INTERVENTION IN SUCCESSION

A METHOD FOR APPLYING SUCCESSION THEORY IN LANDSCAPE DESIGN

WITH A FOCUS ON VEGETATION SUCCESSION IN WESTERN WASHINGTON

By

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To the Faculty of Washington State University:

The members of the Committee appointed to examine the thesis of Lindsey Anne Horton find it satisfactory and recommend that it be accepted.

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Chair

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Abstract

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Landscape architectural design is a venue for revealing the relationships among humans and those elements traditionally examined in ecological science. Landscape architecture uses ecological elements such as water, soil and vegetation as vehicles for crafting artful space for human occupation. *Intervention in Succession* describes a landscape design strategy that necessitates the use of ecological research, specifically in succession theory, and simultaneously responds to human needs and desires in a landscape design.

The objectives in *Intervention in Succession* are to provide landscape architects with a general method for articulating a combined knowledge of ecology, specifically plant succession theory, with human desires in the landscape, and subsequently apply this method to an example landscape. The general succession design method will be the

result of integrating information from the sciences, humanities and design-based fieldwork. *Intervention in succession* ultimately results in a general method for communicating the visual and textual, definition and explanation of a landscape design with vegetative succession as a substantial consideration.

Glossary of Terms

This glossary of terms should be read and referenced to understand or clarify the method and theory put forward in *Intervention in Succession*. These terms/definitions (or variations of them) exist in ecological publications or were created for this paper.

Community
A living, interacting part of the ecosystem (vegetation, humans, wildlife, etc.) (Mack, 2002).

Disturbance
Environmental forces (human force is included) that can alter or destroy a community such as fire, storms, disease, erosion (wind or water), construction, dredging, logging, mining, pollution, and cultivation (Mack, 2002).

Ecosystem
The sum total of the abiotic and biotic aspects and interactions at a location (Mack, 2002).

Intentional Anthropic Manipulations
Predetermined and thought-out landscape change/maintenance by a human. This predetermined change is carried out in order to achieve a desired landscape outcome.

Landscape Design
A landscape plan created for human use in an outdoor environment that uses plants, water, soils or hardscape elements (trellis, bench, etc.). The landscape design is usually designed by an architect, landscape architect or designer.

Mature or Climax community
A community that is apparently permanent and lasts for centuries without change (Mack, 2002).

Primary Disturbance
A disturbance that destroys all life on a landscape and essentially creates a new soil surface. Mack (2002) uses the term primary succession to describe the succession stages that follow this kind of a disturbance.

Projected Species Composition
A projected species (vegetation and wildlife) composition is a specific group of species that, at a particular maturity, stature, and/or quantity will achieve the sought after outcome of the succession design. The vegetation does not have to be the mature or climax vegetation composition for the area.

Secondary Disturbance
A disturbance that destroys only part of the life on the landscape and consequently alters the pathway of succession. Mack (2002) uses the term secondary succession to describe the succession stages that follow this kind of a disturbance.

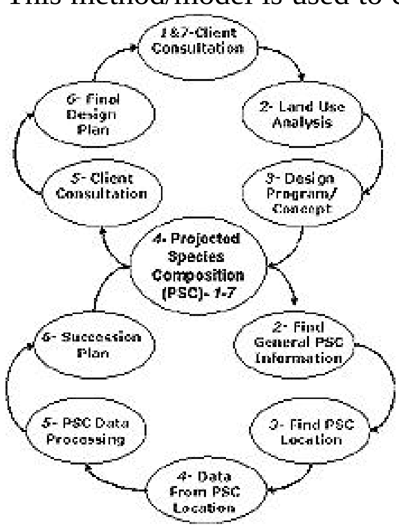
Sere
A sequence of communities or succession stages that will occupy a site over time (Mack, 2002). Seral communities are transitory.

Succession
Vegetation succession is an ordered establishment of plants following a disturbance to a landscape (Glenn-Lewin, D., Peet, R. & Veblen, T., 1992; Luken, J., 1990; Mack, R., 2002; West, D., Shugart, H. & Botkin, D., 1981).

