THE YARDWORKS PROJECT: DEVELOPING URBAN ECOLOGICAL DESIGN STRATEGIES FOR RESIDENTIAL PRIVATE PROPERTY

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1 ABSTRACT

Private residential property already plays a significant role in urban ecosystems, yet considerable potential remains for improving the ecological performance of private gardens and landscapes. Urban ecological innovations on residential property however are only valuable if they are compatible with private landowner interests and needs- otherwise they may never be constructed. Landscape architects would benefit from more comprehensive guidance describing urban ecological design interventions that best fit within residential settings.

This paper describes the results of the first two years of studio research to develop urban ecological design strategies that are compatible with the programmatic and aesthetic goals of residential landowners. Each YardWorks Project began with a collaborative visioning and goal setting process at the neighborhood-level with community members. The design team then dropped down in scale to develop a set of site-level urban ecological design strategies that met these stewardship goals. Finally, the team tested these strategies by incorporating them into site-by-site designs while working directly with individual landowners during the process.

By year two the project developed residential landscape designs for over 35 properties, each incorporating urban ecological benefits compatible with the interests and needs of the owner. The results are organized into a series of emerging urban ecological design strategies for improving the landscape performance of private property in cities. These include strategies for landscape connectivity, vegetative structure, plant diversity, avian forage resource support, pollinator support, stormwater management, and others. Potential metrics for measuring the benefits of proposed project designs are also discussed.

1.1 Keywords

urban ecological design, urban habitat, residential design

2 INTRODUCTION

Private residential property represents a major part of the urban land base, with domestic gardens occupying nearly a quarter of the total urban land area in some cities (Evans et al., 2009). These areas already contribute a range of ecosystem services in cities (Cameron et al, 2012), yet there is substantial potential to improve the ecological performance of landscapes and gardens of private residences (Tratalos et al., 2007). More and more, cities are turning to private property stewardship in order to improve the environmental and ecological performance of cities (Cerra, 2014).

Birds are highly visible species, and are often selected as indicators of habitat quality when studying the ecological impacts of urbanization (Savard, 2000, Fontana et al., 2011, Mcdonnell and Hahs, 2008). Research studies may make specific recommendations for enhancing urban bird habitat, particularly when discussing the results of their specific research effort (see for example Fontana et al., 2011, Carbo-Ramirez and Zuria, 2011)). More complete sets of recommendations for enhancing urban avian habitat have also been made as the result of a literature review, based on years of acquired expertise in the field, or both (see for example Savard et al., 2000, Marzluff and Rodewald, 2006, Marzluff and Ewing, 2008). While these recommendations are insightful, less frequently are they scaled to a residential yard or resolved to the level required to guide site design. When such recommendations are specific to residential environments, they are often driven primarily by habitat quality enhancement goals and are not necessarily integrative of landowner interests and needs typically encountered in residential settings.

Urban ecology is defined by Alberti (2008, p.xiv) as “the study of ways that human and ecological systems evolve together in urbanizing regions.” Urban ecosystems are therefore considered conditional systems derived not independently of human influence, but within the context of interdependent social and ecological processes. The scientific community has also begun investigating social factors and their potential impacts (both positive and negative) on ecological factors in residential environments (Goddard et al., 2013, Belaire et al., 2014). Since local site factors can have an important effect on the assemblage of avian species (Evans et al., 2009), this opens up an opportunity for designers to investigate urban ecological enhancements and their compatibility with the residential aesthetic at the site level. Indeed, Nassauer rightly discusses how ecological design can engage ecology as something more than metaphor, but as an opportunity for designers “to work with dynamic environmental and human phenomena, anticipate surprises, and formulate synthetic normative approaches to intentional landscape change (Nassauer, 2012, p.223).”

Recently new works have made concepts of ecology more approachable to landscape architects by describing principles of ecological knowledge and their relevance to landscape design (Beck, 2013). These kinds of resources advance the dialogue within the profession about how new design strategies can bring ecological benefits to urban private property. Yet while there is growing interest in improving habitat quality on private property (ASLA, 2012, Goddard et al, 2010), landscape architects would benefit from a better understanding of what types of urban ecological design interventions best fit within residential settings. This includes both “what to do” in terms of making good ecological interventions that improve habitat quality, as well as “how to do it” in ways that address landowner preferences and needs, for example by “including design cues of human intention” into design strategies (Nassauer, 1995, p.162), or somehow otherwise nesting ecological interventions within design concepts in ways that are compatible with residential norms.

