

**A combined design approach for integrating habitats in mixed-
use development**

by

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Abstract

This study contemplates the role of landscape architects in integrating habitats and advocates a new framework to integrate habitats in urban environment. The literature shows two types of design approaches that have been explored for protecting or restoring habitats: landscape-specific approach and organism-specific approach. As each approach has its own strength and weakness, this study suggests a combined design approach using both landscape and organism concerns. The combined design approach is applied in one hypothetical site in the Portland metropolitan area to demonstrate how habitats can be integrated into mixed-use development by innovative design. Accounting for site factors, the site design creates and integrates three habitat types: riparian forest habitats, human habitats, and habitats for Pacific tree frogs. Landscape and organism concerns complement each other in the design solution.

Chapter I

Introduction

The concept of “habitat” appears frequently in landscape design practices and management documents. Many landscape architects and design firms justify their design philosophy or project goals, comprehensively or at least partially, as ecological/sustainable design to create or conserve habitats. Designing for habitats is a fairly general topic and has been used broadly and differently.

Integrating habitats in urban environments is more challenging since urban ecosystems are very unique in several ways (Alberti, 2005; Niemela, 1999; Trepl, 1995). Urban ecosystems lack habitat patches, instead they have abundant invasive/nonnative species as well as strong external control of natural succession (Trepl, 1995). And in most cases, there are many ecological, financial, and social constraints on what it is possible to achieve by landscape designs aiming to integrate habitats (Hough, 2004).

The goal of this study is to contemplate a design solution for



*“The best way to know the lay of the land is to start by respecting it. --- Our planners and designers begin by seeing what is natural and sustainable. Our mission? It’s to orchestrate land uses that reduce transportation costs; make high-density projects livable; integrate architecture with the landscape in ways that optimize natural heating and cooling; save on the use and costs of water, energy, and other resources; create green environments that provide social amenities; and conserve natural open space and **habitat** for future generations. Nature is the ultimate example of great design. ----.”*

-----SWA,

<http://www.swagroup.com/>

*“Natural Resources Design Inc. designs with native plants, implements appropriate stormwater management, and creates wildlife **habitats** in its designs. We integrate natural processes and aesthetics into our designed landscapes and work with communities to restore indigenous ecosystems and a ‘sense of place’.”*

-----Natural Resources Design Inc.,

<http://www.naturalresourcesdesign.com/>



integrating habitats by design in mixed-use development, a place with diverse human activities and intricate human-nature interactions.

The idea of integrating habitats in mixed-use development is inspired by the design competition “integrating habitats”¹, which invites innovative design solutions to balance between development and conservation. In Fall semester 2007, I participated in the design competition. This thesis used the same project from the competition, but it is a new design, which includes much more to integrate habitats than what I achieved in my design competition entry. After the competition, I searched the literature further to understand the meaning of integrating habitats in urban environment.

My new design is also inspired by other competition entries, particularly those winning entries. *Nature in Neighborhoods* (McDowell et al., 2008) employs a pre-fabricated modular construction method to reduce the impact on site and its compact arrangement of buildings protects all the habitat conservation areas. However, nature in neighborhoods is not the same as habitats in neighborhoods because it is a mystery that which species and how many species will exist in the “nature” designed by them. *Daily Migrations* (Kennedy et al., 2008) addresses the on-site cyclical journeys of human and wildlife during a day in terms of their flow, destination, stopover and home. Daily migration diagrams are interesting ideas to demonstrate habitat requirements of both wildlife and human. However, it is a mystery why the designers think that their design would accommodate the species listed in their entries. In addition, the large area of building footprint and surface transportation in their design makes me suspect whether migration is possible or safe for the wildlife in their diagrams. *Terra+Scapes* (Zambelli, 2008) is a nice architecture work with almost entirely green footprint. By advocating the development of a modular living unit, *Living Craft* (Page and Kley, 2008) raises up the critical question of how to infuse human and natural orders. Both *Terra+Scapes* and *Living Craft* do not address noticeably the habitat functions of their design.

This study starts with a literature review in Chapter II to understand the meaning of “habitat” and to summarize different theories and practices in integrating habitats by design. Following the literature review, study site conditions and project requirements are

¹ <http://www.oregonmetro.gov/index.cfm/go/by.web/id=21627>

introduced in Chapter III. Based on the analysis of the site factors in Chapter III, a combined approach to integrate habitats by design is proposed in Chapter IV. And Chapter V summarizes the application of the combined design approach to integrate habitats according to the site conditions. It demonstrates a design integrating three different habitat types. The conclusion in Chapter VI reiterates the call to a combined design approach to integrate habitats in urban environment.

Chapter II


Literature review

2.1 Habitat definition

Habitat is a fundamental concept in ecology. Unfortunately, the ambiguity of its definition leads to conceptual confusion for landscape architects and prohibits appropriate design solutions for integrating habitats in empirical projects. In the early 90s, Murphy and Noon (1991) stated that it is difficult to define what critical habitat is for certain species because the terms "habitat" have never been defined precisely and independently.

Similarly, Hall et al. (1997) concluded that its definition is ambiguous, indefinite and unstandardized by reviewing the uses and definitions of habitat-related terms in 50 articles from 1980 to 1994. Only 18% of the articles reviewed were found to use the habitat term consistently while the rest used it in various ways.

In general, habitat refers to the *abiotic /physical environment* that can accommodate certain species, which can be a specific organism or an entire community (Mitchell, 2005). Beyond this general consensus about the physical focus of the habitat definition, there are two different uses of the term habitat as summarized by Miller (2007). And the two different uses of the term habitat origin from different assumptions.



“Habitat is usually conceived as the range of environments or communities over which a species occurs.”

-----Whittaker, Levin et al.(1973), p328

“The place where an organism lives, or the place where one would go to find it”

-----Odum, Paul (1971), p. 234

“...habitat is rather like a mosaic of biotopes, or a landscape that includes all the different types of biotopes needed during the whole life cycle of an organism.”

-----LÖfvenhaft et al. (2002)



One use of the term habitat is *organism-specific* (Miller, 2000; Morrison, 2001; Odum, 1971; Whittaker et al., 1973). It starts with the concern of a given species or a group of species, and assumes that those given species have specific requirements to natural resources and environments for their life cycles. Thus, habitat is defined as a place containing a combination of resources and environmental conditions that are required by a given species or species group to carry out life processes. In this definition, the behavior of a given species in terms of foraging, roosting and nesting as well as their competitors and predators all play important roles in determining suitable conditions for a given species or species group.

The other use of the term habitat is *landscape-specific* (Löfvenhaft et al., 2002). In this instance, the term habitat refers to areas of similar vegetation or landcover. This definition starts with landscape classification and assumes that different landscape types can characterize areas with distinctive environmental conditions and natural resources required by different species or species group. Consequently, each landscape type would be a place in which certain species or species group can live. In this definition, landscapes can easily be classified as different “habitat types” (Daubenmire, 1968).

According to the organism-specific definition, habitat is an area that contains the necessary environmental conditions for certain species. The challenge of the organism-specific definition is how to identify the suitable environment for a given species or species group. First, the behavior of an organism is complicated in terms of its needs for foraging, roosting and nesting, which may require totally different environment. Second, it may be easier to identify a required environmental condition for ‘habitat specialists’ (e.g. coho salmon(*Oncorhynchus kisutch*), spotted owl (*Strix occidentalis*)), but it would be very difficult for species ranging over wide geographic areas of greatly varying conditions (e.g. ‘habitat generalists’ such as whitetail deer (*Odocoileus virginianus*), coyote(*Canis latrans*), crow(*Corvus spp.*)) (Mitchell, 2005). Third, an unnatural environment and atypical habitat components, like bird houses and bird feeders in urban environment, can turn out to be important parts of the living environment for certain species (Figure 2.1). Last but not the least, the required living environment by a species involves evolution or adjustment to environment. And there are complicated inter-species

interactions. The organism-specific definition is conceptually clear, but in reality there are many uncertainties in identifying habitats for a given species or species groups.

In contrast, at some grains and scales, the landscape-specific definition is very convenient to discern from landcover data, aerial photos or satellite images based on geographic information systems (GIS) (Miller and Hobbs, 2007) or even sometimes from field vegetation survey and observation (Maurer et al., 2000). Landscape types or biotypes can be distinguished easily at different scales using varied data resolution to represent the hierarchical structure of ecosystems. This definition of habitat may be useful in understanding of habitat selection or in identifying potential restoration sites at broad scale (Miller and Hobbs, 2007). The real problem with this definition is about habitat function because the natural resources or environmental conditions that the well-being of a species relies on may not correlate exactly with surrogate variables like dominant vegetation types (Mitchell and Powell, 2003). The measure of landscape types is based on two dimensional mapped data while the needs of a species or species group are about the resources that they can find through their migration experiences of an environment (Figure 2.1). By only looking at landscape types, it is difficult to anticipate which species will exist there and how the landscape types



One example of critique for the organism-specific definition of habitat: Is this solar bird feeder in a residential backyard a habitat?



One example of critique for the landscape-specific definition of habitat: Can a tiger ever see and experience landscape from this perspective?

Figure 2.1 Critiques to both habitat definitions

may interact with or affect species abundance or species diversity.

2.2 Different approaches for integrating habitats by design

Similar to the two distinctive habitat definitions, design approaches for integrating habitats fall in two categories: landscape-specific design approaches and organism-specific design approaches. Both approaches rely on making inferences from physical landscape but they have distinctive foundations and assumptions. Landscape-specific design approaches start with landscapes and assume that landscapes will eventually provide habitats. Organism-specific design approaches start with species and aim to create required living conditions for given species.

The landscape-specific design approaches prevail since they only require design of physical environment, and the landscape-specific definition of habitat is easy to operationalize. In discussing ecological restoration, Morrison (2001) made a similar argument that the application of principles of wildlife ecology (organism-specific) to restoration has lagged behind advances related to vegetation ecology (landscape-specific).

2.2.1 Landscape-specific design approaches

2.2.1.1 Native ecosystems

Like the definition of habitat as biotypes under the landscape-specific perspective, there is a long history of advocates for protecting/restoring native ecosystems, or biotypes, in different regions. A “native ecosystem” is considered to be an environment that would accommodate native habitats since native ecosystems might harmoniously integrate organism and environmental conditions through natural selection and the long-history evolution.

"In any area there is always a type of vegetation that would exist without being planted or protected. This native vegetation consists of specific groups of plants that adapted to specific environmental conditions."

----- Smyser (1982), p70

"There are trees that belong to low grounds and those that have adapted themselves to highlands. They always thrive best amid the conditions they have chosen for themselves through many years of selection and elimination. They tell us that they love to grow here, and only here will they speak in their fullest measure."