Succession Design
A landscape plan that primarily uses a combination of native plant associations, hardscape elements (benches, trellis, etc.), water, soils, plant growth habits/functions, planned landscape maintenance, and planting phases to create an environment benefiting the ecosystem, which includes anthropic, biotic or abiotic functions and interactions. A succession design is created by a landscape architect.

Succession Design Maintenance
The intentional anthropic manipulations of abiotic or biotic forces to arrive at a succession design outcome.

Succession Design Method and Model
This method/model is used to create a succession design.



Succession Outcome
Implementation and realization of the final design phase in a succession design, which contains the planned projected species composition/s.

Succession Plan
A landscape plan that uses native plant associations, plant growth habits/functions, and planned landscape maintenance (disturbance), to create an environment benefiting the ecosystem (excluding human use). A succession plan is usually created by natural resource managers or ecologists.

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Chapter 1- Introduction

"The changes in a living person are an expression of the continuous adaptions needed to function and survive. If not, his life ends. When life ends in landscapes, they become deserts where only physical and chemical forces cause any change" (p. 27). Antrop, M. (2005).

Landscape Architecture and Ecology

Landscape architectural design is a venue for revealing the relationships among humans and those elements traditionally examined in ecological science. Landscape architects use elements such as water, soil and vegetation as vehicles for crafting artful space for human occupation. *Intervention in Succession* addresses the opportunity that landscape architects have to utilize ecological knowledge and concurrently express human desires in the landscape. The primary goals of *Intervention is Succession* are to provide a general method for expressing the combination of scientific knowledge and human landuse goals and subsequently apply this method to an example landscape. Providing a method and example for the amalgamation of scientific knowledge (ecological) and human desires will enable landscape architects to experiment with, explore, plan for, respond to and facilitate appreciation for ecological processes.

A Method for Combining Ecology and Landscape Architecture

The objectives in *Intervention in Succession* are to provide landscape architects with a general method for articulating a combined knowledge of ecology, specifically plant succession theory, with human desires in the landscape, and subsequently apply this method to an example landscape. The general method will be the result of integrating information from the sciences, humanities and design-based fieldwork. *Intervention in succession* ultimately results in a general method for communicating the visual and textual, definition and explanation of a landscape design with succession as a substantial consideration.

Vegetation is the unifying element in the method that *Intervention in Succession* is putting forward. Vegetation succession is an ordered establishment of plants following a disturbance to a landscape (Glenn-Lewin, D., Peet, R. & Veblen, T., 1992; Luken, J., 1990; Mack, R., 2002; West, D., Shugart, H. & Botkin, D., 1981). Human expression in a landscape design can involve vegetation cultivation, type or placement. Commonly, vegetation succession planning entails considering plant type, abundance and disturbance (maintenance) and similarly landscape design goals involve plant type, abundance and care (maintenance), together with plant appearance, placement and use. The similarities between succession planning and landscape design objectives create an opportunity for succession design with combined goals.

Definition of Terms

The first step in explaining a succession design method is to clarify terms that will be compared and discussed in the following chapters (See Glossary of Terms p. vi). *Intervention in Succession* will use "maintenance" instead of "disturbance" and landscape care. The definition of maintenance is significant to the proposed design method because of its essential correlations with vegetation succession planning and landscape design. Typically, landscape care and maintenance are two terms used to describe the intentional, anthropic manipulations of a landscape. On the other hand, disturbance is used in succession theory to describe the biotic, abiotic or anthropic unintentional forces that direct vegetation succession. "Maintenance" in *Intervention in Succession* is the intentional, anthropic manipulations of abiotic or biotic forces to arrive at a succession design outcome.