In pursuit of these questions, I developed a three-year, engaged design studio research investigation, the YardWorks Project, in collaboration with the Cornell Laboratory of Ornithology’s YardMap program and Cornell Cooperative Extension. The process of incorporating ecological processes and material changes, at multiple scales, into projects in ways that also critically incorporate the interests, programmatic needs, and aesthetic wishes of cooperating landowners is a key research goal for this project. The YardWorks Project embraces this intent by gathering ecological and community information, developing projects through a client-focused design process, and deriving a series of urban ecological design strategies that can be used by designers when working in typical residential settings. This paper describes the process and emerging results of our first two years of this research effort.

3 METHODS

The YardWorks Project has worked with two communities in New York State to date, and will work with a third in 2015. Each project engages participants within these communities in a semester-long process that begins with development of a vision and goals for enhancing the overall urban ecological condition of their neighborhood. The student design team then analyzes neighborhood-scale environmental systems, assesses individual sites, and works closely with individual landowners to generate habitat-friendly and watershed-friendly design solutions for the properties of each of the participants, consistent with both the community goals and the needs of individual landowners.

While a studio learning environment, the project also works directly with landowners on actual design projects with the understanding that these projects may someday be implemented by the landowner. The studio also functions as something of a "design laboratory" that asks and answers a set of research questions. With these multiple outcomes in mind, the project could be characterized as a variation of 'engaged action research' as described by Deming and Swaffield (2011), with combined pedagogical, practical and research benefits. The overall community engagement process is loosely adapted from a methodological framework described by Morrish and Brown (2000), and is further informed by a voluntary cooperative stewardship effort conducted by the author in private practice (Oregon Solutions, 2015). The approach is composed of a series of steps that are structured around four community meetings depicted in Figure 1. The process is further described below.

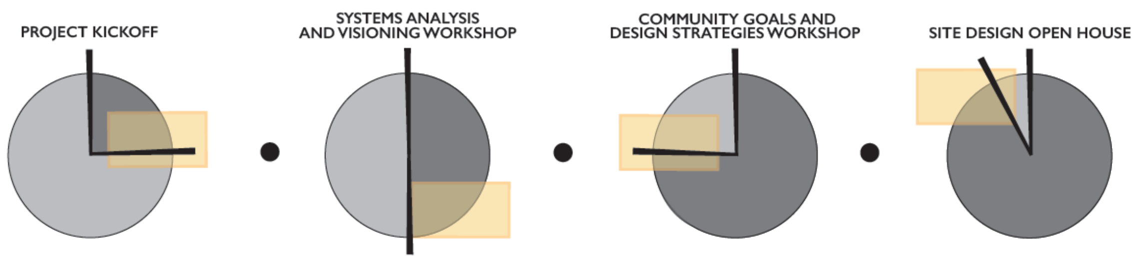

Figure 1. Overview of the YardWorks process for engaging communities (2015). Diagram by the author.

3.1 Project kickoff

The first meeting initiates the project and orients participants to the project process and timeline. It is a chance for both student team members and landowner participants to get to know one another and understand how their roles and relationships will grow and change over the course of the project. After an initial orientation, we also discuss landowner interest in the project, how they decided to get involved, and aspirations they have for the effort. Ultimately, this input allows the student design team to begin scoping a draft vision statement for the project, which we share in the second meeting.

3.2 Systems analysis and visioning

Following the first community meeting, students break into small groups to compose a draft vision statement, and then analyze the existing environmental and cultural systems in the neighborhood and community. During the second meeting the landowners and student design team convene as a group to discuss the draft vision statement, and then the design teams share their systems analysis results with community members in an informal, open house-style board presentation format. Finally, the group convenes again at the end of the meeting discuss specific goals for the project moving forward, informed by the project vision statement and analysis results presented.

3.3 Community goals and design strategies

After the second meeting the design team reviews and assembles the community-wide goals discussed for the project, and uses these goals as a guide to develop a set of related design strategies. These design strategies are typical approaches to site design, or design typologies, that are not specific to a particular site but are oriented to residential settings. While initially derived from the community goals, the development of each strategy is also informed by guidance provided by the Cornell Laboratory of Ornithology YardMap program through their website, selected literature, and consultation with experts in environmental science and design. Many of the urban ecological design concepts are oriented toward bird habitat due to the avian knowledge of the author, the ready availability of avian data, and recurring landowner interest in urban birds.