----- Jensen (1956), p8

A native ecosystem is a complicated, hierarchical and dynamic system, which includes both biotic and abiotic components. A typical definition of an ecosystem is a "[c]ommunity of organisms interacting with one another and with the chemical and physical factors making up their environment. (Miller, 1991, pA7)" A native ecosystem can be considered as the environment that contains the necessary chemical and physical factors for life cycles of native plants, animals and microbes. Consequently, the objective of designing for a native ecosystem is to restore and maintain the physical, chemical, and biological conditions necessary to allow a native ecosystem to function and evolve over time.

Two challenges to integrate native ecosystems by design in urban environment are: geographical challenges and temporal challenges.

The geographical concern is about the question of "native to where?" Site analysis and observation can provide some clues for a native ecosystem. However, it can be challenging to determine what a native ecosystem is to be restored in an urban site with totally invasive plants or a destroyed site without any vegetation. It should be a regional prevailing ecosystem? a prevailing ecosystem in a city? an ecosystem within certain distance to the site? or the ecosystem on the site at some point in history? For instance, one primary goal of the Neal Smith National Wildlife Refuge and Prairie Learning Center, located in Jasper County Iowa, is set to restore the refuge landscape as nearly as possible to the natural condition, the tall grass prairie and oak savanna that existed before Euro-American settlement in the 1840's (Witte, 1999).

The ecosystem in history speaks to the temporal concern in designing for native ecosystems. A common argument is that it takes years to establish native ecosystems in an area because the species of an area need years to co-evolve, to adapt to each other and to the peculiarities of their physical environment (Gould, 1998). However, we also know that an ecosystem is in dynamic changes all the time. It is not always realistic to expect the current ecosystem on a site to be the same as the one thousands of years ago.

Fearful critics deplore new development: they wish that the land might be as it was. But how was it? Certainly never long the same. Environment changes steadily, even without our interference: new species crowd out the old, climates shift, geological processes continue. Decay, waste, entropy, and change are all part of the natural order. The past cannot be regained or the present fixed.

-----Lynch (1981), p123

Landscape architects have attempted to understand and design with the “anatomy” of a native ecosystem as each component is essential in facilitating the ecological function of the ecosystem and the life cycle of native species. There have been a lot of advocates for native plants in design (Figure 2.2). Native plants are not to the same as native ecosystems, which comprise more systematic landscape structure and landscape functions. Native plants are



Figure 2.2 Native plants in Lurie Garden, Chicago

only the vegetation component of a native ecosystem. Another example is the flourishing

design focus in stormwater management to better manage the hydrologic component of an ecosystem (Campbell and Ogden, 1999; Davis and McCuen, 2005; Ferguson, 1998). Single process of an ecosystem is easier to design and manipulate in real projects. However, single process cannot guarantee habitat functions.

2.2.1.2 Landscape ecology and landscape pattern

Landscape ecology, the study of the effect of landscape pattern on landscape process (Turner, 1989), provides another approach to design spatial pattern or spatial arrangement of landscape elements. The concepts of “corridor”, “connectivity”, appear frequently in different projects. For instance, the massive design efforts about “greenways” / “greenbelts” and ecological corridors use some landscape ecological principles (Arendt, 2004; Coutts, 2006; Erickson, 2004). The ecological corridor protected by the Otanerua Eco-Viaduct under the motorway provides some connectivity for wildlife migration through the forests. The ecological corridor protects

“The full definition of landscape ecology is, then, the study of how landscape structure affects (the processes that determine) the abundance and distribution of organisms.”

-----Fahrig (2005), p3



Figure 2.4 The view of the eco-viaduct protecting the ecological corridor

<http://www.transit.govt.nz/planning/urban/alpurtb2.jsp>

native vegetation and ensures the sustainability of local fauna (Figure 2.4).

Landscape ecology can be used in many projects because it implies criteria for designing landscape pattern. For instance, systems with lower diversity tend to be more easily invaded by exotic species and more fragile to pollution regarding their nutrient cycles and ecosystem functioning (Schindler, 1990). The amount of edge for a habitat patch relates to potential predation in avian species and plants species richness (Moser et al., 2002). Connected patches can smooth the migration of species so that those plants and animals are more likely to survive (Forman and Godron, 1986). In **Landscape Ecology Principles in Landscape Architecture and Land-use Planning**, Dramstad et al.(1996) summarized and visualized a series of criteria that suggest implications for different planning/design circumstances. One caution against using criteria from landscape ecology in design is that the relationship between landscape function and landscape pattern has not been fully supported by empirical research. For instance, connectivity may facilitate species migrations between patches (Parker et al., 2008). However, connectivity can also facilitate the spread of diseases, pollution, predators and other disturbances to destroy habitats for certain species (Bennett, 2003; Linehan et al., 1995). It is far from easy to integrate concepts and measurements from the theory of landscape ecology into empirical landscape management (Gustafson, 1998). Landscape management requires much more information about the relationship between patterns and processes (Opdam et al., 2001). As argued by Turner et al. (2001), “there is a need to build a collective library of empirical studies in which ecological responses are related to particular landscape configurations. Unfortunately, we have the power to measure and report more about landscape pattern than we can interpret in terms of effects on ecological processes. (p108)”

2.2.2 Organism-specific design approaches

Organism-specific design approaches are more reliable for conservation efforts. The essential issue in organism-specific design is to identify the given species or species group. According to Wilcove (1994), one must first consider the specific habitat requirements of individual species to determine the appropriate size, shape and distribution of reserves designed to protect them. However, it may not be very easy for

designers to identify the right species quickly due to uncertainties in species behavior within an environment, incomplete information about species behaviors and limited time for a project.

“A major challenge in conservation efforts worldwide is to strike a balance between rigorous science and the need for expediency. Ideally, conservation strategies would be based on detailed surveys and a thorough knowledge of each species’ life history- information that is often unavailable and difficult to obtain. “

----- Hess and King (2002), p28

Conservation biologists have developed shortcuts to identify key species to be focused on for planning/design efforts based on incomplete information. *The idea is that by protecting habitat for the “right” subset of species, one will protect habitat for many other species with similar requirements.* The right subset of species can be a single species or multiple species. Some studies have compared different methods to identify key species(Conway, 1989; Power et al., 1996; Simberloff, 1998; Terborgh, 1986). This thesis combines information from the literature and summarizes different approaches.

Keystone species

A keystone species has a unique connection to the community because its “impact on its community is disproportionately large relative to its abundance” (Power et al., 1996). Studies show that changes in a keystone species may lead to changes in species diversity (Miller et al., 1998), species abundance (Power et al., 1996) or overall ecosystem function (Callicott et al., 1999). A keystone species can alter ecosystem structure in many ways, including food webs, competition, mutualism, and dispersal; or physically by modifying the landscape (e.g., beavers (*Castor spp.*) create wetlands) (Block et al., 1987). For example, Terborgh (1986) found that one-half to three quarters of the total bird and mammalian biomass were lost if palm nuts, figs and nectar were removed from a tropical ecosystem. In areas where keystone species are present, conservation biologists can use the keystone species approach to set aside critical areas and manage them to maintain identified keystone species and the critical ecological

processes in which they participate (Power et al., 1996). Conversely, in areas where habitat had been destroyed and restoration projects were in progress, keystone species would be re-introduced to re-establish and sustain ecosystem structure and stability (Conway, 1989).

The keystone species approach is far from optimal in conservation efforts. First, it is not an easy task to identify keystone species due to the ambiguity of the concept of keystone species, which has been criticized by many scholars (Millers et al., 1993; Simberloff, 1998). Furthermore, the use of a single keystone species is likely to leave conservation gaps, which could result in the loss or decline of species that do not utilize the same habitat as the selected species.

Umbrella species

An umbrella species requires large area as its habitat (Wilcox, 1984). The idea underlying this umbrella species approach is that planning for species with large area requirements will provide a “protective umbrella” for other species with similar habitat requirements and smaller home ranges (Wilcox, 1984). For example, Martikainen et al. (1998) studied the endangered white-backed woodpecker in Finland and Russia. They found that 80% of the threatened beetle populations that utilize the same forests would also be protected by conservation strategies developed for this bird (Martikainen et al., 1998). The umbrella species has been suggested to be used to define the size or type of area needed for a reserve system (Ryti, 1992).

Unfortunately, umbrella species does not cover all species. Kerr (1997) and Prendergast (1993) have shown that one or two umbrella species are unlikely to provide protection for all other species due to species richness in an area. Similarly, studies have shown that the umbrella can leave out species that require rare or specialized habitats (Fleury and Mock, 1998; Millers et al., 1993).

Focal species

The focal species approach is proposed to overcome conservation gaps in the keystone and umbrella approaches (Davis, 1996; Lambeck, 1997). Lambeck suggested selecting the focal species based on the single-species keystone and umbrella approaches

by 1) identifying threatening processes responsible for species decline and 2) selecting a suite of species, each of which is considered most sensitive to each of the threatening process (Lambeck, 1997). In theory, the focal species approach is less likely to leave conservation gaps because more than one species is selected to represent a variety of landscape characteristics that will encompass the needs of many other species. Carroll et al. (2001) utilized the focal species approach in their regional planning efforts to preserve threatened carnivores by human development pressures in the Rocky Mountains of the United States and Canada. Hess and King (2002) used a Delphi survey to obtain information from a panel of knowledgeable people for conservation efforts. Six landscape types and nine associated focal species were identified: extensive undisturbed habitat (bobcat (*Lynx rufus*), eastern box turtle (*Terrapene carolina*)), riparian and bottomland forest (barred owl (*Strix varia*), beaver (*Castor canadensis*)), upland forest (ovenbird (*Seiurus aurocapillus*), broad-winged hawk (*Buteo platypterus*)), mature forest (pileated woodpecker (*Dryocopus pileatus*)), pastures and grassy fields (loggerhead shrike (*Lanius ludovicianus*)), and open and early successional forest (northern bobwhite (*Colinus virginianus*)).

The problems of the focal species approach are that it has not been well tested, and required data are often unavailable (Hess and King, 2002). Also, since more than one species and relevant habitats will be selected and examined, the process can be quite time-consuming. In places where the economic pressure to develop land needs quick decisions, the implementation of a focal species approach will be difficult.

Species guilds

Guilds are species assemblages and classifications. Root (1967, p335) defined guild as a "group of species that exploit the same class of resources in a similar way" in a study of five species of birds that foraged in the same general fashion. The idea of using species guilds in planning/design is that the species guilds approach can categorize species accordingly to different habitat types, which can be incorporated into planning/design processes. In addition, the fact that species guilds cover more than one species can lead to less conservation gaps compared to single species method. Fleury and Brown (1997) used the guild concept to develop wildlife conservation corridors. Based

on the use of corridors for different activities, six species guilds were used in that study: insects, reptiles and amphibians, birds, small mammals, medium mammals and large mammals. The requirements and planned corridors for each guild were explored respectively.

