Portland Pollinator Vision Plan

Prepared for the Wild Seed Project

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The Conway School ◦ Winter 2015

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Gray hairstreak (*Strymon melinus*)

"In all things of nature there is something of the marvelous."
Aristotle

We would like to thank the Wild Seed Project, Portland Pollinator Partnership, and the people of Portland, Maine, who provided valuable input throughout this project.

Thank you to the Conway School faculty, staff, and classmates for their continued guidance, patience, and support.

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Common ringlet (*Coenonympha tullia*)

Executive Summary

Many people and organizations in the city of Portland, Maine, are currently working to improve habitat for insect pollinators in the city. While these efforts are valuable first steps to protecting native species, what's been missing has been a comprehensive vision to ensure that the urban ecosystem can support pollinators in an ecologically robust way. This Plan, produced in a collaboration between the Wild Seed Project, the Conway School, and relevant city stakeholders, proposes a system of habitat patches and corridors to facilitate the proliferation of pollinators in the city.

Pollinators play a key role in the health of our ecosystems by enabling the reproduction and diversity of the majority of the world's plants. Plants and their pollinators have co-evolved over millennia to produce robust ecosystems that clean the planet's air and water, control flooding in human settlements, and provide us with food. Without pollination, these ecosystems and the services they provide us would likely unravel. In recent years, researchers have begun documenting the collapse of many pollinator populations around the globe. While the direct causes of these declines are difficult to identify exactly, it is clear that a global system of local efforts are required to reverse these trends. Because of the unique ecologies and grassroots potential of cities, urban areas offer promising opportunities for conserving and enhancing pollinator habitat.

Currently, Portland contains over 1900 acres of plantable ground, or about 700 more acres than the Falmouth Land Trust has, one of the largest land trusts in the region. While most of this land is not currently hospitable to pollinators, much of it could be converted relatively easily into areas that provide both food and shelter for a wide range of species. This document maps out the habitat potential of the city's parks, schools, community gardens, libraries, highways, power line corridors, hospitals, correctional facilities, and residential neighborhoods. An analysis of the size, connectivity, and public visibility of these sites helped to produce a strategic plan for implementing pollinator habitat in Portland, found in the recommendations section.

The proposed comprehensive habitat network highlights both the properties with the highest potential for planting habitat, as well as those that can most effectively engage the public. Taking into account the recent and historical efforts in Portland to enhance the health of the region's waterways, the Plan also points to the ways in which these projects are compatible with green infrastructure initiatives to manage stormwater.

The Portland Pollinator Vision Plan is, at its heart, a foundation upon which both pollinator and human populations can thrive in an urban environment. While the report identifies key landowners along the habitat network, management recommendations, found at the end of this document, can be used by anyone with access to a pot of soil or a piece of land. Through a purposeful and collaborative effort, the residents of Portland can build a culture that is resilient, regenerative, and respectful of all of the living things with whom we share this world.

Building the Urban Ecosystem

Recently, some Portland citizens have expressed an interest in promoting pollinator habitat in the City. A number of people and organizations are currently involved in planting pollinator gardens in residences, schoolyards, and other community spaces. Yet, despite these efforts, much of the city space is still hostile to pollinators. Native plant gardens are mostly small and disconnected and many landowners spray pesticides. This Portland Pollinator Vision Plan, produced by the Conway School in collaboration with the Wild Seed Project, proposes a network of habitat corridors through the city that would provide connection between habitat sites. Elements of these corridors are broken down to individual projects that could be taken on by the City, individual neighborhoods, or other landowners.

Members of the Portland Pollinator Partnership recently installed a pollinator garden behind Trader Joe's in the Bayside neighborhood.

The goals of the Portland Pollinator Vision Plan are to:

- Assist in the conservation of the native species of Southern Maine;
- Educate the public about the importance of pollinators;
- Help urban residents build a sense of connection with their region's natural heritage;
- Encourage healthy and diverse urban ecosystems.

Children help plant a garden for beneficial insects at the Reiche School in the West End neighborhood.

By following the recommendations laid out in this document, landowners can also help improve the city in the following ways:

- Increase the productivity and resilience of urban and regional agriculture by augmenting native pollination services;
- Manage stormwater with native-planted rain gardens and bioswales;
- Reduce the heat island effect in the city by replacing impervious surfaces with vegetation.

In the following chapters, this Plan will discuss the challenges and opportunities for pollinators in Portland, analyze the geographic distribution of potential partner sites, and present key projects for building the ecological integrity and social reach of the overall vision.

Least skipper (*Ancyloxypha numitor*)

Pollinators

THE ROLE OF POLLINATORS

Plants need to reproduce in order to keep their species alive and evolving. Over two thirds of the world's plant species rely to some degree on other organisms to complete this process (Ollerton et. al 321). These helper organisms are called pollinators. Without pollinators, there would likely be less than half of the plant species that exist today, and flowers and fruits would rarely be seen in the landscape. There are approximately 4,000 known species of native bees identified in the U.S. alone (Evans 106), and bees are only one of many types of pollinators. Birds, moths, ants, and butterflies are other pollinators that significantly contribute to pollination all over the world.

Native pollinators play a key role in preserving plant biodiversity. Many flowering plants coevolved physical characteristics to attract a specific pollinator. As a result, the loss of that pollinator could lead to the extinction of that plant and vice versa. This delicate relationship is one example of the many interspecific relations that are necessary for sustaining regional ecosystems. These ecosystems provide numerous services for humans including improving water and air quality and protecting settlements from coastal storm surges. A decline in certain plant species could disrupt the ecosystem's ability to provide these services.

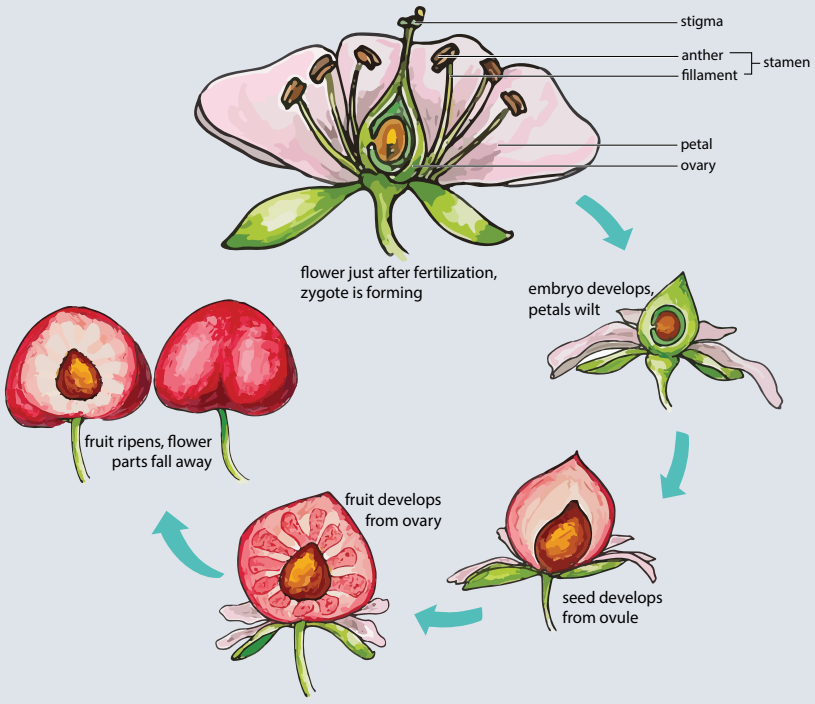
The loss of pollinators could also pose a serious economic problem. Without the aid of pollinators, fruit and vegetable production would decline. Many of the world's agricultural crops, including cabbage, tomato, and apple, rely on pollinators. Reports estimate that insect pollination is needed for seventy-five percent of all the crops directly used by humans (Potts, et al., 345). The global economic value of insect pollination was estimated to be over $190 billion in 2004 (Gallai 810).

POLLINATOR DECLINE

Pollinators require flowering plants for forage and to provide other services such as for shelter and nesting sites. Plant-pollinator interactions play a crucial role in the survival of many other species and in the maintenance of biodiversity (Seifan, et al. 953; Canes

Pollination

Pollination is the process of fertilization in flowering plants. It is crucial for floral plant reproduction and fruit development. Pollination begins when an initial disturbance dislodges pollen grains from the anther of the flower. For fertilization to occur, a pollen grain must be transferred from the anther to the stigma of a flower of the same species; this enables the next step of fertilizing the plant's ovary(ies). Fertilized ovaries develop into fruit, while the ovules develop into the seeds. Pollinators play a crucial role in the initial agitation of anthers to dislodge pollen grains. They may also help transfer the dislodged pollen from anther to stigma by transporting pollen on their body from one flower to another.



and Tepedino 1). Recent scientific research and meta-analyses of large amounts of previously compiled research have confirmed what insect enthusiasts have suspected and reported for years: many pollinator species around the world are declining. The largest body of evidence for this comes from North America and Europe, where pollinator loss has been most extensively recorded and monitored (Potts et al. 351). However, a growing body of literature reveals that this is a global problem (European Commission). The precise factors causing these declines are difficult to determine with certainty. Researchers suspect pesticide application, habitat fragmentation, decreased resource diversity, and climate change all contribute to the decline of pollinators (Potts et al. 348).

Pesticides present a significant threat to pollinator health. Monoculture farming is more susceptible to devastation by pests due to its lack of plant diversity. As a result, farmers are forced to increase their pesticide use to kill these insects. However, this can also decimate populations of pollinators foraging among the crops. Pesticides are not just a problem in agriculture. Unlike many native plants that have developed adaptations to resist local pests, the exotic and highly-bred plants desired by some gardeners may require significant pesticide and fertilizer use for

Pesticides, used to kill pest insects on farms and in home gardens, often have deadly effects on pollinators.

maintenance. Unfortunately, these are often the plants that are most readily available at nurseries and garden shops.

Pollinators are threatened by habitat fragmentation as well. In urban areas, buildings and pavement cover large swaths of land, and this lack of vegetation can be detrimental to pollinators. In Portland, impervious


Native bee pollinating a blueberry bush.

surface covers approximately 17,000 acres (equivalent to 12,000 football fields). Vehicular traffic and artificial lights create additional hazards (Mader 81-96; Evans et al.) that trap and kill pollinators. Even vegetated areas that have been disturbed by humans may not be hospitable to pollinators. Aggressive, introduced plant competitors and exotic insect pathogens are two other possible causes of pollinator decline that are especially prevalent in human-influenced landscapes (Potts et al. 348).

Ornamental plant breeding is another factor that further fragments pollinator habitat. Nurseries often breed plants to maximize the visual appeal of the flower. The breeding methods can result in sterile plants that do not provide food for pollinators. Combined with the chemical pesticides and synthetic fertilizers needed to grow them, these plants contribute to making many landscaped areas unfriendly for pollinators.

Another threat to pollinators and native habitat is climate change. If current carbon emission trends continue, the temperature in Portland is predicted to rise anywhere between three to five degrees Fahrenheit by 2050. Additionally, the Intergovernmental Panel on Climate Change predicts that the warm season in Maine will increase by a full two weeks during this time (Fernandez et al. 2015). Changing climatic patterns may cause new species and pathogens to travel up from southern regions. Such a drastic change in the environment would force many

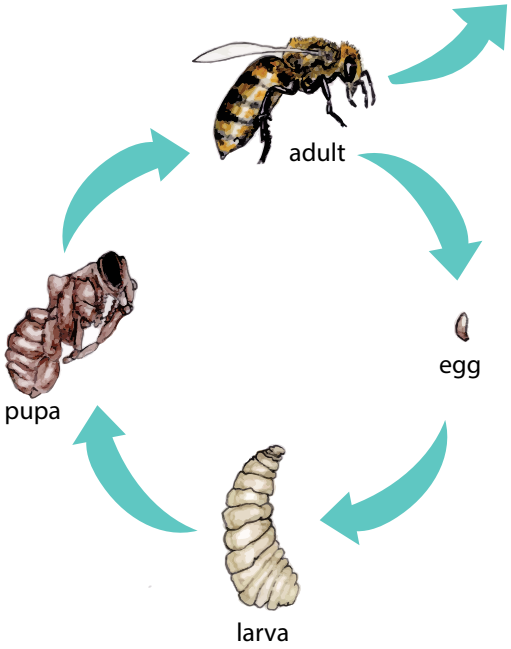
pollinators to either shift their current ranges or somehow adapt to the plant species changing around them. Either option has potential for failure, resulting in species loss. However, if their native habitat continues to be fragmented by human development, pollinator populations are still at risk of becoming trapped and dying. Without efforts to counteract global warming and maintain native habitat, many pollinators could lose their already small habitat and become extinct.

As development occurs, the natural landscape becomes more fragmented. This, coupled with the effects of habitat migration due to climate change, could be devastating for many species.

HABITAT NEEDS

Each pollinator species has a unique set of habitat needs. For example, the monarch butterfly requires milkweed as a host plant for the egg and larval stages of life. And some pollinators, like the blue orchard bee (*Osmia lignaria*), native to Maine, make their home in nest sites created in previously used insect borings in wood and brambles (Ascrizzi). Despite these subtle differences, as a broad species group, insect pollinators require habitat that supports them at every stage of their life cycle. Generally this habitat includes flowers that provide forage, abiotic hosts or host plants where pollinators may lay their eggs or nest, and an environment free of pesticides (Xerces 3).

When pollinator insect larvae hatch from eggs, they require an energy source to continue developing. For nesting bees this food source is often, but not always, provided by a mound of pollen mixture that is left within the egg's brooding area. For other insect pollinators, such as syrphid flies and butterflies, the eggs are usually laid in the vicinity of a food source. This source may be the plant the larvae feed on, other creatures that the larvae consume, or even rotting wood and detritus (Xerces 23).



Insect pollinators, such as the bee, go through various stages of development, undergoing a full metamorphosis. Each of these life stages requires different environmental conditions.

For insects that undergo full metamorphosis, the larvae eventually enter into a third quiescent pupa stage. The adult insect's structures are developed fully during this stage. Throughout pupation, insects often need a sheltered area such as leaf folds, tree bark, or house siding (Xerces 57, 150).

The adult stage is when pollinator insects are most actively involved in the pollination process and need abundant flower forage. In order for populations to successfully reproduce, it is vital that adults have a nearby food source. This allows them to spend a significant amount of their time building nests and giving birth to the next generation.

The Role of Pollinators in Maine

Pollinators continue to support the people and economy of Maine through their contributions to agricultural productivity, ecological resilience, and the preservation and enhancement of Maine's natural heritage.

HEALTHY LANDSCAPES

The landscape of Portland has changed significantly in recent centuries. Since the beginning of European settlement in the early 1600s, Maine has been a source of timber. Blessed with a natural harbor, Portland soon became a major port and urban center, exporting lumber products to Europe and beyond.

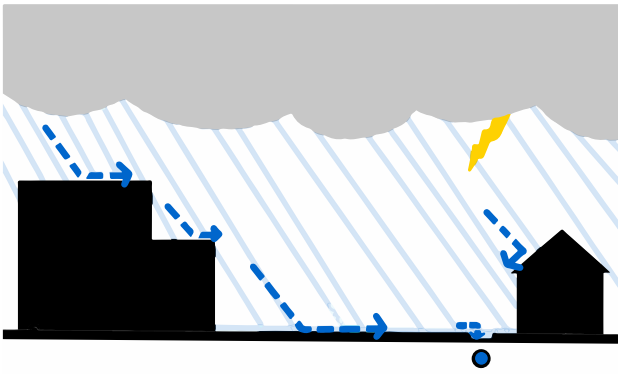
Agricultural products were another significant source of revenue for the early European settlers of southern Maine. In the mid-nineteenth century, Maine began farming blueberries and is today the top blueberry producer in the world (University of Maine Cooperative Extension). While many farmers still use honeybees to pollinate their crops, fears of species collapse and a newfound appreciation for wild bumblebees has renewed interest in pollinating with native species (see callout opposite).