The terms landscape design, succession planning and succession design are contextually similar, but used in three unique ways for this paper. Each term is comparable because they include written or drawn landscape plans and future landscape goals. *Intervention in Succession* defines these terms differently because landscape plans and goals are created for diverse reasons and by professionals in various occupations. For example, a landscape design is typically a written and drawn, artistic expression of a landscape to be created for human use. Landscape designs may be created by a landscape architect, architect, landscape designer, or a property owner/gardener using vegetation, water, soils or hardscape (trellis, buildings, benches, etc.). Alternatively, a succession plan is usually a written document that focuses on altering wildlife or vegetation populations to achieve a succession outcome. A succession plan document is generally written by a natural resource manager, ecologist or an environmental consultant, rather than a landscape architect (Luken, 1990).

In *Intervention in Succession* a hybrid of a landscape design and succession plan is developed, the succession design. A succession design is a landscape plan that primarily uses a combination of native plant associations, hardscape elements (benches, trellis, etc.), water, soils, succession data (regarding native plants), plant growth habits/functions, maintenance, and time to create an environment that benefits the ecosystem, which includes anthropic, biotic or abiotic functions and interactions. A succession design is principally created by a landscape architect.

Benefits of Vegetation and Succession in Design

Landscape architects use vegetation in design for sensorial pleasures (smell, touch, taste, visual or listening), ambiance or mood, or as an environmental control, meaning its ability to reduce noise, screen unwanted views, attract/detract wildlife, filter pollutants and ameliorate microclimate. Microclimate is important for landscape design because an environment that is too cold, hot or windy will create a negative experience for the client/s. Vegetation can change the microclimate by blocking wind and cold temperatures as well as creating shade and decreasing temperatures in warm weather.

Microclimate is important for human comfort in landscape design, but there are additional factors of climate change that should be considered. For instance, vegetation will also alter the climate for the establishment, growth and survival of surrounding plants (Glenn-Lewin, D., Peet, R., & Veblen, T., 1992; Larcher, 2003; Luken, 1990; Spirn, 1984). A simple example is when a sunny, warm location initially planted with small trees becomes a shady, cool environment as the trees grow in width and height. As the original trees grow and establish shade, the planted vegetation that thrives in a sunny environment will not survive. The lack of sunlight and warm temperatures leads to the loss of the sun loving plants. Subsequently, the change in environment could result in a costly removal of intolerant plants followed by the replanting of appropriate vegetation for the surrounding environmental conditions (shade tolerant vegetation). This specific example is simple because plants modify much more than temperature and light availability in a landscape. Vegetation impacts air, soil and water temperatures as well as soil water or mineral abundance and availability (Larcher, 2003).

For a landscape architect or client, the removal of an initial planting (i.e. sun tolerant plants) and reinstallation of appropriate plants (i.e. shade tolerant plants) for specific physical environments are costly and time consuming (Roth and Associates, 1999). Additionally, the maintenance (includes irrigation, fertilizer, pesticide, herbicides and labor costs) required to keep plants healthy when they are not adapted to survive within a site soil or climate can be expensive and extensive (Henderson, Perkins & Nelischer, 1998; Robbins & Sharp, 2003; Roth and Associates, 1999; Spirn, 1984). For instance, lawn is used throughout the United States even though lawn varieties are not suitable for numerous locations (Jenkins, 1994). The installation of lawn in inappropriate environments leads many homeowners to spend large amounts of money to keep lawns alive, green and soft to the touch (Jenkins, 1994; Robbins & Sharp, 2003). Robbins and Sharp (2003) state, "In 1999, Americans spent $8.9 billion on lawn-care inputs and equipment. In the same year, 49.2 million households purchased lawn and garden fertilizers, and 37. 4 million households purchased insect controls and chemicals (p. 427)."

These maintenance and installation costs can be reduced if environmentally suitable or appropriate plants are increased in the landscape. Many scholars and practitioners consider suitable or appropriate plants to consist of native plants because they have adapted to survive and grow in their regional climates and soils (Jenkins, 1994; Henderson et al., 1998; Roth and Associates, 1999; Spirn, 1984). According to Roth and Associates (1999), when a landscape is planted with native plants the client can save 48% of installation costs and up to 82% of subsequent maintenance costs.