Beyond the general categorization of species guilds, Severinghaus (1981) suggested that one species from a guild could be chosen as a "guild-indicator species," and its population and habitat monitored in lieu of monitoring those for every species from the guild. The guild-indicator approach seems to be able to simplify the implementation of species guilds. However, Block (1987) suggested that indicator species should be used with caution. They investigated the ability of mountain quail to indicate the presence of other species from the guild and to index the quality of the habitat for other species. Mountain quail habitat was significantly different from the habitats of sympatric species from the guild. Consequently, they suggest that, if indicators are used, they should be applied to guilds composed of species that closely share ecological affinities.

The appropriate application of guilds is challenging because there are many different ways to categorize guilds and define guilds composition (Jaksic', 1981; Mannan et al., 1984). The degree to which species in a guild are similar in resource use is critical in the use of species guilds. Too general a guild definition creates too much uncertainty within that guild, while too detailed a guild definition can be too time-consuming for conservation efforts.

2.3 Summary comments about different methods for defining habitat

Defining habitats for design is complicated. Many methods are available as reviewed but none of them provides optimal solutions (Table 2.1). The choice of either a landscape-specific method or organism-specific method is more by operational necessity or ethical concerns rather than by concrete theoretical proof. Some people think that the focus on individuals and populations is simplistic and it is thought to be relevant only for sensitive species requiring special attention (Knight, 1990). In contrast, others consider that the positioning of a site in relation to extant populations of species of interest is an

essential component of successful design. Estimating the likelihood of site colonization by target species is a means of evaluating site quality (Scott et al., 2001).

As a summary, landscape-specific methods may POTENTIALLY provide habitats for many species, however it is a mystery that which species will exist there and how many species will exist there. The habitat value of the landscape designed by the landscape-specific method is difficult to be anticipated and evaluated. In contrast, organism-specific methods are straightforward about habitat values if we can identify the RIGHT species and its associated habitat. However, regardless of selecting single species or multiple species, there are always potentials for conservation gaps. It seems that a design method combining both landscape-specific method and organism-specific method would help to overcome the constraints of each method because the organism-specific method can at least ensure a site to be a suitable living environment for one or a group of species as well as species with similar habitat requirements while landscape-specific method has the potential to provide habitats for many other species.

Table 2.1: Strength and weakness of different design approaches to integrate habitats by design

Design approaches	Strength	Weakness
Landscape-specific	The potential to provide habitats for many species.	Uncertain which species will exist there and how many species will exist there.
<i>Native ecosystems</i>	<i>The potential to support native habitats.</i>	<i>-It is a complicated system. -Difficult questions in need of answers before design, like “native to where” and “native to when”.</i>
Landscape ecology and pattern	<i>Available design criteria of landscape pattern that are easily manipulated in real projects.</i>	<i>The relationships between landscape pattern and landscape functions have not been fully examined and supported.</i>
Organism-specific	Clear habitat values.	Difficult to identify the right species and potentials for conservation gaps.
<i>Keystone species</i>	<i>Simple, single species that has large impact on a community.</i>	<i>Difficult to identify keystone species due to the ambiguity of the concept of keystone species.</i>
<i>Umbrella species</i>	<i>A “protective umbrella” for other species with similar habitat and smaller home ranges.</i>	<i>Potentials to leave out species that require rare or specialized habitats.</i>
<i>Focal species</i>	<i>A variety of landscape characteristics that will encompass the needs of many other species.</i>	<i>Time-consuming, not been well tested and required data are often unavailable.</i>
<i>Species guilds</i>	<i>Potential to provide habitats for different species accordingly to different habitat types.</i>	<i>Many different ways to categorize guilds and define guilds composition.</i>

Chapter III

Study site conditions and project requirements

The site used for this study is drawn from the “Integrating habitats” competition². It is not real, but prototypically represents common habitat and development types found in the Portland Metropolitan area of Oregon, USA. All site descriptions in this chapter are summarized from the competition brief (2007).

3.1 Site context



Figure 3.1: site context (modified from competition brief, 2007, p 16-18)

Landuse

² <http://www.oregonmetro.gov/index.cfm/go/by.web/id=21627>

This 6.8-acre site is zoned for commercial/residential mixed-use development (Figure 3.1). It is bordered to the south by industrial uses. The northern edge of the site is of high commercial value because it is bordered to the north by mixed-use / residential projects, and to the northwest by multi-family residential development. Existing retail and entertainment provide amenities for the district's residents (Competition brief, 2007).

Transportation

The site is located near the southwest corner of the intersection of two streets, a parkway to the south and an arterial street to the north. The north-south running parkway is a four-lane road with a center boulevard and speed limit of 45-mile per hour. A transit stop is located to the east of the site across the river. The site can be accessed by car from the north by the arterial and from the southwest by a north-south running street. "At present the site can be accessed by car from the north by the arterial and from the southwest by a north-south running street". Besides, the site can be accessed by "a multi-use recreational trail system running alongside the parkway across the stream from the site, and farther to the south of the site" (Competition brief, 2007, p 11).

3.2 Site description

The site is ecologically important considering its riparian location and excellent connectivity opportunities with a perennial urban creek to the east and a municipal natural park to the west (Figure 3.2).

A perennial urban creek borders the east side of the site and can be a valuable urban riparian corridor that extends through the site, the city and beyond. To protect this river corridor, the site is designated into three areas: High level Habitat Conservation Areas (HCAs), Low level HCAs, and the rest. High level HCAs is an area of land adjacent to the stream's ordinary high water line. "Plants communities in HCAs are the same as those along riparian slope with the addition of Douglas fir (*Pseudotsuga menziesii*) and a shrub understory composed of snowberry (*Symphoricarpos albus*), Oregon grape (*Mahonia aquifolium*), and other species tolerant of drier conditions in the upslope areas" (Competition brief, 2007, p12). Low level HCA is an area adjacent to the high level HCA due to its proximity to the stream corridor. Plant communities are primarily

invasive, non-native shrubs such as Armenian blackberry (*Rubus armenicus*). The rest of the site is vacant and mainly consists of non-native grasses (Competition brief, 2007).

The municipal nature park that borders the west side of the site has received a moderate HCA designation due to its intact native plant communities. This park is a dense mixture of native deciduous hardwood and conifer over-story tree species with species composition similar to those found along the upslope areas of the urban creek. The difference is that this park has greater proportions of Douglas fir and other species that tolerate drier conditions than the upslope area of the urban creek. Further west, the park is linked to a significant upland forest wildlife corridor (Competition brief, 2007).



Figure 3.2: site description of the connectivity opportunities
(modified from competition brief, p 16-18)

The entire site has soil suitable for built-up and/or stormwater infiltration. No wetlands are on site and the floodplain of the urban creek is outside of the site. Prevailing

winter and summer winds are from the north and from the west respectively. The slope within the high HCA areas is generally towards the urban creek to the east (<5% grade). The rest of the area has a gentle slope towards the arterial to the north (<5%). (Competition brief, 2007). According to the rough slope information, the stormwater on site will be running from the southwest to the northeast toward the creek, as shown in figure 3.3.

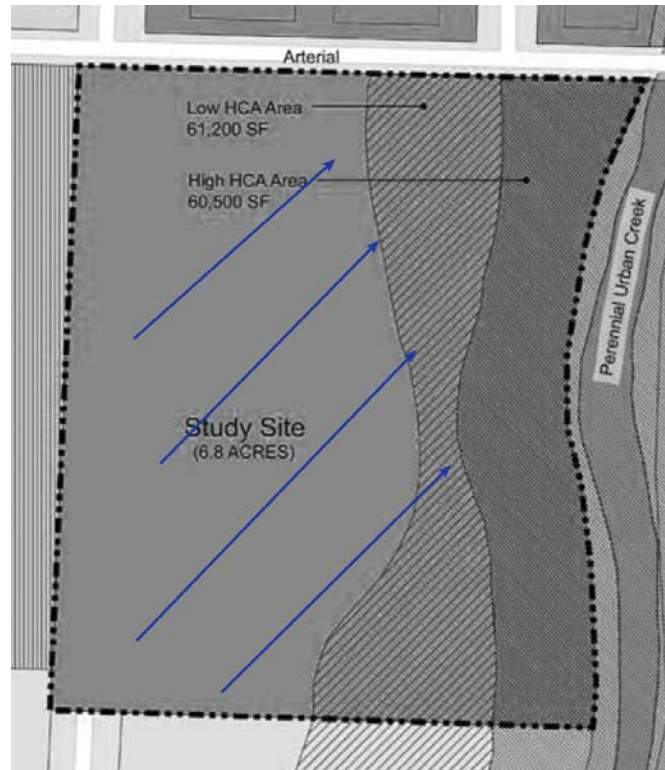


Figure 3.3: Stormwater flow direction according to site slope

3.3 Project description

This site calls for a “nature-friendly” development of a mixed-use area to protect the urban creek and associate riparian habitat. Primary goals for this design are to:

- Enhance interior forest and riparian habitat quality
- Improve habitat connectivity through the restoration of existing habitat and introduction of new habitat corridors
- Apply resourceful, creative stormwater management practices (minimizing the amount of stormwater generated on site and retaining the stormwater on site to the greatest practical extent)
- Provide for the housing, commercial and recreational needs of a diverse community
- Utilize materials and energy efficient design strategies that enhance livability

• Develop clear linkages to a light rail transit stop and a major recreational corridor/bike trail, both within walking and biking distance of the site.” (Competition brief, 2007, p11)

The required programmatic elements are summarized in table 2.1 (Competition brief, 2007, p14-15).