In developing these strategies, the design team conducts this research to set the rationale for each design concept and add greater depth in terms of its design potential. Each typology is examined from multiple perspectives to study the materiality, design methods, and dimensioning of the strategy. They are also investigated graphically in order to better understand how they may best be placed within a typical residential landscape layout. The design team shares this work in board layout format with landowners during an open house workshop. Landowners are asked to think about the kinds of design strategies they would like to explore, while the design team seeks feedback on how these strategies might be integrated into site-level projects.

The benefits of the ‘design typologies’ approach are two-fold- they encourage design ideation and innovation within the design team, and when completed provide a “menu of options” for landowners to see how their community-level goals can manifest in the form of site-level design outcomes that may be compatible with their own property interests. The result is that both ‘learning communities’ engaged in the YardWorks process- the students and the neighborhood participants- can share a common language of urban ecological design ideas and definitions that can be employed, explored, and refined moving forward. This approach greatly aids in project communication and workflow during the course of the semester, and adds consistency and compatibility as the project transitions to site design of the landowners’ properties, which is the final step of the project.

3.4 Site design development

Following the meeting, each student is assigned a landowner ‘client’ to work with for the remainder of the project. Over the course of the next two months, each student meets with this landowner to discuss their property design goals. They then conduct a site inventory and analysis to begin the design process. Through a series of additional exchanges students develop design concepts for the landowner’s property and share these with the landowner for feedback. After a process of landowner input and in-studio critiques, students move forward with finalizing their design concepts. Ultimately, they produce a complete set of material graphics and work products (e.g. plans, plant lists, diagrams, perspective drawings), site metrics for estimating design performance benefits, and a set of final design boards composing this information. Each one of these projects reflects a careful balancing of urban ecological goals with the intricacies of neighborhood cultural character, landowner programmatic needs and aesthetic interests.

Students share their work with their landowner client and other interested landowners during the final open house-style community meeting. The project closes by discussing with the landowners possible next steps for moving forward, including technical assistance and material resources that are available to them through the participating local county extension office and other organizations.

4 RESULTS AND DISCUSSION

Each YardWorks studio results in a) a consensus-based vision for the project; b) a set of stewardship goals set by the community based on the project vision; c) an analysis of human and natural systems present in the neighborhood; d) a series of design strategies that explore the spatial implications of goals set forth by the community; and e) a set of proposed project designs that reflect combined community and landowner interests for each participant property. These outcomes are immediately valuable to the community and individual landowners in the form of design products and community building, provide meaningful site design and client development learning experiences for students, and support the research intent of the YardWorks Project- that of extracting compatible urban ecological design strategies that can enhance the ecological and hydrological condition of residential neighborhoods.

A select set of these emerging urban ecological design strategies is described below. While we have developed other strategies specific to local needs of the certain neighborhoods (such as shoreline enhancement strategies for lakeside neighborhood participants) the following eight strategies are intended to be applicable to other urban and suburban locations throughout US. For each design strategy, the rationale, methods, and metrics for designing and measuring the benefits of these strategies in the studio are summarized. With respect to performance evaluation, the project intentionally sought metrics that were approachable, easily measured and achievable in a design studio setting.

4.1 Landscape network support

This strategy accesses an understanding of the surrounding landscape ecological network to look for clues in terms of how to compose a given project design within it. Making significant contributions to landscape ecological function can be challenging in urban areas where questions of parcel size, scale and degree of disturbance may limit contributions. However even relatively small interventions have the potential to contribute some connectivity value in consideration of certain species and ecosystem services (Beck, 2013). Habitat corridors and stepping stones can support urban ecosystem networks by improving connectivity that facilitates species movement and dispersal (Opdam and Steingrover, 2008). If the site is alongside an existing corridor, it could also enhance the corridor by contributing to corridor width, an indicator of corridor quality (NRCS, 2004, Beck, 2013).

