliefs of human exceptionalism. Whether or not designing for mutualism will be effective in altering the ecological consciousness of the human inhabitant, it will still positively impact the biodiversity of the ecosystem either way (Hale et al. 2020, 10).

Collage depicting a harmonious coexistence between human and non-human species.

Chapter 3: Guidelines for Harmonious Dwelling

Inhabiting the Natural Environment

The Coniferous Forest

Coniferous forests in Nova Scotia are capable of supporting a diverse range of plant and animal species and are therefore a vital element of the province's natural ecosystem. In these environments, coniferous trees such as pines, spruces, and firs tend to dominate the landscape and resultingly create a dense yet perforated canopy. Throughout the seasons, these forests are able to maintain their green appearance due to the evergreen foliage; however, the decomposition of the conifer needles often results in acidic soils within these environments (Killham 1990). Plants such as ferns, mosses, and wildflowers capable of adapting to these acidic soils thrive along the floor of the coniferous forest. In Nova Scotia, coniferous forests are home to various species of fauna including squirrels, deer, hares, and various avian species such as warblers and spruce grouse (Wildlife & Birds of Nova Scotia 2021; Johnsgard 2008). Additionally, the ability of these environments to absorb and store carbon dioxide helps to significantly mitigate the impacts of climate change. Overall, Coniferous forests in Nova Scotia are home to a diverse variety of both flora and fauna and have great ecological importance.

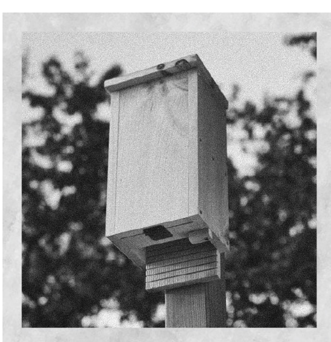
Elevated Form

When developing homes in coniferous forest environments, designing elevated forms rather than constructing directly on the forest floor has various positive ecological implications. An elevated form would allow for the preservation of existing vegetation, minimizing the disruption caused to the natural ground cover. Ground cover plants in these landscapes provide habitat and food sources for a wide variety of species, and elevated houses offer a way to maintain these intricate ecosystems despite the addition of the built form. Additionally, building away from the ground cover allows for the preservation of pre-existing wildlife movement corridors along the forest floor. Disrupting these familiar pathways may disrupt the ability of certain species to navigate through their habitats to locate food. By elevating housing developments in these environments and creating void spaces beneath the home, native wildlife can continue to move freely throughout the site without being disrupted by the presence of human habitation. An elevated form is also beneficial for the human inhabitants of coniferous forests as it provides additional protection against wildfires and flooding.

Collage depicting an elevated form.

Light Quality Preservation

The Coniferous forest floor is a delicate and unique ecosystem that is relatively dependent on sunlight. Accordingly, ensuring that the addition of a built form does not significantly obstruct the natural flow of light is crucial in preserving the quality of light within the landscape. Understory plants in coniferous forests play a crucial role in providing food and habitat for a wide range of species, so minimizing the light disruption caused by human developments is significant in maintaining the ecological balance. Building in generally shaded areas rather than areas directly under a significant canopy opening would be ideal to maintain the unique mosaic of flora. The general form and roof type can play a crucial role in the way the building either disrupts or disperses natural light. A steep gable roof with no overhang, for example, would allow for significant sunlight penetration to reach the ground cover. Further, large windows are also effective in improving light penetration through the built form to the forest floor, however, clear and reflective glass should be avoided in order to minimize bird-window collisions. Light quality preservation in this type of environment should be carefully addressed during the design process in order to maintain the overall health of the ecosystem and minimize the ecological disruption typically associated with human development.

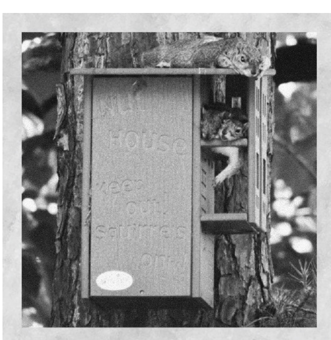


Photograph of a typical wooden bat box (Perrett and Perrett, 2019)

Bat Boxes

The addition of bat boxes to otherwise anthropocentrically designed homes could potentially provide various benefits to both the human inhabitant and the overall ecosystem. In Nova Scotia, there are currently three different species of bats at risk; the Little Brown Myotis, the Tri-coloured Bat, and the Northern Myotis. The inclusion of bat boxes when developing homes in coniferous forests provides additional shelter and resting spaces for these vulnerable bat species, compensating for the potential loss or destruction of their natural habitats. By providing safe and secure spaces for bats to live and reproduce, bat boxes help maintain bat populations in human-dominated landscapes. Regarding the benefits bats may provide for the human inhabitants of a site, pest control is a significant advantage. Bats typically consume insects at a large scale, such as moths and mosquitos (Ducummon 2000, 1; Riccucci and Lanza 2018, 161). This reduces the need for chemical pesticides, and resulting, maintains a balanced ecosystem by minimizing the implications of harsh chemicals on other species on site. Additionally, some bat species are effective pollinators, and a diverse variety of plant species rely on bats for seed dispersal. Typically, bat boxes are constructed using wood and are generally 17 inches wide by 2 inches tall. These boxes should ideally be situated facing either east, south, or west for proper solar exposure, and should also be shielded from harsh lights or high winds (“Building Homes for Bats” 2015, 3-11). Overall, the addition of bat boxes to constructed human habitats is a subtle way of mitigating the bat habitat destruction typically caused to our development.

Squirrel Houses



Photograph of squirrel house (JCs Wildlife, 2022)

Similar to bat boxes, squirrel houses are another effective method of compensating for the habitat destruction our anthropocentric housing developments may cause in coniferous forest environments. Squirrels are fairly prevalent within Nova Scotia coniferous forests, and they play a crucial role in their regeneration. As they bury and store seeds and nuts, they inadvertently plant them as they frequently forget to retrieve them later on. This process results in the dispersal of seeds throughout the forest which promotes the natural regeneration of various species of flora (Goheen and Swihart 2003, 1637). Squirrel houses are constructed quite similarly to birdhouses, with the major difference being the location of the entrance. Rather than a circular entrance at the front of the form, squirrel houses typically have openings towards the top sides for easier access while climbing trees. By incorporating these nesting boxes into the residential design, the human inhabitants are able to foster a harmonious coexistence with the wildlife surrounding them.

The Riparian Woodland

The riparian woodlands of Nova Scotia are crucial ecosystems responsible for maintaining water quality and providing habitat for a diverse variety of species. These environments are characterized by their close proximity to watercourses such as streams, rivers, or wetlands, and as a result, they often maintain high moisture levels. Riparian woodlands are essentially defined as areas of transition between aquatic ecosystems and wooded ecosystems (Stacier 2005, 3). Consequently, they are capable of fostering a wide range of species due to the diversity of natural habitats they provide. These transitional spaces also function as transportation corridors for native wildlife. When building within these environments, it is crucial to carefully preserve these biologically rich zones of elemental transition. The overall significance of these ecosystems is largely centred around water. Vegetation within the watercourses of riparian woodlands assists with filtering runoff by reducing pollutants and sediments and ultimately improving the quality of water. Common flora within these environments are Red Maples, Yellow Birch, White Pine, and Black ash. Regarding wildlife, riparian woodlands in Nova Scotia are home to a diverse variety of species such as Beavers, Otters, Wood Ducks, Pileated Woodpeckers, Barred Owls, Eastern Wood Pewee, Veery, and Muskrats (Stacier 2005, 3; Beazley and Cardinal 2004, 94).

Reduction of Impervious Surfaces

When building in riparian woodland environments, reducing the amount of impervious surfaces used and maintaining the general permeability of the ground cover is a top priority. Impervious surfaces often used in traditional housing developments, such as concrete sidewalks and driveways, disrupt the natural water cycle by preventing rainwater from infiltrating into the soil underneath. Natural infiltration of rainwater directly into the soil allows for the removal of contaminants and in turn, replenishes groundwater systems. When an impervious surface covers soils, rainwater will quickly run off these surfaces and collects contaminants along the way before finally reaching a water body, which is not favourable. One alternative approach is to implement elevated pathways or boardwalks to minimize the disturbance caused to the natural permeability of the forest floor. Another alternative is using permeable paving systems rather than traditional poured concrete. Overall, the reduction of impervious surfaces in human developments within these ecologically rich environments can help to preserve the health of the ecosystem and in turn, benefit the local wildlife.

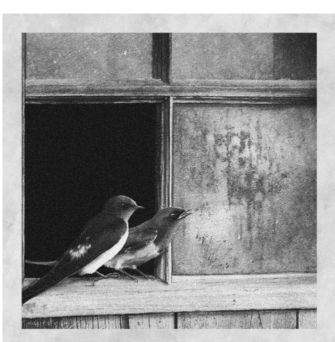
Photograph of elevated walkway (Graana, 2021)

Building Away from Water

In riparian environments, protecting aquatic habitats and the overall water quality from our housing developments is crucial. Building too close to bodies of water may result in the water pollution or the disturbance of aquatic ecosystems due to runoff from the impervious surfaces of the home. By positioning buildings far away from significant water bodies, we can begin to minimize the direct introduction of pollutants and preserve the natural quality of water within these landscapes. Additionally, these areas of elemental transition within riparian woodlands are often rich in biodiversity as they provide habitats for a wide variety of aquatic and terrestrial species. Building away from these ecologically rich zones minimizes the fragmentation of natural habitats typically associated with human development. Further, building too close to riparian water bodies may disrupt natural hydrological processes by altering natural water flows, decreasing the water quality, and even increasing flood risks due to altered drainage patterns. By maintaining a sufficient setback distance when developing in riparian woodland environments, we can minimize disturbance to aquatic species, preserve the natural water quality, support natural hydrological processes, and preserve riparian habitats.

Nesting Ledge

Human development in riparian environments can easily result in a significant loss in biodiversity and, more specifically, it can pose a great threat to local avian species. The inclusion of resting ledges in the design of our homes can create opportunities for avian species to interact with the built form in a more positive way. These ledges can physically manifest in a wide variety of ways, including roof overhang ledges, protruding floor slabs, protruding stairs, railings, or protruding window frames. Designing opportunities for avian resting ledges could provide essential



Photograph of birds resting on window ledge (Vest, 2013).

perching spaces for local birds. Further, resting ledges offer avian species a vantage point for spotting potential predators, and also function as alternative nesting sites to support avian reproduction. Resting ledges work to mitigate the limitations imposed by the loss of natural nesting sites due to our traditional housing developments. Overall, the inclusion of this inhabitable envelope component makes way for ecological cohabitation among humans and a wide variety of avian species.

Nesting Boxes

Unlike resting ledges, nesting boxes can provide private enclosed spaces for various species of fauna including owls, lizards, and frogs. These artificial nesting sites can help in compensating for the loss of natural habitat due to anthropocentric developments. Additionally, they provide protected and secure areas for various species to construct their nest and raise their young. Nesting boxes also offer protection against harsh weather conditions, predators, and human disturbances. By including nesting boxes within the design of the residential envelope, human inhabitants are able to increase the availability of local suitable nesting sites and as a result, support the successful reproduction of a wide variety of native species. Nesting boxes are also effective in promoting species diversity, as their design can generate habitat diversity and therefore attract a wider variety of species.

The Wetland

Wetlands can be defined as areas of ground that are continuously saturated with still or flowing water, either naturally or artificially. Typically, a wetland will remain wet long enough for vegetation and the presence of various organisms to develop (Muchamad and Mentayani 2011, 2). Wetland environments generally contain a significantly high level of biological diversity (Muchamad and Mentayani 2011, 3), including many wetland-dependent species. As a result, there is a distinctively rich biota that is only associated with wetlands due to their highly productive biological and ecological functionality (Gibbs 2000, 314). It has been estimated that since 1700 AD, approximately 87% of naturally occurring wetlands have been lost on a global scale. Over the 20th and early 21st century, this loss of natural wetlands has accelerated by 3.7 times as we continuously drain and in-fill these saturated environments for our agricultural, urban, and infrastructural developments (Davidson 2014, 934). This ecologically devastating loss is largely a result of destructive human practices that seek to conquer and control the natural environment and as a result neglect the potential of a harmonious coexistence between humankind and nature.

There are various functions associated with wetlands, some of which are groundwater recharge, groundwater discharge, flood control, shoreline stabilization/erosion control, sediment/toxicant retention, nutrient retention, biomass export, storm protection/windbreak, micro-climate stabilization, water transport, and recreation/tourism (Dungan 1990, 14-20). The relationship between wetlands and groundwater systems is of particular interest given that 45.8% of Nova Scotia’s population is dependent on groundwater as their primary source of drinking water. Other provinces such as Prince Edward Island and New Brunswick are significantly more dependent on this resource, with 100% and 66.5% of their populations dependent on groundwater systems respectively (Rutherford 2014, 4). Though groundwater systems are supposed to be naturally renewed through the water cycle by using areas like wetlands as recharge zones, the accelerated over-extraction performed by humans has classified groundwater as a non-renewable resource. In addition to regulating the water supply in nature, wetlands also systemically function as mechanisms for keeping the environment clean and balanced. The community of flora within wetlands prevents various toxins from entering the water supply by absorbing and breaking down contaminants ("Nova Scotia Wet Places" 2018). There is a long-term precedent for the conversion and degradation of natural wetlands for the perceived benefit of humanity (Davidson 2014, 939), however, the conservation of wetlands plays a crucial role in tackling our current global environmental crisis and protecting wetland-dependent organisms (Gibbs 2000, 314).

In Nova Scotia, wetlands make up approximately 15% of the province's total land area and are home to numerous species of flora and fauna. Wetland environments generally provide rich food and shelter opportunities for wildlife and are often regarded as safe places for them to start new life. Many species of birds, fish, and amphibians utilize wetland habitats as nurseries where they can make their nests and raise their young due to the abundance of food and environmental protection. Some native species of fauna such as beavers, wood ducks, four-toed salamanders, water boatmen, American bitterns, muskrats, and painted turtles are dependent on wetlands for their survival. Further, some species of flora such as the sundew, cattail, pitcher plant, and bulrush easily thrive and grow in excess within wetland environments. Other species like the little brown myotis, moose, deer, green-winged teal, northern ribbon snakes, and sticklebacks will often forage in Nova Scotia wetlands ("Nova Scotia Wet Places" 2018). Overall, the immense biological diversity that wetland environments are capable of fostering is indicative of their ecological significance.

Lightweight Dwelling - Native Wisdom from Indonesia

Due to the ecologically rich nature of wetland habitats in Nova Scotia, developing these environments should only be considered an absolute last resort. If development is necessary, looking at Indonesia for native wisdom on sustainable wetland housing would be an ideal place to start. The people of Indonesia have grown accustomed to living harmoniously with wetlands given that the country contains 47% of the world's total wetlands, making it one of the largest wetland contributors globally (Nyssa et al. 2022, 625). Their key objective when building on wetlands is to minimize the disturbance of water circulation caused by the house (Muchamad et al. 2010, 4). This is achieved by elevating the house off the wetland using stilt construction, typically comprising local wood (Nyssa et al. 2022, 631). Rather than attempting to conquer the site, the natives of Indonesia, specifically the Banjarese, consciously avoid sacrificing 'space' on the wetland to ensure the water remains capable of flowing freely (Muchamad et al. 2010, 5). Using this native wisdom, these stilt houses are capable of sustainably lasting hundreds of years in wetland conditions (Nyssa et al. 2022, 626).

Photograph of stilt house in Indonesia (Nomad Architecture, 2020)

There are two main types of foundations used for the construction of these stilt houses: pedestal foundations and pile foundations. A pedestal foundation is typically used in the earthquake-prone regions of Indonesia as it is more suitable for handling horizontal loads, while a pile foundation

Collage depicting a lightweight dwelling.

is better capable of handling soft soils within the wetland (Nyssa et al. 2022, 628). Further, the construction of native Indonesian stilt houses prioritizes systems of construction that provide ease of repair and maintenance processes. Aside from their long-term durability, these stilt houses are also considered highly environmentally friendly and effective in encouraging the harmonious coexistence of humans and natural wetlands (Nyssa et al. 2022, 631). A symbiotic home in the wetland habitat should follow an elevated stilt structure similar to the ones used by natives of Indonesia to avoid disrupting the natural circulation of water. Further, an elevated form ensures that the addition of the home does not take away opportunities for non-human species to utilize the portion of wetland covered by the house.

Enhanced Glass Visibility for Avian Species

Aside from habitat destruction, window collisions are the second largest human cause of avian mortality globally (Klem 2008, 244). These fatal collisions are largely attributed to the use of transparent and/or reflective glass panels in man-made structures that appear unobtrusive to various species of birds (Klem 1989, 606). In Canada, it is estimated that approximately 25 million birds are killed annually due to window collisions, with 90% of these fatalities being caused by houses (Machtans et al. 2013, 1). These statistics surrounding bird-window collisions are a clear demonstration of the direct role architecture plays in the mortality of non-human species. The visibility of glass panels to avian species should be a conscious consideration in all housing developments, however, it is especially significant when developing wetland habitats. Wetlands are one of the most productive ecosystems for avian species (Kushlan 1989, 693), and as verified in Daniel Klem's 1989 study, environments with an increased bird density will typically experience a higher frequency of fatal bird-window collisions (Klem 1989, 619).

In Daniel Klem's 1989 study of bird-window collisions, there were no recorded collisions between birds and opaque or stained-glass windows (Klem 1989, 613). The issue appears to stem from the inability of birds to identify transparent or reflective glass panels as obstacles, causing them to perceive domestic windows as clear openings rather than barriers (Klem 1989, 606). The common method of combating this concern has been to use tinted, stained, frosted, or patterned glass in place of conventional transparent and/or reflective glass. While effective, one shortcoming of this method is that it compromises the quantity and/or quality of light delivered to the interior of the home. There are ample design opportunities to find ways of continuing the use of transparent and reflective glass panels in domestic design without endangering the lives of avian species. Some methods of achieving this are as simple as angling the glass panels downwards to reflect the ground rather than the sky to enhance visibility for birds (Machtans et al. 2013, 12). Other methods may include more intricately designed obstructions in front of the glass panel to differentiate it from a clear opening. Regardless of the design approach, a symbiotic home built in a wetland habitat has a crucial responsibility to ensure the protection of avian species from potential window collisions.