Table 3.1: development program suggested for the competition

Building Program	Floor Area Square feet (SF)
Residential	
(36) ‘family’ residential	units @ 1200 SF/unit 43,200
(48) 2 bedroom residential	units @ 800 SF/unit 38,400
(60) studio residential	units @ 600 SF/unit 36,000
Community	
Day Care Center*	* 2,400
Community Center	6,000
Enclosed bike storage	1,000
Commercial	
Small grocery	3,600
(8) Retail spaces	@ 2,000 SF/space 16,000
Café**	2,000
Net Total Building Program (plus circulation, typically +/-10 to 15% of total building area)	148,600 SF
Parking, circulation and path system program	
Residential	(one space per unit x 144 units @ 350 SF/space, typical***) 50,400
Community	(8400 SF x 1.5/1000 SF ratio = 13 spaces @ 350 SF/space, typical***) 4,550
Commercial	(21600 SF x 1.5/1000 SF ratio = 32 spaces @ 350 SF/space, typical***) 11,200
Net Total Parking Program	66,150 SF

** the day care facility requires connected outdoor play space (this space may double with the shared open space below, as appropriate)

** the cafe requires connected outdoor space

**** includes parking spaces, aisles and access roads Note: in addition to parking, site path systems should be incorporated into a strategy that links them up with nearby regional multi-use trail systems; the strategy may locate proposed trails within HCAs

The competition also requires at least 15% of the total site area to be devoted to shared outdoor use. The design should avoid the development disturbance of HCAs. For

the high level HCAs, no more than 10% of its area may be disturbed. Low level HCAs may be disturbed if necessary and facilities that infiltrate stormwater on site is appropriate to be placed in low level HCAs. “For every acre of any HCA disturbed (high, moderate, or low), 1.5 acres of native plant restoration must be completed elsewhere on site, either within or contiguous to existing HCAs (Competition brief, 2007, p14).” If more than 50% of all designated HCAs is protected by design, the maximum building height can be increased to 65 feet.

Chapter IV

A combined approach for integrating habitats by design

As discussed in Chapter I, both landscape-specific and organism-specific methods have some disadvantages in designing for habitat. The habitat values of the environment designed by landscape-specific methods are difficult to be anticipated, while environment designed by an organism-specific method potentially has conservation gaps.

Considering the constraints of each method, I intend to use a combined approach to integrate habitats, which will combine both the landscape-specific method and the organism-specific method.

One key component of the landscape-specific concern in my design is to accommodate the native ecosystem on site, which is obviously a riparian forest ecosystem as shown in Chapter II site analysis. Riparian forests can provide significant ecosystem functions, which:

“...protect and improve water quality by cooling the water, slowing and storing water to replenish groundwater, reducing urban runoff, and filtering out toxics and excess sediments. Riparian areas are biologically diverse, complex ecosystems that contain more plant, mammal, bird, and amphibian species than the surrounding upland areas. In the Portland metropolitan region at least 45% of all wildlife species depend on riparian habitat and 93% use riparian habitat at some point during their life cycle. In naturally forested areas near water and in site designs and new development, every tree matters.” Competition Brief (2008, p6)

The organism-specific component is to design suitable habitat for the Pacific tree frog (*Pseudacrus regilla*), which is a common amphibian species in the



**Figure 4.1 Pacific tree frog
(*Pseudacrus regilla*)**

http://www.lmconsult.com/pvaudubon/hummin-v27_6-pacific-tree-frog.jpg

West Coast of the United States (Figure 4.1). I chose an amphibian species because amphibian species need both aquatic and terrestrial habitats, and the site has high potential to serve as a corridor linking the creek to the east and the forest park to the west. In addition, amphibians play an important role in stream-riparian dynamics (Bury, 1988) and “reciprocal subsidies (the dynamic interdependence between terrestrial and aquatic food webs)” of stream-riparian zones (Baxter et al., 2005). I did not select any endangered or rare species in Oregon because I do not know whether the environmental or climate conditions of the site are suitable for those endangered species. The Pacific tree frog is common, but is also a keystone species because many other species, like garter snakes, depend on its abundance as a prey item for survival. It was named as the state frog of the State of Washington in 2007.

In summary, my combined design approach for integrating habitats is to design for a riparian forest ecosystem to provide habitats for many species while specifying habitats for one common amphibian species, Pacific tree frog.

4.1 The riparian forest ecosystem in Oregon and restoration

Design strategies for the riparian forest ecosystem rely on ecological information about the structure and function of riparian forests. Furthermore, since the majority of the site is vacant with nonnative grasses, the design needs to address the restoration of riparian forests.

The Oregon Coast Range ecoregion includes two major vegetation types, the western hemlock (*Tsuga heterophylla*) and the Sitka spruce (*Picea sitchensis*) associations (Franklin and Dyrness, 1988). Shade intolerant conifers such as Douglas fir (*Pseudotsuga menziesii*) tends to appear upslope, over distances up to approximately 30 m from streams (Nierenberg and Hibbs, 2000). They are the primary climax species. Hardwood species, particularly red alder (*Alnus rubra*), is the pioneer species, which can initially occupy a place after disturbance in that region (Nierenberg and Hibbs, 2000). Big leaf maple (*Acer macrophyllum*), willow species (*Salix, spp.*) and black cottonwood (*Populus trichocarpa*) are other pioneer species in that region. salmonberry (*Rubus*

spectabilis), a rhizomatous shrub and vigorous competitor, can dominate a site as the hardwood stands degenerated after 9—150 years (Nierenberg and Hibbs, 2000).

Riparian forests can be restored by natural regeneration or managed succession.

Nierenberg and Hibbs pictured the natural regeneration process of pre-settlement riparian vegetation in Oregon coastal bioregions. Following fire disturbance, any existing underground salmonberry rhizomes sprouted rapidly (Tappeiner et al., 1991). The other rapid grower, red alder, also quickly occupied open spaces. Douglas fir, the most fire-resistant tree species, could have had limited regeneration due to competition in salmonberry-or red alder-dominated areas. Other conifer species could also colonize both partial and complete burns. The initial recolonization period could last up to 40 years. There may be other post-fire disturbances such as animal activity, floods, debris flows, and landslides that might cause a shift in dominance or permitted regeneration of a new cohort of trees. Colonization of riparian environments by hemlock, red cedar, and spruce might also have occurred without disturbance, but the extent to which this is possible is not clear. Between stand age of 100 and 150, the original alder population senesced. Existing conifers would continue to grow. Some shade-tolerant conifers may also regenerate. Small-scale infrequent disturbances will regenerate new patches of alder. The long-term dynamics of salmonberry patches is unknown. They appear immortal but disease or animal factors may interfere to create tree regeneration opportunities. Alternatively, hemlock, red cedar, and spruce may slowly colonize them.(Nierenberg and Hibbs, 2000)

Natural regeneration takes a long time, i.e., the two hundred years suggested by Nierenberg and Hibbs (2000). Hough (2004) proposed managed woodland succession according to the principles of natural succession, which can speed up forest regeneration by assisted management. It follows three general phases:

“-an initial planting of fast-growing, light-demanding pioneer species that quickly provide vegetative cover, ameliorate soil drainage, fix nitrogen and stimulate soil micro-organism, and create favorable micro-climatic conditions for more long-lived species;
- an intermediate phase of plants that ultimately replace the pioneers;
- a climax phase of slow-growing, shade-tolerant species that are the long-lived plants. (p96)”

Hough (2004) suggested that the different planting phases to be introduced at intervals because this has proven to be more successful than getting all planting phases done all at one time. This can be explained by the fact that successful regeneration of trees requires an adequate seed bed, and sufficient light and water.

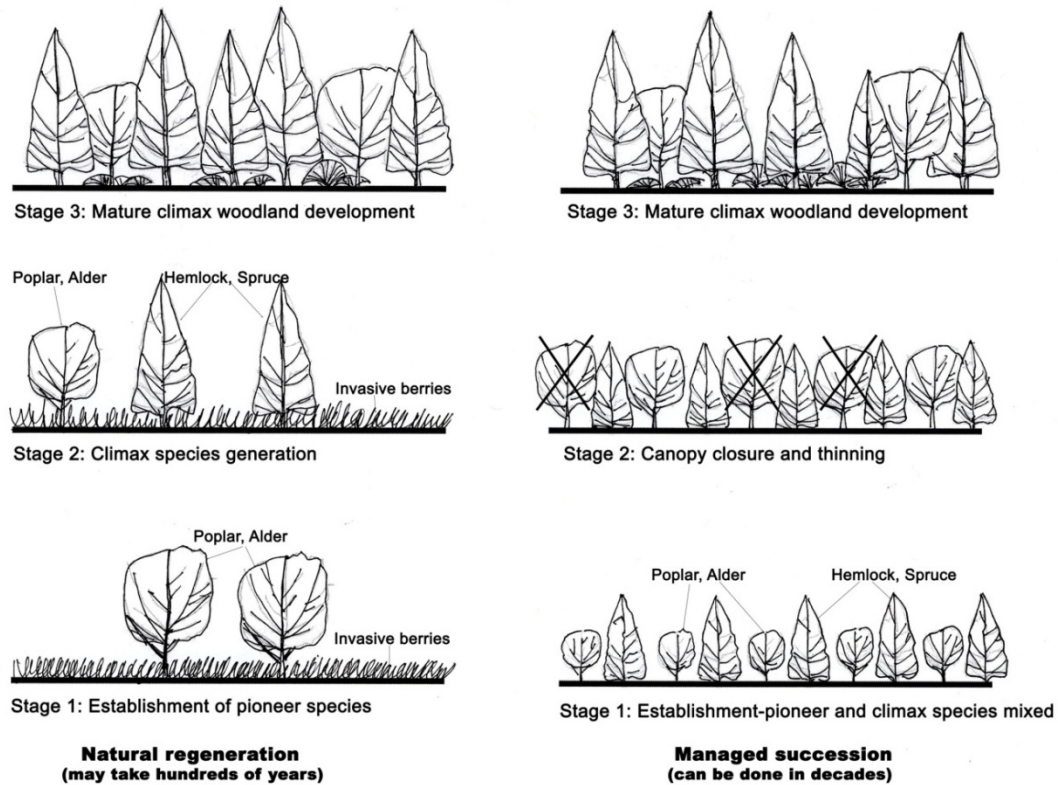


Figure 4.2: Comparisons of natural regeneration with managed succession for reforestation in Portland area (modified from Hough 2004, p98)

My design will use the managed succession method to restore the riparian forest on site while considering the natural regeneration processes. The differences between my managed succession and the natural regeneration are shown in Figure 4.2. The natural regeneration starts with the establishment of pioneer species and invasive berries (berry species different in different places) in Stage 1. In Stage 2, climax species takes the place after some of the pioneer species die. Invasive berries are still the dominating under-story species. Managed succession establishes mixed pioneer and climax species in the initial stage with the control of invasive berries to encourage the growth of native shrub. When canopy reaches certain closure, managed thinning can facilitate the establishment of

climax species in Stage 2. In general, managed succession takes a much shorter time to achieve mature climax woodland development than natural regeneration.

4.2 Habitat requirements for the Pacific tree frog (*Pseudacrus regilla*)

Pacific tree frog has been described as the most common frog in the Pacific Northwest (Leonard et al., 1993). They are found anywhere from Baja California all the way up to British Columbia. They are also found eastward to Montana and Nevada.

Pacific tree frogs need both aquatic and terrestrial habitats.