In response to the oppressive social conditions of the Industrial Revolution, many writers and artists in the nineteenth century began praising natural landscapes as places for leisure and vacation. In Maine, these sentiments helped to bolster the state's fledgling tourism industry. Although it conflicted with the timber industry's interests, Maine's tourism sector began to grow with a focus on protecting the state's natural resources. Today, pollinators play an important role in allowing for the continued reproduction of many of Maine's most scenic landscapes.

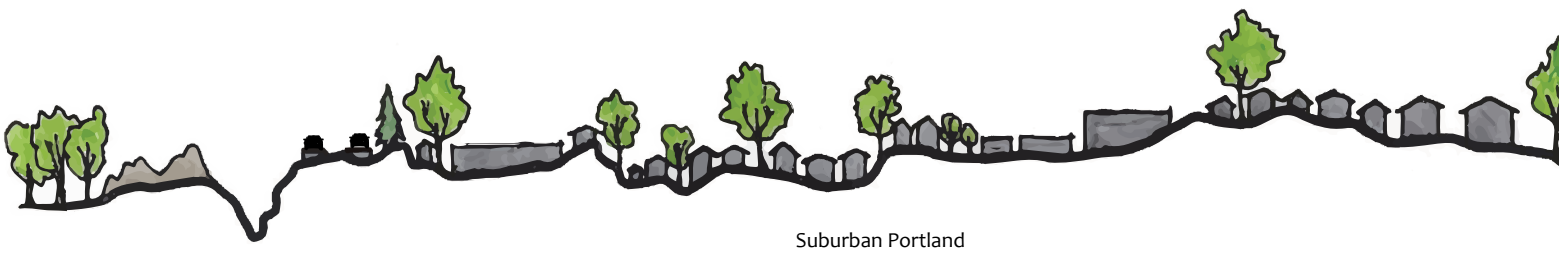
Agriculture has been and continues to be an important piece of Maine's economic output. An abundance and diversity of pollinators will assist in the continued productivity of Maine's farms.

CLEAN WATER

Maintaining water health is extremely important in urban environments like Portland where there is a significant amount of impervious surface. Surfaces such as asphalt and concrete collect pollutants and shed them into local water bodies when it rains and



Impervious surfaces shed water and do not allow it to seep into the ground.



Suburban Portland

snows. In addition to other work, supporting the health of local plant communities, which infiltrate and clean stormwater, is vital for the restoration of Southern Maine's rivers, estuaries, and coastal waters.

Portland's history is deeply tied to the area's rivers and marine environment. The harbors of Portland are known for remaining ice-free in the winter, making it a valuable shipping center throughout the year. Historically, the nutrient-rich waters of the Gulf of Maine supported a globally successful fishing industry along the New England coast. In recent years, however a combination of factors including overfishing, ocean acidification, and the eutrophication of waterways has significantly jeopardized the stability of these marine ecosystems.

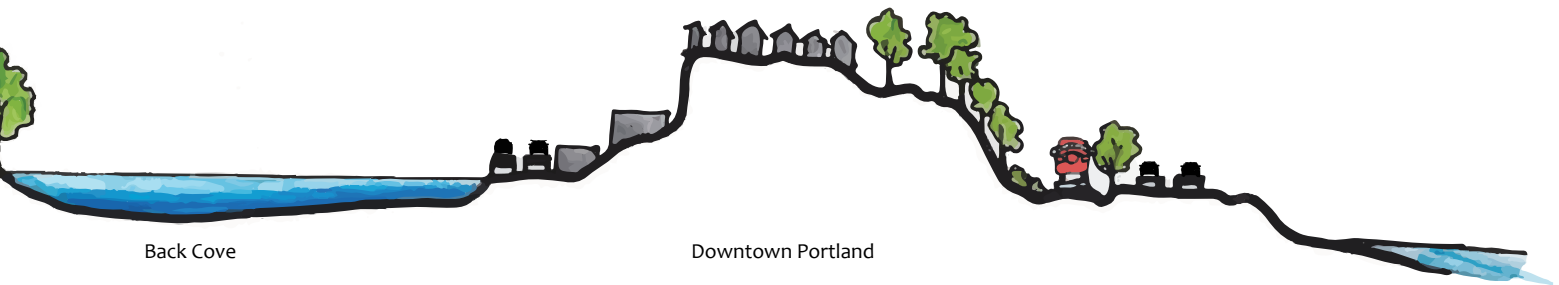
In an effort to restore the health of the area's waterways, vegetation should play an important role along rivers and shorelines. This vegetation would also serve pollinating insects . Pollinators help to build genetic diversity within plant communities, which in turn helps to maintain the resilience and continued function of these ecosystem services in the face of climatic and landscape changes.

When you look at Portland's history and how it has shaped the city and region, it helps shed light on how pollinators have and continue to play a key role. Their existence helps maintain the thriving ecosystem that makes up the ecology of Southern Maine.

The Gulf of Maine ecosystems face severe pressures from all sides. Overfishing and ocean acidification affect all levels of the food chain. Maintaining healthy terrestrial ecosystems can reduce the threats of eutrophication and water contamination.

Native Bees

Concerned about the collapse of honeybee populations, some Maine blueberry farmers have begun looking into native mason and leaf-cutting bees (*Osmia spp.*) as viable alternative pollinators. There are seventeen species of native *Osmia* bees in Maine. Because these species have adapted to survive in the Maine climate they are significantly more effective at pollination than the exotic honeybee, which will rarely fly in poor weather conditions. Also, unlike honeybees, *Osmia* bees do not live in colonies but rather reside by themselves in tree bark, woody stems, or sandy soils. To attract these species, some farmers have begun setting out nesting boxes, which consist of blocks of woods with varying sizes of holes drilled into them and hung from trees (Ascrizzi). Blueberry blossoms only provide pollinator forage for a few weeks, so it is also important to provide these bees with diverse patches of native plants to feed on throughout the growing season.



Back Cove

Downtown Portland

Opportunities for habitat in the city

Pocket parks such as Tommy's Park (left) create patches of higher sunlight and nearby shelter in a dense urban environment. If planted with pollinator forage, these spaces can provide many of the same benefits insects receive from a forest clearing (right).

It is easy to immediately categorize landscapes as either rural or urban, natural or artificial. Long-standing cultural biases tend to paint all cities as biological deserts while much of what is outside the city is perceived to be far more "natural." In reality, many of even the most wild-looking landscapes are influenced in some way by human actions and the effects of human development on plants and animals is widely varied and not always negative. This second observation is central to the field of urban ecology.

While the composition of species communities tend to vary widely from an urban to a non-urban landscape, the physical structure of these areas may share some surprising similarities. Skyscrapers for example provide ideal vantage points for hawks and other aerial predators to survey the land below. In this way, some have suggested, the urban environment mimics the structure of cliff-face ecosystems (Forman, 248).

Though less well-studied, cities may very well offer similar landscape analogues for insects. Because of regular disturbance patterns, cities in the northeast United States tend to have more vegetation in low- to mid-successional states than the surrounding landscape. This often means more sunlight reaches the ground and can lead to diverse assemblages of flowering plants and invertebrates. In this way, vegetated patches in cities mimic forest clearings where pollinator populations have been shown to do well (Matteson 140; Williams and Winfree, 15). Additionally, a higher incidence of patches of bare sandy soil in cities may benefit ground-nesting solitary bees.

While cities present many challenges to pollinators, the physical structure of the city offers numerous opportunities for improving conditions for pollinators through low-cost landscaping strategies. As such, managing for native pollinators in an urban environment such as Portland is a question of reducing the negative factors of the urban landscape while enhancing the positive.

Vacant lots and overgrown areas can provide shelter and forage for pollinators.

SOCIAL BENEFITS

Given habitat loss, pollution, and climate change, it is easy to think that all human interactions with the natural world are negative. However, this need not be the case. The San Francisco Green Hairstreak Project (below) is just one example of a community coming together to bring positive change to its environment. While a dense concentration of humans can create a host of problems for local ecosystems, many humans working together to assist other organisms can have a profoundly regenerative effect on the environment. Conversely, humans can benefit from this as well. To reach this point, people must be given the opportunities to build an emotional connection with the natural world. It is easy for people living in cities to feel powerless to support threatened natural communities. By bringing pollinators into the city and allowing people to interact with them and the areas they inhabit, emotional connections can be formed and a coalition of support for these species can build.

Like all good mutualistic relationships in nature, the human residents of Portland can also benefit from having more pollinators in the city. In addition to the physical services that pollinators provide, recent psychological studies suggest that contact with nature can be a viable method for improving one's mental health (Brymer, 21-27). Giving people the opportunity to plant pollinator gardens and be active participants in building habitat could help to improve the quality of life of the city's residents.

People coming together to help pollinators helps the community as well.

In 2012, Mayor Michael F. Brennan announced his Healthy Sustainable Food Systems Initiative to support, among other things, urban agriculture. This program signals Portland's commitment to building a resilient local food system. In the coming decades, pollinators will play a key role in the productivity of these systems and the ability of Portland to support a growing human population.

Case Study: Green Hairstreak Project

Green hairstreak (*Callophrys rubi*)

Similar to Portland's downtown, San Francisco's Inner Sunset District sits on a densely developed peninsula. The combination of copious impervious surface and limited habitat connectivity makes both of these environments very dangerous for pollinator species that cannot travel far between habitat patches. This situation also makes the construction of a corridor very difficult because it requires buy in from many different landowners.

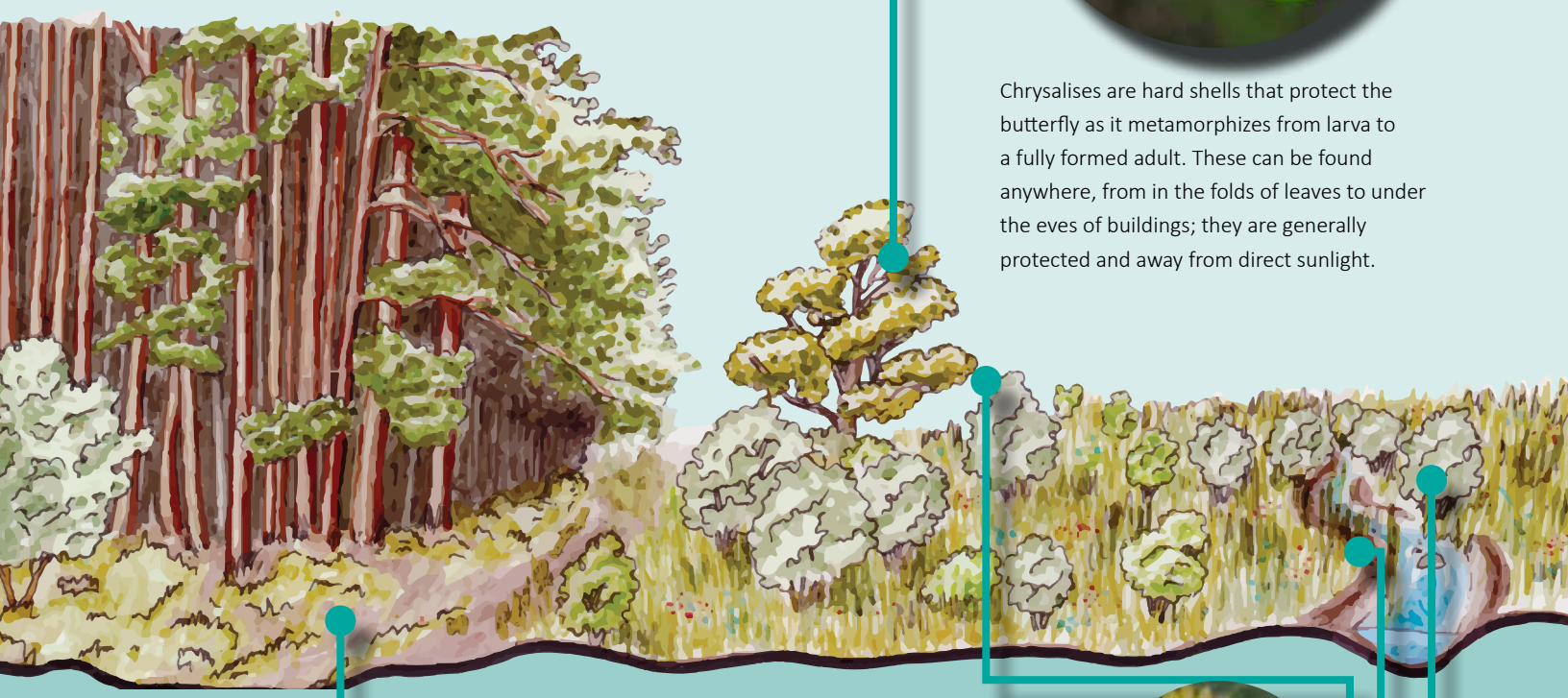
In 2006, San Francisco-based lepidopterist Liam O'Brien first discovered a small population of green hairstreak butterflies in the city's Inner Sunset District. Once abundant throughout the outcrops and dunes of the Bay Area, the hairstreak was thought to be extinct in the region. O'Brien determined that the district was home to three distinct populations. Unfortunately, these populations were disconnected from one another by residential development and were at risk of dying off as the result of further development and lack of genetic mixing.

Founded by O'Brien, the Green Hairstreak Project is now a well-publicized volunteer effort run through the organization Nature in the City. As their website explains, Nature in the City is composed of a "devoted team of government employees working to preserve what is left of the city's riparian corridors, bay edge wetlands, oak woodlands, rocky outcrops, grassland hilltops, and dune ecosystems." In 2011, the city incorporated this project into their open space planning efforts. Since the start of the project, Nature in the City has added twelve new habitat patches connecting public lands, residential gardens, and school yards. Its goal is to reach Hawk Hill in the south, which is the highest dune habitat in North America. Hoover Middle School, on Hawk Hill, has already completed their green hairstreak garden in anticipation of the butterfly's arrival.

POLLINATOR EDGE HABITAT

Habitat for various stages of a pollinator's life cycle can be found in transitional areas between different landscape typologies. This space, also called edge habitat, creates a unique set of microclimates that help shape microhabitats for larva, growth, and nesting stages of various pollinators (Henning 155-160).

Chrysalises are hard shells that protect the butterfly as it metamorphizes from larva to a fully formed adult. These can be found anywhere, from in the folds of leaves to under the eves of buildings; they are generally protected and away from direct sunlight.



About 70 percent of native bees are solitary ground nesters (Xerces 35). The queen bumblebee hibernates in an underground nest, and some bees and wasps live in entire underground colonies. Maintaining uncovered, well drained soil is important to support underground nesting habitat.

Butterflies and syrphids often lay their eggs on leaves. Butterflies generally lay their eggs on a host plant and syrphids lay eggs near aphid colonies. These arrangements ensure an immediate food for the larva once they hatch.

Approximately 30 percent of bees make their nests in tunnels. These tunnels can be reoccupied holes made by other animals. Some bees also chew the pith of smaller woody plants or use hallow reeds to make a home (Xerces 32).