By looking out in the landscape, designers can also begin to interpret the types of vegetative patches that exist in the landscape in order to better understand what types of vegetative conditions are present in the area. Ultimately the potential for a site to contribute to the landscape network will depend on the position and condition of the ecological network and a site's spatial and programmatic opportunities and constraints. Examples of connectivity interventions that may be compatible in residential areas include filling in gaps in street tree and other canopy corridors, connecting small patches of habitat with hedgerows, and providing planted stepping stones that reduce the isolation of other patches of similar habitat. See Figure 2. Metrics for measuring connectivity benefits of a design include changes in gap distances between stepping stones, degree of corridor continuity, distance between patches along a corridor, and corridor width.

In urban areas limited availability of data can create challenges for interpreting the landscape network, as the resolution of available land cover information may not be scaled to site design needs. Landscape-scale data can be generated however; in the urban areas we worked in, we found tree canopy to be the most readily available cover type due to its visibility in aerial photos and lidar data. Using digitized tree canopy data derived from these sources, we were able to determine the relative degree of connectivity, patch size, and isolation of a given site with respect to the tree canopy cover type.

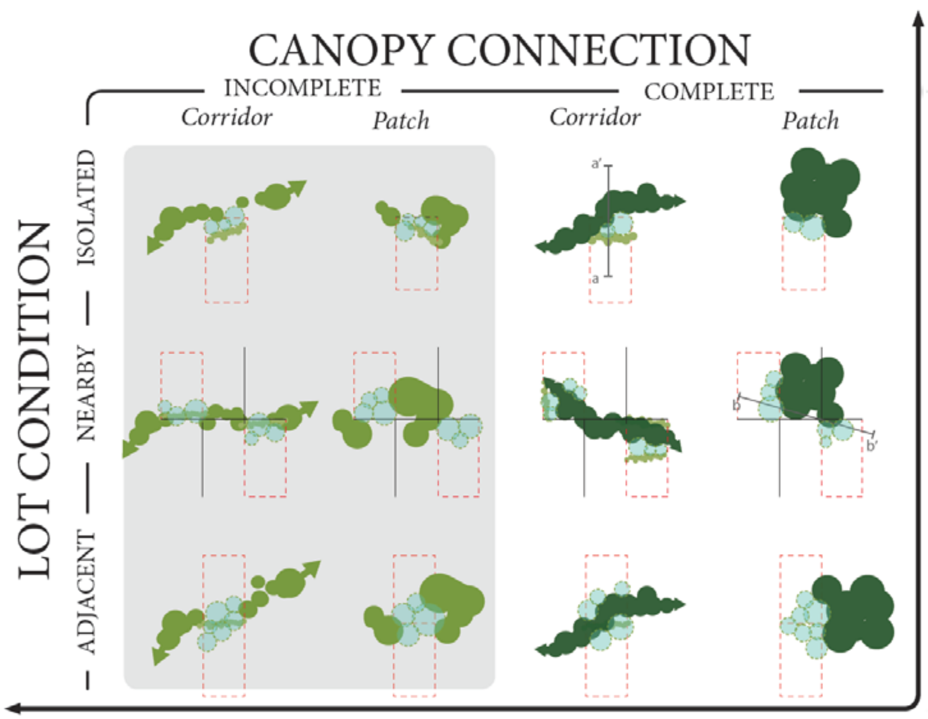

Figure 2. Landscape network support strategies diagram (2013). Graphic by and reproduced with permission of Alexander Reese BSLA'14 and Emma Martone BSLA'14, 2013 LA4010 Studio (Cerra), Cornell University.

4.2 Vegetative structure

This design strategy improves the composition of canopy, subcanopy, and groundlayer components in the landscape. Vegetative structure is a key factor defining habitat quality for birds and other species in the landscape. One or more of these vegetative layers that make up habitat structure are often absent in residential settings; the shrub component in particular is often lacking for birds (Stokes and Stokes, 2003). By being aware of the existing structural condition, designers can improve habitat quality by addressing structural deficiencies within a given site design. If you know what birds are using a given site and their habitat structure needs this can greatly inform your design moves, but you can also refer to nearby reference habitats to understand their vegetative structure as a guide. Filling in gaps in plant layers can also improve *vertical connectivity* in the landscape. For example placement of shrubs can improve connectivity and safe movement between overstory and understory layers for birds using a landscape. (YardMap, 2015a) Notably, layering of canopy, middle, and ground layers is also a basic planting design method (Booth, 2011). Properly executed, design in consideration of vegetative structure can be beneficial to both wildlife and people. See Figure 3. Vegetative structure can be assessed by calculating the percent cover of canopy, subcanopy, and groundcover layers and comparing these numbers against desired targets or predesign conditions.