For most of their life cycles, Pacific tree frogs live in low shrubbery (Leonard et al., 1993), or cool, moist retreats used for overwintering or aestivation (Weitzel and Panik, 1993). The breeding habitat of Pacific tree frog is aquatic, in both temporary and permanent waters. In western Oregon and Washington, breeding of Pacific tree frogs can happen anytime from November-July (Weitzel and Panik, 1993). Breeding habitat includes most aquatic sites, including lakes, ponds, slow-moving streams, backwaters of large rivers, wet meadows, emergent marshes, forested swamps, reservoirs, muskegs, pools, golf course ponds, and irrigation ditches (Gardner, 1995; Leonard et al., 1993; Rorabaugh et al., 2004; Stebbins, 1985; Waters, 1992) In the Pacific Northwest, they are often found breeding in fishless, ephemeral wetlands that dry up before mid-summer (Leonard et al., 1993). They are most likely to use shallow, quiet waters for breeding, especially waters with submerged and/or emergent vegetation (Nussbaum et al., 1983). There is no known difference between male and female habitat characteristics.

4.3 Cultural concerns for the combined approach

Integrating habitats into human-dominated areas is complicated due to potential incompatibility of human uses and wildlife habitats. It is important to consider how individual species respond to the habitat alteration and human activity in developing overall conservation strategies (Miller and Hobbs, 2000).

“Integrating nature into settlement increases contact and friction between people and ecologically rich landscapes. People threaten streams, lakes, wetlands, woodlands, and prairies by changing the flow of energy or material into these habitats and by actually encroaching on them with development. These flows may be as apparently innocuous as a pet cat prowling an early meadow, as invisible as the flow of herbicides carried in rainwater from lawns to lakes, or as dramatic as a massive fish kill in a poisoned stream. ”

-----Nassauer (1997), p7

In my study site, the chemical contaminants produced from human settlement may impact the survival of Pacific tree frogs (Blaustein et al., 2003; Kiesecker et al., 2001). It is better to treat all stormwater on site before it reaches aquatic habitats for Pacific tree frogs. In addition, the migration of Pacific tree frogs in a human-dominated environment needs special attention, particularly in areas with road crossings. Probability of amphibians being killed by traffic is reported as 34% to 61% on a road with 3200 veh/d (Forman, 2003). Tunnels, wing walls and vertical retaining walls have been suggested as useful to facilitate the migration of amphibian and reptiles (Jackson, 2003).



Figure 5.1 Site plan

Chapter V

Site design using the combined approach to integrate habitats

The application of the combined design approach to my study site aims to create and integrate three habitat types: riparian forest habitats, human habitats, and habitats for Pacific tree frogs (Figure 5.1).

The integration of different habitat types is achieved by a minimized human development to save spaces for natural habitats; a managed succession of riparian forests at the south edge of the site; and a careful allocation of suitable habitats for Pacific tree frogs to minimize human disturbance and avoid human habitat as an ecological trap for frogs. Human development is centralized at the northern edge of the site along the arterial street according to site context that it is bordered to the north by mixed-use / residential projects and to the northwest by multi-family residential development. In understanding that wider ecological corridor can provide better connectivity and ecological functions, my design does not provide several finger-shaped small corridors, but preserves the south edge of the site as the main corridor connecting the western park and the eastern creek.

5.1 Human habitat and cluster development

The site design and allocation of human habitat is based on “cluster development” because the site has an extensive development program, which leaves limited space for biotic habitats. The idea of cluster development originates from Arendt’s advocates of better subdivision and land use development patterns, which was called “conservation subdivisions” (Arendt, 1996, 1999, 2004). Cluster development is used in this design to minimize development for human uses by grouping of development on a portion of the available land while reserving a significant amount of the site as biotic habitats. In addition, research has shown that cluster development is better to provide biotic habitat (bird habitat) than conventional development (Odell et al., 2003).

Roads are strategically located to minimize fragmentation and disturbance. According to the site context of adjacent transportation, there are three options for the design of the main road on site (Figure 5.2). Option 1 is the most common way to arrange a road by connecting existing entrances to the site. It provides direct and clear connection of the south industrial area with the north mixed uses through the site. However, the road along west side of the site would have placed a physical barrier between the residential units and the natural areas, for both human and animals. Option 2 places the road in the middle of the site, which allows for partial integration of the western park into the neighborhood but still serves as a barrier. Meanwhile, through traffic runs across the neighborhood may weaken the sense of community. Option 3 only connects the site with the northern arterial but has no connection to the southern industrial area. It sacrifices the convenience of human activities to move through the site. Instead, Option 3 provides the opportunity to protect the southern area of the site from transportation disturbance. This design utilizes Option 3 to arrange the roads.

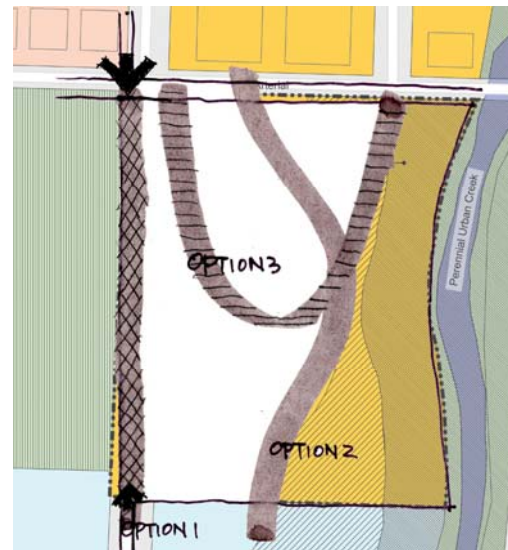


Figure 5.2: Options for main through traffic on site

In my design, commercial uses are arranged in a row facing the northern arterial street (Figure 5.4). The grocery store and café have two entrances to serve for people from both the northern street (Figure 5.3) and from the neighborhood. Retail spaces are only accessible from the street side to minimize their disturbance to the inside neighborhood.



Figure 5.3 Entrance to Grocery and Café from the arterial street on the north

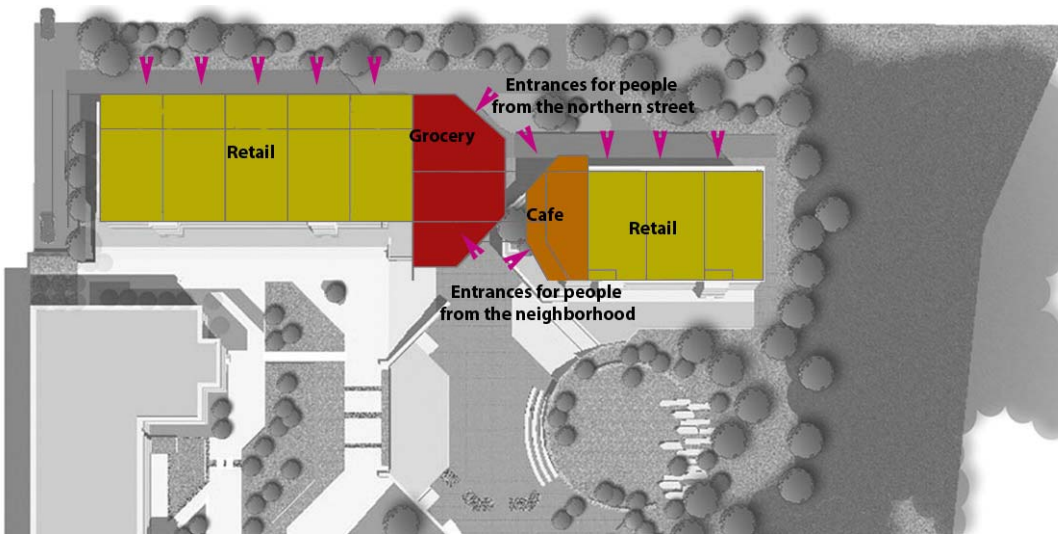


Figure 5.4 Commercial uses on the first floor at the northern edge

Residential development is placed above commercial uses and in another separate building (Figure 5.5). The perpendicular building arrangement embraces a center “courtyard-like” community space, which is composed of a roof-top plaza and a ground-level plaza. All floors in the development have residential units with views either to the western forest or to the center plaza. Buildings overlook and interact with natural areas and community activity spaces.

The community center and daycare center are placed in the transition of the roof-top plaza and the ground-level plaza (Figure 5.6). They both have easy access from all buildings and community public spaces. In addition, they locate in a place adjacent to natural forests, which provide tranquility and nice views to both kids and adults using the daycare and the community center.

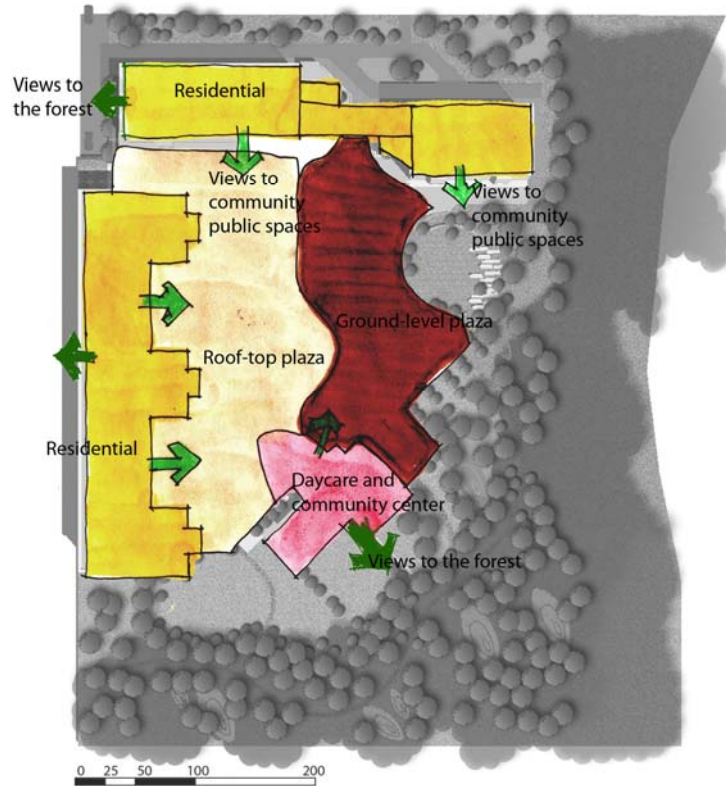


Figure 5.5 View orientation of residential development



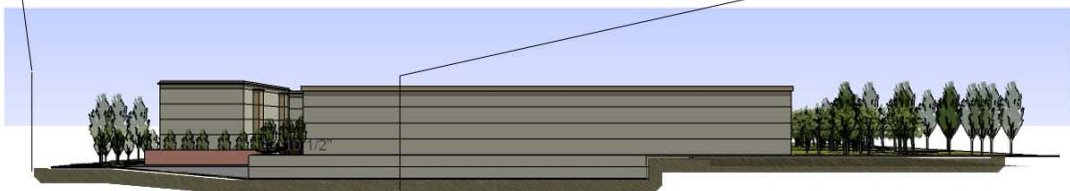
Figure 5.6 View from apartments on top of the commercial to the daycare and community center



Entrance from the parking to the roof-top plaza



Enlarged parking entrance from the arterial street



Section of the parking from the northern arterial street to the southern forest

Figure 5.7 Parking sections and entrance view from the roof-top plaza

An underground parking garage is used rather than surface parking lots. The two floor parking garage is arranged underneath proposed buildings with entrances from the northern arterial street (Figure 5.7, 5.8). The parking lot has a centralized entrance to the upper level plaza and buildings (Figure 5.7, 5.8).