Constructed Wetland Roofs

A constructed wetland is a man-made ecosystem intended to mimic the biogeochemical cycles that occur within natural wetlands. Though constructed wetlands have primarily been used for their water purification capabilities, they also provide habitat for various species and in turn are an effective method of mitigating biodiversity loss (Vol et al. 2019, 40) (Zhang et al. 2020, 2). The loss or degradation of a natural wetland can be detrimental to an ecosystem, and especially to wetland-dependent species. Constructed wetlands offer a way to offset the negative ecological impacts associated with the loss of natural wetlands to a certain extent. In some circumstances, the biodiversity found in these artificial environments has been documented as comparable to the biodiversity found in natural wetlands (Zhang et al. 2020, 3). In recent years, constructed wetlands have been used within green roof systems for their significant thermal benefits. Constructed wetland roofs are efficient in decreasing roof temperatures due to the high rates of evaporation typically associated with wetland flora. In addition to providing thermal benefits, wetland flora is also capable of acting as a carbon sink due to the high biomass they accumulate (Song et al. 2013, 141).

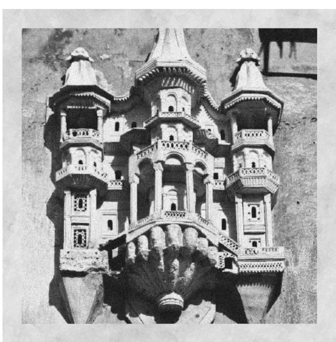
When building in a natural wetland environment, maintaining other species' access to water should be a priority to avoid habitat fragmentation. Even with an elevated building form, avian species may be restricted or discouraged from utilizing the wetland space under the built form. Constructed wetland roofs offer a way of mitigating this loss of natural space caused by the presence of architecture for avian species. Although the addition of a constructed wetland roof in a natural wetland environment offers an interesting element of wetland mitigation, constructed wetland roofs would also greatly benefit any type of environment. Specifically, dry environments stand to gain the most from

Collage depicting a constructed wetland roof.

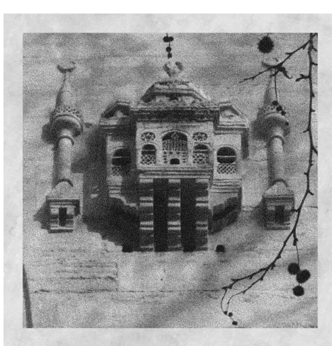
the addition of constructed wetlands in terms of biological diversity as the new habitat diversity will work to attract more species (Wiegleb et al. 2017, 566). Overall, the addition of a constructed wetland to a green roof system is an easily manageable low-cost, and low-energy consumption method of providing additional non-human habitat opportunities through the domestic envelope (Zhang et al. 2020, 2).

Avian Shelter Within the Facade - Ottoman Microarchitecture

During the 16th century, Ottoman architecture began to provide artistically sculpted shelters for avian species often referred to as bird palaces. Bird palaces typically took on the appearance of an ornamental façade element and could commonly be found decorating public buildings such as schools, inns, and libraries (Tunay 2016, 147). More specifically, bird palaces were a staple element of 18th-century mosque architecture within the Ottoman Empire. It has been speculated that these avian shelters were a response to a famous hadith in which the Prophet Muhammad S.A.W states: "there would enter paradise people whose hearts would be like those of birds." This consciousness of birds as soft-hearted beings likely resulted in the intricate and beautifully sculpted bird palace designs that were built as early as 1380 (Gruber 2021, 1-2). These microarchitectural avian habitats were widely spread throughout the ottoman empire even though they do not provide any tangible benefit to human beings. They are believed to have been sculpted primarily out of compassion for avian species (Özen 2012, 1) and can thus be considered a manifestation of ecological egalitarianism.



Photograph of bird palace in Turkey (Cangül, 2017)



Photograph of bird palace on an Ottoman facade (Betul, 2022)

Wetland environments are considered one of the most ecologically productive habitats for avian species (Kushlan

1989, 693). Accordingly, new housing developments in wetland habitats should intend to maintain or enhance the desirability of the site for various bird species. The designed integration of avian shelter within the domestic façade may ensure the continued presence of avian species on the site as well as provide diverse habitats to attract new species. The design of these avian shelters does not require the high level of artistic complexity displayed in the ottoman bird palaces to ensure their success as inhabitable building components. The design can be as simple as a sheltered nook or an opening to a wall cavity, the overall intention is to provide a wide variety of habitable spaces that would be desirable to avian species. The ecological benefits of designed avian shelters within the domestic façade are not limited to wetland habitats, this form of ecological cohabitation could also be applied in coniferous forests, riparian woodlands, farmlands, and urban environments.

Inhabiting the Anthropocentric Environment

The Farmland

The intensification of agricultural practices has been noted as the primary cause of biodiversity loss in farmland habitats over the past half century (Brenton et al. 2003, 182) (Fahrig et al. 2015, 220). This ecological degradation can be attributed to the large quantity of land typically required for agricultural practices, as well as the vigorous magnitude of environmental manipulation and use of pesticides currently inherent to our farming methods. Further, it is unfortunate that the most desirable areas for agricultural use are often also the most critical and productive environments for non-human species (Mineau and McLaughlin 1996, 106). On a global scale, intensive agricultural practices pose a threat to approximately 60% of red-listed birds and amphibians (Fahrig et al. 2015, 220). The process of converting arable environments to productive farmlands has traditionally involved the uniformization of the landscape. Land uniformization is inherently unnatural and typically results in habitat fragmentation for various non-human species. In the farmland environment, heterogeneity is a crucial component in mitigating the decline in biological diversity. In this context, heterogeneity refers to a large variety of habitat types, scales, locations, and conditions. In essence, maximizing the diversity of habitat types provided by a site allows for a higher diversity of species capable of inhabiting the site (Benton et al. 2003, 185).

There are currently two opposing methods for ensuring heterogeneity within the farmland environment: taking portions of land out of production and transforming them or altering the size of the crop fields and focusing on boundary conditions. The first method has been shown to significantly enhance the biological diversity within farmland habitats in North America. The simple notion of pulling land out of agricultural production and setting it aside for other species to inhabit has provided great hope in reversing or at least halting declines in farmland biodiversity that have been observed for several decades (Buskirk and Willi 2004, 1), however, it may not be a financially feasible approach for many farmers. The second approach aims to enhance the configurational heterogeneity of cropped areas within the agricultural land to increase the number of field boundaries that act as potential habitats for non-human species. Enhancing the diversity of field boundary conditions has been shown to benefit various species groups such as birds, plants, and invertebrates (Fahrig et al. 2015, 223). Altering the spatial layout of crop fields to increase configurational heterogeneity offers farmers a way to enhance species biodiversity without compromising the amount of land used for agricultural production.

Though anthropocentric agricultural practices can account for a significant portion of biodiversity loss in recent decades (Benton et al. 2003, 182), It is humans that are most reliant on ecosystem services, such as farmers, that are most at risk for being negatively impacted by this biological decline (Diaz et al. 2006). The erosion of habitat heterogeneity caused by land uniformization in these inherently ecologically rich environments has been documented as being the primary ecological concern. Habitat heterogeneity provided through either the addition of set-aside agricultural land or the spatial configuration of existing crop fields is crucial in maintaining and increasing the biological diversity found within farmland environments (Benton et al. 2003, 186). The addition of housing developments on these ecologically degraded landscapes requires a conscious approach to restoring heterogeneity to the site.

Compositional and Configurational Crop Field Heterogeneity

The intensification of agricultural practices is a major driver of biodiversity loss largely due to the homogenization of productive farmlands (Tscharntke et al. 2021, 919). In farmland environments, methods of creating landscape heterogeneity that focus on the restoration of semi-natural elements are not always economically feasible for farmers (Alignier et al. 2019, 654). An alternative solution that does not significantly impact the economic nature of agricultural production is diversifying the crop field mosaic. Regarding crop field diversity, a distinction is made between compositional heterogeneity and configurational heterogeneity. Compositional heterogeneity refers to diversity within the planted crop types, while configurational heterogeneity refers to diversity within the spatial arrangement of the field (Alignier et al. 2019, 655). Both forms of crop field heterogeneity hold the potential of multiplying the biodiversity found in conventional agricultural landscapes without impacting the productivity of the cropland (Tscharntke et al. 2021, 919).

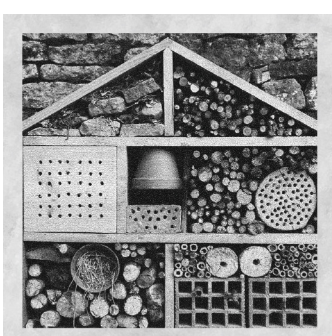
Field boundaries play a critical role in providing habitat for non-human species in farmlands, especially in the Canadian context. Predatory insects are often unable to survive through Canadian winters in open cultivated fields, but crop field boundaries offer them refuge and can impact the density of these insects in the spring (Mineau and McLaughlin 1996, 101). Configurational heterogeneity is effective in increasing biodiversity because it increases the amount of field boundary conditions in the farmland and resultingly increases habitat opportunities for non-human species. Field boundaries can take the form of hedges, grass margins, field corners, drystone walls, or ditches, each of which offers unique habitat opportunities for a wide variety of species including birds, lichen, aquatic wildlife, insects, amphibians, and small mammals (“Field Boundaries”). In the crop field mosaic, smaller crop fields typically contain a richer biological diversity than larger crop fields. It is hypothesized that this is a result of easily accessible field boundary habitats within smaller crop fields being more desirable for inhabiting species (Fahrig et al. 2015, 223). Overall, the implementation of compositional and configurational heterogeneity within crop fields offers a way of increasing species diversity within the farmland environment without requiring farmers to take land out of production (Alignier et al. 2019, 654).

Parametric Facades for Habitat Heterogeneity

Due to their customizable design, parametric facades offer unique opportunities to create habitat niches for a wide variety of non-human species. These façade systems can be used to create artificial habitats that use functional biomimicry to attract and shelter native species. By integrating ecological design elements such as perching spots, nesting cavities, and even foraging opportunities within the design of the façade, the built form can begin to compensate for the loss of habitat heterogeneity typically associated with traditional agricultural practices. Parametric facades can also include features such as vertical gardens, flowering places, and insect-friendly structures to support insects and pollinators crucial for farmland environments. These heterogenous façade systems can work to promote the enhancement of local biodiversity within farmland environments by creating a magnitude of habitat niches within the domestic envelope.

Insect Hotels

The addition of insect hotels to otherwise anthropocentrically designed homes may help in mitigating the habitat loss caused by their development. Insect hotels are wooden structures with a wide variety of hole sizes to create habitat opportunities for various insects. These structures are constructed by using materials such as pine cones, hollow stems, straws, twigs, bamboo canes, wood chips, bark, or corrugated cardboard to create a diverse array of nesting cavities. Insect hotels provide refuge for endangered insect species within farmland environments by creating safe sheltered spaces for them to hibernate and nest. Insects

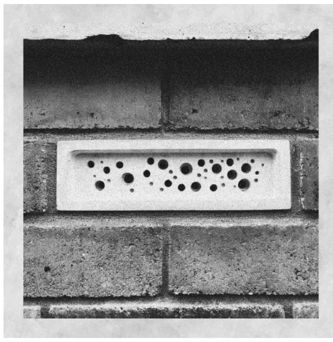

Photograph of insect hotel
(Domoney, 2014)

Collage depicting insect hotel facade panels.

such as ladybugs, beetles, butterflies, spiders, solitary bees, butterflies, moths, lacewings, and earwigs are all able to make use of the nesting cavities found throughout typical insect hotels. In general, insects place a significant role in farmland ecosystems as they contribute to pollination as well as natural pest control. Incorporating insect hotels within the domestic envelope is a practical method of mitigating the destruction caused to their natural habitats by human development.

Bee Bricks

In farmland environments, bees play a crucial role within their ecosystems as they are the primary pollinators of agricultural crops (Shaw et al. 2022, 285). Bee bricks offer a simple way to incorporate habitat for solitary bees within the domestic envelope by providing safe and appealing



Photograph of a bee brick (Green&Blue, 2022)

nesting spaces for them. Solitary bees are better fit to live alongside humans as they do not produce honey and are a non-swarming species. Given that these bees have no honey to protect, their presence around humans and our domesticated pets pose very little threat (Shaw et al. 2022, 289). Each brick provides 18 nesting cavities for solitary bees, and can easily be incorporated within the building façade to promote local biodiversity (Shaw et al. 2022, 290-92). Solitary bees are able to provide efficient pollination services in farmland environments, benefiting both agricultural crops and wild flora. The inclusion of bee bricks in masonry farmland homes can greatly benefit both the human inhabitant as well as the overall ecosystem.

Photograph of a bee brick (Green&Blue, 2022)

The Urban

Like most other urban areas, the urban environments within Nova Scotia are heavily altered by human developments to accommodate for our modern way of life. As previously discussed in Chapter 1, the way in which we currently approach urban developments often results in habitat fragmentation, the spatial displacement of native species, and often even the complete destruction of ecosystems. These urban landscapes may alter the natural hydrological processes of their ecosystem due to the increase of impermeable surfaces and altered water drainage patterns. In Nova Scotia, our urban environments often attempt to reintroduce natural elements in small ways through way of greens paces such as gardens and urban parks. Biodiversity conservation efforts are often made to preserve these green spaces and to use native plants in urban landscape strategies. Regarding wildlife, urban environments in Nova Scotia primarily attract and foster raccoons, pigeons, starlings, and deer mice (Wildlife & Birds of Nova Scotia, 2021). When building for human habitation in these environments, ecological cohabitation efforts should make an effort to attract new native species to the landscape to enrich the overall local biodiversity.

Reduced Light Pollution

Light pollution can negatively impact numerous non-human species by disrupting the natural light-dark cycle. More specifically, avian species were shown to wake up earlier than usual and get less sleep on average due to the pollution caused by artificial light (Raap et al. 2015, 1). In urban environments where light pollution is already quite prevalent, it should be a priority to minimize these disturbances to non-human species in future developments. There are numerous ways to reduce light pollution within the architectural context, such as opting for motion sensor lighting, positioning light fixtures downwards rather than upwards to minimize light spillage, or selecting warm-coloured low-intensity lights rather than intense cool-toned lighting. There are also ample design opportunities in regard to minimizing light disturbances by designing shielded outdoor lighting and/or unique window treatment systems. Aside from preserving sleep quality for local non-human species, reducing light pollution in developed urban environments also helps to create dark corridors and pathways that could potentially reconnect fragmented habitats.

Addition of Water Features

Water features provide vital habitat opportunities for various species and work to attract more wildlife to a site. The addition of water features to housing developments can contribute to the restoration of urban species diversity in Nova Scotia. These water features can take the form of constructed wetlands, fountains, ponds, birdbaths, rainwater harvesting systems, waterfalls and cascades, or any small water body that creates an aquatic habitat to support an array of flora and fauna. Water features can also be strategically placed to act as biodiversity corridors and connect fragmented habitats within urban environments. Further, the addition of water features can also contribute to the creation of a microclimate that can help moderate temperatures during hot summers. This microclimate would also support a wider range of both aquatic and terrestrial species and positively impact the health of the overall ecosystem.

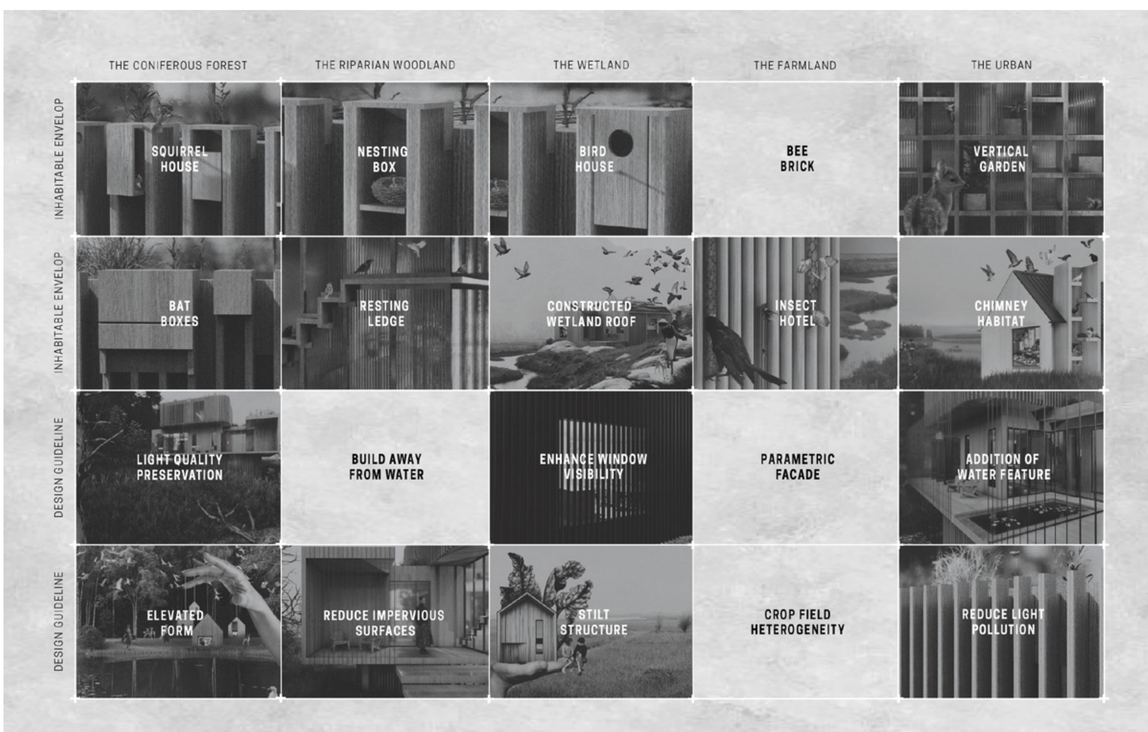
Chimney Habitat

Traditional chimneys have long provided nesting opportunities for various non-human species such as birds, bats, and raccoons. Chimneys typically provide safe and secure spaces for these species to dwell, nest, and raise their young. While traditional functioning chimneys are effective in attracting and maintaining avian populations, non-functional chimneys can also be incorporated into the residential design specifically to promote this biological diversity. Chimney-like structures can be designed to incorporate nesting ledges and/or boxes to enhance their overall habitat heterogeneity and resultingly serve a wider variety of non-human species. These chimneys can also be designed with openings for the human inhabitants to place food and other resources for the inhabiting species. By enhancing these architectural elements that are already familiar and commonly used by non-human species, housing developments in urban environments can begin to compensate for the destruction of natural habitat opportunities they cause for these species.

Collage depicting a chimney habitat section.

Vertical Garden

Vertical gardens can provide ample benefits for the overall health of an ecosystem, including the creation of new habitats and the introduction of new food sources for non-human species. By utilizing the vertical surface of the residential building envelope such as walls and fences, these gardens can function as nesting sites, provide shelter, and create foraging opportunities for a wide variety of species. Nectar-producing flowers can be planted to attract and maintain the presence of pollinators such as butterflies and bees, which would resultingly enhance the diversity of local flora. Select berries and vegetables can also be planted to feed animals such as deer, birds, squirrels, hares, or raccoons. Vertical gardens may also assist in improving air quality by filtering harmful pollutants and releasing oxygen. These gardens can take the form of living walls, rooftop gardens, green facades, or hanging gardens. The addition of vertical garden systems within residential developments can allow urban spaces to support a harmonious coexistence between humans and various other species.