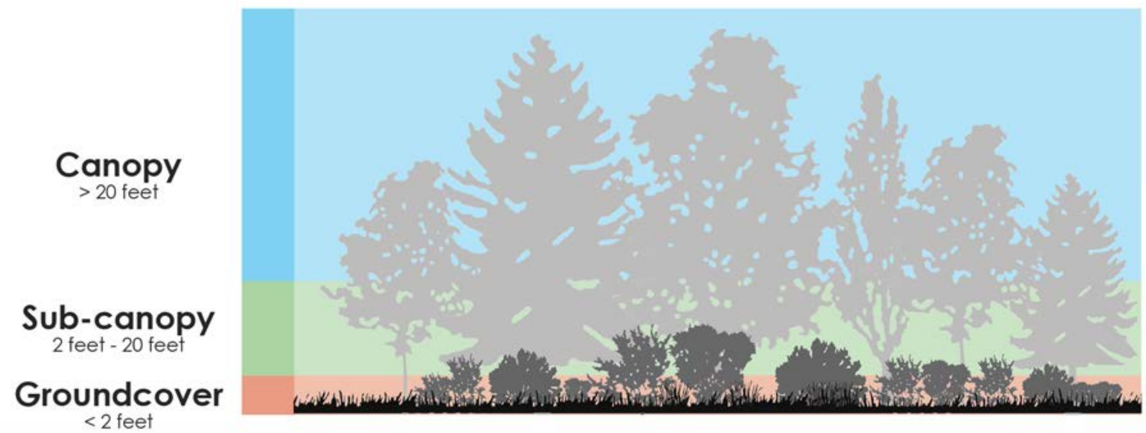

Figure 3. Illustrative diagram of vegetative structure elements (2013). Graphic by and reproduced with permission of Jeremy Schaub BSLA’14, Seung Ha Song BSLA’14, and Elizabeth Thompson BSLA’14, Cornell Landscape Architecture 2013 LA4010 Studio (Cerra), Cornell University.

4.3 Site refuge

This design strategy calls for clustering of shrubs to improve refuge opportunities for birds. Particularly in urban areas where a relatively high proportion of predators may be present in the landscape (e.g. house cats), providing areas of escape and safety from predators may improve the habitat quality of a site for species that may have this sensitivity. Planting shrubs in clusters increases the size of a shrub ‘patch’ and its cover potential for birds (YardMap, 2015a). Clustering of shrubs in groups of multiple plants of the same species versus individually is also a basic planting design method that improves the massing qualities and visual legibility of a planting (Booth, 2011). This compatibility improves the potential for integrating this strategy into the design process in ways that contribute to both urban ecological and aesthetic design goals. Metrics for measuring provision of site refuge in a given site design include areal proportion of shrubs that are in a clustered arrangement, and number of shrub patches.

4.4 Avian forage resource support

This design strategy optimizes the plant palette by providing forage for bird species when they need it. It is based on the understanding that most birds using our study areas can be categorized into three types- migratory birds that may only visit a site during migration in the spring and/or fall, breeding birds that are present typically during summer months, and resident birds that are present year-round. For example in upstate NY (roughly) migratory birds may visit in the spring between early March and May and in the fall between late July through September, breeding birds are typically present from May to July, while resident birds are present year-round. Publicly available avian database resources like Ebird (ebird.org) and the Breeding Bird Survey (available by state) are used to determine what birds have been identified at a project locale (and when). The planting design pallete can then be selected so that plant species produce seeds, berries, nuts, and other forage resources for birds when they are present. In this way, designers can accommodate the needs of migratory, summer breeding, and/or year-round birds by syncing the availability of forage resources to their temporal requirements. See Figure 4.

In our project studies to date, we've found all three categories of birds using the neighborhoods, and in both cases chose to design for year-round sources of food to the extent possible to accommodate these birds, both at the site-scale and at the neighborhood scale. Often the form, massing, and textural characteristics of plants desired by landowners could be met with forage-providing plants, and designers were therefore able to use them in their design projects. We found it challenging however to provide these types of forage opportunities in the spring season. Metrics used for determining the effectiveness of project designs in providing avian forage resource support include the proportion of individual plants or plant areal cover in a project design that provides forage during the seasons corresponding to the presence of spring migrants, breeding birds, fall migrants, and/or the winter season where year-round birds are present.