With such an intense focus on bees, it's easy to forget the range of pollinators that exist. Flies often pollinate flowers that are pale and dull to dark brown or purple that have putrid smells (Flies USDA).

URBAN HABITAT ANALOGIES

Due to the widely varied nature of urban landscapes, cities can provide unexpected opportunities for insect pollinators to find food, water, and shelter all in close proximity. Though these requirements—especially food—may be less abundant in the city, there are many ways to build upon the potential of these transitional areas.

Pollinators need to drink water, like the rest of us. They often get their water from free-standing puddles or highly saturated soils (PennState).

Flowers planted across a cityscape can provide forage and habitat stepping-stones for pollinators.

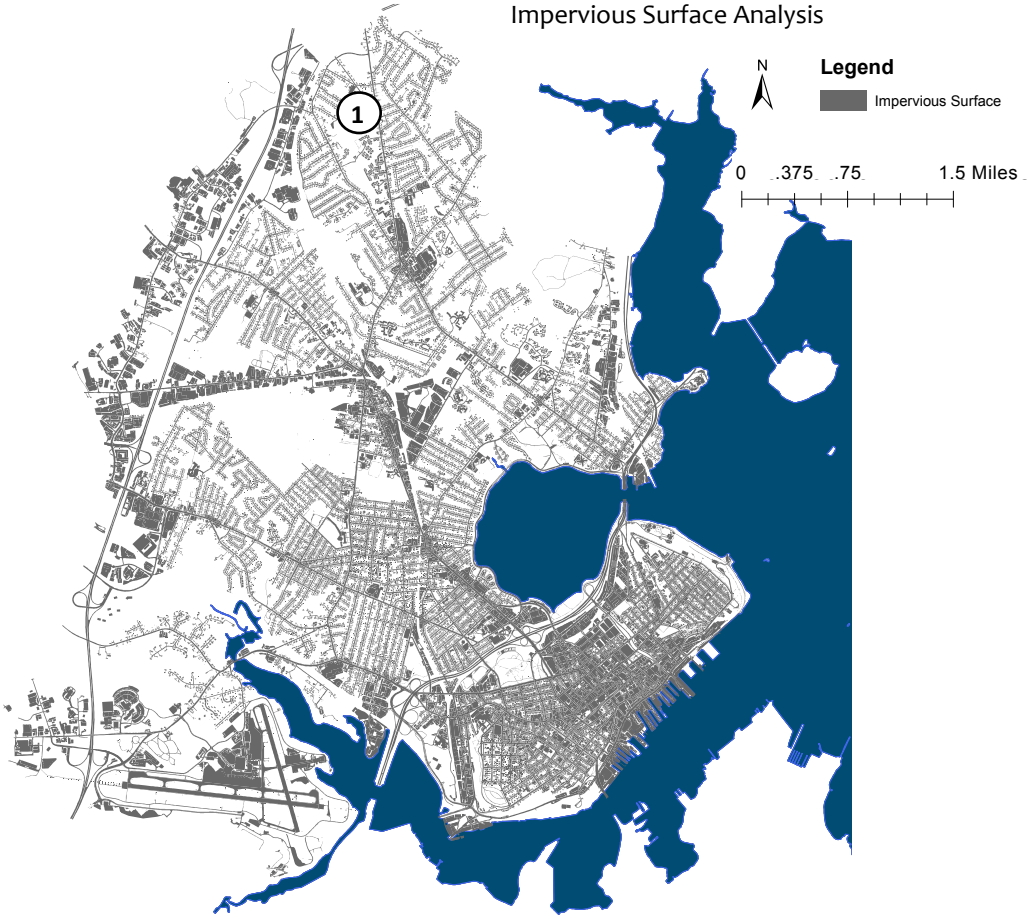
The leaves of trees and their flowers provide habitat in urban spaces, they also reduce the urban heat-island effect, provide shade, and have been correlated with positive social effects.

Monarch butterflies are one of many butterflies that require heat for mobility. A monarch's muscles must be at least 55°F (13°C) in order to fly. Asphalt and other rough, dark surfaces in the city provide ideal warming locations for these creatures (Journey North).

Where can pollinators exist in the city?

Habitat Needs

"Where there is dirt, you can grow native plants." Heather McCargo, Director of the Wild Seed Project



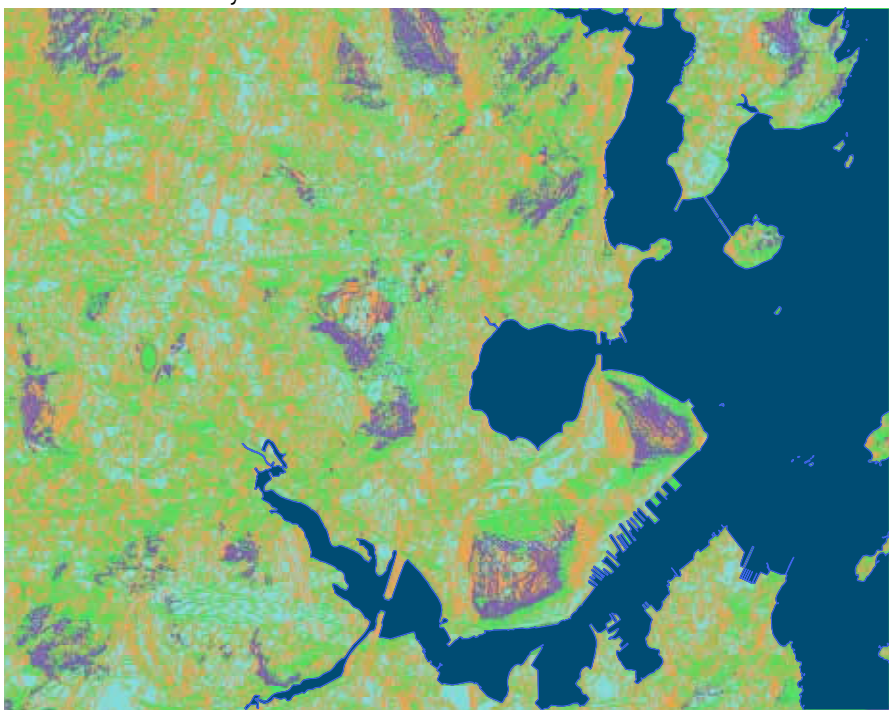
While much of the peninsula is impervious, large areas of pervious surface suitable for pollinator habitat are located in the North Deering neighborhood ①.

Generally speaking, pollinators have few habitat requirements: a flower-rich foraging area, suitable host plants or places where they can lay their eggs, and an environment free of pesticides (Xerces, 3). All pollinating insects go through the basic life cycle discussed in the introduction. A larger habitat patch will have an increased chance of providing all of these life cycle requirements than a smaller one. Additionally, a larger patch will generally be more capable of supporting more plants that bees can use as forage. If there are more flowers in the pollinators' immediate vicinity, they will be able to expend more energy building, reproducing, and defending nests rather than searching for food. The Xerces Society states that bigger habitat patches within proximity to each other are most beneficial. Research supports the idea that patch size is a significant factor in determining overall pollinator biodiversity on a site (Williams, Hennig). From this evidence, and additional research, potential patch size and solar radiation will help to determine potential areas for habitat across the city (see Appendix B pp. 48-50).

For the potential-patch-size analysis, the pervious surface per parcel is determined. Pervious surfaces are defined as areas where man-made impervious surfaces are absent. These pervious surfaces are assumed to have soil and therefore potential for habitat. Understanding that pollinators need more than a sizeable piece of pervious land, this analysis begins to reveal where habitat may easily be created. Areas of pervious space present opportunities that may be currently vegetated, or may benefit from altered regimes in vegetation management and planting.

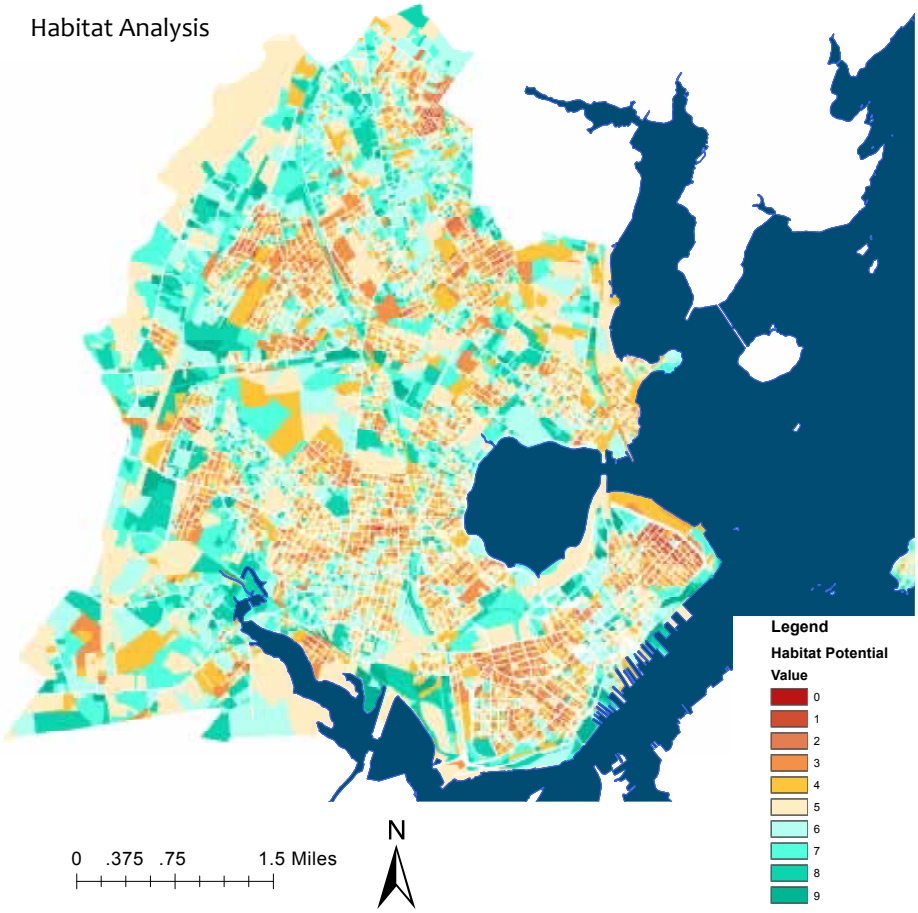
For this map, impervious surfaces include constructed surfaces, such as roads, parking lots, brick, asphalt, concrete and areas of man-made compacted soil or material such as unpaved parking lots or areas being mined (no vegetation present). Buildings are not consistently included in this data layer. Because of this, the few building footprints found on the impervious surface layer are erased with the overlapping areas of the building footprints layer.

Solar Radiation Analysis



Some of the lowest areas of radiation are located in downtown and near Evergreen Cemetery.

Habitat Analysis



The solar radiation analysis revealed the effect of the sun and accounted for various elements such as seasonal shift and steepness of an area. This analysis was useful for showing broad landscape patterns of sun and shade. While many pollinators require shady nesting areas, they spend the majority of their life in sunny areas with flowers for foraging. While conclusions about pollinators' behavioral responses to sun levels are still rudimentary hypotheses, there is enough substantive and accepted evidence to support the importance of sunlight for pollinator habitat (Williams 12-16). The Xerces Society states that "The best pollinator habitats will also have good sun exposure… the main characteristic to consider is that the site be in full sun for at least part of the day." (Xerces 100).

The resulting map reveals the combined potential: where there are sites that have lots of pervious surface and, generally, receive more sun than other areas. This is useful for identifying privately owned parcels that harbor high habitat potential. Although the results still need site-specific confirmation, this is the beginning of a more in-depth process that could lead to the development of a substantive urban pollinator habitat model. This model would extend beyond identifying potential and take into account more extensive scientific research about pollinators, urban habitat and other factors, such as local microclimates.

The combined solar radiation and impervious surface analysis shows potential areas where pollinator habitat may exist. This analysis could be used to target homeowners to implement habitat patches.

SCHOOLS AND COMMUNITY GARDENS

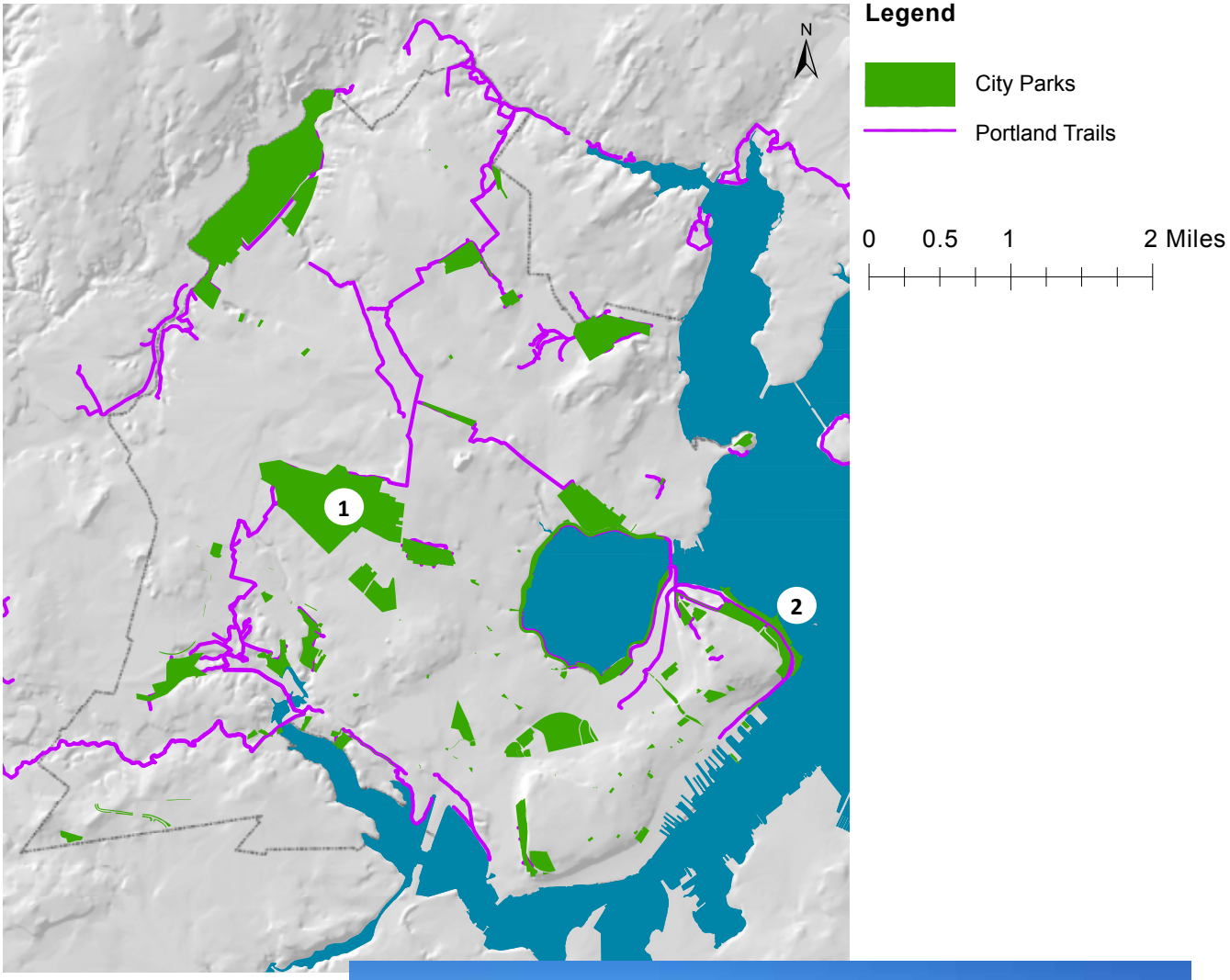
Portland contains more than twenty schools (pre-kindergarten to university level) whose properties in total contain roughly 84 acres of non-impervious surface, less than 1 percent of the city's total area. Ranging in parcel size from a quarter acre to nearly twenty acres, these schools are in every neighborhood except for Stroudwater and Riverton in the southwest. The School Ground Greening Coalition (SGGC) works with a number of these schools to bring nature into students' curriculum and play. Pollinator gardens are currently a significant piece of SGGC's work.