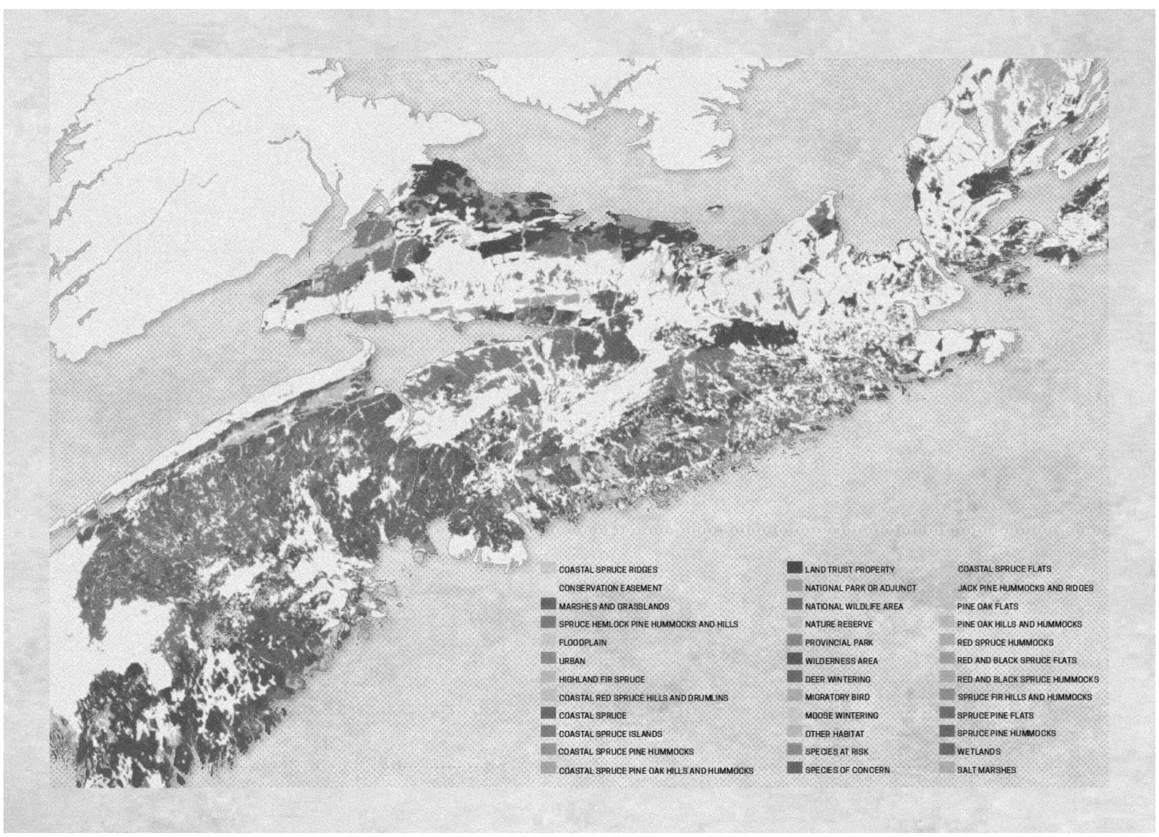


Design grid illustrating the contents of Chapter 3 included within the design.

Chapter 4: Design

The Site

The site selection process began with identifying and mapping out specific characteristics of interest across Nova Scotia. Geographic data such as the location of groundwater regions, wetlands, salt marshes, wells, ecological land classifications, provincially protected areas, and locations of species at risk were individually mapped out and later overlayed to reveal an ideal site to test the hypothesis of this thesis. Using the information displayed through the overlay map, a set of site selection typologies was then established to guide the selection process, with each typology offering a unique narrative for the design.



Overlay map used for site selection. (Government of Nova Scotia, 2002; Government of Nova Scotia, 2015; Government of Nova Scotia, 2016; Government of Nova Scotia, 2022a; Government of Nova Scotia, 2022b; Government of Nova Scotia, 2023)

The first typology is defined as Bare, referring to locations void of groundwater, wetlands, salt marshes, floodplains, significant species, and protected lands. Additionally, locations with a Bare typology hold an ecological land classification of ‘Urban’. A bare site would likely be lacking in biological diversity as it would not possess the ecological features required to foster a wide variety of species. Selecting a site within this typology would create a narrative of restoration for the project, as the focus would be placed on repairing the land and attracting new species. The second typology is Rich, referring to locations containing groundwater regions, wetlands, or floodplains. Locations that fall into this typology would not hold an ecological land classification of ‘Urban’ or contain any significant species of concern. Ideally, areas of this typology would be protected on a provincial level. A site that meets this set of criteria should, in theory, be capable of fostering a large variety of non-human species. Selecting an ecologically rich site would create a narrative of preservation for the design, as the focus would be placed on maintaining the biological diversity on the site. The third typology is Critical, which refers to areas with rich ecological land features that contain the presence of significant species of concern and

Habitat selection typologies.

Bog/fen wetland region.

additionally, are desirable for future housing developments. This desirability can be quantified by the site’s proximity to other built infrastructure, ease of access to nearby goods and services, significant views, and so forth. Selecting a site that falls into this typology would create a narrative of interventive conservation for the design, as the focus would be to enhance the biological diversity already present on the site through the addition of a built form. Creating this narrative of interventive conservation is closely aligned with this project’s overall goal of finding ways to mitigate the biodiversity loss and ecological damage that is often brought forth by new housing developments.

Spruce pine hummock region.

Though various sites throughout Nova Scotia meet the criteria for the critical typology, precedence was given to locations closest to the urban center. Proximity to the provinces’ urban core is used as an indicator of perceived desirability for future housing developments, which would enhance the critical status of the site. Through analysis of the overlay map, the most viable site was selected based on a critical site typology and close proximity to the urban center. The selected site is located in Waverly, Nova Scotia along Ridge Avenue. Aside from the location’s close proximity to the urban center, the site may be perceived as highly desirable for future housing developments due to the unobstructed view of Lake William it would offer. On a larger scale, the site marks an intersection between a wetland, a coniferous forest, a riparian woodland, and a suburban community. This unique intersection of habitat typologies creates the ideal testing ground for ecological cohabitation through a symbiotic dwelling. On a more focused scale, the site comprises a fen/bog, is a bedrock groundwater region,

Species of concern in Lake William

Site plan of Ridge Avenue, Waverly, Nova Scotia. Base map by Ben Cottrill.

and is a primary watershed flowing in the direction of the Bay of Fundy (Nova Scotia Groundwater Atlas).

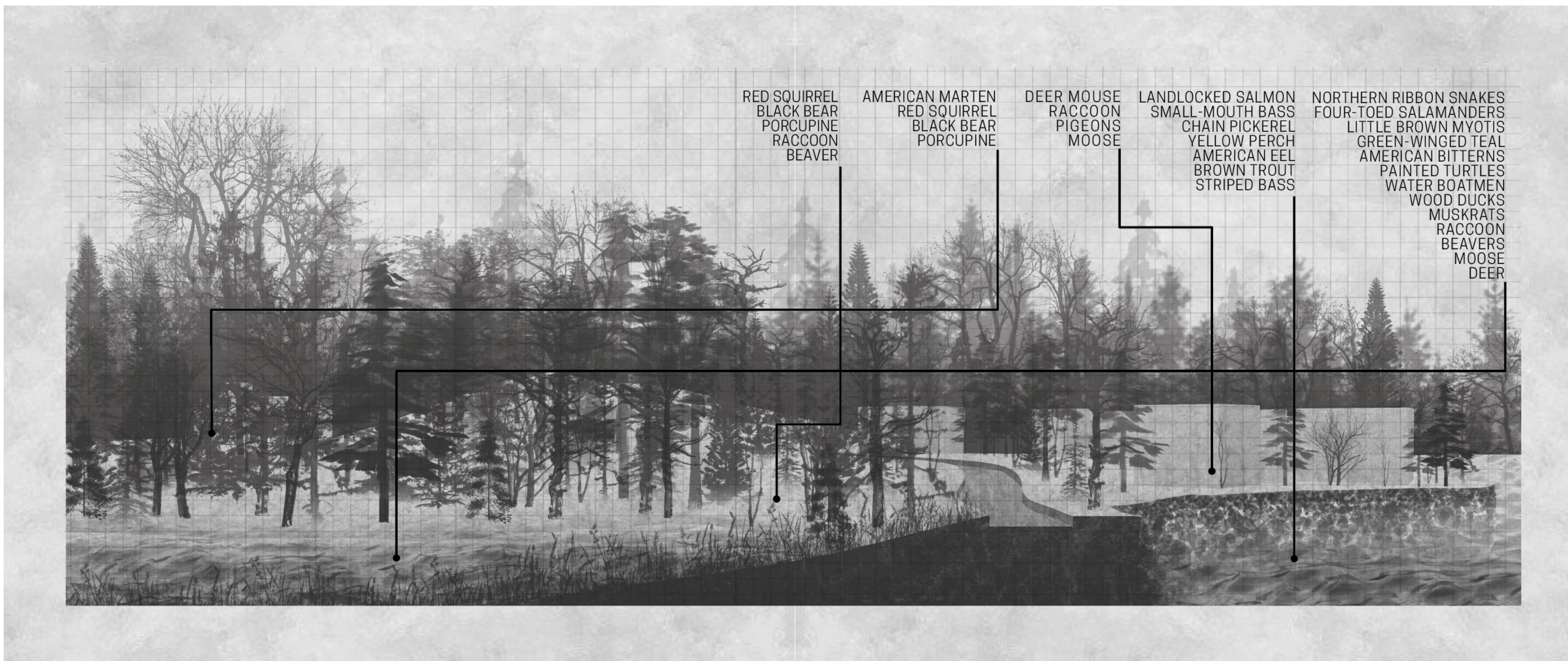
On a general level, wetlands in Nova Scotia are capable of fostering various forms of fauna including, amphibians, insects, rodents, reptiles, birds, and mammals (Wildlife and Birds of Nova Scotia). Regarding the biological diversity on site, this wetland is home to a wide variety of species of both flora and fauna. During site visits, a photo journal was kept to document the diversity of species observed throughout the seasons. The coniferous forest bordering the east of the wetland is comprised of a spruce pine hummock and is home to a wide variety of mushrooms. The moist environment created by the nearby wetland makes this forested area especially favourable for the development of fungi. Generally, coniferous forests in Nova Scotia are known to be home to animals such as red squirrels, porcupines, American martens, and black bears (Wildlife and Birds of Nova Scotia). Toward the south end of the wetland, there is a stream that connects the wetland to the coniferous forest. Along this stream, there appear to be the beginnings of a beaver dam, with various animal-made wooden shelters lining the nearby forest ground. Along the perimeters of the paved road and the adjacent stream, salamanders can often be spotted foraging for food. These observations are especially significant as the presence of salamanders is a great indicator of the health of an ecosystem. Overall, the site is extremely rich in biological diversity and as a result, it is an overwhelmingly beautiful landscape worthy of interventive conservation.

The Methodology

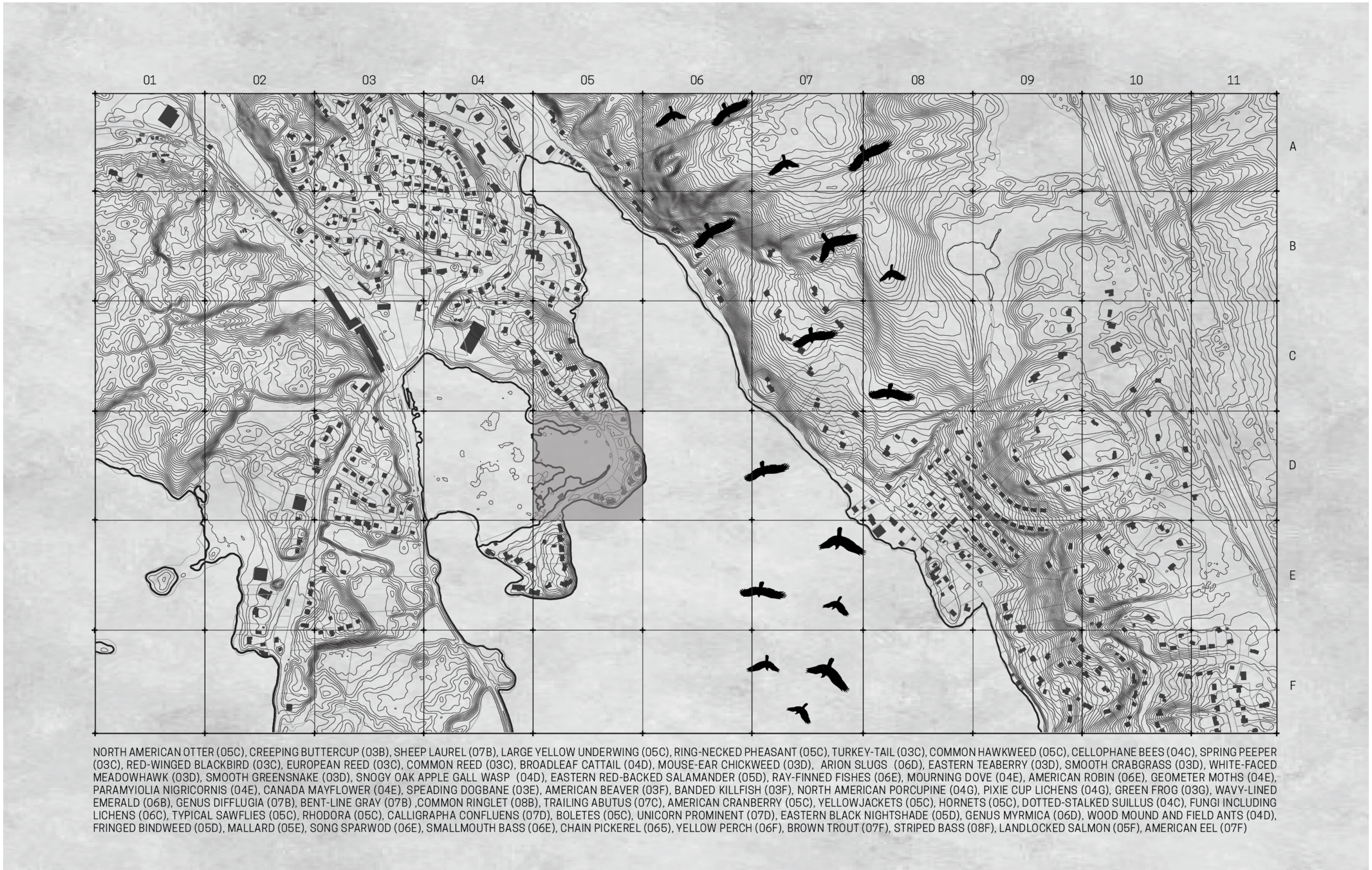
The design of this symbiotic dwelling aims to address the multidimensional liminality of the project. The first dimension focuses on the physical liminality of the site, acknowledging it as a space between a coniferous forest and a wetland, as well as a space between the natural environment and a man-made environment. The second dimension focuses on the liminality of the domestic envelope; a space between interior and exterior, a space between human and other. The design will allow ecological cohabitation to occur at the intersection of these two dimensions. The design process is broken down into four phases to form a general methodology that, in theory, can be used to design symbiotic dwellings capable of fostering ecological cohabitation in various types of environments.

Phase I: Site Analysis

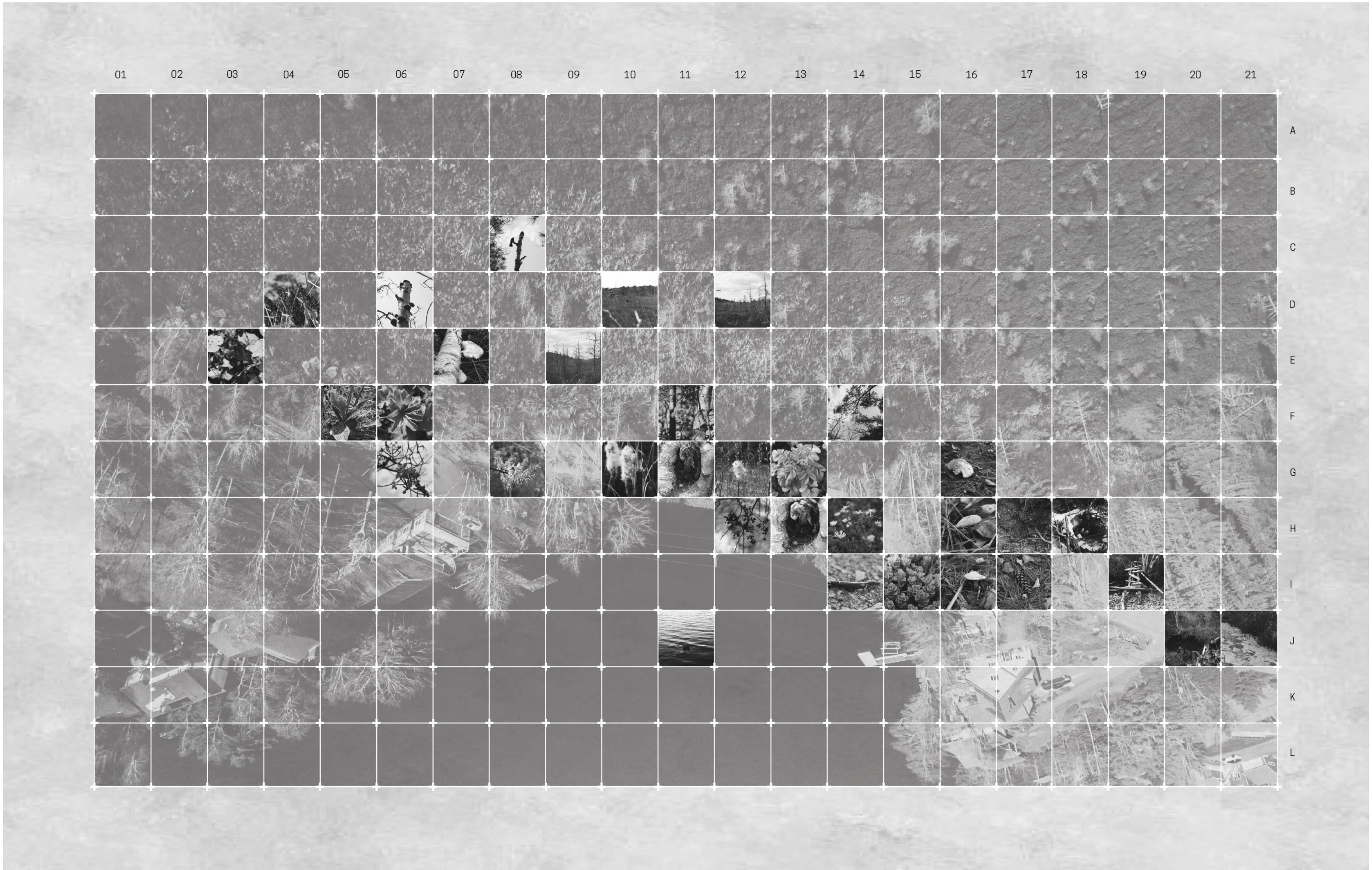
The first phase of the design process calls for a thorough analysis of the site in order to better understand the ecological systems at play. Solar studies revealed which areas on site were consistently under shade, and which areas received consistent sunlight. This information will later be beneficial in guiding the floor plan configuration process. Mapping out visual observations of fauna on site provided a better understanding of where certain species prefer to dwell, and additionally, revealed the potential non-human inhabitants of the project. Eastern Red-Backed Salamanders, Red Squirrels, Deers, Starlings, and Warblers appeared to be the most frequent site dwellers during the course of this research. Inside Lake William, a diverse range of fish species was observed by local fishers, including Small-mouth Bass, Chain Pickerel, Yellow Perch, Brown Trout,



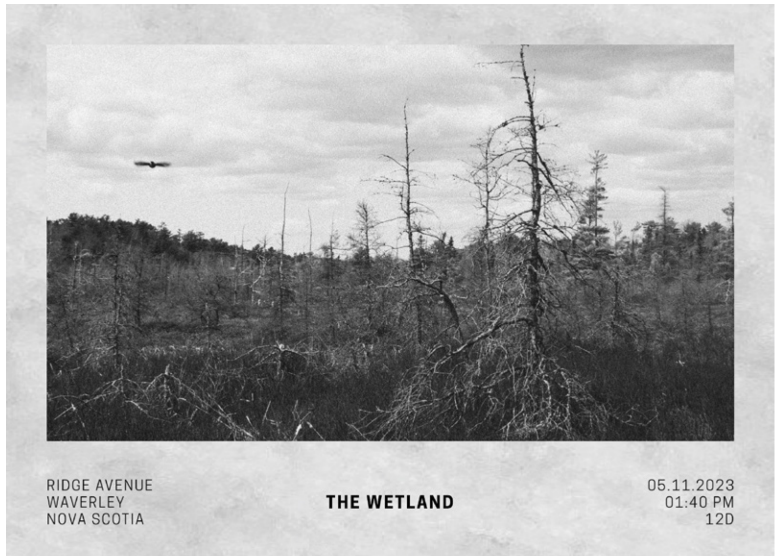
Site section showing general species on site in the coniferous forest, riparian woodland, wetland, urban area, and Lake William.