Other opportunities to improve the effectiveness of this strategy include incorporating information about season avian forage selection choices (e.g. Baird, 1980). It is also conceivable that information about the nutritional content of certain forage resources could be used to choose plant palletes that provide high value forage resources when species need them, or a broad range of nutritional forage types at a given time. Explicitly including provisions for incorporating "non-vegetarian" sources of food into this design strategy- e.g. by intentionally providing habitat for insects and other prey species- could also be further pursued, though aspects of this may be indirectly covered in other design strategies. Research continues in this area to tune and refine approaches to this design strategy.

4.5 Pollinator support

People often associate pollinators with European honeybees, and flowers with spring; however many species of native pollinators are also operating in the landscape, and collectively these pollinators are typically present for a much more significant part of the year than just spring. This strategy proposes that designers intentionally develop a plant palette that provides nectar resources across the entire season when pollinators are active. Mader et al (2011) recommend designing with a variety of plants that have overlapping bloom times throughout the seasons by choosing at least three pollinator plants within each of the three blooming periods of spring, summer, and fall. They particularly encourage planting flowers that bloom in the early spring to support early-emerging bees and those pollinators that produce multiple generations per year, like bumblebees (Mader et al, 2011). Different plants bloom at different times; by diversifying the 'portfolio' of nectar resources available, a project design can support a broader array of pollinators upon which many species (including ourselves) rely on for critical ecosystem services including plant reproduction and agricultural productivity (Mader et al, 2011). See Figure 4. Metrics for determining the effectiveness of project designs in serving this strategy include percent of individual plants or areal cover of plant species in a design that provide nectar within subsets of the pollination season, for example during early spring, spring, summer, late summer, and fall seasons.

We found that found that landowners were often interested in providing a balanced site nectar 'portfolio' for pollinators- particularly those that were interested in designed flower beds. Some landowners preferred flushes of similar species, rather than diverse 'meadow-like' plantings. In fact, planting groups of the same species of flowering plant is recommended for improving pollination efficiency (NAPPC, 2015), and such groupings over three feet in diameter may be more attractive to pollinators than smaller, more widely dispersed groupings (Mader et al, 2011). It should be noted that many species of shrubs and trees also flower, and can serve as significant sources of nectar for pollinators within a planting design.

Designers can also support pollinator life histories by including locally-suitable larval host plants- specific plant species upon which certain butterflies, whose caterpillar larvae have specialized food needs, must lay their eggs in order for their young to be able to feed when hatched- in their planting design palette (Summers, 2011, Mader et al, 2011, Sheperd et al, 2008). Other design opportunities include strategically locating nesting and overwintering habitat in the form of bare ground, nest boxes, and other site features (Mader et al, 2011, Shepherd et al, 2008).