In order to save maintenance costs, native plants must be planted in their correct environmental conditions. Correct environmental conditions include the range of precipitation, temperature, light or soil requirements that facilitate plant growth and reproduction. For example, native plants of southern California do not survive in all of the microclimates in the southern half of that State. Native plants will require different microclimates with fluctuating temperatures and quantities of shade, sun, precipitation, soil water availability and soil nutrients. Native plants, by themselves, are just one aspect of improving vegetation survival, but native vegetation planted in its correct environmental conditions is the fundamental way to reduce plant removal and landscape maintenance costs.

Designing a landscape with succession as a primary design component, is the complete way to plan for environmental conditions that enable plant survival and growth and therefore minimize installation and maintenance costs (Baschak & Brown, 1995). Succession planning includes the use of native plants and components of environmental change. Over time, plant succession alters the landscape environment (which includes microclimate, soil minerals or water availability) and these environmental amendments will improve the conditions for specific plants. The combination of time, suitable vegetation, site location and environmental conditions will improve the plant growth and survival rates and simultaneously decrease maintenance and installation costs for the client or designer.

Succession planning for a landscape architect includes five important aspects, which will be explained in detail throughout chapters of *Intervention in Succession*. The succession landscape design aspects include:

- **Native Plants**- A succession design consists primarily of native plants because they are adapted to and prone to survive in their local climates and soils.
- **Research**- Scientific data pertaining to the optimum environmental conditions for the growth and establishment of the landscape plants.

- **Planting Phases**- A succession design has multiple planting phases that correspond with the growth rates of the vegetation. Each phase changes the environment (microclimate, soil minerals or water availability) to assist the establishment of the proceeding planting phases.
- **Succession Goal**- A succession design should have a final vegetation composition and abundance goal (projected species composition). The final projected species composition can include any sere (succession stage) and does not have to be the presumed mature or climax vegetation composition for the region.
- **Maintenance**- Again, the definition of maintenance in *Intervention in Succession* is the intentional anthropic manipulations of abiotic or biotic forces to arrive at a vegetation succession outcome. The maintenance of vegetation in a succession design may contain various and repetitive types of disturbance in the landscape.

Using succession in a landscape design necessitates the integration of native plants, research, planting phases, succession goals, and maintenance into design processes and products. The following chapters describe these aspects in the context of theory, application, background, integration (science and human expression) and examples. The culmination of this information results in a methodology for landscape architects to utilize when designing with the science of succession and human expression in landscape architecture.

Chapter 2- Theory of Succession

Allogenic VS Autogenic Succession

The theory of succession has been divided into allogenic and autogenic succession by some ecologists (Glenn-Lewin et al., 1992; Shugart, 1984; West, D., 1981). According to Glenn-Lewin et al. (1992) "Allogenic succession is vegetation change due to environmental conditions and environmental change (external forces)" and "autogenic succession is vegetation change due to forces of biotic interactions and biotic modification of the environment (Tansley, 1935)" (p. 15). The design methodology presented in *Intervention in Succession* integrates the allogenic and autogenic theories and distills them; succession directed by vegetation type/growth and site disturbance (biotic, anthropic or abiotic). Vegetation and disturbance are two aspects of succession that can be controlled in a succession design. A landscape architect has control over the types of planted vegetation, biotic disturbance (animal attraction/detraction, etc.), anthropic disturbance (plant propagation or removal, herbicides, construction, etc.) or abiotic disturbance (sun/shade, hydrology, etc.). Chapter 2 details how a landscape architect can control succession in a landscape design with vegetation type, growth and disturbance.