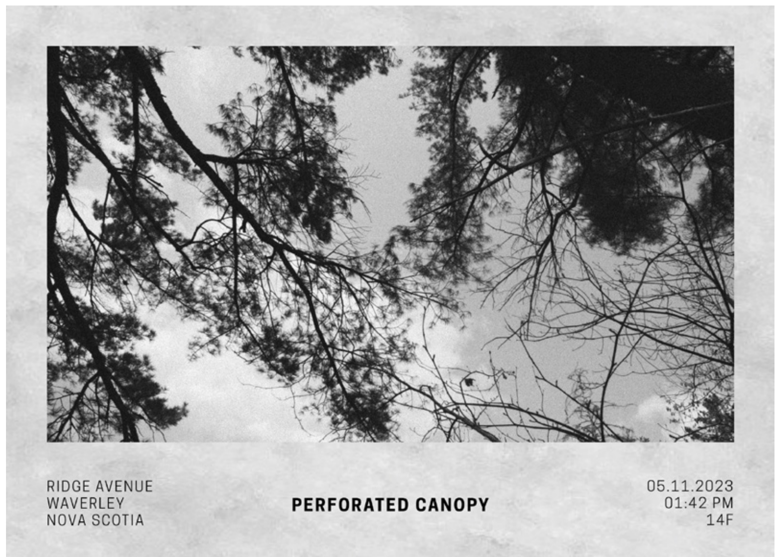


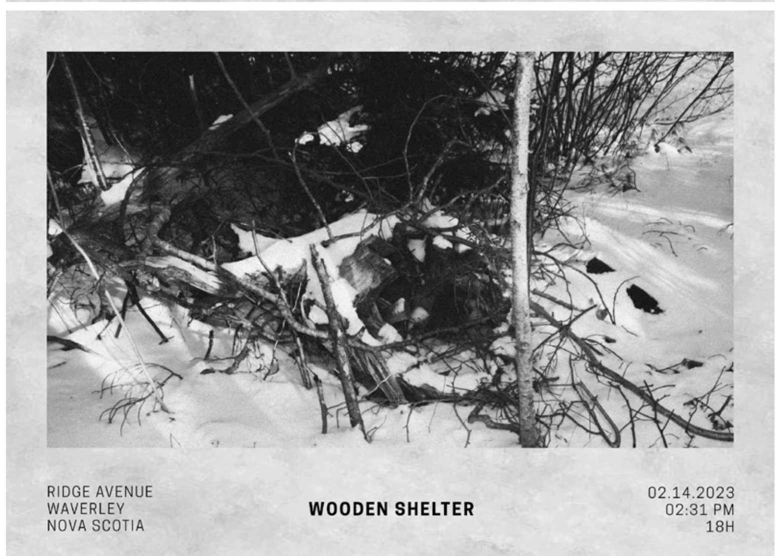
Map of Waverly depicting species observed on site. Base map by Ben Cottrill.



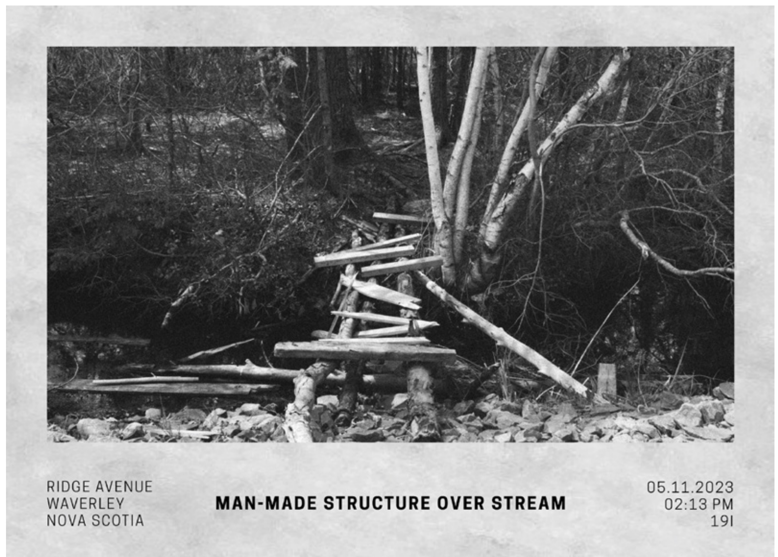
Geographic index of site photos.







Site photographs from photo journal.



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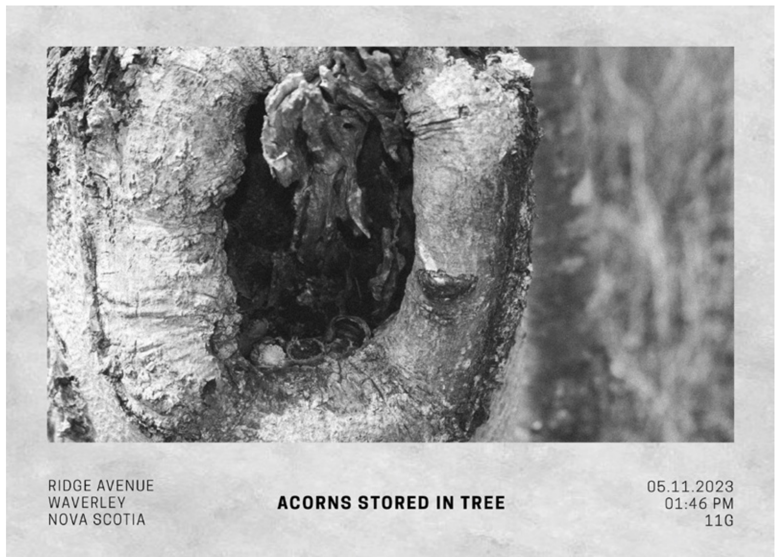

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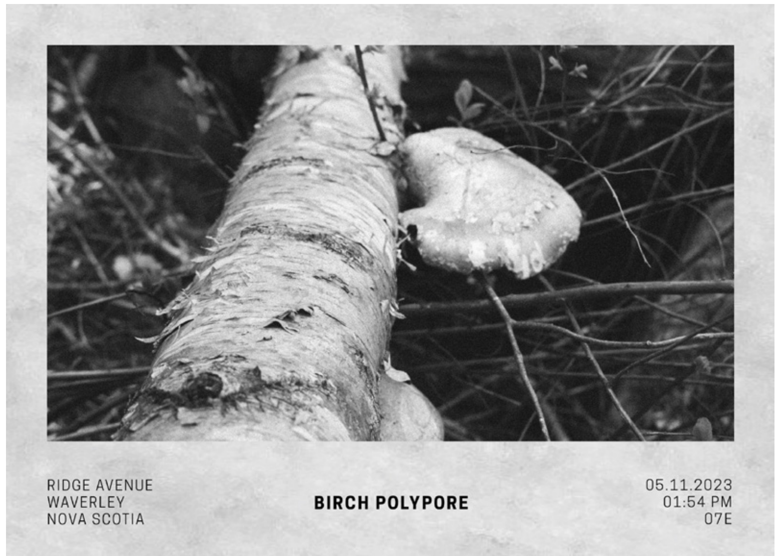

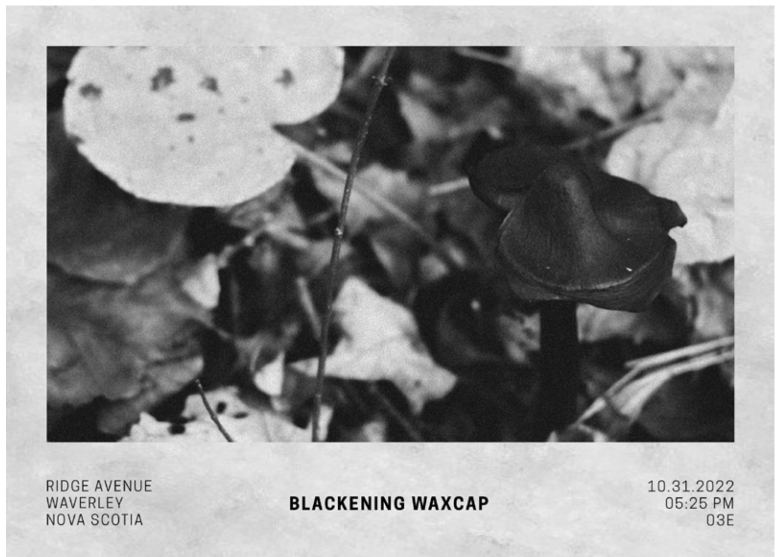

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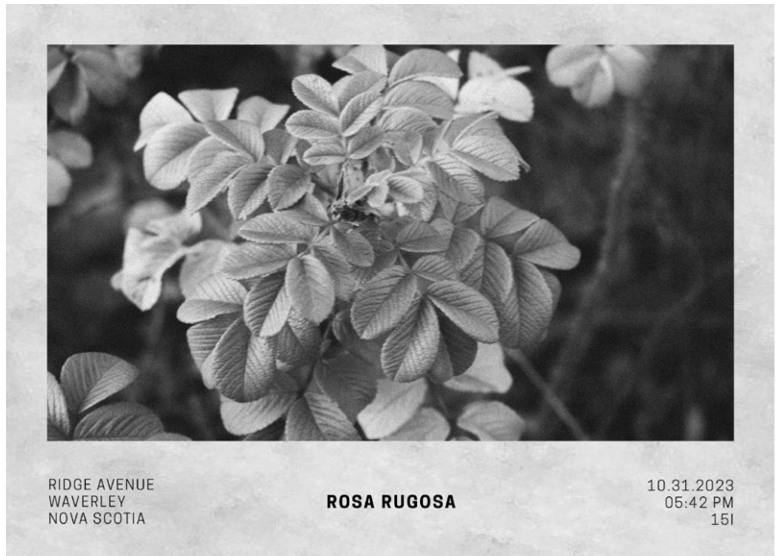

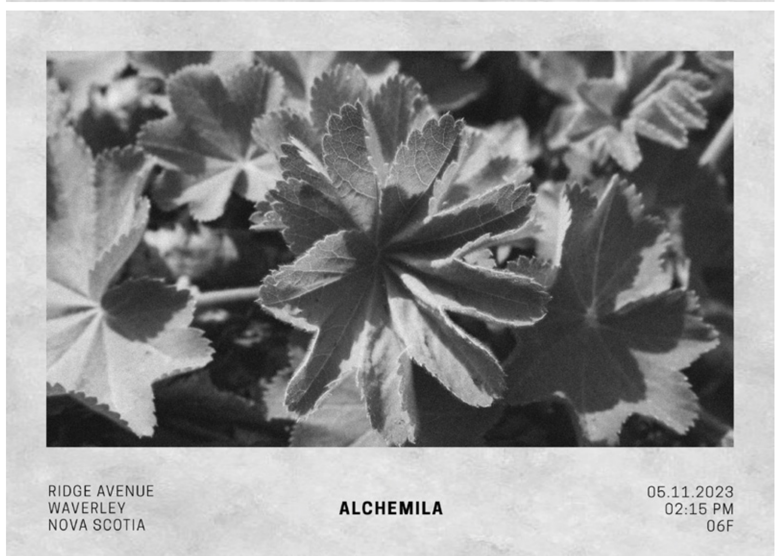

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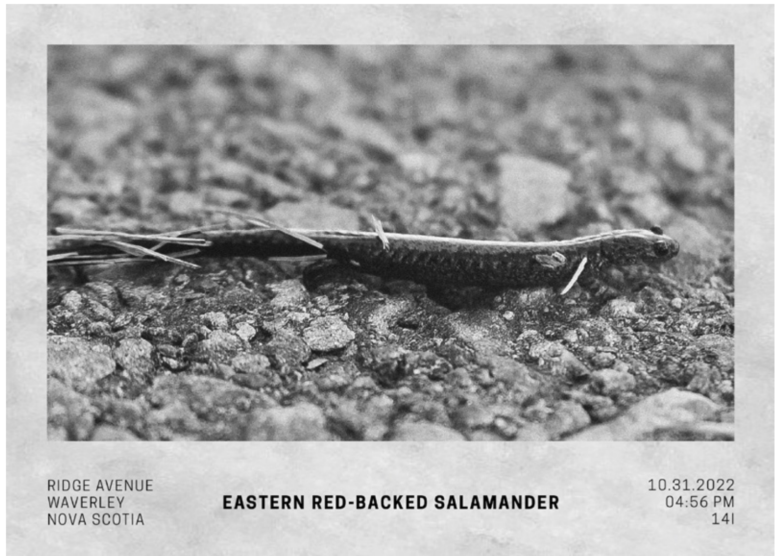
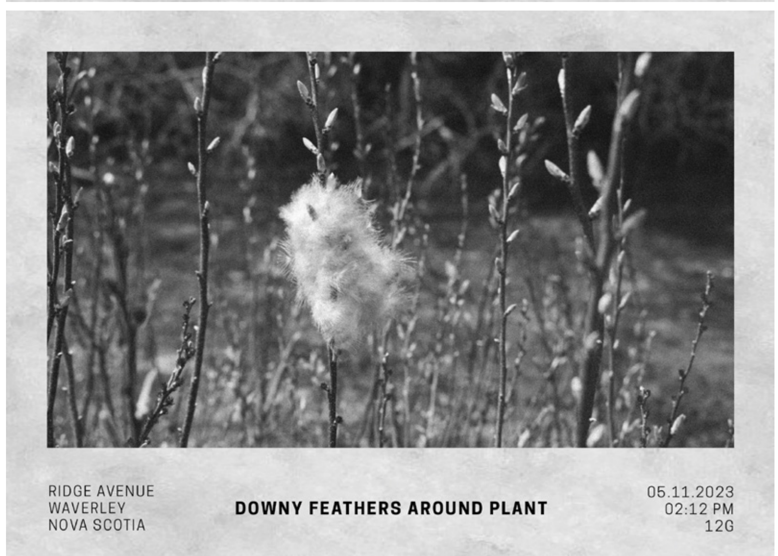
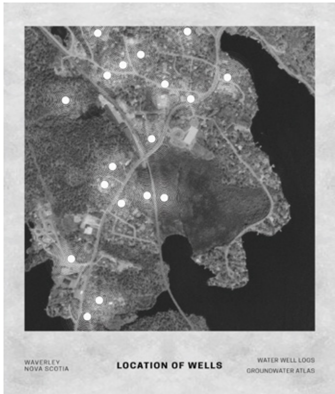




Site photographs from photo journal.

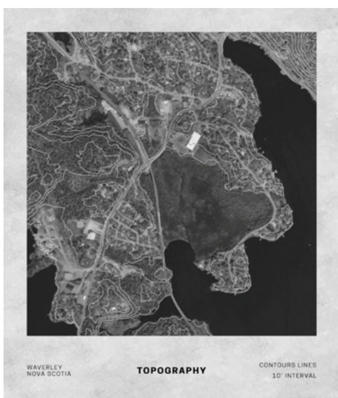
Site photographs from photo journal.



Location of wells throughout the site.

Striped Bass, American Eel, and Landlocked Salmon (Nova Scotia Fishing, 2013).

The most significant ecological process on site is the flow of water throughout the landscape. The wetland is fully saturated and is naturally functioning as a groundwater recharge zone. A drilled well is located on the northwestern portion of the wetland and is being used for domestic water supply. Analysis of the Well Log Record reveals that the wetland is approximately 35 feet above bedrock and has a primary geology of clay (Department of Environment and Climate Change, 2009). The closest groundwater level study to be conducted near the site took place in Fall River, Nova Scotia in 2019. The results of the study showed normal groundwater levels in the area, which is indicative of an overall healthy water cycle (Groundwater Levels Timeline, 2012-2019). In order to maintain this ecological process within the wetland with the addition of a built form, careful consideration must be given to how the form can be designed to work with the natural flow of water on the site in order to avoid compromising the permeability of the wetland. Compromised permeability can impact the ability of the wetland to function as a groundwater recharge zone.



Topography of the site.