Cultivating Community manages the city of Portland's community garden program. This regional non-profit maintains one urban farm and six small community gardens throughout the city. These programs primarily encourage food production and promote sustainable practices. In addition to Cultivating Community's gardens, there are numerous other public and private gardens that have yet to be formally mapped. For example, Longfellow Garden Club is in charge of the Longfellow Garden downtown as well as the Longfellow Arboretum, which is located within Payson Park.

Community gardens provide a wide range of plants that give pollinators forage.

Due to their small size and lack of connectivity, schoolyards and community gardens alone cannot provide an ecologically robust system of urban habitat. However, because of their broad distribution and roles as community centers, incorporating these sites into a larger corridor network would create invaluable opportunities to build awareness and support for the pollinator network.

CITY PARKS AND TRAILS

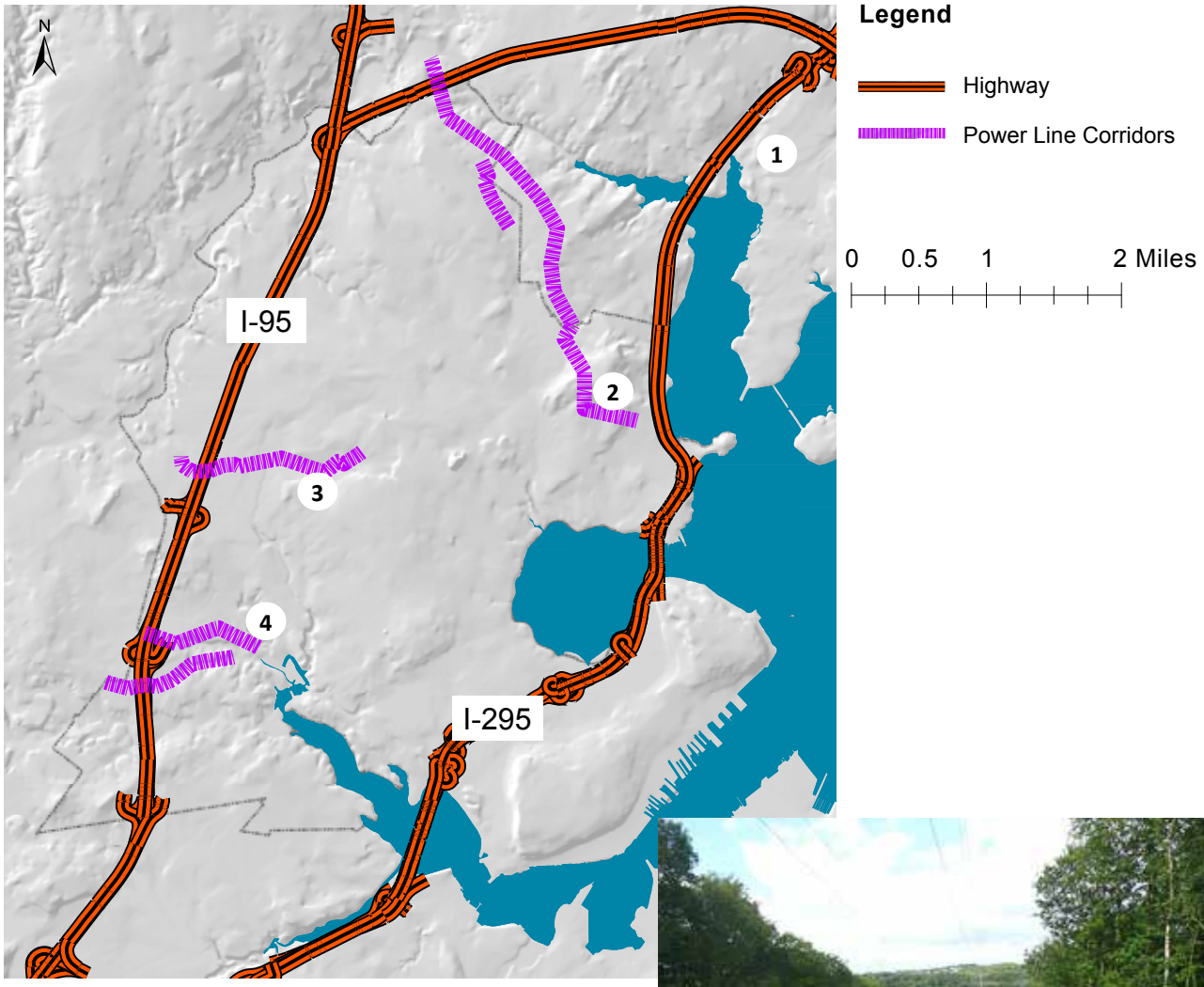


Originally designed by Frederick Law Olmsted, the Eastern Promenade ② has great habitat potential if its large open spaces were converted to no-mow areas.

The City of Portland owns over 1,000 acres of open space within the city boundaries. These parks come in many sizes and host a variety of uses. The largest green space in the city, Evergreen Cemetery ①, lies in the city's suburban outer ring. Roughly 50 percent of this cemetery is covered by forest. At the opposite end of the spectrum are the small pocket parks located in the heart of downtown that provide green spaces to the urban core. In addition to these city parks, an urban land trust called Portland Trails oversees the use of over seventy miles of recreational pathways in the greater Portland area. These trails include both paved and unpaved surfaces for walking, biking, and winter recreation, many of which link up to larger parks.

Portland's existing networks of open space and trails provide a strong framework for building a pollinator-friendly city. Additionally, the process of developing habitat in these areas would be simplified since it would involve working with only one landowner.

POWER LINES AND HIGHWAYS



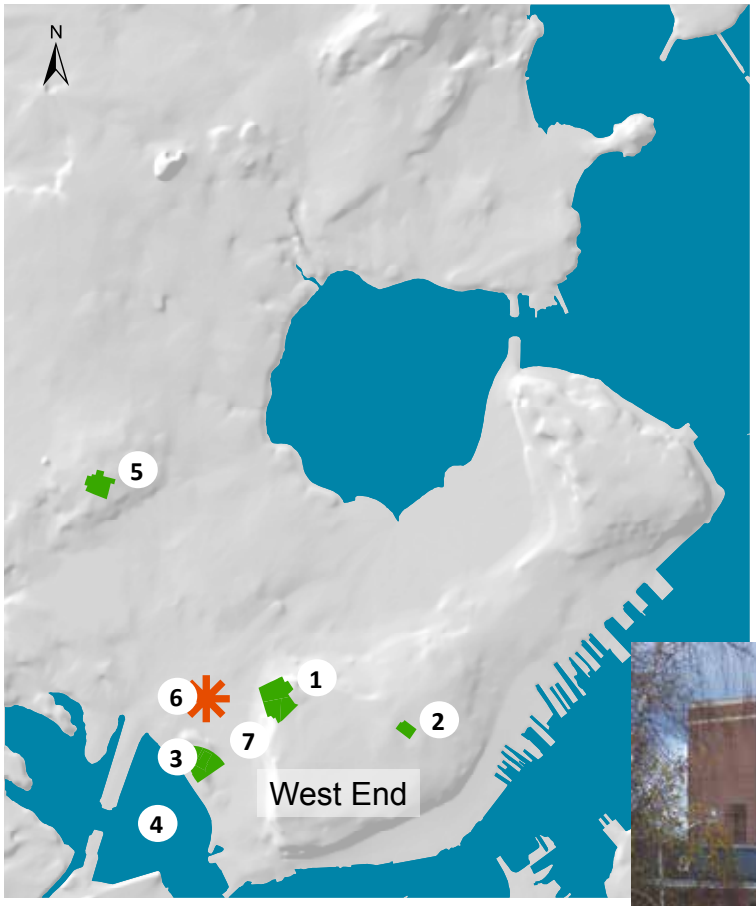
There are approximately ten miles of interstate highway within the Portland city limits. The I-95 corridor traces the western edge of the city for five miles while I-295 travels for another five miles along the coast and across the Portland Peninsula. Just south of the city, I-95 merges with I-295 and extends down the East Coast all the way to Miami. The two routes connect again in the north and follow the Maine Turnpike to the Canadian border. The Maine Department of Transportation manages both of these interstate routes within Portland.

Additionally, three power line corridors, spanning roughly seven miles, cut through the forests of suburban neighborhoods. Some of them are also adjacent to large open spaces that could provide a beneficial pollinator relationship. One long corridor, starting in Falmouth ①, skirts Portland's northeast border before passing through the Ocean Avenue Recreation Center ②. Three other shorter power line corridors run perpendicular to I-95. One of these enters the city directly above Evergreen Cemetery ③, while the other two cross through the Fore River Sanctuary ④. The corridors are owned and managed by the Central Maine Power Company.

Power line corridors provide vital connections for pollinating insects.

Vegetated strips of open land that border highways and power line corridors provide space that could be used to promote native pollinator habitat. Because these strips cover large distances, they are valuable resources for creating connectivity between different elements of the corridor network.

LARGE INSTITUTIONS



Legend

Hospitals

Cumberland County Jail

0 .375 .75 1.5 Miles

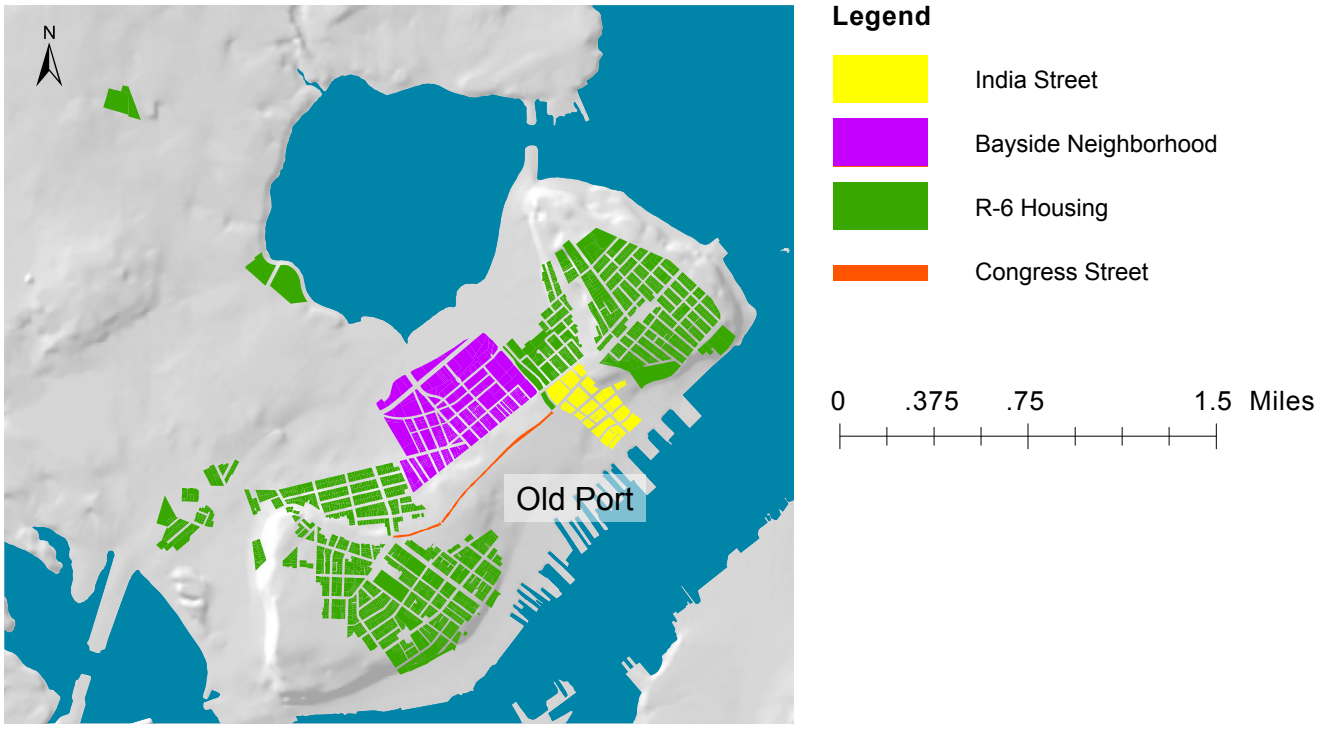
The West End neighborhood houses two hospitals: Maine Medical Center ① and Mercy Hospital ②. Mercy Hospital, owned by the Sisters of Mercy of the Americas and the Eastern Maine Healthcare Systems, also maintains another campus ③ along the Fore River ④ just east of I-295. Another major hospital—Brighton Medical Center ⑤—is in the Oakdale neighborhood.

The Cumberland County Jail ⑥, run through the Cumberland County Sheriff's Office, lies at the base of the Western Promenade ⑦ adjacent to Mercy Hospital's Fore River campus.

Though these institutions own a relatively small amount of land (less than three quarters of an acre each), their strategic location within some of the most heavily developed parts of the city makes them appropriate targets for promoting habitat.

Hospitals, jails and other large institutions have many planting beds and open spaces that could be used as pollinator patches that could serve as an educational component of the corridor.

CURRENT AND FUTURE DEVELOPMENT



Many major development projects will be changing the landscape of Portland's downtown peninsula over the coming decade. The Bayside neighborhood has been undergoing development since 2008 and R-6 zoned housing units are scheduled for development, which will increase residential infill. While details are not yet public, there are also plans to further develop the Old Port waterfront area, making it an even larger tourist hub by connecting it to the airport (Koenig). It will be important to communicate with developers to encourage them to incorporate either large pollinator patches or, if nothing else, to use a native plant palette in their designs.

Bayside Neighborhood Development

In 2000, Portland published "A New Vision for Bayside," a plan detailing the future re-development of the downtown Bayside Neighborhood, which has a long industrial history. The plan focused on the following goals:

- Develop an urban gateway
- Provide economic and employment opportunities
- Make the neighborhood more walkable
- Provide more housing and a neighborhood center
- Build multi-level parking structures
- Make the development transit-oriented
- Emphasize and highlight open space and recreational areas
- Provide a social service resource network
- Re-develop the scrap yard
- Continue with environmental remediation

Since the publication of the report, development has been ongoing and while there is still more to do, the neighborhood is already feeling re-energized.

Development in Bayside will re-purpose former industrial areas into more usable areas for the community.

Planning the Network

A CITY-WIDE NETWORK of native plant communities will protect and extend pollinator habitat in Portland. The following recommendations weave together public common space, private lands, and linear regional space to support both robust habitat and human interaction with the natural world.

Pollinator habitat can theoretically be established anywhere that has access to soil, sun, and water. The proposed elements form a coherent and continuous corridor, linking the city's urban core and densely settled neighborhoods with Portland's larger open spaces and the greater region of Southern Maine.