Vegetation Succession Theory

Succession is the sequential order of plant establishment following a disturbance to an area (Glenn-Lewin, D., Peet, R. & Veblen, T., 1992; Luken, J., 1990; Mack, R., 2002; West, D., Shugart, H. & Botkin, D., 1981). The sequential order of processes that establishes plant succession was first published by Clements in the early 1900s (Glenn-Lewin, D., et al., 1990). He believed in a six step process that would predict the cycle of plant establishment (Glenn-Lewin, D., et al., 1990). The six steps are: "(1) nudation, which is the creation of bare area or partially bare area by the disturbance which initiates succession, (2) migration, arrival of organisms at the open site, (3) ecesis, the establishment of organisms at the site, (4) competition, the interaction of organisms at the site, (5) reaction, the modification of the site by the organisms thereby changing the relative abilities of species to establish and survive, (6) stabilization, the development of a stable climax" (Glenn-Lewin, D., et al., 1990, p. 3). Clement's six step process has been the subject of much scientific debate because the simple framework cannot explain the various ecosystem outcomes, at any given time, that are driven by abiotic and biotic factors. Step 6 (stabilization) of Clement's framework is the most scientifically debated because ecologists believe that an ecosystem will never become a stable community due to the constant dynamism in "nature" (Connell & Slatyer, 1977; Glenn-Lewin, D., et al., 1990; West, D. et al., 1981).

Since Clement's six step succession process was put forward in the early 1900's, the theory of plant succession has been significantly developed and has become increasingly complex. There are a variety of succession models, such as facilitation, tolerance or inhibition that may predict an outcome for any given plant community (Glenn-Lewin, D., et al., 1990; Mack, R., 2002; West, D. et al., 1981). These models are based on plant communities' ability to facilitate, tolerate or inhibit the establishment of subsequent communities. For example, in a facilitation model, nitrogen fixing plants can amend the soil so that higher nitrogen levels are available to vegetation that would not survive with low soil nitrogen. Therefore, the nitrogen fixer is facilitating the establishment of vegetative species that require higher nitrogen levels in the soil.

To simplify the intricacy of vegetation succession models, *Intervention in Succession* uses the framework of succession that West, D. et al. (1981) suggests, “Succession as the differential expression of life histories” (p. 34). Succession in terms of species life history, according to West, D. et al. (1981), is a comparison of the life history patterns of vegetative species that are or have been in association with each other for any period of time. This expression of succession can be applied by landscape architects when using scientific data for a succession design. For instance, a landscape architect could use the previous facilitation example (nitrogen fixer) in a species life history model to arrive at a different succession outcome. An example would be that the nitrogen fixer facilitates the establishment of species that need high levels of soil nitrogen and the nitrogen-loving species grow quickly (in height and width) and establish a shady environment beneath them which inhibits the growth of a light loving species. When one designs succession with species life histories you are able to use the growth habits, species interaction, species life span, seed establishment or resource requirements to create various succession outcomes.

The flexibility associated with the species life history theory is important when trying to design succession for a landscape. A designer or client may have a large, small, or diverse landscape with a complicated succession design that involves several succession stages (seres) or unique plant associations. To achieve the succession outcome the designer may need to implement plant associations not currently found in the native landscape. The current definition of life history succession does not include non-natives, but the definition of plant species life history could be altered to include flexibility in plant choices for the design process. Species life history theory (including some nonnative plants) can create important options for a landscape designer when she is planning for the multiple and diverse aspects of design, including the client, environment, microclimate, ecological process, nursery stock availability, utilities, local, state and federal laws and home owner's association codes.

Disturbance

Life history, facilitation, tolerance and inhibition succession models are based specifically on living plants interactions, reactions and adaptions to other plants. Therefore, these models focus on vegetation and its ability to alter succession outcomes. Alternatively, environmental aspects that are not related to living plants can change the path of succession as well. For instance, the initial disturbance or nudation that stimulates succession is created by various anthropic, biotic or abiotic types of disturbance that are not related to living vegetation interactions. Types of disturbance that can initiate plant succession are: fire, wind storm, climate change, landslides, mining, flood, soil movement, construction and resource development. Each disturbance has a unique affect on the environment, whether it changes the soil chemistry, physical soil characteristics, hydrology, temperature, mineral accessibility, seed or light availability. Consequently, initial disturbances change environmental conditions that in turn effect what vegetation can originally populate, grow and reproduce in the disturbed area.