It is of some concern that such an ecologically rich site is mostly enclosed by transport infrastructure. Roads and railways surrounding the wetland are likely contributing to the mortality of various species of fauna within the ecosystem. Aside from being catalysts for collisions, transport infrastructure such as roads and railways can be fatal for various non-human species due to wire strikes, rail entrapment, and electrocution ("Railway Ecology" 2017, 11). Railways tend to have lower wildlife mortality rates than roads likely due to slower traffic flow and narrower corridors,

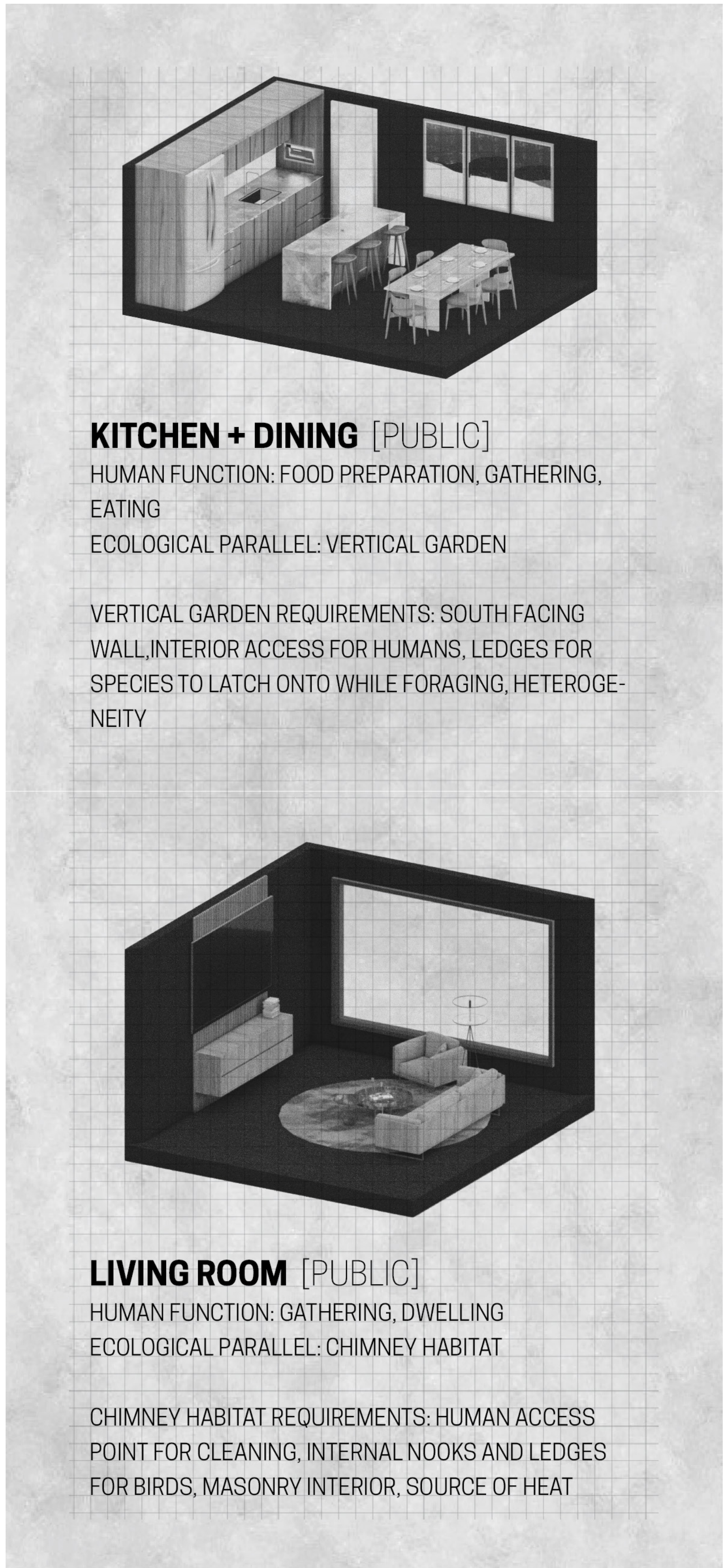
Transport infrastructure around the site.

though approximately 26-38% of mammals found dead are found on rail tracks (“Railway Ecology” 2017, 7). Given that the design aims to attract non-human species to the site, it is important to ensure they are not being lured into the surrounding transport infrastructure.

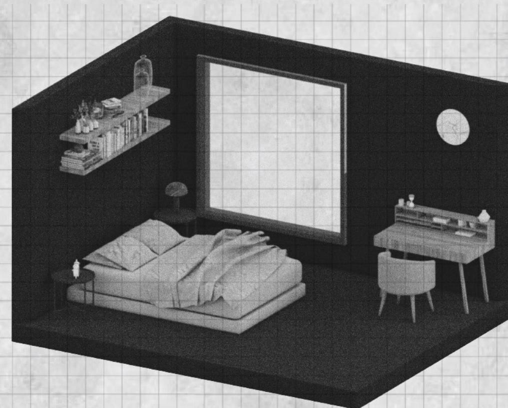
Phase II: Program Analysis

The second phase of the design process involved breaking apart each component of the program into its simplest form in order to analyze the core functions of each space. Once the core functions were identified, concepts for ecological parallels can be brought forth. The intention of this process is to create a functional symmetry between the interior and exterior realms of the home and to ensure that the envelope is capable of supporting various habit functions. Initially, the program was broken down into seven different components; the living room, the dining room, the kitchen, the bedrooms, the bathroom, the washroom, and the laundry room. After an initial analysis of their core functions, the dining room and the kitchen morphed into a single component, as did the bathroom, the washroom, and the laundry room. The four remaining components were separated into two categories; public and private. The living room and the kitchen + dining were categorized as public spaces within the home, while the bedrooms and the wash/bathrooms were classified as private spaces. This distinction will later influence the spatial configuration of the design.

For the living room component, the core function of the space was identified as gathering and dwelling; it is a space where one can relax while in the presence of others. The ecological parallel assigned for this component was a chimney habitat, in which a variety of avian species or raccoons



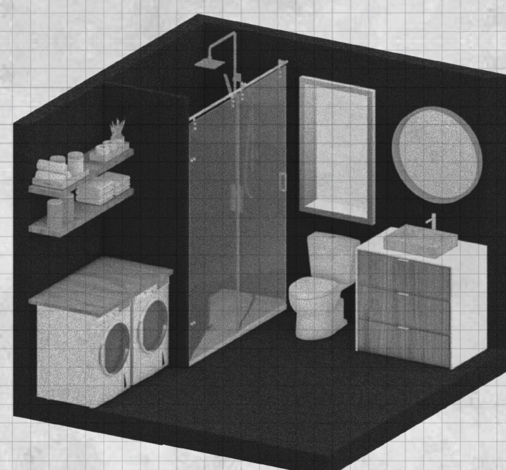
Programatic components and their assigned ecological parallels.



BEDROOMS [PRIVATE]

HUMAN FUNCTION: SLEEPING + WORKING
ECOLOGICAL PARALLEL: BIRD HOUSE, BAT BOX, SQUIRREL HOUSE, INSECT HOTEL

INSECT HOTEL REQUIREMENTS: CLOSER TO GROUND
BAT BOX/BIRD HOUSE REQUIREMENTS: ELEVATED LOCATION



WASH/BATHROOM [PRIVATE]

HUMAN FUNCTION: CLEANSING
ECOLOGICAL PARALLEL: BIRD BATHS, DUST BATHS

BIRD BATH REQUIREMENTS: DRAINAGE POINT FOR CONSTRUCTED WETLAND ROOF

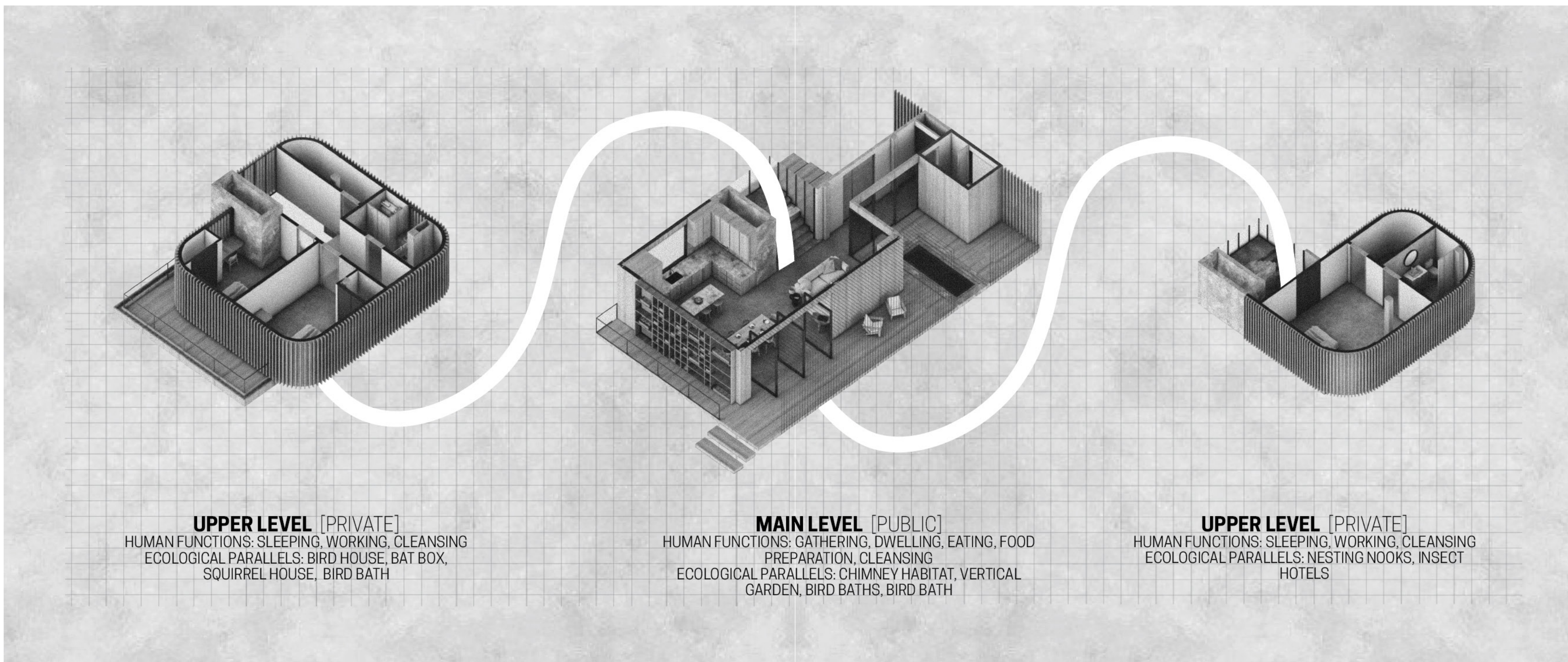
Programatic components and their assigned ecological parallels.

can dwell in the company of others throughout the seasons. For the kitchen + dining component, the human function was identified as food preparation, gathering, and eating. In essence, the functionality of the space is centred on food. The ecological parallel assigned to this component is a vertical garden system, specifically one designed to serve species native to the site. The bedroom component primarily functions as a space for sleep and private relaxation, and so private nesting quarters such as birdhouses, bat boxes, squirrel houses, and insect hotels were assigned as the ecological parallel. For the wash/bathroom component, the core function of the space was identified as bodily cleansing, to which the ecological parallel assigned was bird baths/dust baths. This program analysis will later be used to organize the floor plan based on each component's human and ecological function requirements.

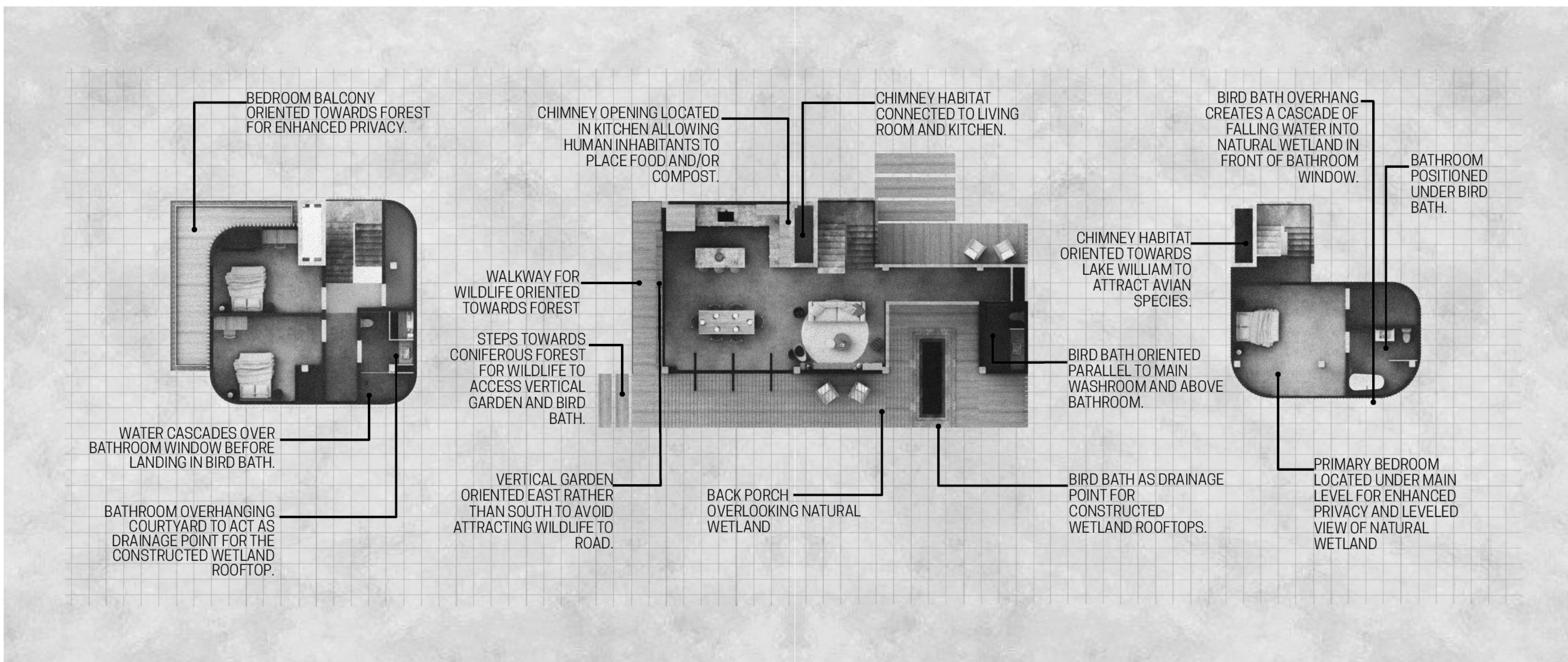
Phase III: Spatial Configuration

Throughout this phase of the design process, the intention is to use the knowledge gained through the prior site and program analysis to guide the spatial design of the home. This approach allows the home to be designed uniquely to its surrounding landscape. Further, playing around with the spatial configuration of the design based on the requirements of individual programmatic components ensures that these components are able to function in their intended way. In order to preserve space on the site, the home is broken down into three stories. Public areas such as the living room and kitchen + dining space are all located on the main floor, while private areas such as bedrooms and bathrooms are located on floors above and below to maintain their privacy.

Ideally, the kitchen + dining component would be south facing to best accommodate the vertical garden. However, in the case of this particular site, a south-facing vertical garden would be positioned towards the residential road. The vertical garden is intended to attract various non-human species, so placing it so close to a road would likely increase the rate of animal fatalities due to transport infrastructure. In order to avoid this, the vertical garden would need to be oriented in either the east or west direction. With an east orientation, the garden would be facing the adjacent spruce pine hummock and would thus attract a new demographic of species. On the west, it would be oriented towards the open wetland, still quite exposed to the nearby road. Either way, the garden would still be in unfavourably close proximity to the road, but by opting for an east-facing vertical garden, the spruce pine hummock could be used as somewhat of a barrier between the garden and the road. Regarding the chimney habitat, though primarily belonging to the living room space, it should ideally be adjacent to the kitchen + dining area. This adjacency would allow for an opening into the chimney through the kitchen where the human inhabitant could place seeds for inhabiting birds/bats or even place compost for inhabiting raccoons. The lower ground floor contains the master suite, while the second floor contains two bedrooms and a bathroom. Unlike the public ground floor, both of these private floors are clad with wood slats to support various habitable inserts as well as to enhance the visibility of the windows for avian species. This phase of the design process should end with a set of preliminary floor plans and sections describing the optimal locations of each programmatic component based on their functionality and site limitations.



Spatial configuration of the design based on previous site and program analysis.



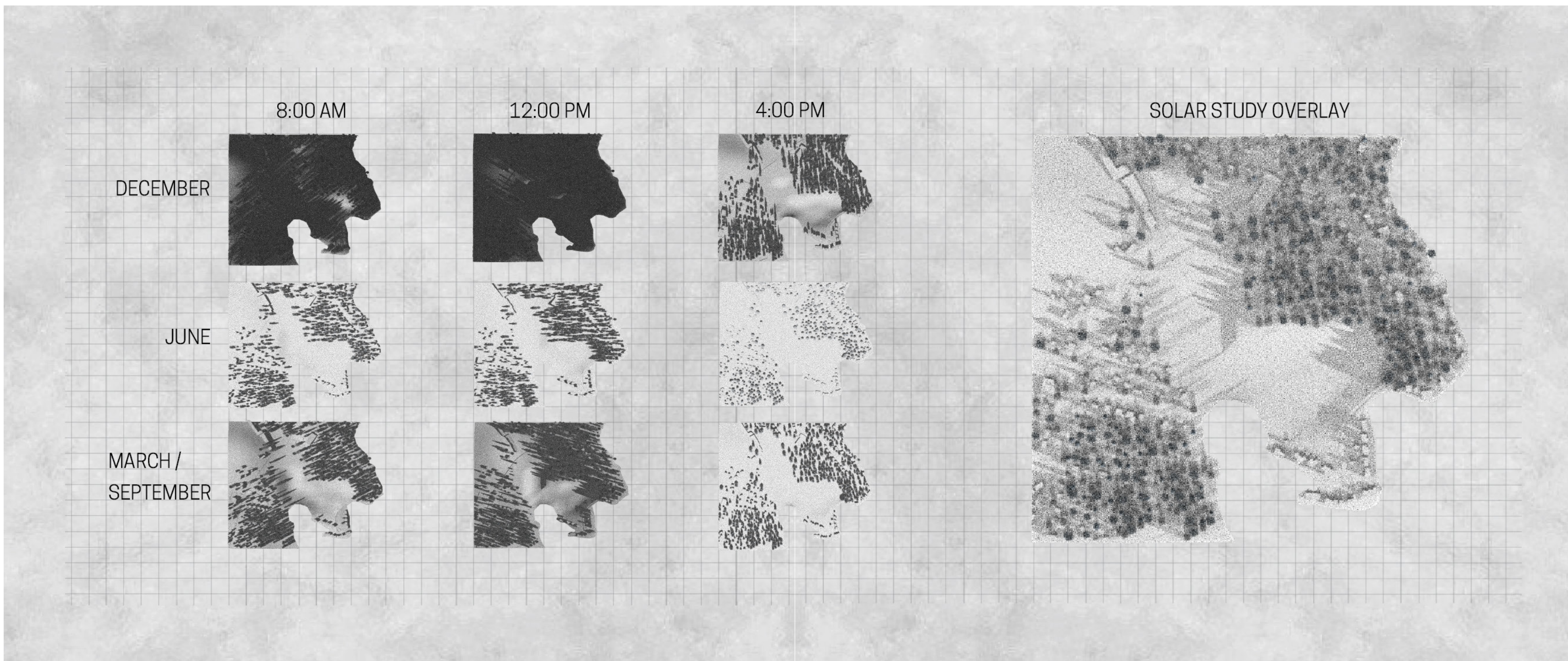
Spatial configuration of the design based on previous site and program analysis.