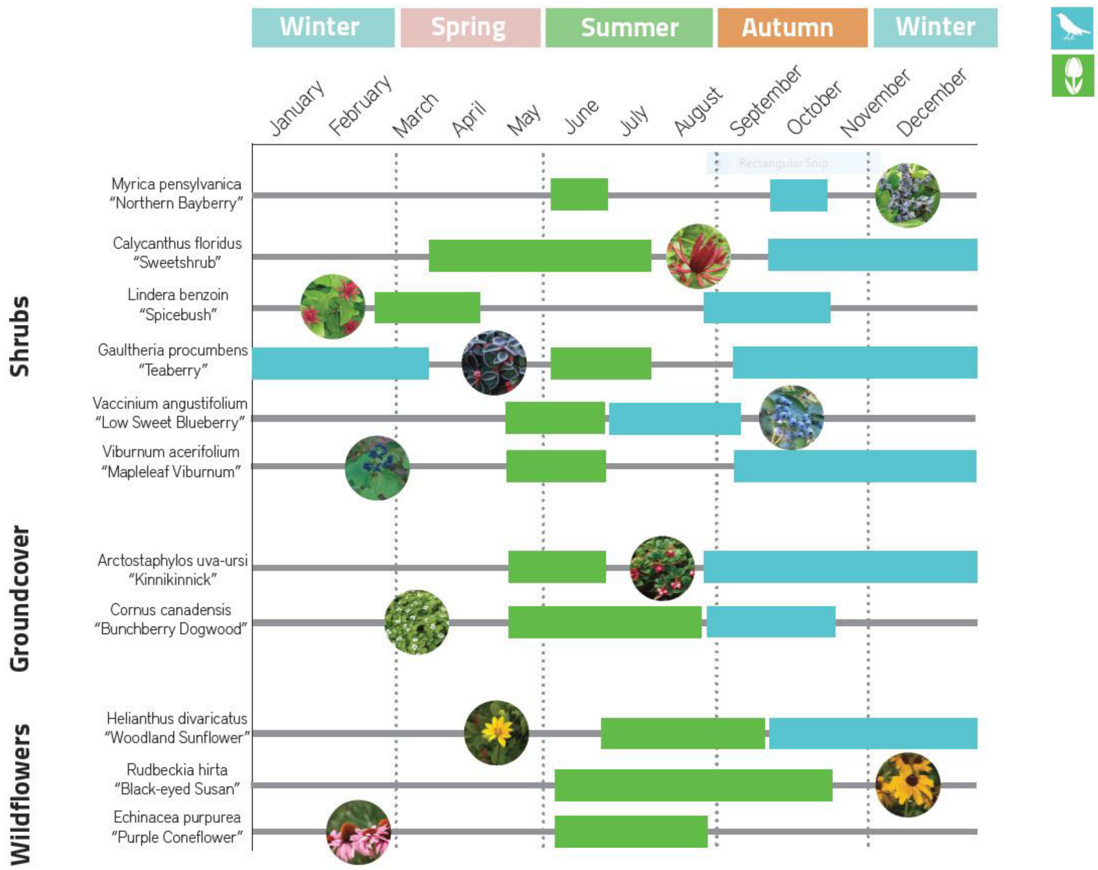

Figure 4. Plant pallete diagram depicting temporal distribution of avian and pollinator resources (2013). Graphic by and reproduced with permission of Lindsay Rappa BSLA'14, 2013 LA 4010 Studio (Cerra), Cornell University.

4.6 Plant diversity

Some residential landscapes may exhibit relatively low plant diversity. During the design process, consider the relative diversity of your plant palette and whether there are opportunities to increase diversity, particularly by providing species with traits like those identified in some of the other design strategies described. In doing so you might also consider the diversity of habitat quality benefits provided- for example provision of diverse seed, nut, and berry forage types. Increasing diversity is a general guide, but it may provide benefits and/or niche opportunities for a broader array of species in the landscape. Plant diversity may also need to be balanced in consideration of planting design legibility, landowner preferences and maintenance constraints in residential settings. Metrics for evaluating diversity can be as simple as identifying how many individual species are present on a landscape relative to pre-design conditions.

4.7 Discrete habitat features

Certain site assets operate as features in the landscape that provide habitat value. Examples include rock walls and piles, snags, and brush piles (YardMap 2015b). These features can provide different ecological niches in your yard, and contribute suitable habitat for birds and other wildlife. Often they can be creatively inserted into the landscape in ways that complement a design layout, or they may be screened by certain aspects of the layout. See Figure 5. A thoughtful design layout can introduce these features in ways that contribute additional habitat quality without detracting from the aesthetic wishes and programmatic needs of the landowner.