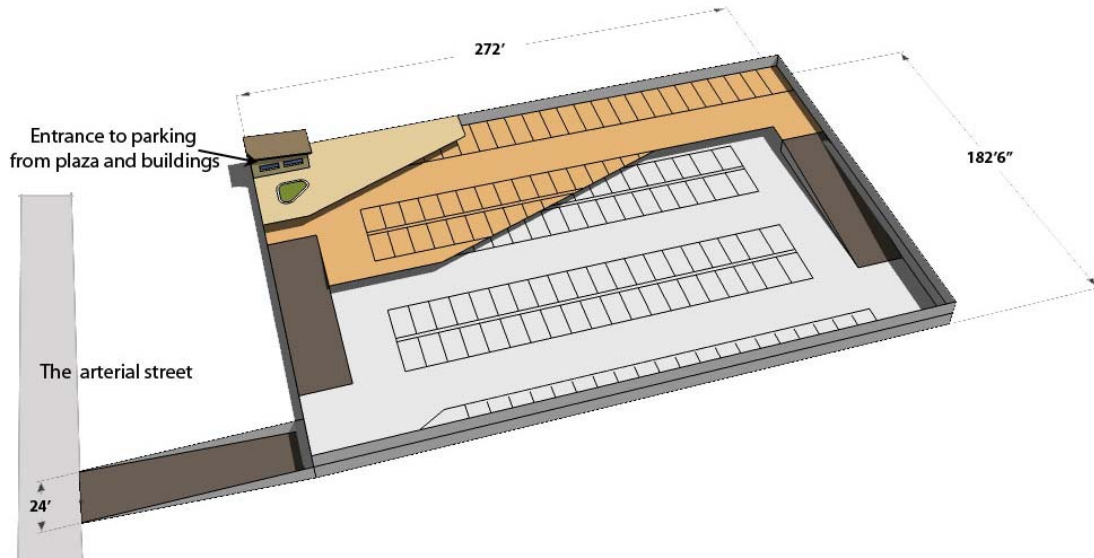


Figure 5.8 Parking layout

The two-level plaza provides diverse places for community activities and events (Figure 5.9, 5.10, 5.11), which include both passive and active activities, like walking, seating, dining, enjoying music or play from the stage, talking with neighbors etc.



Figure 5.9 View to the ground-level plaza from the roof-top plaza



Figure 5.10 View of the southeast corner of the ground-level plaza: a passive place and a transition to riparian forests

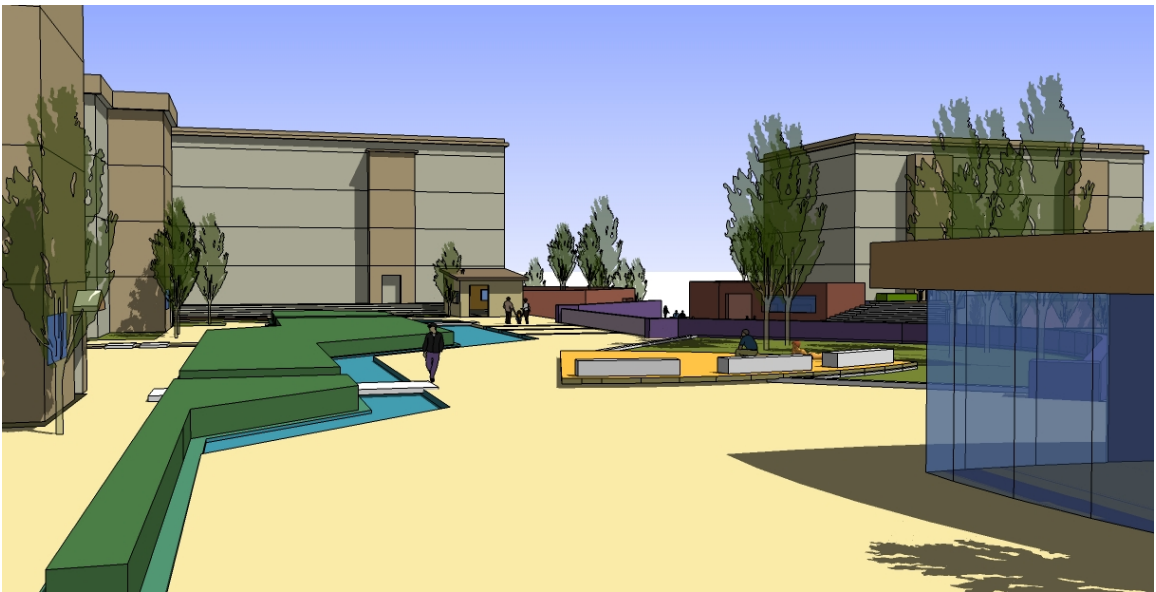


Figure 5.11 View of the roof-top plaza

Walking and bike paths are designed as the primary on-site transportation (Figure 5.12). Bikeways and foot paths weave throughout the site, linking the neighborhood with adjacent mass-transit, surrounding neighborhoods, and parks. Bikeways and foot paths direct people's movement and lead them to different experiences.

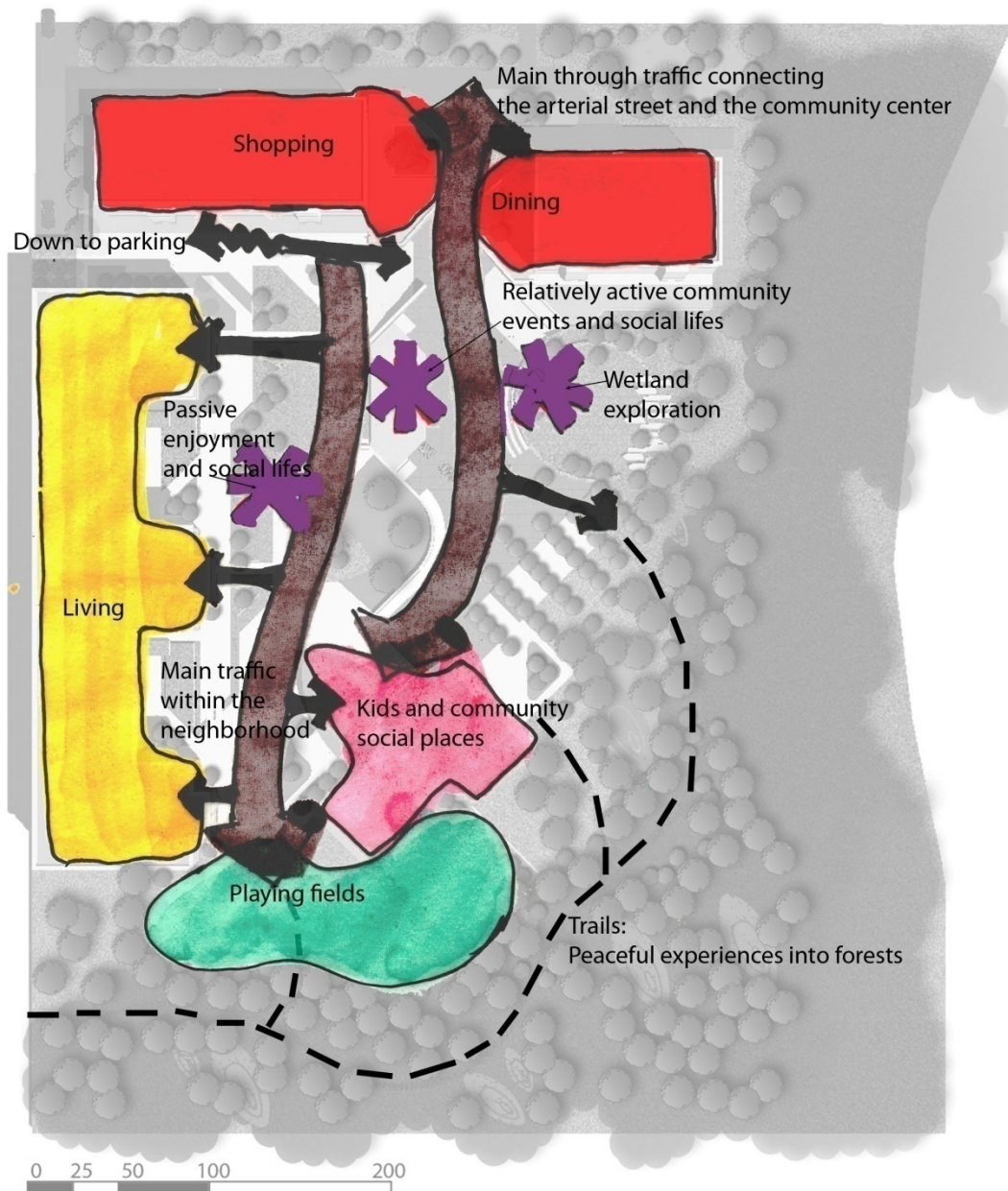


Figure 5.12 *Walk paths directing human experiences*

In general, the human habitat design aims to blend work, play, home and education into a small environmental footprint that respects the natural systems of the site.

5.2 Succession of the riparian forest habitat

The development is a catalyst for restoration of the surrounding riparian forest habitats (Figure 5.13). The site provides a key corridor connecting the riparian habitat across the site with the western natural park and eastern perennial creek. In addition, the riparian forests buffer the neighborhood from the industrial zones at the south.

This development disturbs less than 50% of the low HCA areas and restores undeveloped portion of the site. It does not encroach upon the high HCA zone. The disturbed low HCA area is primarily used for stormwater treatment. By restoring the riparian forests and adding in new areas to increase interior forest conditions, animal habitats will thrive and become healthier. The connectivity of the site with adjacent park and creek will facilitate species migration from/to surrounding areas, thus promote a matrix of ecological communities.