Some proposed corridors (highlighted in red) are primarily aimed at bringing the pollinators directly to the people of the city, others focus more on enhancing the ecological integrity of the overall network (highlighted in yellow).

ESTABLISHING ECOLOGICAL FOUNDATIONS

A functioning pollinator corridor needs to be capable of supporting a diversity of pollinator species at every stage of their lives. Factors of habitat that are needed for establishing a thriving local and diverse pollinator population include areas with large swaths of non-impervious surface. Large habitat patches, important for supporting pollinator diversity, could be incorporated into these areas (Xerces, Williams). Additionally, lands that connect large areas of potential habitat within the greater region enable the pollinators' ability to move easily throughout the habitat network.

Some of the following recommendations are geared to the ecological foundations of the network. For these places that are considered more ecological than social, habitat functionality is the essential design and programmatic priority, above other factors. These projects are primarily aimed at providing robust habitat that can establish and support smaller populations across the city.

Large areas that connect with other habitat patches are valuable for maintaining the ecological integrity of the corridor.

FORMING SOCIAL CONNECTIONS

Providing robust habitat is important, but that alone does not fulfill the goal of educating people and reconnecting them with their local ecologies. Social connections are vital for the ultimate sustainability of the corridor. Through initiatives to bring native plants and pollinators into areas of high pedestrian traffic and personal use (public trails, library yards, hospitals, and jails), citizens will become more informed and engaged. Here, aesthetics and accessibility are important considerations.

Implementation of habitat within these socially focused areas may at first require substantial initiative by individuals and organizations. After pollinator habitat is established though, opportunities for enjoyment of and involvement in these corridors will increase. As the network grows in its public exposure, a powerful grassroots movement can begin to grow. To encourage participation, supporters might be mailed seed packets and information about plant propagation; run workshops for gardeners and landscape contractors; and produce Pollinator Corridor-branded items such as planter boxes to bring a sense of identity to the project and those involved.

EVALUATING THE OPPORTUNITIES

"Corridor elements" are identified parcels, places, and connectors between them in the city of Portland. Each corridor element comes with set recommendations about management and implementation. The recommendations are ranked on a scale of one to three for their ecological and social value. Ecologically valuable elements have larger areas of non-impervious surface and/or provide useful connections between other corridor elements. Socially valuable elements are generally highly visible public spaces and have a high potential for engaging a range of citizens and organizations.


Oak Nuts Park
North Deering Power line
Riverside Golf Course
North Deering
Ocean Avenue Recreation Center
Riverton Community Garden
I-95
I-295
Murray Street
Warren Avenue Power lines
Evergreen Cemetery
Payson Park
Back Cove
Eastern Promenade
North Street Community Garden
Munjoy Hill
Brighton Medical Center
Fore River Sanctuary Power Lines
University of Southern Maine
Boyd Street Urban Farm
Oakdale
Franklin Street
Deering Oaks Park
Congress Street
Libbytown
Maine Medical Center
Mercy Hospital
Spring Street
Commercial Street
Portland International Jetport
Western Promenade
West End

Recommenations Key

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- Eastern Promenade
- Deering Oaks Park
- Oak Nuts Park
- Payson Park
- Ocean Avenue Recreation Center
- Evergreen Cemetery

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3. Trails
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- Harbor Walk
- Back Cove Trail
- Riverton Rail Trail

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5. Community Gardens
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- Riverton Community Garden
- Boyd Street Urban Farm
- Additional privately owned gardens throughout the city, such as Longfellow Community Garden

6. Power Lines
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- Fred P. Hall Elementary School
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- King Middle School
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- Libbytown
- West End
- Munjoy Hill

15. North Deering
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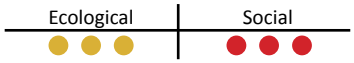
1. LARGE PARKS

- Western Promenade
- Eastern Promenade
- Deering Oaks Park
- Oak Nuts Park
- Payson Park
- Ocean Avenue Recreation Center
- Evergreen Cemetery



Larger patches of habitat reward pollinators for moving greater distances. Parks offer space to accommodate reservoirs of pollinator populations that can enhance the viability of native plants in the city. Additionally, these parks provide space for educating the public through signs, workshops, and nature walks. In Evergreen Cemetery, sensitive site design can respect grave sites while maximizing the productivity of unmown strips along the roads and forest edge. Deering Oaks Park is recommended as a suitable place to establish habitat because it is one of the most heavily used parks in Portland. No-mow patches beneath the trees and native meadow restorations along the wetlands could provide essential habitat for pollinators, while signs will educate citizens on the plight of local pollinators and build a sense of civic identity around the pollinator movement.

Longfellow Arboretum in Payson Park is part of the existing vital open space network.

Implementation:

- Reach out to the city as well as advocacy organizations involved with parks.
- Identify edge habitat and other habitat areas.
- Provide native plant lists and possible planting design templates for each park.
- Provide city with management guidelines that emphasize lower maintenance costs for low-mow strategies and pesticide reduction.

Located at the western edge of downtown, Deering Oaks Park, designed by F. L. Olmsted, could implement a selective mowing regime. This type of management would be of great benefit to the pollinator corridor.

2. RIVERSIDE GOLF COURSE

Ecological | Social

Golf courses provide excellent opportunity for restoring native meadow habitat in the spaces bordering the property and between the fairways (see below). The United States Golf Association, Audubon International, and the Golf Course Superintendents Association of America are all involved in initiatives to improve wildlife habitat on golf courses. Because of its large size, the city-owned Riverside Golf Course could become a sanctuary for pollinators region-wide. Patrons of the golf course could hold work days to help plant more natives and remove invasive plants from low-mow patches.

Implementation:

- Engage with city and golf course patrons.
- Provide plant palettes and design templates for various uses.
- Develop signs for education.
- Provide management guidlinges for patches of low-mow between fairways.

Riverside Golf Course can be a vital link in enhancing habitat.

Case Study: Rockland Country Club

In 2000, the Rockland Country Club in Sparkill, NY, decided to eliminate mowing during the growing season in the rough between the fairways of its golf course to save money on maintenance costs and to promote wildlife habitat. Many club members were initially concerned that these changes would give the course an unkempt look. To counter these notions, course superintendent Matthew Ceplo communicated with the club's members throughout the process. Before the areas started growing in, Ceplo posted attractive pictures in the clubhouse of what these areas would look like and also publicized how much the reduced maintenance was saving the club.

Despite these efforts, Ceplo began receiving complaints after the first few years when the "scruffier" plants began to grow in. These plants included milkweed, goldenrod, and boltonia, all of which are valuable for pollinators. In response, Ceplo posted information about the ecological value of these plants and set up a terrarium in the clubhouse containing monarch larvae and a milkweed plant for members to view.

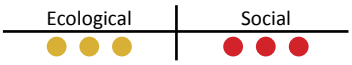
Throughout the years, Ceplo has had to adjust management practices, including controlling for invasive plants. For aesthetic variability, some areas have higher densities of certain plants. Areas where golfers are prone to hit balls receive an additional coarse mow during the season.

By effectively relaying the club's intentions to its members, Ceplo eventually turned the tide of opinion. Some members even told him that they were allowing milkweed to grow in their home gardens. The Rockland Country Club is an example of how small management changes can have a beneficial impact on native pollinators while at the same time educating golfers and giving them the opportunity to feel part of a larger project (Ceplo).

For more information visit: rocklandcountryclub@blogspot.com

3. TRAILS

- Bayside Bike Trail
- Harbor Walk
- Back Cove Trail
- Riverton Rail Trail



Long corridors of green space line many of the city's public trails. The Bayside Bike Trail is one of the city's newest walking and biking paths, built in conjunction with the development plan for the Bayside neighborhood. Some areas along this path have open space on either side where Portland Trails can introduce pollinator habitat. Other trails often possess similar spatial opportunities for planting. The Back Cove Trail is one of the city's oldest and most popular walking and biking paths. Between this trail and the road, the city maintains a buffer of mown grass while the waterfront side is a small salt marsh. This roadside area could have native plant patches to improve its appearance and provide a connection for pollinators between downtown and the suburbs in the north. Adding native plants to these trails could provide connective strips of pollinator habitat.

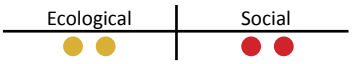
Implementation:

- Propose plant palettes and basic design templates as well as management guidelines.
- Develop educational materials and interpretive signs.
- Work with city's Department of Environmental Programs and Open Space to plant native vegetation in city parks, adopt no-mow strategies, and build pollinator habitat boxes.

A cyclist rides through pollinator habitat that thrives where there was once bare grass along the Bayside Bike Trail.

There is ample lawn at the University of Southern Maine.

4. UNIVERSITY OF SOUTHERN MAINE



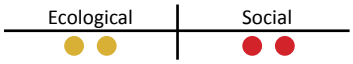
The USM campus is a key component within the connector neighborhood of Oakdale. The Portland Food Forest Garden, located on the campus, has been designated by the school as a pesticide-free zone, which is a valuable asset in this higher density neighborhood. Building off this initiative, the Department of Facilities Management may be interested in expanding ecological landscaping projects throughout the campus. Additionally, the school's Department of Biological Sciences could monitor sites around the city and integrate research about urban pollinator ecology.

Implementation:

- Coordinate with Department of Facilities Management to set aside low-mow patches and plant pollinator gardens on campus.
- Identify key faculty interested in creating research gardens.
- Establish program for implementing more pollinator gardens
- Work with faculty and students to start city-wide monitoring program as well as educational materials such as interpretive signs for pollinator habitat around the city.

5. COMMUNITY GARDENS

- North Street Community Garden
- Riverton Community Garden
- Boyd Street Urban Farm
- Additional privately owned gardens throughout the city, such as Longfellow Community Garden



Urban Agriculture depends on pollinator health. While most of the space in these community garden plots is devoted to food production, spaces could also be set aside for pollinator habitat. While the garden space is small relative to other potential habitat areas in the city, these gardens are socially valuable, and visible examples of chemical-free gardening practices.

Implementation:

- Connect with Cultivating Community.
- Provide design consultation & educational workshops to gardeners for creating native pollinator habitat.

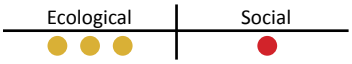
Gardens like this on Munjoy Hill, managed by Cultivating Community, can serve as an educational tool for nearby school children.

Community gardens bring people together to plant pollinator habitat, further strengthening the emotional connection between pollinators and humans.

Pollinator habitat can easily fit within community gardens like the Valley Street Community Garden managed by Cultivating Community. These gardens could also serve as air and water filters, as well as buffer zones that take in high alkaline road runoff that could damage the health of an edible garden.

6. POWER LINES

- North Deering
- Warren Avenue
- Fore River Sanctuary



Three power line corridors form direct pollinator access between Portland and it's suburban neighbors. These strips of land cut through forests, are currently kept in a low-succession state, and may already support significantly higher levels of plant and animal species diversity than the surrounding woodlands (Wagner et al. 2014). Without this connection between the urban and rural landscapes, pollinators in the city risk becoming genetically isolated from regional populations. The connectivity of the network would be significantly enhanced by managing these corridors for pollinator habitat.

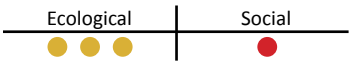
Implementation:

- Contact Central Maine Power Company.
- Monitor for pollinator diversity and abundance.
- Organize work groups to remove invasives and saplings.

The land below power lines is generally kept open in a mid to low succession state, which can be ideal pollinator forage habitat

Converting parts or all of the Portland International Jetport into native meadow would create an important regional hub for pollinators.

7. PORTLAND INTERNATIONAL JETPORT



Joining the new movement to make airports key players in pollinator habitat, Portland's airport could serve as a hub for pollinators as well as planes (Beurteaux). No-mow seed mixes could be used along the runways. While patrons of the airport won't be able to see the habitat up close, signs and exhibits could explain its benefits within the airport.

Implementation:

- Galvanize support and approach Port Authority with detailed proposal.
- Develop low-height no-mow native plant palette that will not attract birds.
- Provide educational materials to be used within the airport.

No-Mow Grass Alternatives

There are many types of plants that many property owners are switching to for lawn alternatives, such as clover, that grow low to the ground and don't require mowing. By not mowing, these hardy plants continue to provide pollinator forage through the growing season.

8. I-95 AND I-295

Ecological | Social

Just as I-95 transports humans through the region, it can also form the main artery for pollinators travelling into and through the city. Beyond the required mown boundary exists large open spaces that could be transformed into habitat. Continuous bands of native meadows between the road and the forest edge would support robust habitat for a diversity of pollinators, hinder growth of invasive species, and anchor the connection between the city and the outlying undeveloped lands. A clover-leaf exit ramp off of I-295 near the Western Promenade could be seeded as a central downtown pollinator forage patch. Despite its ecological value, these habitat patches would have minimal public engagement. If the Maine Department of Transportation (DOT) were to get involved with the pollinator network, this could create a large market for native seeds and plants. This may encourage more nurseries to stock native plants, which would make them more available for homeowners and organizations.

Implementation:

- Connect with Maine DOT, provide native plant palette and management guidelines.
- Contact Reps Alcee Hastings (D-FL) and Jeff Denham (R-CA) to learn more about the Highways Bettering the Economy and Environment Act.

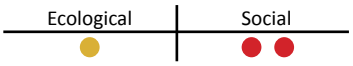
Case Study: Highway Wildflowers in Texas

The Texas Department of Transportation manages over 800,000 acres of highway right-of-way around the state. Since the 1930s, the Department has planted this land yearly with over 5,000 species of native wildflowers. In addition the DOT works with landscape architects to plant a variety of trees and shrubs that will better establish natural systems. The yearly wildflower displays along the medians and roadsides are an internationally recognized attraction for flower enthusiasts, vacationers, and residents alike (Wildflower Program).

Selective mowing regimes and planting wildflower mixes could profoundly change the aesthetics and the function of the major highways of Portland, such as I-95, above.

Libraries and schools, such as Portland High School, are community centers where residents can learn about pollinators through classes and speakers, while the land around the buildings can be used to create habitat along important corridor routes.

9. LIBRARIES



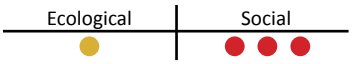
Libraries are spaces where people of all ages and backgrounds could learn about pollinators and native habitat. Patrons and staff could create programs and displays that engage the public with literature about gardening and pollinators. Book clubs could focus on books related to southern Maine's natural history. Additionally, libraries could develop interactive pollinator gardens that have literary themes. While some libraries downtown don't have much open space on the ground level for planting, large inner courtyards or rooftops could be converted to areas of habitat that connect people and pollinators. Existing ornamental gardens can be supplemented with native plants where they don't exist.

Implementation:

- Contact Portland Public Library with information about city pollinators.
- Provide design ideas, including a plant palette for library gardens.
- Help to develop educational and interactive programs for library patrons.
- Provide educational materials to keep in collections.
- Design seasonal displays of books related to pollinators and the ecology of Maine.
- Organize speaker series on the topics of pollinators and native ecology.

10. CONNECTOR SCHOOLYARDS

- Reiche School
- East End Community School
- Fred P. Hall Elementary School
- Wayneflete School
- King Middle School
- Portland High School



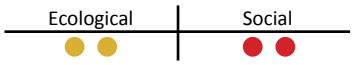
Schoolyards provide an opportunity to educate and engage with the future stewards of the city. Early exposure to local flora and fauna can help children develop an emotional connection with natural systems. For this reason, all schools in the city should be considered as sites for implementing pollinator habitat. The schools listed above are high priority given their geographic location as links between larger patches and anchors along narrow corridors.