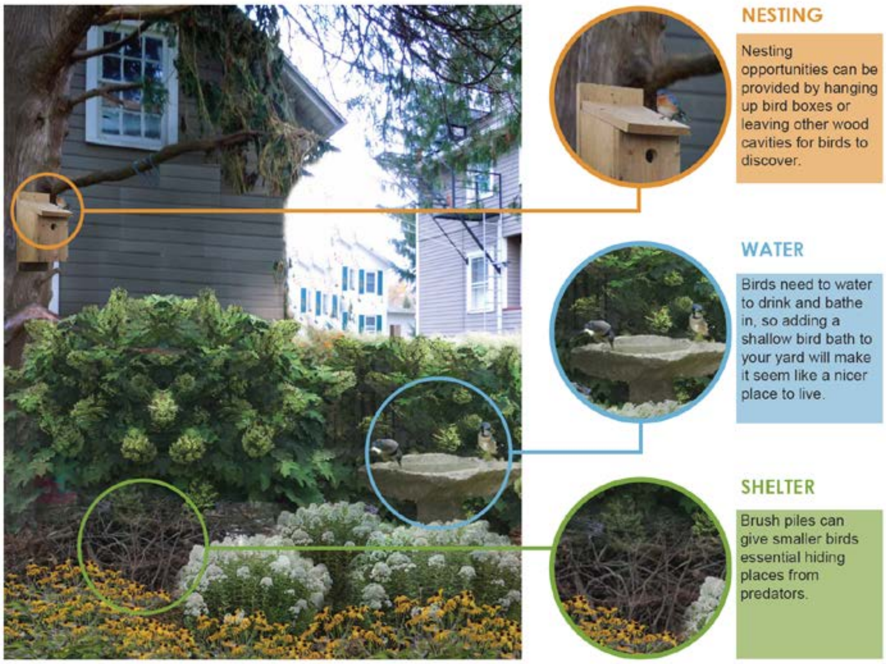

Figure 5. Discrete habitat features illustrative diagram (2013). Graphic by and reproduced with permission of Hilary Garnish BSLA'14, 2013 LA4010 Studio (Cerra), Cornell University.

4.8 Green infrastructure

While terrestrial habitat has been primarily discussed above, aquatic habitat in the form of streams, wetlands, lakes, and other water features is another important resource type in cities. Urbanization typically includes increases in impervious surface areas and storm sewer infrastructure that efficiently moves water off of and away from these surfaces. This lowers rates of infiltration and results in higher runoff volumes and velocities (Arnold and Gibbons, 1996). This can result in higher peak flows, higher nutrient and contaminant concentrations, reduced biotic richness and other aquatic impacts within an urbanized watershed (Paul and Meyer, 2001). Landscape architects can limit these impacts by incorporating low impact development or green infrastructure techniques into project designs.

In our work, we found certain green infrastructure strategies to 'fit' better than others in residential environments. Rooftop impervious surfaces were the most easily accessible sources of runoff we encountered. They are contained in size, often have a concentrated source of outflow that can be intercepted (gutter downspouts), and have the added benefit of being relatively low in contaminants like road salt. While some of the design projects we developed have included vegetated swales, rain gardens with their relatively small, localized footprints and low maintenance requirements seemed to scale well to the residential conditions and landowner interests we worked with. In certain situations, proposing disconnection of the downspouts from the sewer network was also possible and desirable, particularly if soil, slope, and vegetative conditions allowed for adequate infiltration.

While perhaps not initially considered a habitat enhancement technique, green infrastructure techniques actually can contribute valuable habitat benefits in urban areas. The difference between this urban ecological design strategy and others discussed is that these interventions may primarily provide ecological benefits offsite of a project property rather than directly onsite. However green infrastructure facilities can also introduce different microclimatic conditions (e.g. different hydrologic patterns) that may allow different types of plants to grow in them than in other project locations. These variations can then be accessed by a designer to support other urban ecological design strategies within a site design.

5 CONCLUSION

Urban ecological innovations on residential property are only valuable if they are compatible with private landowner interests and needs- otherwise they may never be constructed. The YardWorks Project responds to these needs by developing, testing, and refining a series of approachable strategies that can enhance the ecological condition of residential properties in ways that are compatible with the needs and interests of residential landowners. It does so by bringing the potential for urban ecological change to actual communities of people through a collaborative process of engaged discovery, learning, and decision-making in an academic studio setting.

From the standpoint of the practicing landscape architect, there are few available resources describing site-based urban ecological design strategies or methods that explicitly appeal to the profession. It is the belief of the author that if clear, understandable and reasonably implementable strategies for urban ecological design were readily available to members of the profession, the likelihood of their adoption would be higher. 'Clear, understandable, and reasonably implementable' means strategies that: a) are conceptually approachable and within the technical grasp of the profession; b) describe techniques that leverage the spatial sensibilities of landscape architects; and c) can be implemented in fast-paced project environments where time is often limited. The YardWorks Project pursues development of such a resource.

Paker et al. describe the need for interdisciplinary investigations "between landscape designers and zoologists, in order to achieve a better understanding of the required garden structure and composition for enhancing the enjoyment of people as well as the number of bird species living in it (Paker et al., 2014, p.193)." Nassauer wrote about how a synthetic approach to the "landscape medium" "can contribute urban ecological design knowledge to science and make science knowledge applicable to urban ecological design (Nassauer, 2012, p.227)." While there is much work left to do in meeting this aspiration, practitioners in urban ecological design are poised to make significant positive impacts on human and natural environments by contributing new insights into how sustainable site ecosystems can be situated in urban spaces, for the benefit of all city inhabitants.

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