Figure 5.13 View of forests along the trail

The restoration process of the riparian forest habitat is based on managed succession as describe in Hough (2004). According to the characteristics of natural regeneration of riparian forests in Oregon (Chapter IV), the site design starts with alternative planting of both climax and pioneer species. In human dominated areas, the plants with mixed climax and pioneer species will grow naturally for natural succession.

In the south riparian forest corridor, managed thinning of pioneer species is used to speed up forest regeneration when the canopy reaches certain enclosure. The succession of riparian forests follows three general phases as suggested by Hough (2004): alternative planting of climax and pioneer species, thinning of pioneer species and climax condition (figure 5.14).

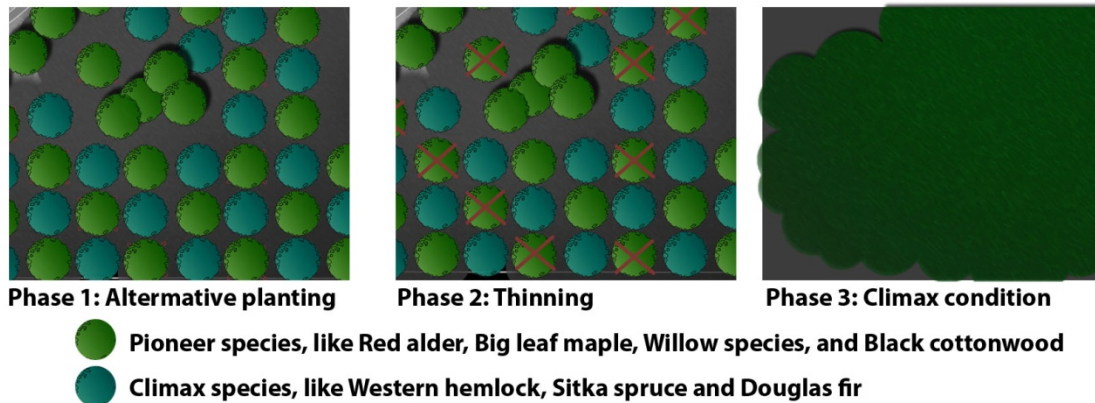


Figure 5.14 Conceptual plan views of the three phases for managed succession of riparian forests

5.3 Habitats for Pacific tree frogs

Stormwater treatment for frog habitats

The design has a systematic stormwater treatment chain (Figure 5.15, 5.16, 5.17) that considers the aquatic breeding habitat requirements of Pacific tree frogs. Different stormwater treatment techniques, like roof gardens, permeable paving, vegetated swales, and vegetated infiltration basins, are used to manage stormwater on site. These strategies can filter polluted runoff, protect local soils, reduce runoff volume, increase air quality, lower surface temperatures and cool local climates.

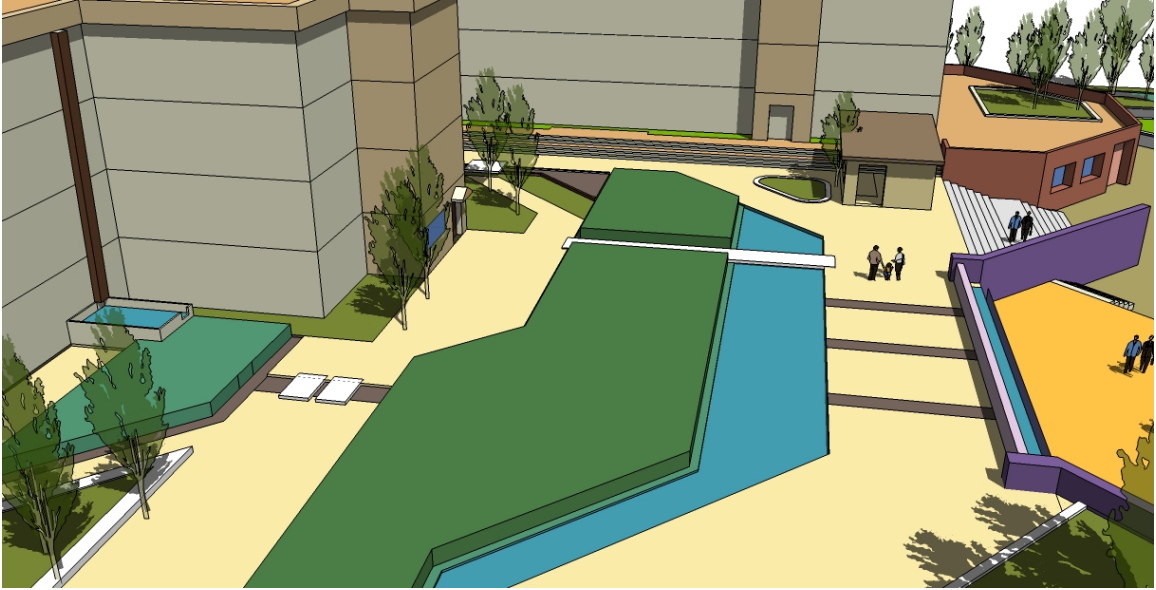


Figure 5.15 View of the stormwater treatment from the community center



Figure 5.16 Elevation of the stormwater treatment

Buildings and stormwater treatment chain celebrate rain water (Figure 5.17). The rain drains off the roof, feeding a series of wetland plants, and gets captured in an invisible cistern which in turn meets the daily needs of the buildings' residents. Excess rainwater can be further treated in the surrounding wetlands near the cistern. The filtered water is directed to another wetland pond to the east, from there, the cleared rainwater will be released gradually through the forests into the creek.

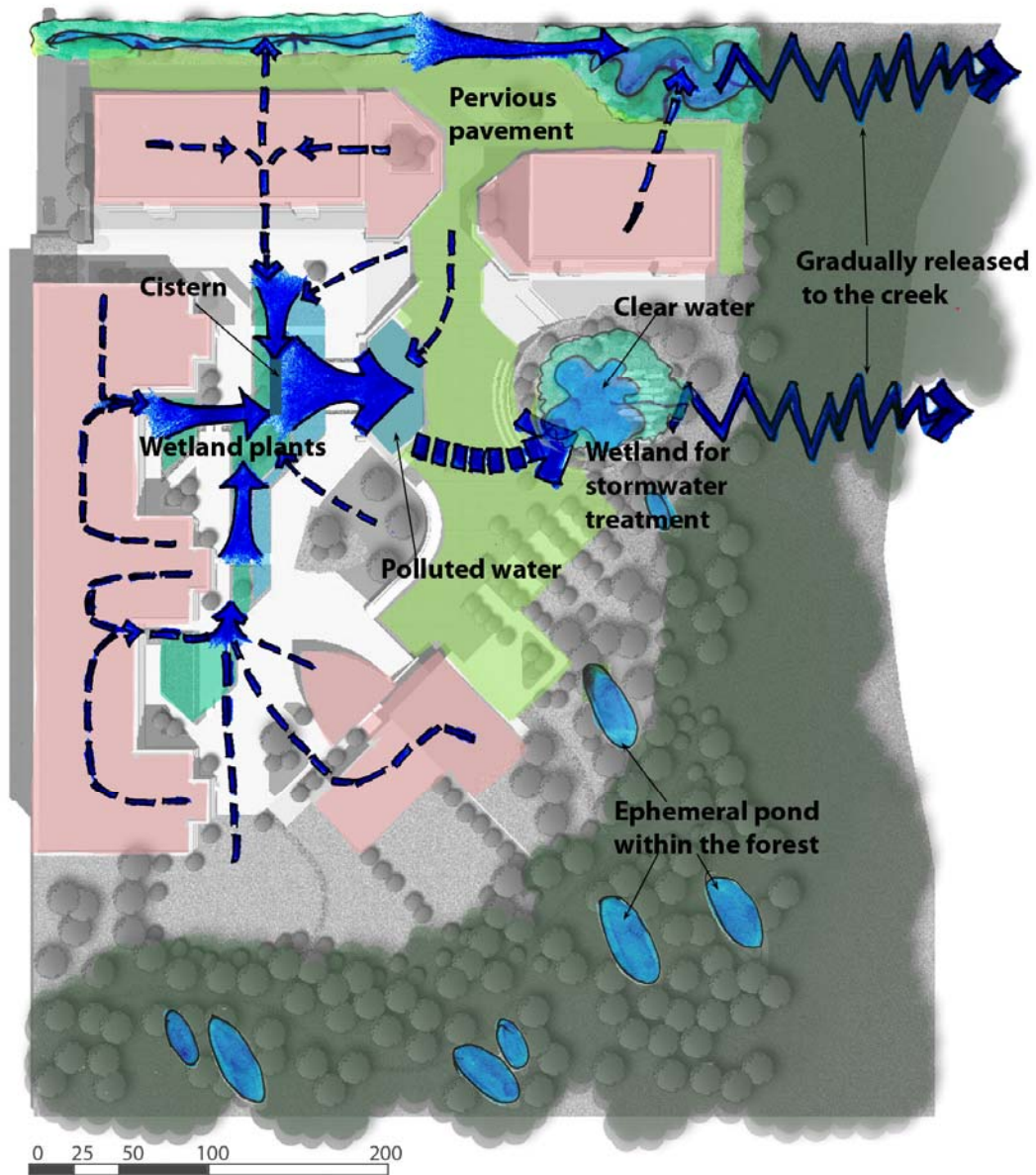


Figure 5.17 Stormwater treatment chain on site

Frog habitats

Pacific tree frogs are common species and can use many landscapes as their habitats (Chapter IV). However, not the entire site is suitable as habitat for Pacific tree frogs. For instance, urban stormwater run-off can contain pollution, which is harmful to the life cycles of Pacific tree frogs. According to the landscape quality on site and habitat requirements of Pacific tree frogs, the site is designated into three habitat zones (Figure 5.18). Zone 1 is the encouraged habitat area for Pacific tree frogs with cleaner water for

breeding, cool/moist forests for nesting, and free connections to the western forest and the eastern creek. Zone 2 and 3 are not suitable as frog habitats. Zone 2 can be polluted by the arterial street and untreated stormwater from buildings on site. Zone 3 centralizes human activities and polluted stormwater treatment on site. The migration of frogs into these areas is discouraged using buildings, stairs and retaining walls to prevent the area to be a sink for Pacific tree frogs. Zone 2 and 3 is not habitats for tree frogs but is also critical for the health of frog habitats due to its ability to treat polluted stormwater and release relatively clear water into Zone 1.