Phase IV: Envelope Design

The final phase of the design process involves designing the habitable envelope components for the home. An important consideration throughout this process is ensuring heterogeneity within the designed components. Providing a wide variety of inhabitable spaces within the design is a key strategy in maintaining and enhancing the biodiversity of the site. The primary envelope components being designed for this home are the constructed wetland green roofs, the vertical garden, the habitable inserts (bird houses, squirrel houses, bat boxes, insect hotels), as well as the vertical garden. The following section will further discuss the designed envelopes within the project.

The Design

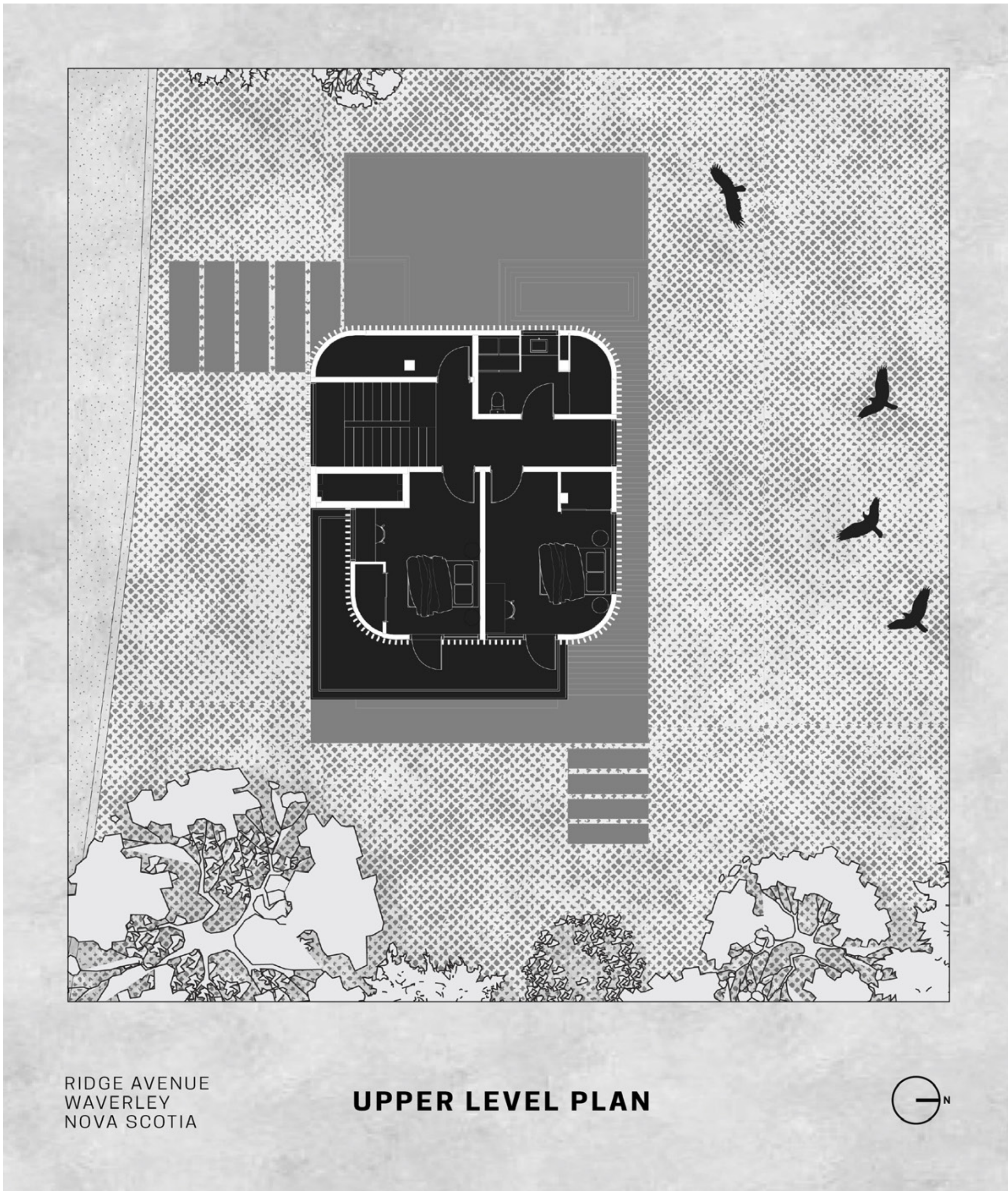
Solar studies of the site assisted in selecting the exact location of the home, as predominately shaded locations would be favourable. Locations accustomed to receiving shaded sunlight for a large portion of the year would be less likely to be negatively impacted by the addition of a built form, which would inevitably alter the solar exposure of nearby flora. The home is situated along the northern side of Ridge Avenue, Nova Scotia, covering the wetland and riparian zone by the coniferous forest. This location offers an intimate and unobstructed view of Lake William, increasing its desirability for human inhabitants. The home is positioned close to the road to protect aquatic habitats within the wetland and riparian zones, as discussed in Chapter 2. The steps from the road to the front porch are elevated, hovering over the landscape to minimize disturbances to existing habitats underneath. The entire form of the home is elevated on stilts, approximately 13 feet above water level



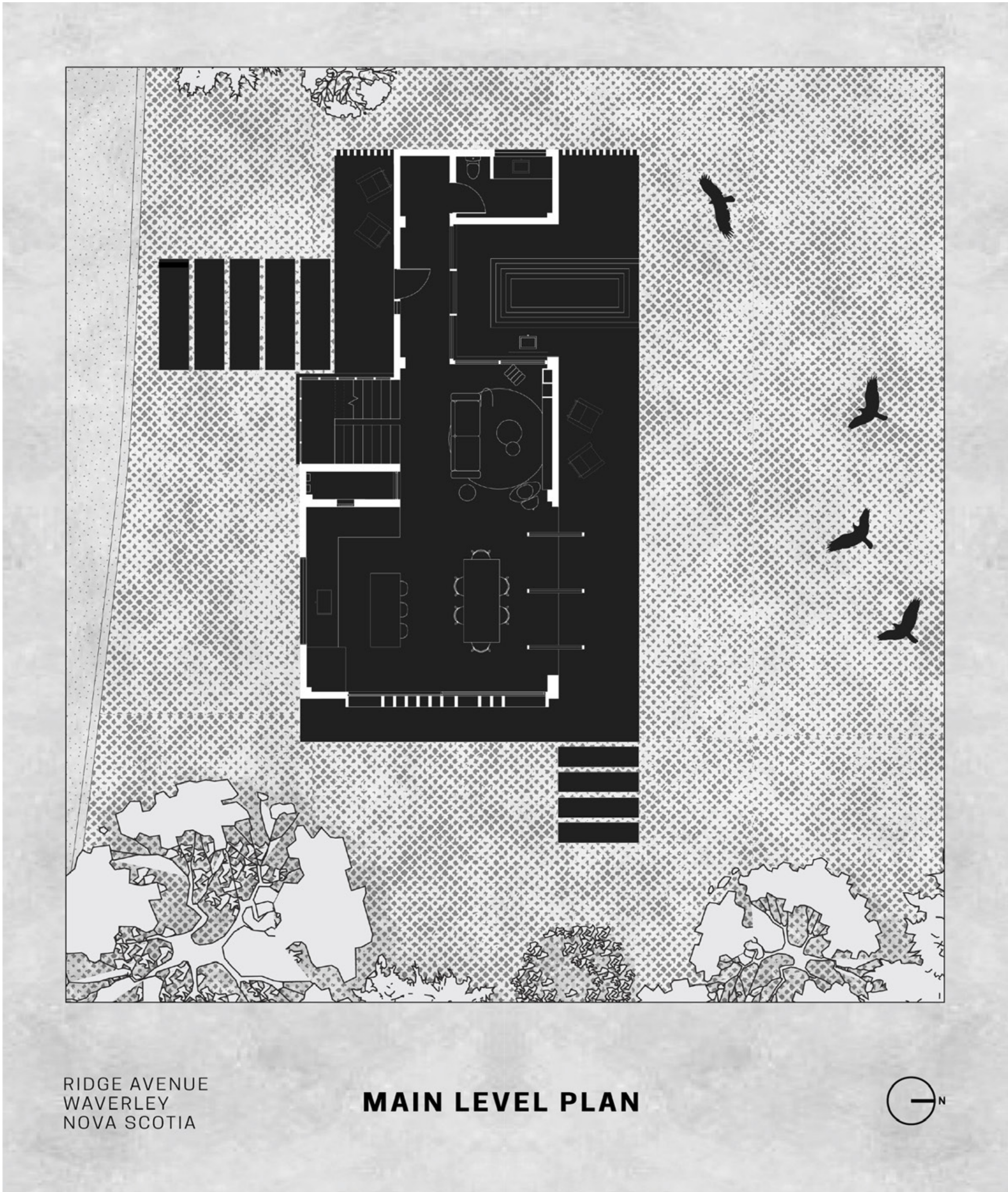
Solar studies of the site.

toward the northern end. The site is a non-coastal wetland and is not at risk for future flooding. The unique placement of the home on the site allows for a connection to the forest floor on the northeastern portion in the form of elevated steps. These steps allow the site's human and non-human inhabitants to access the home through the coniferous forest. This provides opportunities for human inhabitants to go out and explore their surrounding landscapes and enhance their connection with the natural world.

The entire wetland region is currently not split up into separate properties, and during the design process, no hypothetical property lines were drawn or considered. A central concept within this project is that the home is owned, but the land is not. While the notion of land ownership is an incredibly complex issue, and well outside the scope of this thesis, it is necessary to point out the differences observed through this design. If you look at the existing properties throughout the site, you will notice the property lines are quite generous. For the most part, these lake houses take up less than a third of the overall property, while the remaining land is typically transformed to freshly mowed grass with very little flora diversity. Though the owners of these properties spend significant time and effort ensuring their grass lawns look pleasant, they are actively making the land uninhabitable for a wide variety of native species. Further, these freshly kept lawns are also widely unused by human inhabitants, essentially making their functions ornamental even though they naturally hold incredible habitation potential. The propped design, however, was not defined by any pre-existing or hypothetical property lines. As a result, the human inhabitants of the home cannot assume entitlement to modify or alter their surrounding landscape



Floor plan drawing of upper floor.

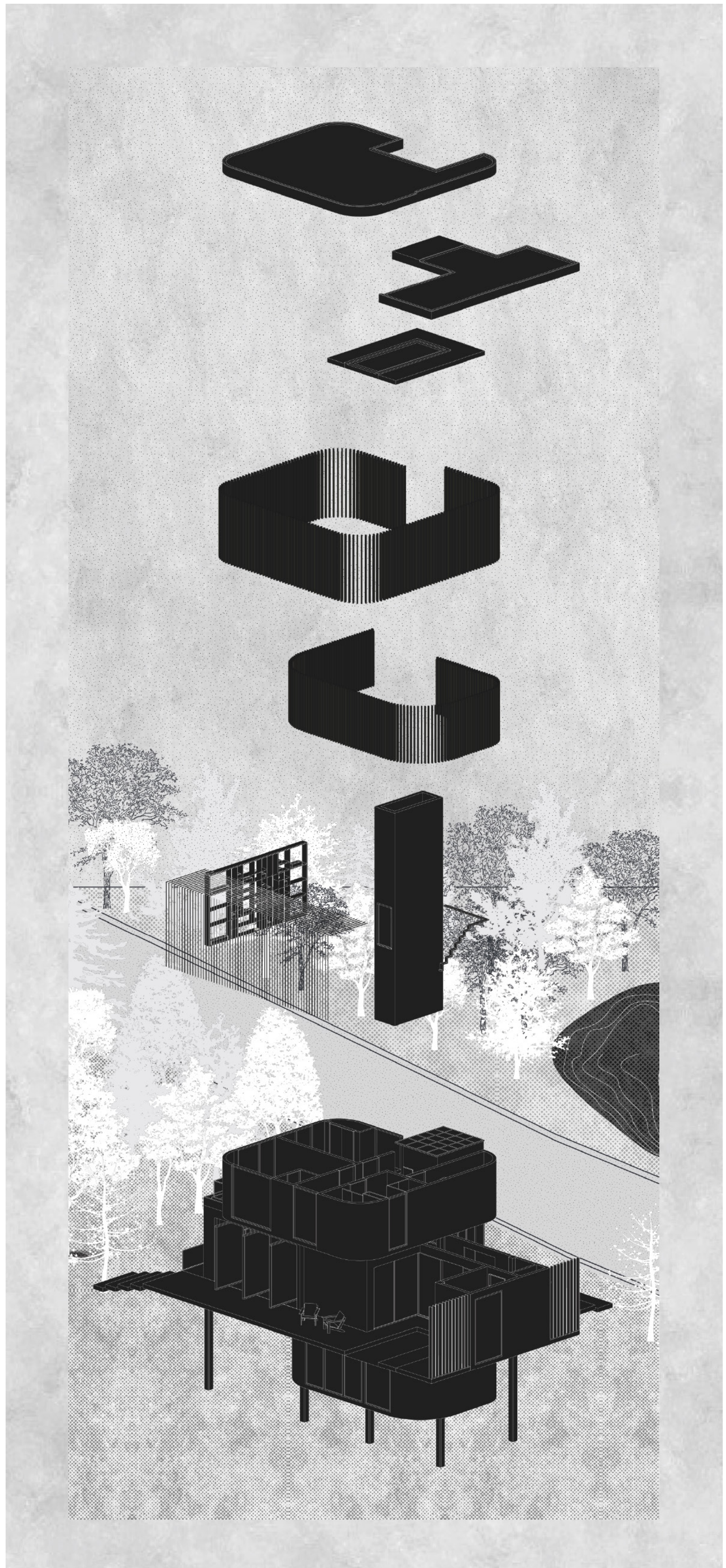


Floor plan drawing of main floor.

Floor plan drawing of lower floor.

Site section drawing, cut east to west.

Site section drawing, cut north to south.



Exploded drawing of ecological design componenets.

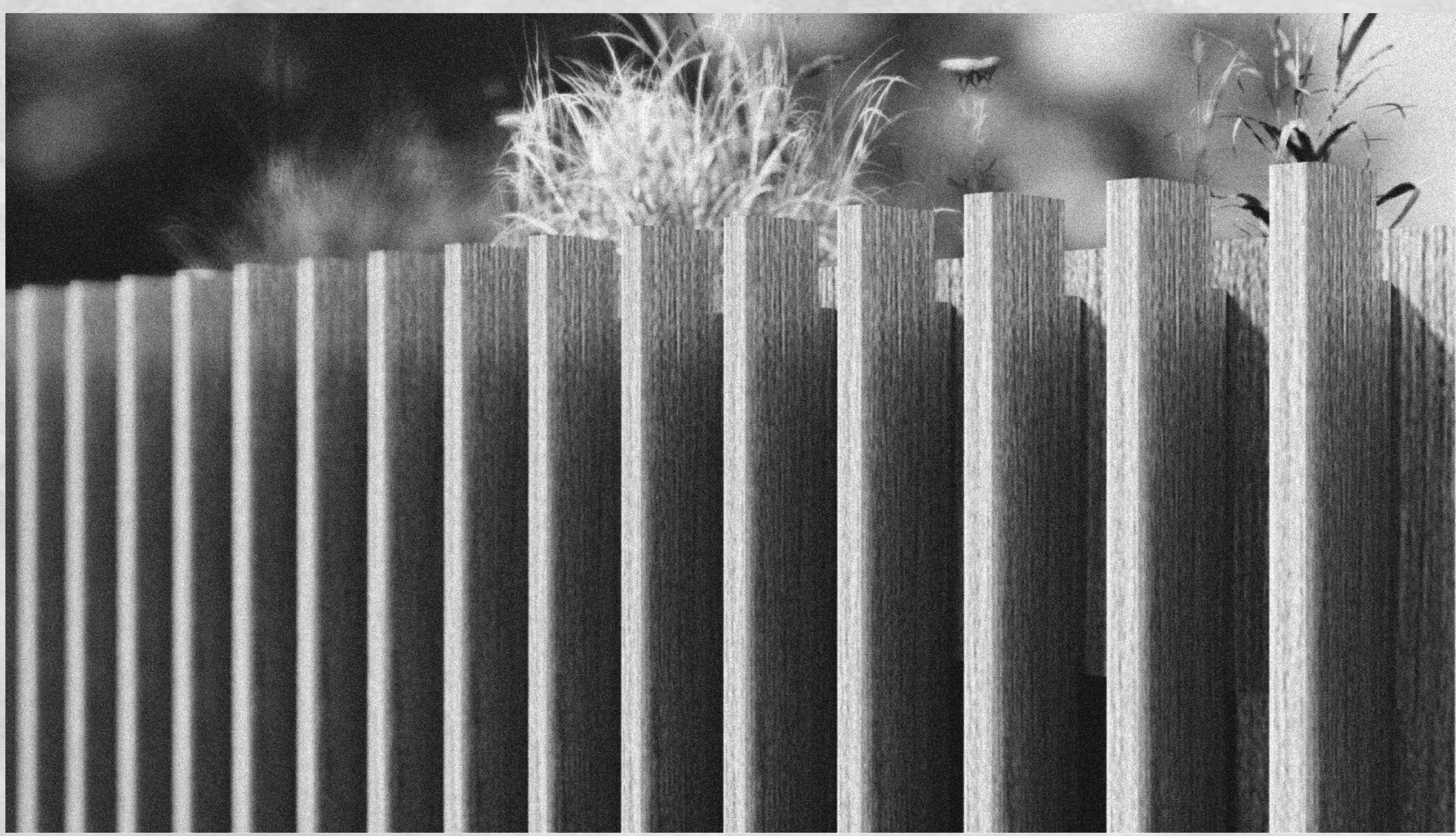
for superficial purposes. Further, the lack of property lines heavily informed the outcome of the design. Without property lines, there is no pressure for the designer to develop every portion of the property, and as a result, the landscape and ecosystem were minimally altered.