Implementation:

- Coordinate with facilities managers to implement pollinator habitat around the school.
- Identify point person or project leader at school to promote programs around pollinators.
- Coordinate with faculty to create curriculum
- Provide planting palette and potential design templates for classes to adopt.

11. HOSPITALS

- Mercy Hospital
- Brighton Medical Center
- Maine Medical Center

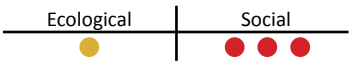


Portland's hospitals sit strategically in some of the city's most difficult neighborhoods for implementing habitat. Oakdale and the West End are largely residential areas with many small parcels and little vegetation. Both of these factors make constructing a viable corridor a challenging process. These three hospitals are some of the largest landowners in the area and would be valuable assets for furthering the pollinator network. All of these sites maintain sizeable, landscaped entrance and parking areas, which could be converted into pollinator gardens and native plant rain gardens. There may be interest within the hospital to implement therapy gardens for the patients as well as convert existing planting beds to native pollinator planting beds. Additionally, Maine Medical Center, adjacent to the Western Promenade has ample space in the south to develop a more extensive therapy garden program.

Implementation:

- Connect with the hospitals and their grounds departments.
- Provide design templates for therapy gardens and plant palettes for replacing existing beds.

12. CUMBERLAND COUNTY JAIL



Many state institutions have gardening programs for inmates which double as therapeutic stress-relieving activities as well as job training (worldwatch.org). The jail could be another place where pollinator habitat could become a large part of the grounds. Existing beds in the entrance area could be converted to native plant gardens. In addition, inmates could be in charge of implementing large native pollinator gardens. Being part of a city-wide pollinator network may help inmates feel a greater sense of value and connection to the community while serving time. Located adjacent to Mercy Hospital's Fore River campus, the area at the base of the Western Promenade could be an important habitat area for pollinators.

Implementation:

- Connect with jail and grounds department.
- Provide design strategies to management as well as a plant palette and design ideas.

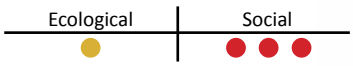
Inmates that participate in gardening show signs of reduced stress.

Chicago Botanic Garden

The Chicago Botanic Garden (CBG) has been incorporating horticulture therapy for the past 25 years into their gardens and in 1999 they dedicated the Buehler Enabling Garden, a designed garden space to hold therapy programs. Of all the diverse programs offered through CBG, the Thresholds Veterans Project that began in 2014 has had a particularly positive effect. Veterans in the program are able to work in the garden, tending to the plants. One veteran mentioned this experience evoked memories from his childhood, which was a healing experience. Through the relaxing activity of gardening, these participants are working to maintain and improve their health in a positive way.

13. STREETS

- Congress Street
- Spring Street
- Commercial Street
- Franklin Street
- Murray Street

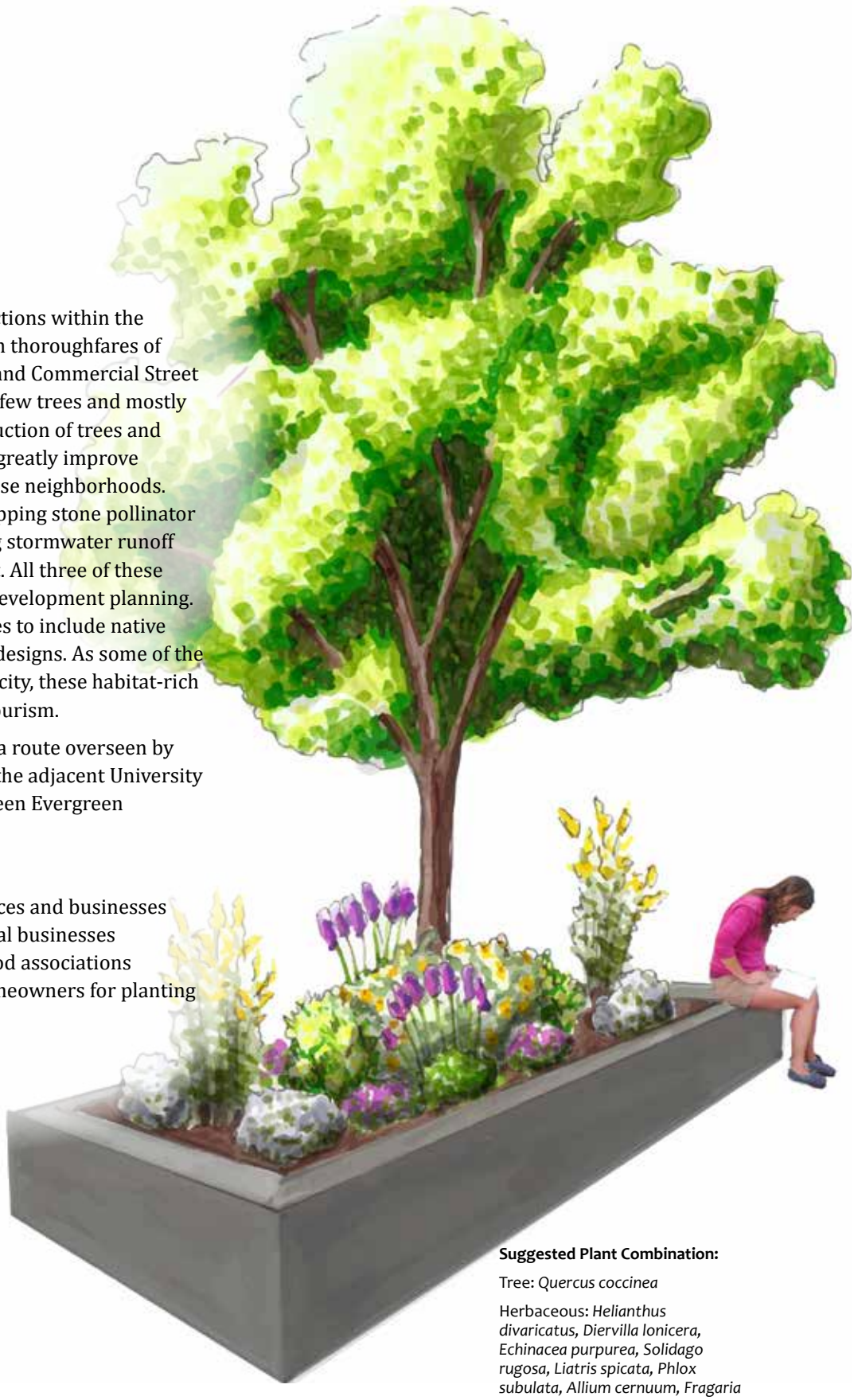


Streets provide a web of connections within the habitat network. The downtown thoroughfares of Congress Street, Spring Street, and Commercial Street were identified as areas having few trees and mostly impervious surface. The introduction of trees and raised native plant beds would greatly improve conditions for pollinators in these neighborhoods. These streets could provide stepping stone pollinator habitat in addition to mitigating stormwater runoff issues and the heat island effect. All three of these streets are in the process of redevelopment planning. This could provide opportunities to include native plant palettes in the landscape designs. As some of the most highly visible areas in the city, these habitat-rich streets can enhance the city's tourism.

Murray Street is situated along a route overseen by Portland Trails. This route and the adjacent University Park can act as a corridor between Evergreen Cemetery and Payson Park.

Implementation:

- Direct mailings to residences and businesses
- Market planter pots at local businesses
- Connect with neighborhood associations
- Provide workshops to homeowners for planting strategies.



Raised Planter Design:

This 5'x 15' raised planter is perfect to place in front of most businesses in downtown Portland, where space permits. The scarlet oak provides shade for patrons to sit and parked cars while the mixed woody/ herbaceous planting provides color and pollinating potential through the growing season. This planter is meant to tolerate full sun and, once established, will need very little water.

Suggested Plant Combination:

Tree: *Quercus coccinea*

Herbaceous: *Helianthus divaricatus, Diervilla lonicera, Echinacea purpurea, Solidago rugosa, Liatris spicata, Phlox subulata, Allium cernuum, Fragaria virginiana*

Downtown Street Design

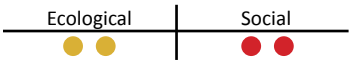
Trees in new raised planting beds line the street in front of businesses in downtown Portland. These plants provide pollinator habitat, shade, and help reduce the urban heat-island effect.

Old Port Street Design

In Old Port, trees could be added and used to help manage stormwater as climate change will likely increase flooding.

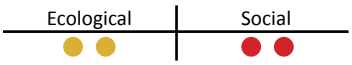
14. KEY CONNECTOR NEIGHBORHOODS

- Oakdale
- Back Cove
- Libbytown
- West End
- Back Cove
- Munjoy Hill



High-density neighborhoods can create either a barrier or corridor for pollinator movement into the downtown. Currently, the landscape in the more suburban area outside of downtown is dominated by lawn and most residences throughout the city have moderate tree cover. If residents that have lawn converted it into native plant habitat, and those that don't have much space could replace existing vegetation with native plants, these neighborhoods could facilitate the free movement of pollinators to other parts of the city, including downtown.

15. NORTH DEERING

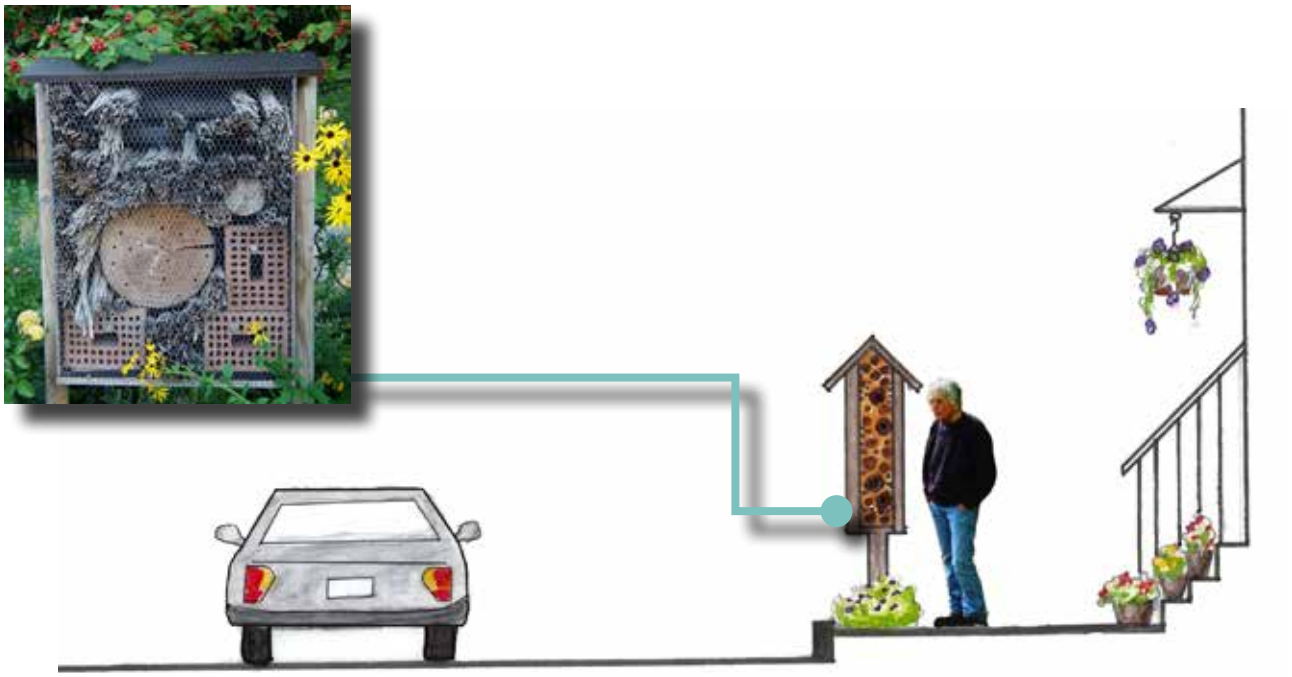


North Deering (Key Connector Neighborhood) is the least densely populated neighborhood in Portland. Large non-impervious area per parcel makes these residences ideal for creating strong pollinator habitat. As more homeowners adopt low-mow strategies and native plant gardens, the neighborhood can begin to take on a distinctly Southern Maine aesthetic. By taking the lead on these practices, North Deering can be an example for Portland's neighboring suburbs.

Implementation:

- Connect with neighborhood associations.
- Utilize direct mailings.
- Market planter pots at local businesses.
- Provide workshops and planting palettes to homeowners.

An example of a downtown city street in a residential area that has been landscaped with native pollinator habitat.



A pedestrian stops to look at a bug hotel in front of a downtown residence. These man-made pollinator structures provide valuable habitat for pollinators, such as solitary bees that usually live in hollowed reeds and pithy woody plants. Since there are fewer of these plants in an urban environment, including bug hotels can be a creative solution for this lost habitat.

Stoop planter pots:

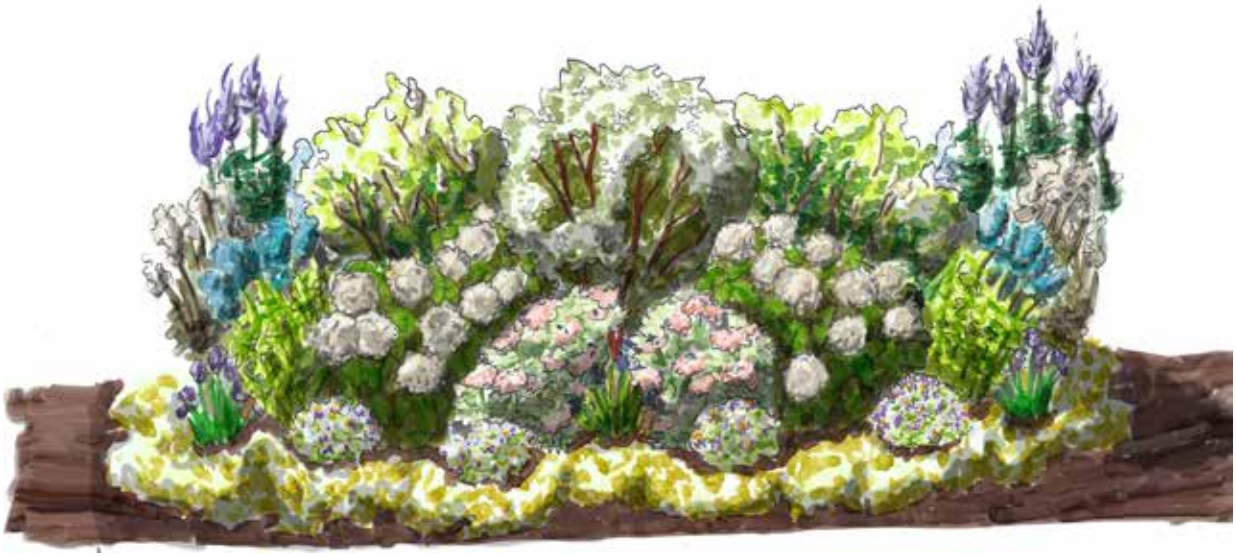
Perfect for the average downtown residential front staircase, colorful plant combinations will provide great pollinator habitat while beautifying home entrances. Choice of plants will depend on the orientation of the doorway. One combination works with sun to part shade with moderate watering and one is tolerant of full shade.