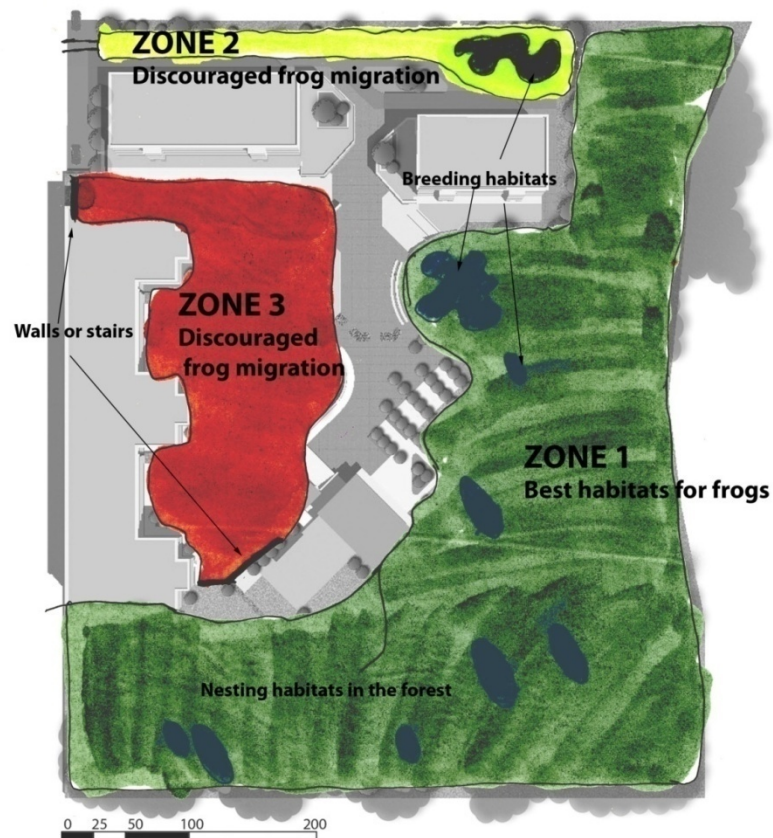


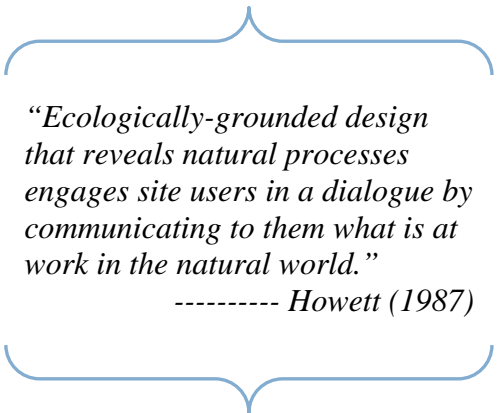
Figure 5.18 Habitat zones for Pacific tree frogs

5.4 Interaction of human and biotic habitats

This design addresses not only how to reconstruct boundaries for the coexistence of the natural and human habitats, but also explores how each habitat can mutually strengthen the other. The mutual interaction of human and biotic habitats is achieved in

this design by increased human appreciation of the biotic habitat and public participation in management and monitoring of biotic habitats. By providing “sensorial” and “explorative” landscape and encouraging public participation, the neighborhood residents would play the role as both of the actor and of the audience towards landscape (Turri 1998, Cited from Castiglioni, 2007).

The development meets the needs of the community while enhancing each person’s day-to-day experience by immersing them in an environment rich in natural processes. Many components of biotic habitats are designed to be enjoyable by humans. As the rainwater flows through wetland plants on the roof top plaza, a unique educational opportunity is created (Figure 5.15 and 5.16). Residents can see this vibrant stormwater clearing chain when using this plaza as a pathway, a resting area or a social place. Stormwater running through the roof-top plaza to the ground-level plaza forms an ephemeral water fall, which serves as a nice background for the stage and a visual focal point for the ground-level plaza (Figure 5.19). The wetland at the east with relatively clear water is another place with education and exploration opportunities. It is a place that residents can look over for nice views, enjoying the chorus of frogs, exploring wetland species using the stepping stones through the wetland, and peaking into the riparian forests adjacent (Figure 5.20).



“Ecologically-grounded design that reveals natural processes engages site users in a dialogue by communicating to them what is at work in the natural world.”

----- Howett (1987)



Figure 5.19 Stage using the stormwater as background



Figure 5.20 Wetland experiences

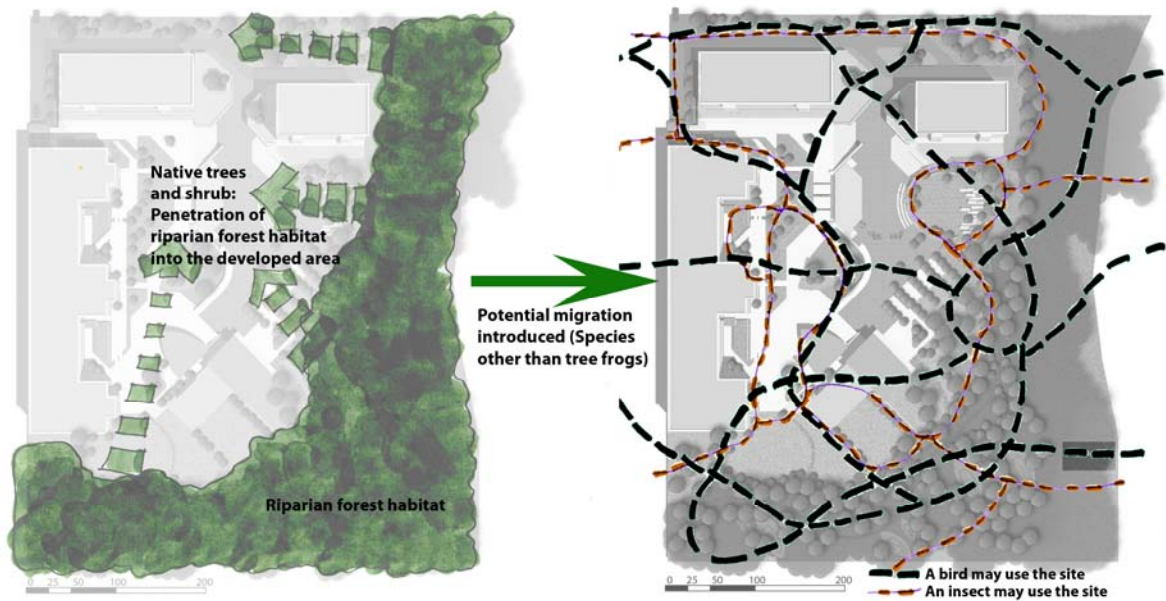


Figure 5.21 Potential wildlife migrations other than tree frogs

Landscapes in areas heavily manipulated by human activity are intentionally designed to serve as a barrier for migration of certain species while a matrix for migration of other species. As discussed in Figure 5.18, the developed area for human uses is intentionally separated from the frog habitats due to the effect of pollution on the life cycles of frogs. However, the developed area is still critical to the frog habitats considering its function of treating pollutants and releasing relatively clear water to the frog habitats near the creek. On the other hand, the purpose of the landscape-specific component of my design is to accommodate habitats for other species except Pacific tree frogs and species having similar habitat requirements as tree frogs. If the developed area is not an ecological trap for certain species, the developed area can be designed to serve as a matrix to the adjacent forest habitat or at least a penetrable space for species using the space (Franklin, 1993). In my design, native trees and shrubs used in the developed area are the same as those in the adjacent riparian forests. In such a case, some species (like birds or insects) from the adjacent forests can use the human habitats as temporary stepping stones or as resting places in their migration (Figure 5.21). In addition, native species can discourage the spread of exotic species and further help the regeneration of the eastern and southern riparian forests by pollination.

Interaction of human and biotic habitats can be further strengthened by public participation in management and monitoring of biotic habitats. Involvement in the management process reinforces the doctrine that humans are a part of nature and that they have both the responsibility and the skills to steward the land on which they live. The design suggests that there is a good opportunity for public participation in the process of forest succession. Residents can help to plant alternative pioneer and climax species, and later on to thin pioneer species when the forest canopy reaches certain closure. As the blackberry is a barrier for the establishment of riparian forests on site, the community can ask residents help in destroying blackberry to help the regeneration of native species. Residents can also involve in monitoring. The site is changing and the changes are not all predicable. The managed succession is conceptually feasible, but there are many factors that will intervene with the growth of riparian forests. Monitoring is a process to assess the site thus to modify our actions or our nonactions. Monitoring can help us to work with the natural regenerative processes inherent in the patterns of each landscape.

Chapter VI

Conclusion

This study contemplates the role of landscape architects in integrating habitats and advocates a new framework to integrate habitats in urban environment. The literature shows two types of design approaches that have been explored for protecting or restoring habitats: landscape-specific approach and organism-specific approach. As each approach has its own strength and weakness, this study suggests a combined design approach using both landscape and organism concerns. The combined design approach is applied in one hypothetical site in the Portland metropolitan area to demonstrate how habitats can be integrated into mixed-use development by innovative design. Accounting for site factors, the site design creates and integrates three habitat types: riparian forest habitats, human habitats, and habitats for Pacific tree frogs. Landscape and organism concerns complement each other, which makes this design solution embody principles of individuality, harmony and beauty in both biotic and human habitats.

As a summary, design principles to integrate habitats in my project are listed with the purposes of advocating them to other projects elsewhere.

- Development for human uses is clustered to save spaces for biotic habitats.
- Vehicle transportation and surface parking are minimized to reduce fragmentation and disturbance caused by vehicle circulations.
- Site design encourages pedestrian experiences to enhance site users' interaction with surrounding natural landscapes.
- Stormwater is collected, treated and reused in developed areas so that the pollution effect of development can be released.
- Managed succession is used to facilitate and speed up the natural regeneration process of the native ecosystem on site.
- Site design provides suitable habitats for the “right” subset of species, which is carefully selected to protect habitat for many other species with similar requirements.

- If the developed area has the potential to be an ecological trap for selected species, site design needs to intentionally discourage the migration of selected species into the developed area using appropriate landscape elements.
- If the developed area is not an ecological trap for certain species, site design can accommodate the developed area as a matrix to the adjacent biotic habitat or at least a penetrable space for species using the space.
- Components of biotic habitats are designed to reveal natural processes while being enjoyable by humans so that site users can learn what is at work in the natural world.
- Public participation in management and monitoring of biotic habitats is encouraged to enhance site users' understanding and appreciation of biotic habitats through stewardship.

In conclusion, I want to reiterate the call to a combined design approach for integrating habitats into urban environment: landscape + species. For the purpose of integrating habitats, landscape architects must work collaboratively with ecologists and conservation biologists to understand the habitat requirements of species, about which we may always have limited knowledge. Interdisciplinary work is a challenge but also an opportunity for us to infuse many theories and knowledge into more sustainable design solutions for the over populated and fast-paced world.

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