Slat Facade System

In order to preserve space on the site, the home is broken down into three stories. Public areas such as the living room, kitchen, and dining space are all located on the main floor, while private areas such as bedrooms and bathrooms are located on the floors above and below to maintain their privacy. The lower ground floor contains the master suite, while the second floor contains two bedrooms and a bathroom. Unlike the public ground floor, both private floors are clad with wood slats to support various habitable inserts as well as to enhance the visibility of the windows for avian species. Aside from habitat destruction, window collisions are the second largest human cause of avian mortality globally, and wetlands are amongst the most ecologically productive sites for avian species (Klem 2008, 244; Kushlan 1989, 693). As a result, enhanced window visibility is a high priority for the design. The wood slats lay 6 inches apart and wrap around the upper and lower forms. This creates enough of an obstruction to prevent bird-window collisions without significantly compromising the quality or colour of the light entering the home. The slats are notched at the top and bottom to allow for the customizable addition of habitable inserts. The top form can support bird houses, nesting nooks, squirrel houses, and bat boxes, while the lower form can support insect hotels and nesting nooks. These habitable inserts allow for symmetry between the

Render of inhabitable inserts placed into the slat facade system.

wide variety of wetland flora, and they primarily function to serve avian species on the site. Plants such as rushes, cattails, sedges, yarrow, bee balm, butterfly weed, swamp milkweed, marsh marigold, blue flag, arrowhead, and marsh fern are all capable of thriving within constructed wetland ecosystems. These constructed wetlands ensure that the built form does not minimize the access of avian species to the wetland ecosystem, as well as creates new habitat opportunities for other non-human species on site. Both

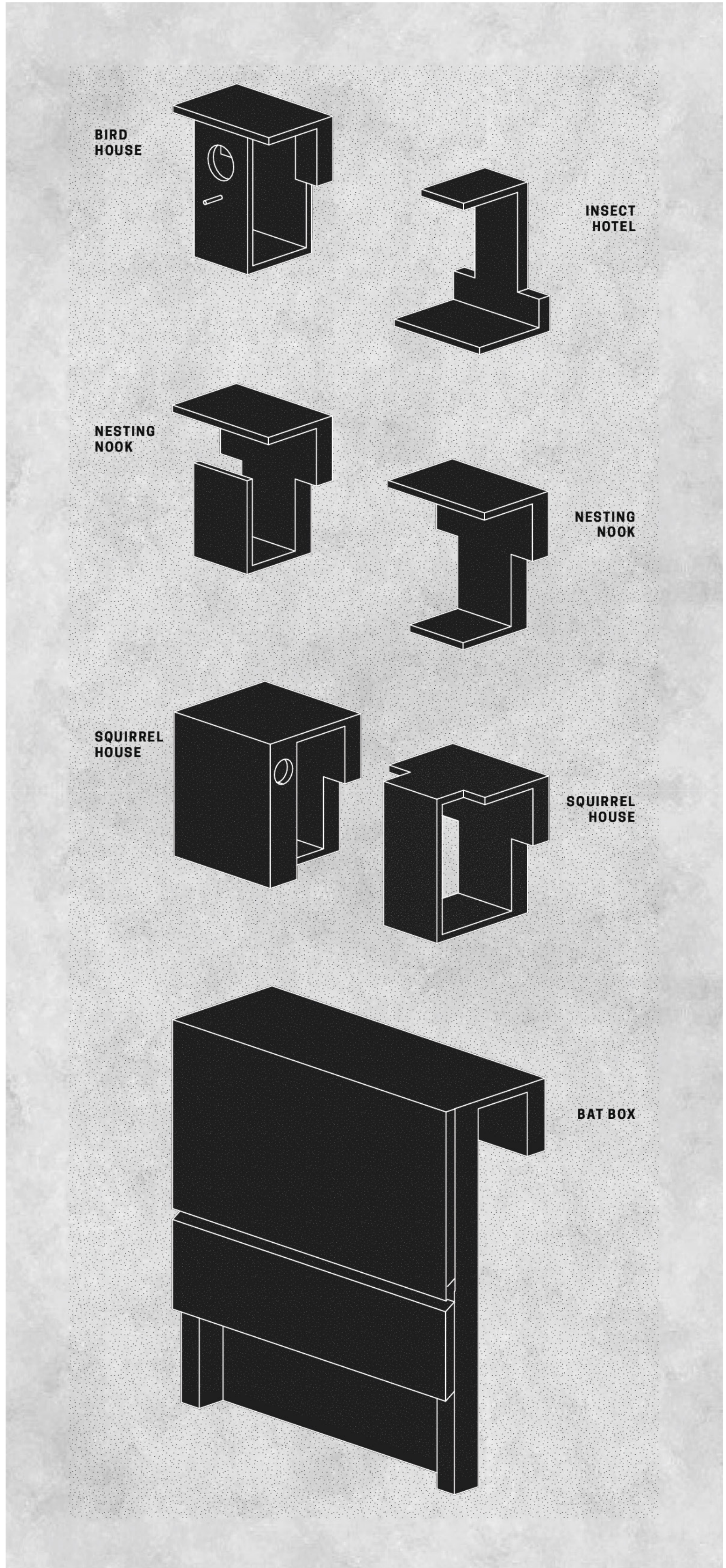


ECOLOGICAL DESIGN
ELEMENT

SLAT FACADE

VIEW FROM
WETLAND

Render of slat facade system.



Drawing of habitatble insert designs for the slat facade system.

ECOLOGICAL DESIGN
ELEMENT

INHABITABLE INSERTS

VIEW FROM
WETLAND

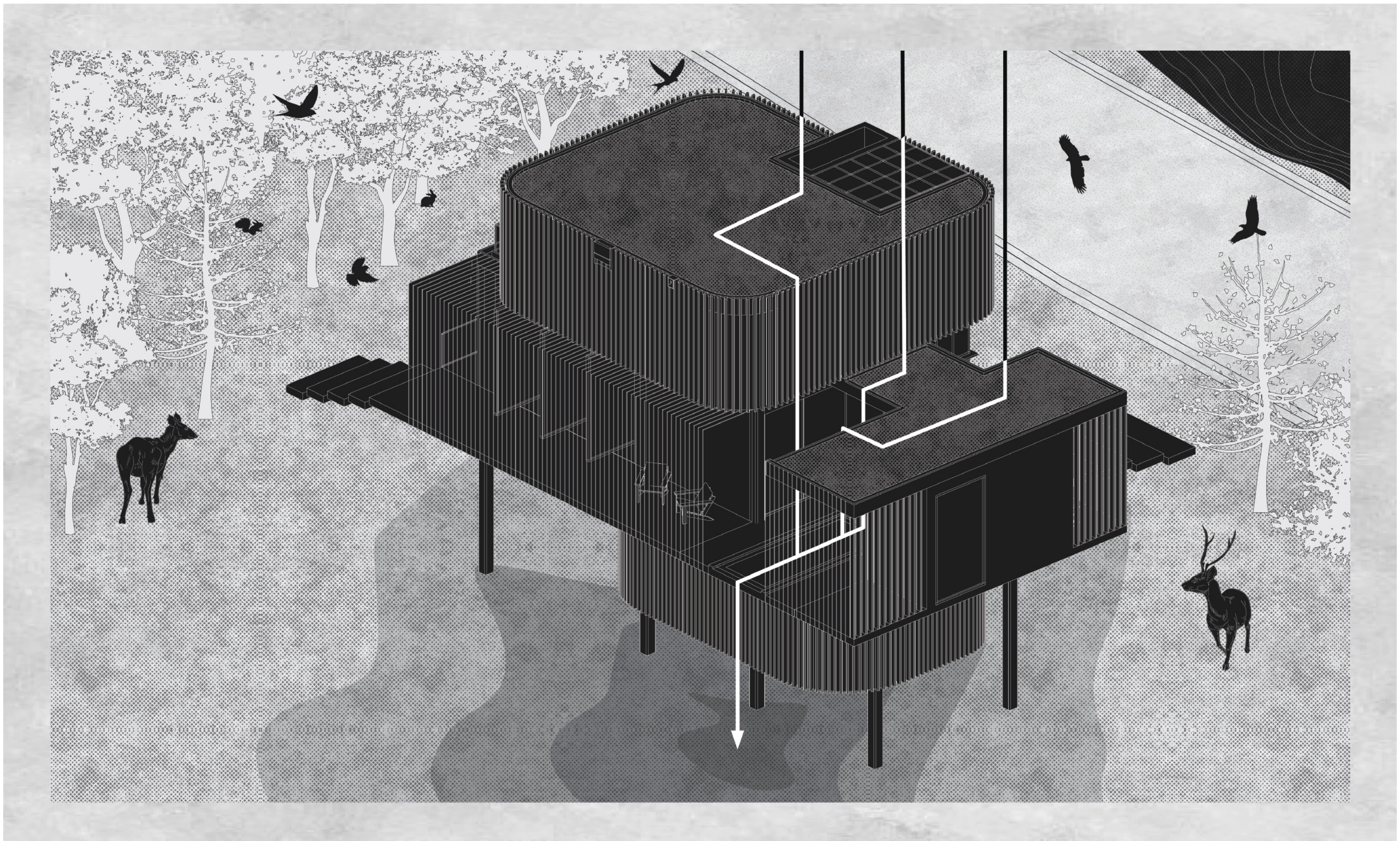
Render of slat facade system with inhabitable inserts.

internal and external functions of the private portions of the home and create a resting parallel.

Constructed Wetland Roof System

The home sits on stilts so as to not touch or disturb the wetland underneath, however, it is still taking up space on the landscape. To accommodate for this, there are two constructed wetland roof systems at play. Both of these constructed wetland roofs are capable of hosting a

Render of constructed wetland roof.



Axonometric drawing of the design depicting water flow through the design to the site. Water lands on constructed wetland roof systems, drains downwards towards the birdbath in the courtyard then drains down to the natural wetland below.

constructed wetland roofs drain downwards towards the bird bath in the courtyard, where the water is then drained down to the natural wetland. All three bathrooms within the home are positioned directly underneath the three drainage points to create a cascade of flowing water and further strengthen the symmetry between the internal and external functions to create a cleansing parallel.

The Courtyard and Back Porch

As the water from the two constructed wetland roofs drains downwards into the birdbath, it creates a cascade of flowing water that gently lines the courtyard. The courtyard separates the private and public space on the main floor and creates a serene area for human inhabitants to dwell. Aside from functioning as a drainage point for the constructed wetland roof system, the bird bath also acts as a watering area for surrounding wildlife. The courtyard is open to the back porch, which is connected to the nearby coniferous forest by a series of elevated steps. The only windows throughout the home that are not clad in wood slats for enhanced window visibility are located along the back façade of the main floor. Instead, these clear and reflective windows use different methods of avoiding avian collisions. For instance, the dining room is lined with glass pivot doors, allowing the interior space to open up to the surrounding landscape and enhance the human inhabitant's connection to nature. In this case, where obstructive wood slats would not be ideal, the porch is instead lined with thin wire railings to prevent bird-window collisions with the clear glass doors. Additionally, the wire railings also function as a perching space for birds as they can rest and gather by latching to the top of the wire. A similar method is used regarding the glass panels lining the courtyard. By placing a watering area directly in front of

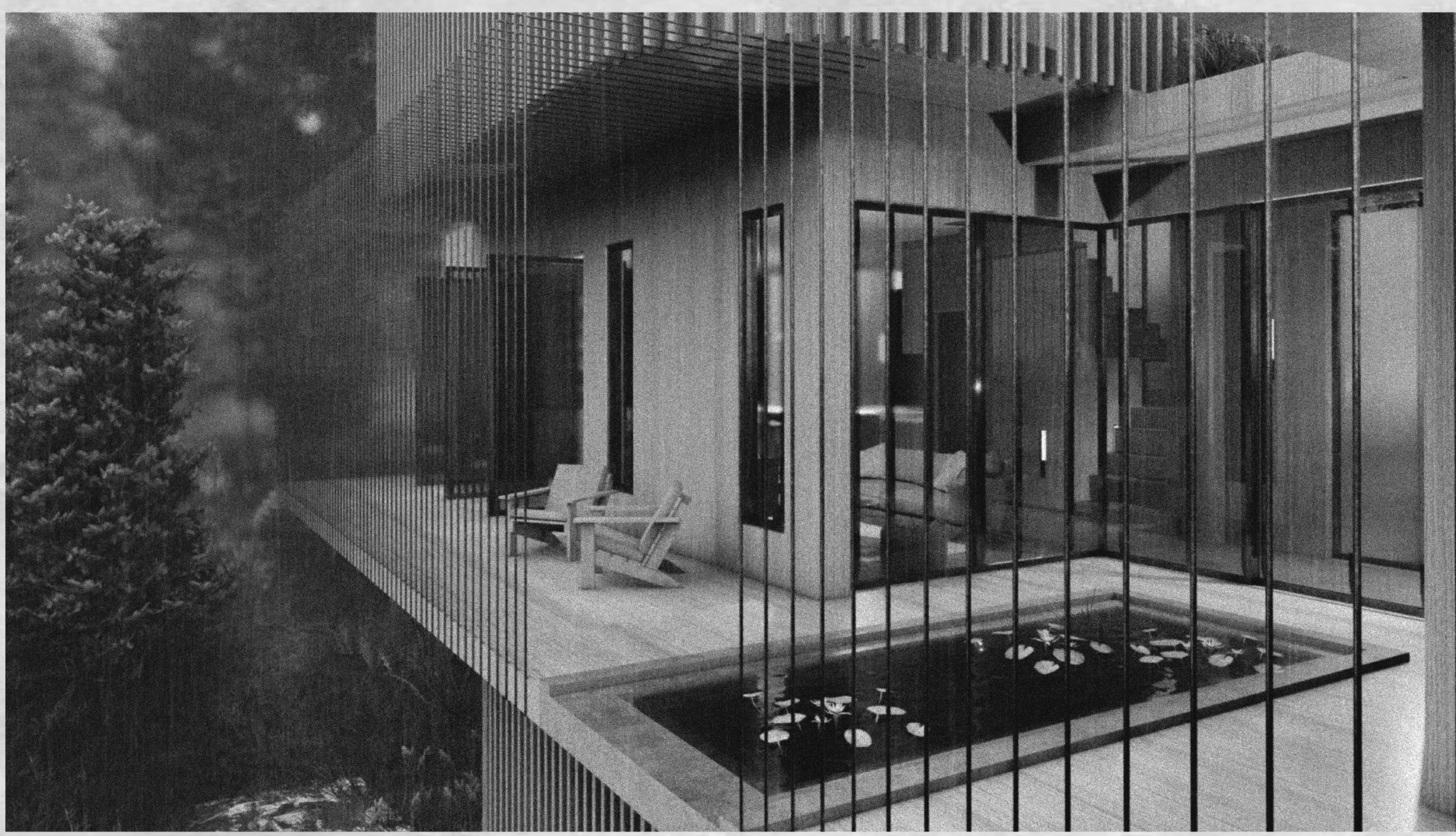
Render of courtyard and back porch.

GENERAL DESIGN

COURTYARD ENTRANCE

VIEW FROM
FRONT DOOR

Render of the interior entrance to the courtyard.



GENERAL DESIGN

BACK PORCH

VIEW FROM
WETLAND

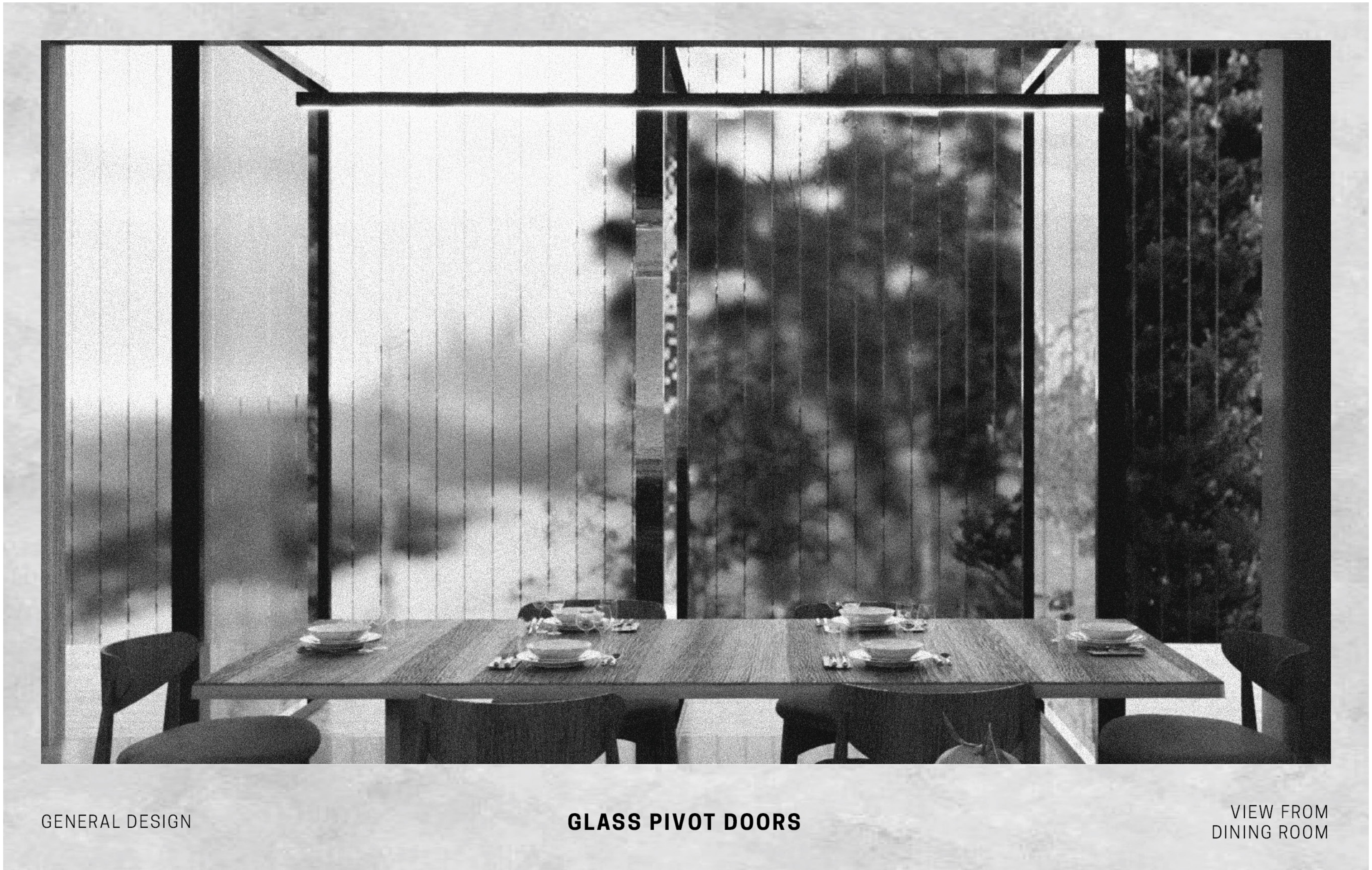
Render of the courtyard and back porch.