Suggested Plant Combinations:

Shade: *Lobelia siphilitica, Polygonatum commutatum, Symphyotrichum divaricatus, and Polemonium reptans*

Sun: *Rudbeckia hirta, Asclepias tuberosa, Amsonia tabernaemontana*

Native plantings bring new life to this yard in Oakdale neighborhood



Home Garden Design:

This 10'x20' bed is intended for the average yard in Portland and works in either full sun or part shade with moderate watering. It includes a mixture of woody shrubs as well as herbaceous perennials that give attention to all parts of the growing season to maximize the pollinating potential.

Suggested Plant Combination:

Aronia arbutifolia, Clethra alnifolia, Hydrangea arborescens, Veronicastrum virginicum, Amsonia tabernaemontana, Penstemon digitalis, Asclepias incarnata, Aster novi-belgii, Iris versicolor, Geranium maculatum

In this example of a suburban front yard, the native plants frame the sidewalk. They replace flat lawn with vibrant colors and texture.

Managing Urban Native Plants

Incorporating native plants in recommended sites can be more complicated than it looks. Management strategies involve a range of actions.

WATERING

When first placed into a new space, plants require more water than they may once established. If planting from seed, some plants may also take two growing seasons to germinate. Increased monitoring and care should be taken during the establishment period.

LOW MOW

Many insects rely on native plants for all or part of their life cycle. Some will feed only on the nectar of certain flowers while others, such as the monarch butterfly, deposit their eggs in only one plant species. Therefore it is important these plants are available throughout the growing season. Unfortunately, many landowners choose to mow their property regularly during the growing season. This often eliminates the plants pollinators depend on.

Mowing less and more strategically can help meet needs of pollinators throughout their life cycle. By mowing the whole yard or just a section only in the late fall, landowners can provide food and shelter for pollinators season (McCargo).

Contrary to popular belief, low mow areas are often visually appealing as well as ecologically functional.

What to look for in your habitat patch

Insects find valuable shelter in leaf litter through the winter.

Larval food

One of the prime reasons for a lack of butterflies in urban areas is a lack of larval food. The most well-known example of this is milkweed, which provides food for the monarch in the early stages of its development. Like the monarch, many species of butterfly have particular larval host plants, including various grasses, nettles, clovers, vetches, and violets (Dennis 151-152). Including these plants in habitat patches contributes to the species' survival.

Trees

While many native flowering trees, such as basswood, provide pollinators with valuable nectar resources, trees are also important to pollinators in a variety of other ways. Leaves and woody debris falling from trees provide shelter for many insects. Leaf litter is also a valuable resource for holding water and nutrients in the soil. Many important native-animal-pollinated plants will only grow in forest leaf litter, including bloodroot, Solomon's seal, and trout lily (Tallamy 131). Trees can also serve as windbreaks, which benefit some pollinators by allowing them to move more freely in an area (Evans 111).

Planting useful trees is a necessary part of building robust, native pollinator habitat. In addition, trees in urban environments can go a long way towards reducing summer cooling costs and sequestering atmospheric carbon dioxide to mitigate the effects of climate change.

LEAF LITTER

The leaves that fall from deciduous trees as well as the other herbaceous plants that die back in autumn provide a valuable organic layer. Many insects live in nests or cocoons through part of the year, housing themselves in twigs, dead wood, leaves, or bare sandy soil. Few of these elements are available in most manicured landscapes. This organic layer not only provides shelter for insects that overwinter, it also helps add nutrients to the soil as things decompose.

To access these benefits, homeowners can simply not gather leaves or they can set aside areas in their yard where leaf and plant debris can be deposited. A great place for this is in designated planting beds. This will provide valuable overwintering habitat while feeding the ground for the next growing season.

CULTIVATING NATIVE HABITAT PATCHES

For the landowner who prefers a more manicured look, habitat patches can be created in areas that are overly wet, dry, or shady where other ornamentals might not do as well. To smother weedy plants and provide a future fertile planting bed, sheet mulch in the early fall, laying down a covering of cardboard or newspaper over existing vegetation and weighing it down with a thick layer of straw, wood chips, grass clippings, leaves or seaweed. In the late fall, shrubs,

Wood chips are laid over cardboard sheet mulch to prevent weed growth.

trees, and other bare root species can be planted directly into this bed. To sow seeds, apply a layer of weed-free mulch on top of the sheet mulch. Deposit seeds under the mulch out of reach of birds and other animals (McCargo).

To create habitat, landowners who are willing to experiment can plant patches of native plants in more cleared areas, since the most important characteristic is to have access to sunlight. This will help to support more native, specialist pollinators by providing a more diverse habitat patch, further fortifying the native ecosystem.

LARGE-SCALE HABITAT

For large-scale sites, such as power line corridors and riparian areas, it may not make sense to start from scratch. Here, simple management practices can greatly benefit pollinators. To ensure adequate sunlight, projects should aim to prevent vegetation from reverting back to a forested state. Every four to five years, field crews should go into these areas and cut back saplings. Additionally, it would be beneficial to remove invasive exotics such as Asian bittersweet and Japanese barberry. (For information on removing invasives and preventing saplings from sprouting back refer to www.newenglandwild.org/article-depository/removal.)

Trails along power line corridors can be paved or unpaved. The important idea is to keep the surrounding vegetation intact and, aside from occasional maintenance, untouched.

Access roads or paths beneath power lines have also been found to increase plant diversity by creating more regular disturbance patterns (Wagner et al. 236). Where these do not exist, Portland Trails could work with Central Maine Power to create walking trails through these areas.

STORMWATER MANAGEMENT

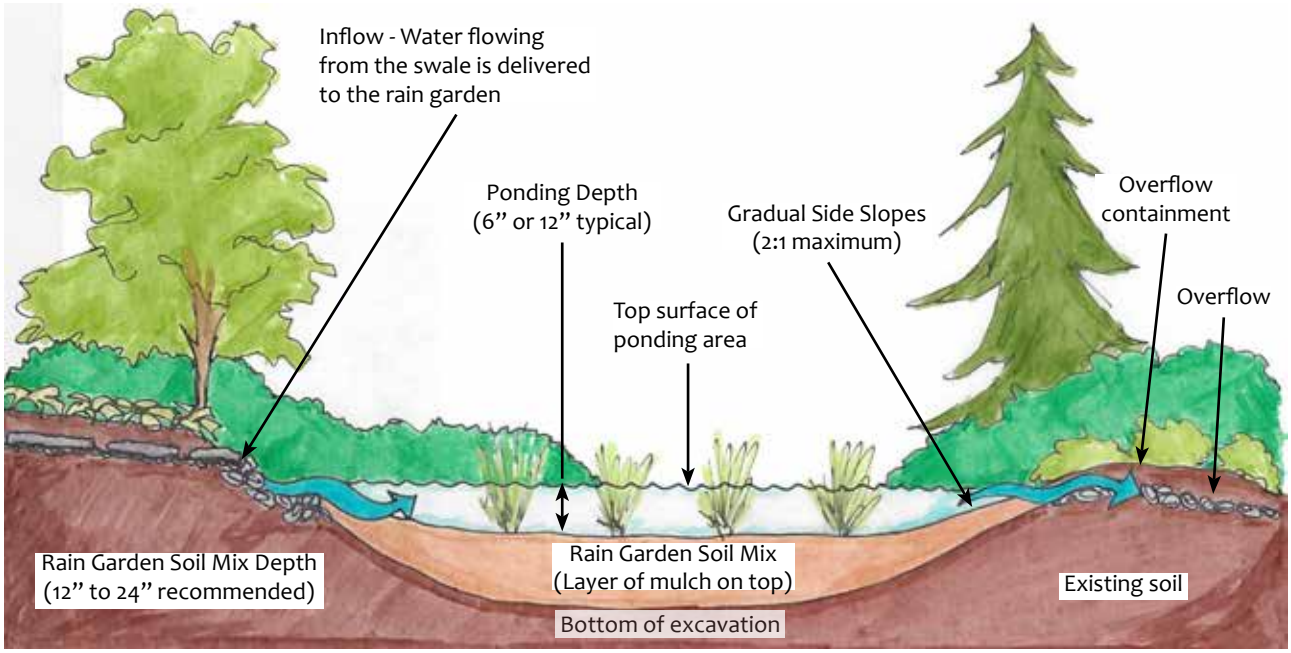
Capturing and filtering rainwater are important functions people can implement in all areas of the city. Much of Portland operates on a Combined Sewer Overflow (CSO) system, using one pipe for both sewage and stormwater. In large rain events, the pipes are designed to overflow into area waterways, often with a combined sewage/stormwater mix. Many of the recommended corridor elements can not only serve as pollinator habitat but can also help manage the city's stormwater.

Many planting beds can be converted into functional rain gardens, a type of depressed garden bed that also helps to detain and infiltrate water, reducing the overall water amount heading into the average street drain. Rain gardens are best placed a short distance from structures, where a series of swales can funnel runoff from impervious surfaces like roofs. (Plants that can tolerate wet root systems are available at wildseedproject.net.) The ultimate goal is to have the rain garden completely infiltrate water within 24-48 hours.

Rain barrels collect roof runoff and the water can be used in your garden.

Rain barrels also benefit new habitat patches. Roof downspouts can lead directly into water catchment systems that can then be used to water plants. This helps to re-use stormwater as well as infiltrate it through the plant beds.

RAIN GARDEN SECTION



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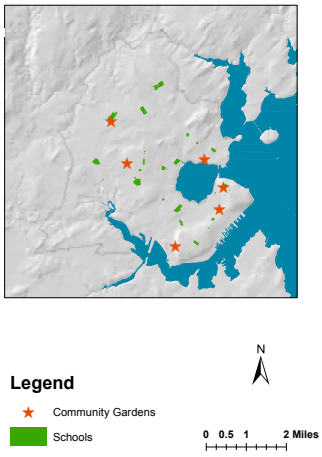
Map Citations

Habitat Analysis

City of Portland MIS Division
- Parcels
- Impervious surface
- Buildings

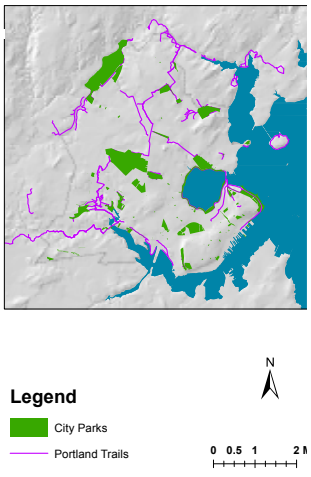
Maine Office of GIS
- Elevation

Parks and Gardens



Maine Office of GIS
- Schools
- 2014 National Aerial Imagery Program Mosaic

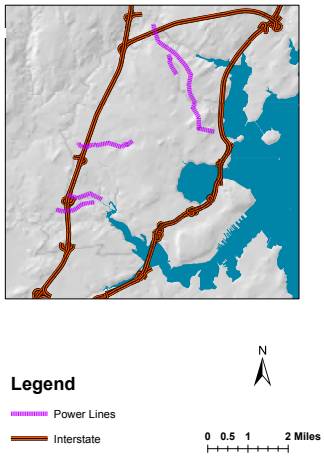
Parks and Trails



City of Portland MIS Division
- Open Space

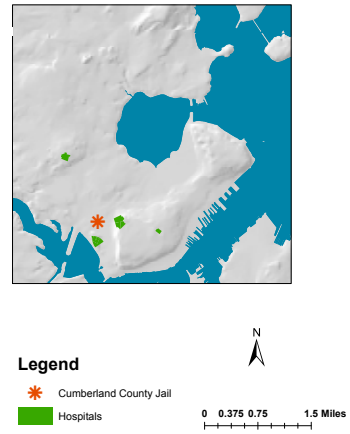
Portland Trails
- Trails map (.kmz)

Power Lines and Highways



Maine GIS
- Roads
- National Aerial Imagery Program Mosaic

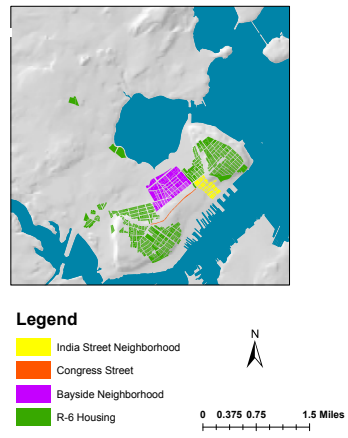
Large Institutions



Maine Office of GIS

- Hospitals
- Correctional Facilities

Development



City of Portland MIS Division

- Parcels

Appendix A

HABITAT POTENTIAL GIS ANALYSIS

The following analysis was carried out using ESRI ArcGIS 10.2. The resulting map reveals habitat potential: where there are sites that have abundant pervious surface and, generally, receive more sun than other areas. A next step would be to groundtruth the habitat potential map results and to talk with the parcel owners.

This initial model may need to be further refined, taking into account a more extensive body of literature about pollinators' needs, community dynamics, and urban habitat. Such a model could then examine refined site-specific factors that can have major impacts, such as local microclimates created by structures.

Potential Patch Size Criteria

For this map, impervious surfaces were defined as constructed surfaces, such as roads, parking lots, brick, asphalt, concrete, mines or unpaved parking lots (no vegetation present). Buildings were not consistently included in this data layer. For this reason the few building footprints found on the impervious surface layer were first removed. The impervious surface layer and buildings footprint layer were sliced along parcel lines and recombined. The result was a layer that contained information on a per parcel basis about the amount of area covered by impervious surface, the amount of pervious surface, the built and non-built area, and the total parcel area. The resulting map was symbolized based on the criteria of pervious area per parcel and then rasterized.

Potential Light Level Criteria

This map used a solar radiation analysis to reveal the effects of the sun over a geographic area for specific time periods. The solar radiation analysis accounts for atmospheric effects, site latitude and elevation, steepness (slope) and compass direction (aspect), daily and seasonal shifts of the sun angle, and effects of shadows cast by surrounding topography. This analysis is useful for showing broad landscape patterns of sun and shade. We were concerned with identifying parcels that were fullly shaded and potentially sunny based on these broad patterns of sun and shade. The result was a raster map that was reclassified based on natural breaks in the solar radiation analysis results.

Habitat Potential

The first step for determining the potential of a parcel to support large, potentially sunny patches was to add together the light level criteria map and the patch size criteria map. The resulting map was then put through a zonal statistics processing function to display the average score per parcel; a higher score means more space and/or more sun. This information was then converted to vector format and connected to the parcels layer so that parcels information about ownership and zoning could potentially be connected with the habitat potential data.

Solar Radiation Analysis Settings

Sky size: 100x100px

day_interval of special days: the equinoxes

hour_interval of 4hrs

slope_aspect_input_type

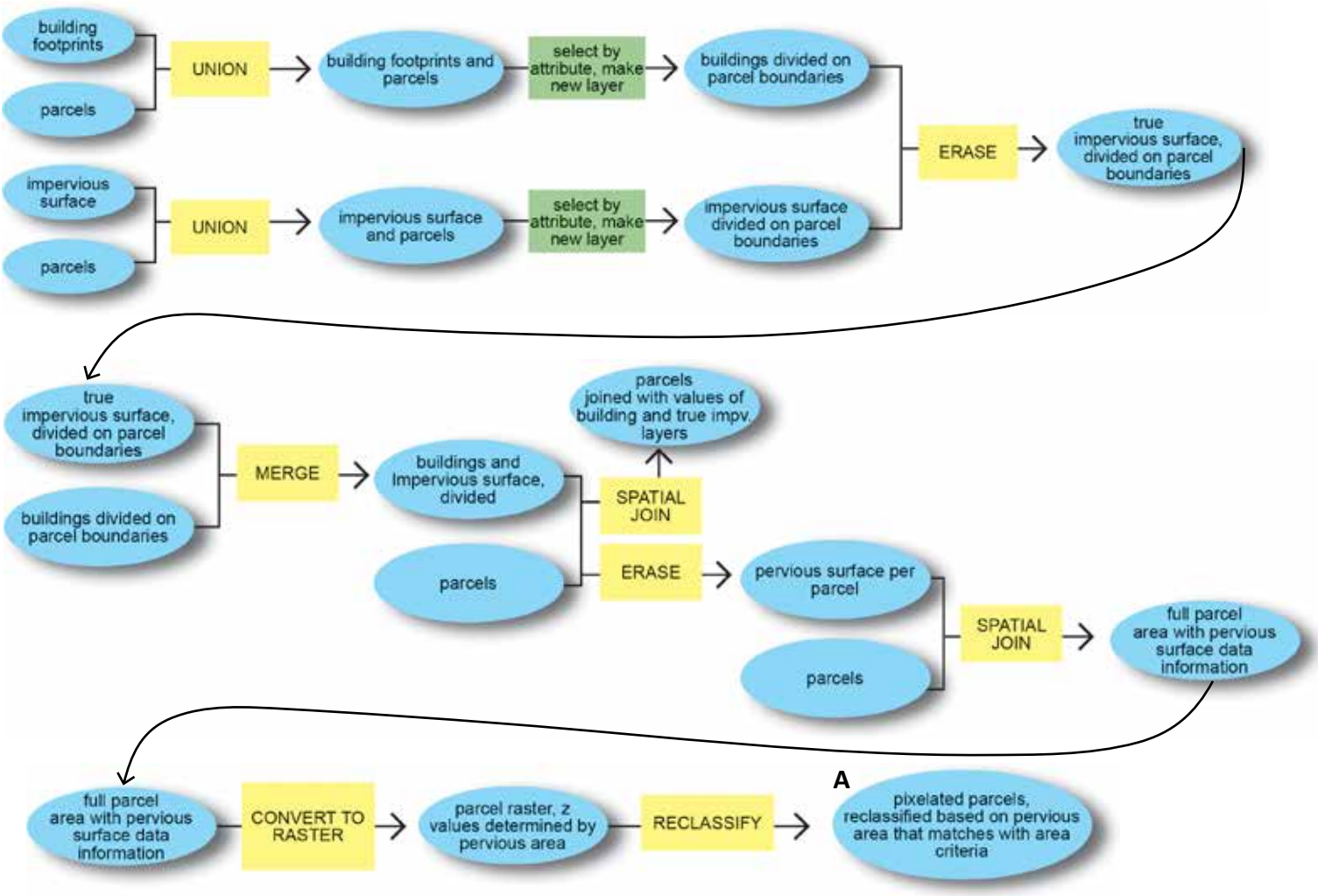
zenith_divisions: The number of is divisions used to create sky sectors in the sky map. The Habitat Potential map used eight divisions (relative to zenith).

Azimuth divisions: The number of divisions used to create sky sectors in the sky map. Habitat Potential map was generated with eight divisions (relative to north).

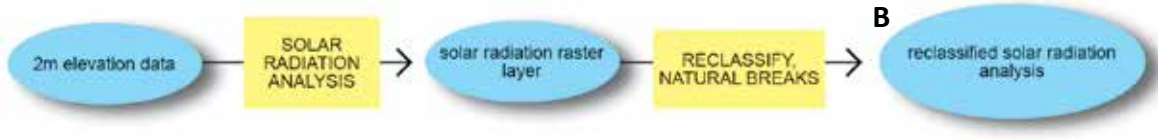
Sky Setting: STANDARD_OVERCAST_SKY — Standard overcast diffuse model. The incoming diffuse radiation flux varies with zenith angle.

Transitivity. The fraction of radiation that passes through the atmosphere (averaged over all wavelengths). Values range from 0 (no transmission) to 1 (all transmission). The habitat potential model used a default of 0.5 for a generally clear sky.

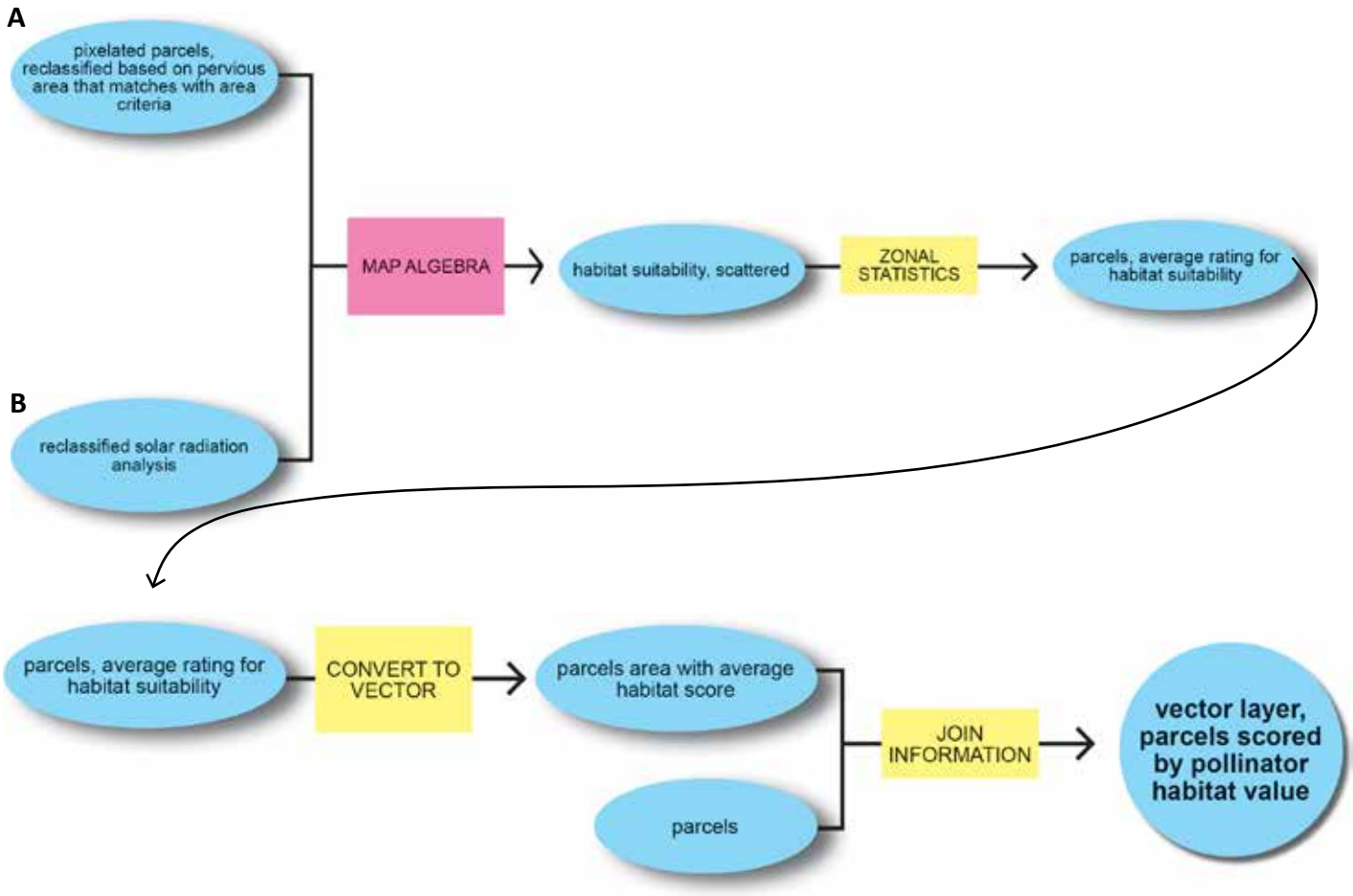
Potential Patch Size Criteria



Potential Light Levels Criteria



Habitat Potential



KEY

MAP ALGEBRA

GEOPROCESSING

INTERNAL

DATA LAYER

RECLASSIFIED HABITAT VALUES

AREA CRITERIA

0 m² to 1,300 m² = 0
1,301 m² to 2,500 m² = 2
2,500 m² to 20,000 m² = 4
20,001 m² to 31,500 m² = 5
31,500 m² or greater = 2

LIGHT AMOUNT

Solar Radiation, natural breaks, WH/m2

Portland GIS: Parcels, Buildings footprint, Impervious surface
Maine GIS: 2m Digital Elevation Model

Appendix B

RESOURCES

Resilience Hub

Portland Trails

Honey Exchange

Portland Pollinator Partnership

Cultivating Community

Maine Yardscaping Project

Wild Seed Project

Bayside Neighborhood Association

Mayor's Initiative for Healthy Sustainable Food Systems

School Ground Greening Coalition

Environmental Program and Open Space

University of Southern Maine

University of Maine Cooperative Extension

Friends of Longfellow Park

Friends of Evergreen Park

Friends of Deering Oaks

Friends of the Eastern Promenade

Bayside Neighborhood Association

Cumberland County Soil and Water Conservation District

East Bayside Neighborhood Organization

Maine Audubon

Mayo Street Arts

Organic Consumers Association

Portland Maine Permaculture

Portland Trails

University Neighborhood Association

West End Neighborhood Association

Appendix C

PHOTO CREDITS

Cover - Burhans, Molly. *City Skyline*. 2015. Edited Digital Image. Web.

Cover - Burhans, Molly. *Pollinators*. 2015. Graphic Illustration.

Inside Cover - Hendershot, Chris. *Strymon melinus*. 2010. Digital Image.

Executive Summary - Hendershot, Chris. *Coenonympha tullia*. 2009. Digital Image.

Page 3 - Seikonia, Annie. *First Pollinator Garden.* 2014. Digital Image.

Page 3 - Wirth, Wynne. *School Garden.* 2015. Digital Image.

Page 4 - Hendershot, Chris. *Ancyloxypha numitor.* 2009. Digital Image.

Page 5 - Burhans, Molly. *Flower to Fruit*. 2015. Graphic Illustration.

Page 6 - *Insecticide.* 25 March 2015. Digital Image. Web.

Page 6 - Hendershot, Chris. *Pollinating Bee.* 2015. Digital Image.

Page 7 - Burhans, Molly. *Habitat Fragmentation*. 2015. Graphic Illustration.

Page 7 - Burhans, Molly. *Bee Life Cycle*. 2015. Graphic Illustration.

Page 8 - Delano, Jack. *Tater Tot*. 1940. Photograph. *Shorpy*. Web. 15 March 2015.

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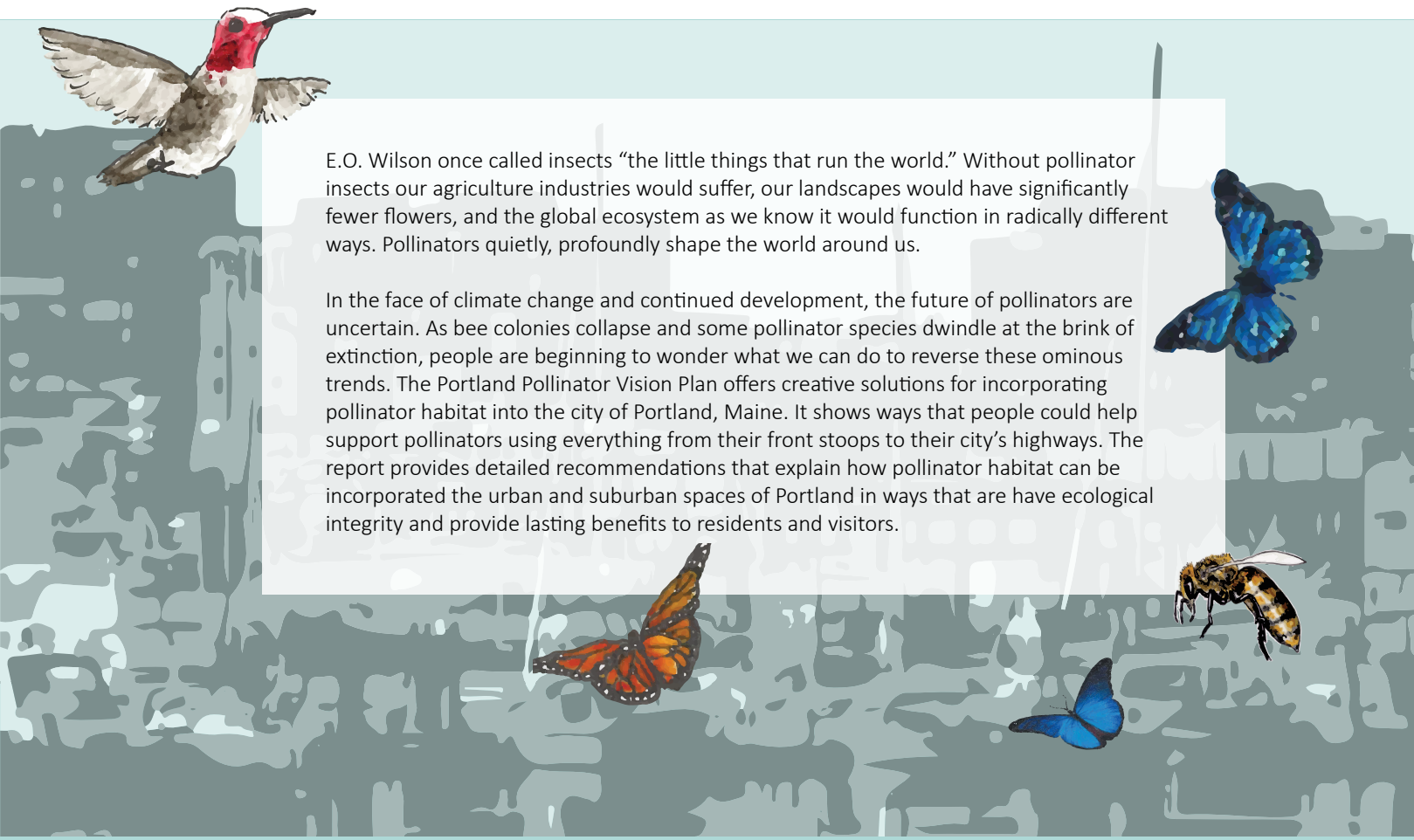

E.O. Wilson once called insects “the little things that run the world.” Without pollinator insects our agriculture industries would suffer, our landscapes would have significantly fewer flowers, and the global ecosystem as we know it would function in radically different ways. Pollinators quietly, profoundly shape the world around us.

In the face of climate change and continued development, the future of pollinators are uncertain. As bee colonies collapse and some pollinator species dwindle at the brink of extinction, people are beginning to wonder what we can do to reverse these ominous trends. The Portland Pollinator Vision Plan offers creative solutions for incorporating pollinator habitat into the city of Portland, Maine. It shows ways that people could help support pollinators using everything from their front stoops to their city’s highways. The report provides detailed recommendations that explain how pollinator habitat can be incorporated the urban and suburban spaces of Portland in ways that are have ecological integrity and provide lasting benefits to residents and visitors.

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