GENERAL DESIGN

BACK PORCH

VIEW FROM
WETLAND

Render of the courtyard and back porch.



Render of glass pivot doors in dining room.

GENERAL DESIGN

LIVING ROOM

VIEW FROM HALLWAY

Render of living room with a view to the courtyard.

Render of the birdbath in the courtyard.

clear and reflective glass, the rate of bird-window collisions significantly decreases as an incentive is created for them to slow down as they approach the glass.

The Chimney Habitat

Though the chimney habitat primarily belongs to the living room space, it is also positioned adjacent to the kitchen and dining areas. This adjacency allows for an opening into the chimney habitat through the kitchen where the human

Rendered section of the chimney habitat, depicting a parallel dwelling function throughout the interior and exterior realms of the home.

inhabitant can place seeds for inhabiting birds or bats, or even compost for inhabiting raccoons. The masonry chimney is lined with various ledges and nesting nooks on the inside to provide a diverse array of habitats for various species. Towards the living room, the chimney habitat has a large window-like opening for the human inhabitants to observe and admire the inhabiting species as they all dwell in harmony with one another. This opening also allows humans to access the inside of the chimney habitat for cleaning purposes. The top of the chimney habitat is approximately 3 feet higher than the surrounding constructed wetland roof and is positioned towards Lake William. Resultingly, the entrance is prominent for avian species as they fly by the site, and accessible to other species utilizing the constructed wetland roof. Further, the chimney also contains slight openings towards the base for water drainage and access for terrestrial species.

Render of the chimney habitat.

ECOLOGICAL DESIGN ELEMENT

KITCHEN - CHIMNEY OPENING

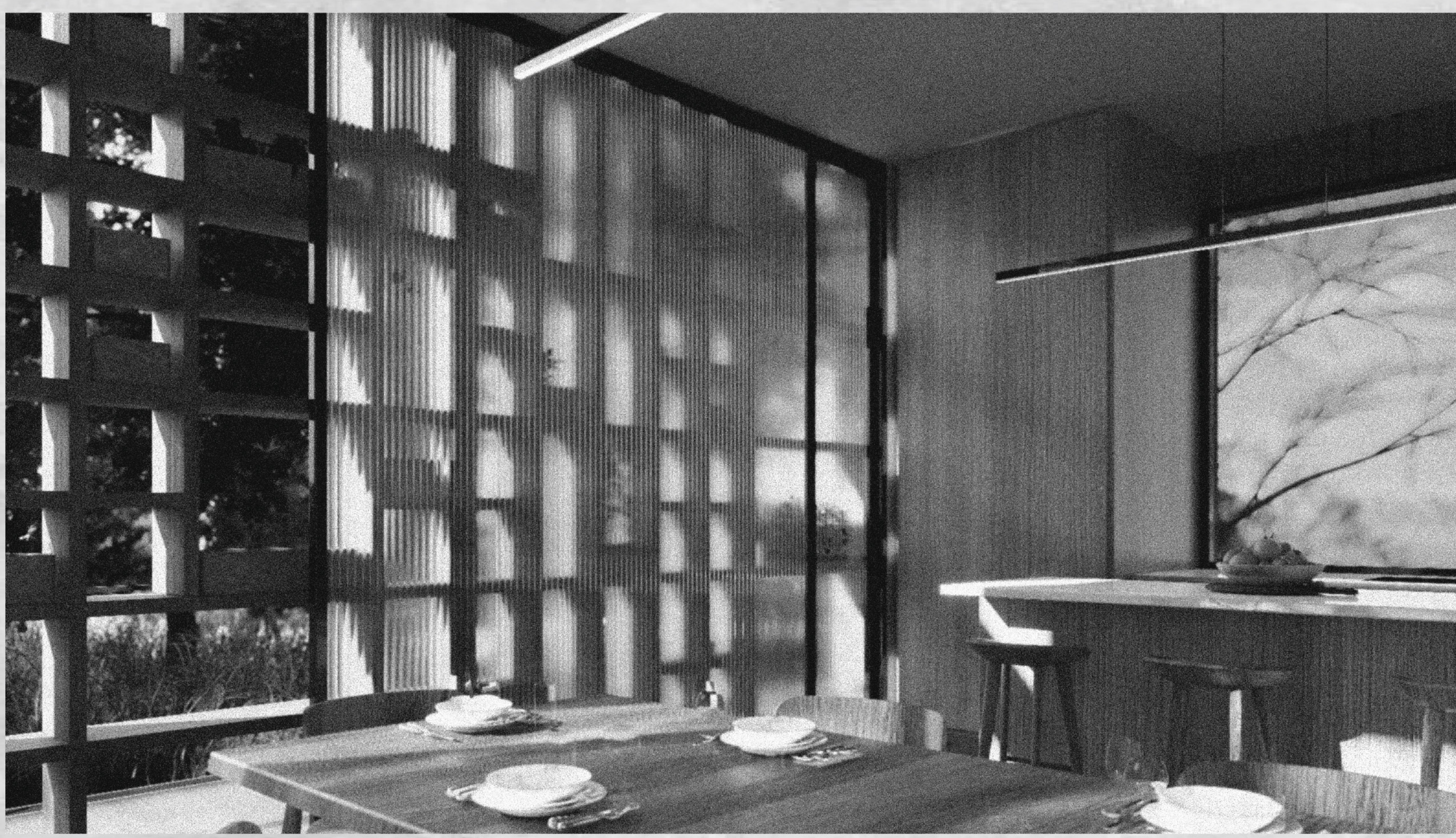
VIEW FROM KITCHEN

Render of the kitchen depicting an opening to the chimney habitat.

Exterior render of the vertical garden.

The Vertical Garden

The vertical garden is located along the east wall of the home, adjacent to the kitchen and dining area. With an east orientation, the garden faces the surrounding coniferous forest and riparian area and thus attracts a wide demographic of non-human species, including squirrels, deer, porcupines, beavers, raccoons, and so forth. The shelving system within the vertical garden is designed to accommodate a diverse



GENERAL DESIGN
ELEMENT

VERTICAL GARDEN

VIEW FROM
DINING ROOM

Render of the vertical garden from inside the home.

GENERAL DESIGN

KITCHEN AND DINING AREA

VIEW FROM
LIVING ROOM

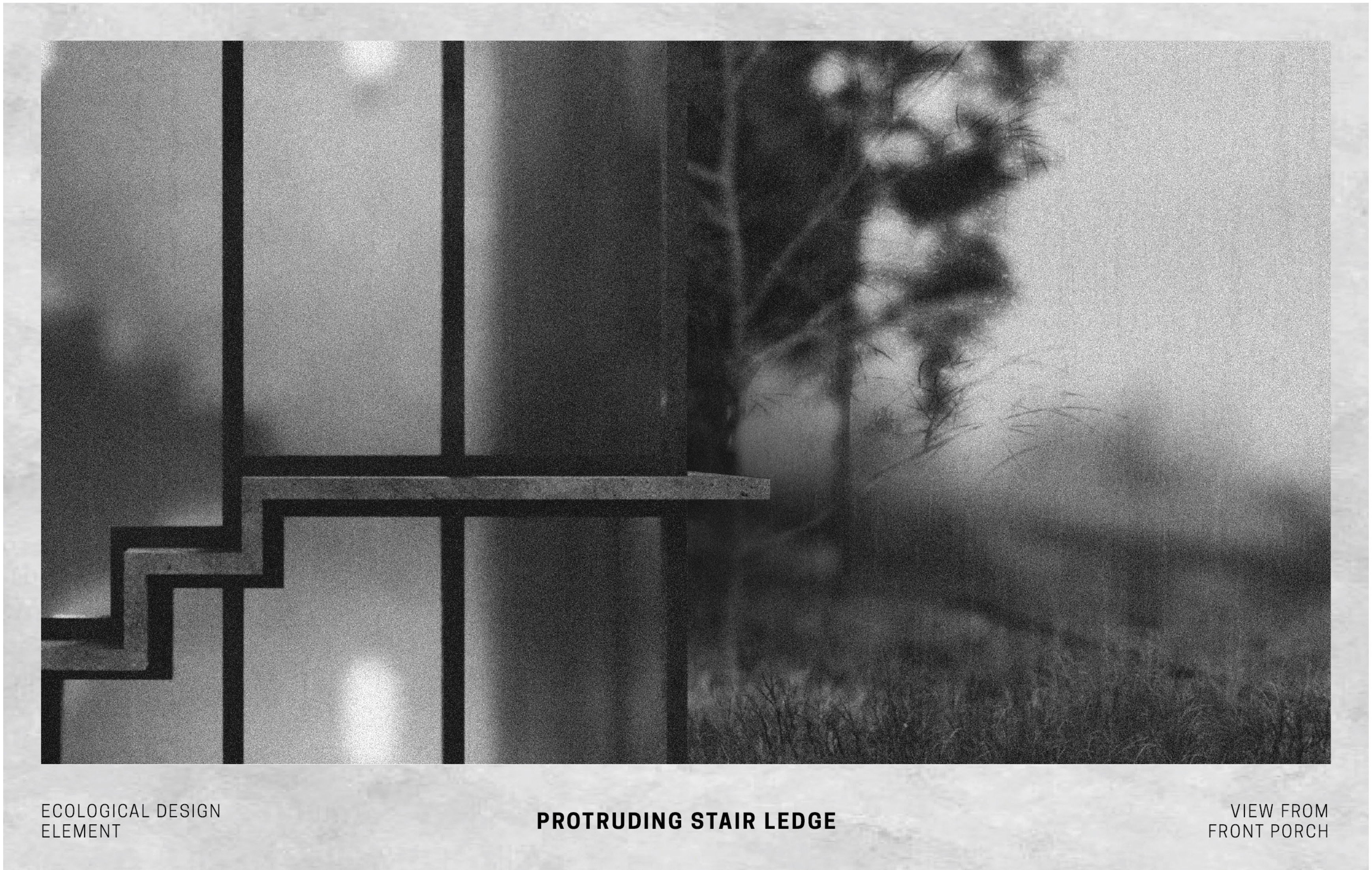
Render of the kitchen and dining area.

Rendered section of the vertical garden, depicting parallel eating functions throughout the interior and exterior realms of the home.

array of plant sizes and can be left without plants to also function as habitat nooks. The east orientation of this garden allows for the human inhabitants to plant flora such as Bee Balm, Purple Coneflower, Black-Eyed Susan, Cardinal Flower, Elderberry, Winterberry, Serviceberry, Switchgrass, Ostrich fern, Northern Bush Honeysuckle, or Common Milkweed for birds, butterflies, and bees. Red Clover, Buckwheat, Orchard Grass, Sunflowers, Hazelnut Bush, can also be planted to feed local deer and squirrels. On the inside of the home, the vertical garden is easily accessible through a sliding door, allowing the human inhabitant to plant their choice of flora to feed whichever native species they please. On the outside of the home, the vertical garden is attached to a walkway for wildlife that bridges between the natural wetland and the spruce pine hummock. This walkway is also connected to the back porch, allowing wildlife to easily take their food to the birdbath for cleansing. Through the vertical garden, a parallel is created between the interior and exterior functions of the home in regard to human and non-human eating spaces.

Overhangs and Perching Spaces

Throughout the design, there are various designed opportunities for perching spaces throughout the home. Other than the wire railings that line the back porch, the protruding stair slabs also create spaces for avian species to rest and dwell. These perching spaces face Lake William, with the wire railings providing perching spaces oriented towards the wetland. The protruding stair ledges demonstrate a simple design modification that can be incorporated into future developments to generate more habitat opportunities within the building envelope. Along the balcony on the upper level, typical metal railings also create additional perching spaces for birds. Further, the unconventional form of the home naturally generates significant overhangs which can be used as roosting spaces for bats. These overhangs are located all along the house and at varying levels. The most significant overhang occurs under the back porch, generating a shaded roosting spot in close proximity to the wetland underneath. The slat façade system on the upper



Render of protruding stair ledges.

Render of protruding stair ledges functioning as perching spaces.

level also generates ample perching areas for avian species, oriented towards all directions of the site.

Framed Natural Views

Throughout the design, key natural views are carefully framed to enhance the human experience within the home. In the kitchen, a large window offers an intimate and unobstructed view of Lake William. A one-sided matte tint is

GENERAL DESIGN ELEMENT

FRAMED VIEW OF LAKE WILLIAM

VIEW FROM DINING ROOM

Render of framed view of Lake William in the kitchen.

GENERAL DESIGN

FRONT PORCH

VIEW FROM
RIDGE AVENUE

Render of front porch, facing Lake William.

Rendered section of a bedroom, depicting a parallel resting function throughout the interior and exterior realm of the home.

applied to the exterior of the window to minimize bird-window collisions while simultaneously preserving the quality of light entering the home. The front porch of the home offers a sheltered nook for the human inhabitants to dwell with a direct view of Lake William. This dwelling area is also in close proximity to the protruding stair ledges, which act as perching spaces for avian species. On the upper level of the home, the two bedrooms both open outwards into a shared balcony space. This balcony area is lined with planters to support various forms of vegetation and is oriented primarily toward the spruce pine hummock. The coniferous forest shelters the balcony area, allowing it to feel intimate and private. The north end of the balcony provides a direct view of the wetland, while the south end provides a direct and unobstructed view of Lake William. Aside from creating intimate moments for the human inhabitants to admire their surrounding landscape, this balcony also functions as a point of access to the constructed wetland roof system, for both human and non-human species, and additionally provides a place for the human inhabitants to add or remove inhabitable inserts along the slat façade system.

The design of this home focuses on creating moments of ecological cohabitation within the residential envelope. Through this approach, a harmonious coexistence can be achieved between humans and other species surrounding them, and as a result, the home can work to mitigate the biodiversity loss typically associated with new housing developments. Traditionally, the residential envelope is primarily used to separate the interior realm from the natural world. By redefining this liminal space, the envelope can serve as a catalyst for ecological cohabitation and function in a way that supports the habitation of various non-human species. By generating habitat heterogeneity within the envelope of our homes, humans are given the opportunity to share their dwellings with the species surrounding them and as a result, we can inhabit the natural environment without fragmenting existing habitats.

Render of front exterior.

GENERAL DESIGN

BACK EXTERIOR

VIEW FROM
WETLAND

Render of back exterior.

Chapter 5: Conclusion

This exploration began with a curiosity about what it would look like to design a home capable of serving both human and non-human species simultaneously, and ultimately, prioritizing the health of the overall ecosystem rather than just the human experience. Generally speaking, humans have grown accustomed to the comfort that our homes provide us in regard to biological isolation. We do not necessarily like sharing our intimate spaces with bugs and other species, and this project does not intend to do that. Instead, the intention was to use the building envelope of residential developments as a way to facilitate ecological cohabitation while maintaining a comfortable level of biological isolation for the human inhabitants. The liminality of the building envelope holds tremendous potential in bridging the gap we have created between the man-made and the natural environment. For centuries, we have used the envelopes of our homes to isolate ourselves from the natural world and exile non-human species from their native land. By redefining this liminal space that typically separates human and other, we can begin to design opportunities for other species to inhabit our architecture alongside us.

The traditional approach to residential design often treats native non-human habitats as a necessary sacrifice for our own habitation, but this conceptual prototype rejects this common notion that it must be either us or them. The intention of this work was to develop a design methodology that could allow our homes to act as a catalyst for a harmonious coexistence between us and the species surrounding us. While Chapter 3 of this work focuses on establishing general design guidelines for ecologically responsible dwellings in different environments, the message behind this work is not that we should continue developing in ecologically rich or sensitive locations if it can be avoided. Developing in such areas should be viewed as a last-case scenario, and attention should currently be given to promoting biodiversity within pre-existing developments. There are various elements of this conceptual prototype that could be applied to existing traditional homes, such as the addition of a slat façade system to support various habitable inserts or the inclusion of water features on the site. Though promoting biological diversity within existing developments should be a current priority, this work aims to establish a design methodology for future developments in order to mitigate the overall biodiversity loss our housing developments typically create.

Throughout the design process, the issue of land ownership became increasingly apparent. Observation of property lines throughout the site revealed that homes often occupy less than a third of the overall property, yet the human inhabitants still alter the remaining landscape for superficial reasons. The modifications made to these widely unused lawns typically leave the landscape unsuitable for non-human habitation. The long-upheld practice of dividing up large parcels of land for proprietary reasons appears to create a culture of unnecessary land modification for aesthetic purposes, and resultingly, depletes the habitat heterogeneity naturally present within these environments. Though the concept of land ownership is incredibly complex, it is difficult to ignore the damaging implications it has on our natural environment. An alternative approach is to view the home as owned property, rather than the land itself, regardless of what property lines may otherwise imply. By rejecting the notion that land can be owned outside the context of the built form, a new culture can emerge wherein making superficial modifications to the landscape would be frowned upon rather than expected.

The insights gained throughout this research may have various implications for future housing developments. I believe it is increasingly necessary to reconsider our perception of land ownership and redefine what it means to inhabit the land that we ‘own’. Why should we continue to maintain our carefully kept grass lawns for aesthetic purposes, when the impact on local biodiversity is so negative? In the midst of our current environmental crisis, careful consideration must be given to all things we prioritize in the process of inhabiting the earth. Prioritizing a lightweight dwelling in future housing developments is essential in minimizing habitat fragmentation and, consequently, the loss of biological diversity. Further, ensuring our future developments are designed to accommodate not only us, but also the species surrounding us is imperative for our harmonious coexistence. Utilizing the domestic envelope as a catalyst for this ecological cohabitation is, conceptually, an effective approach to designing a multi-species accommodating home. Finally, the design methodology developed throughout this work can, in theory, be applied within any environment type to result in a unique, holistically designed home perfectly suited for its exact ecosystem. The intention behind this methodology is to try to give at least as much as we take from our ecosystems, and to transform our anthropocentric design approach to a more ecocentric one.

The most significant takeaway from this research for me was that species biodiversity is heavily dependent on habitat diversity. Throughout the design process, generating habitat heterogeneity was a top priority. Whether it be designing the water features of the home at different scales or ensuring the vertical garden could accommodate a variety of plant sizes, the intention was always to create diversity in design. By designing a wide variety of inhabitable spaces within the envelopes of our homes, we can begin to live harmoniously alongside other species while maintaining the level of biological isolation we have grown accustomed to. My hope is that this work could provide a glimpse into an alternative way of inhabiting the Earth by prioritizing a respectful coexistence between us and the species surrounding us.

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