Traditionally, the primary disturbance (*Clement's nudation) is considered the major succession catalyst because it modifies the site (soil, microclimate, hydrology, etc.) which directly corresponds with vegetation establishment and growth. Often, smaller secondary disturbances are overlooked as factors in succession progression (Luken, 1990;

*Clement's nudation theory is the creation of bare area or partially bare area by the disturbance which initiates succession.

Shugart, 1984). Examples of small disturbances may include trees falling from wind damage or disease, herbivory, mowing, pruning or application of certain herbicides. These disturbances would cause a shift in resource allocation, plant reproduction or population without eradicating all the vegetation on site. Smaller disturbances are significant in succession because of the potential to alter resource allocation and plant community development.

Land resource managers frequently focus succession planning on the primary disturbance and seedling establishment, but neglect management of secondary disturbance in the later succession stages (Luken, 1990). Planning for succession, specifically a preferred and accelerated succession objective, must consider the primary and secondary disturbances (Shugart, 1984). Together, primary and secondary disturbances can be used as landscape management tools to understand and create current and prospective biotic and physical characteristics of a site environment. For instance, consider a primary anthropic disturbance on a site with soil removal for building construction. Initiating plant growth on the site would begin with soil modifications and, if required, the addition of top soil or mulch. Additionally, herbaceous species such as grasses or legumes could be utilized on the site to fix nitrogen or control soil erosion. The secondary disturbance occurs at a later time by the removal of herb species either mechanically or with herbicides, etc. The removal of these herbs allocates more resources (light, nutrients, water) for the next seral species establishment (shrubs or trees).

Overall, secondary disturbances are an import tool for succession management because they can be administered in a landscape with or without a planned initial disturbance. A secondary disturbance can be applied to a landscape to alter its current vegetation growth at any time and can control unwanted vegetative species while facilitating and accelerating the growth of others. For example, fire (prescribed burn or a cool fire) is a disturbance that is frequently used to control and kill some vegetative species while initiating colonization and growth in others (Luken, 1990). Also, grazing, clipping, cutting, mowing, mulch, landscape fabric and herbicides are applied in the landscape to control some species growth while encouraging propagation or expansion in others. Luken (1990) gives examples of ecologists or landscape resource mangers using the previously mentioned small disturbances to change seed availability, attract animals, detract animals and alter water, mineral or light availability. Each secondary disturbance is utilized to achieve specific succession outcomes.

Patch Size and Landscape Scale

The theory of succession typically involves regional vegetation abundance and composition over large areas (Glenn-Lewin et al., 1992; Shugart, 1984). Characterizing succession in regions is a response to the often distinct vegetation types and growth patterns within the regional climate and soils. Vegetation growth in a region responds to the average and extreme, moisture and temperature throughout the seasons. Also, the regional processes that form and manipulate the soil are important in vegetation reproduction, survival and growth. For instance, Franklin and Dyrness (1988) categorize fifteen vegetation succession zones* in Washington and Oregon State. Each succession zone has distinct vegetation, climate and/ or soil types. An example zone is the *Tsuga heterophylla* (Western hemlock) succession zone in western Washington State (Franklin

*Franklin & Dyrness (1988), "a (succession) zone is most usefully defined as the area in which one plant association is the climatic climax" (p. 46).

& Dyrness, 1988). The seral stages in this succession zone are often dominated by *Pseudotsuga menziesii* (Douglas-fir). Douglas-fir is a tree that grows well and dominates the region in the lower to middle elevations, maritime climate and mostly acidic/ deep soils of western Washington (Franklin & Dyrness, 1988).

Small areas within a region are frequently considered insignificant in the larger regional vegetation succession (Glenn-Lewin et al., 1992; Shugart, 1984). Minor landscape succession sequences are considered fluctuations in succession that do not significantly affect the greater landscape vegetation abundance (Glenn-Lewin et al., 1992). These fluctuations are considered "gap" or "patch" succession sequences and can be compared to any small landscape. An example of gap or patch succession occurs with the death or damage of trees within a forest canopy. The death of these trees opens up resources (light and nutrients) for the regeneration of a succession sequence, but the gap does not drastically contribute to the regional abundance of vegetation types (Glenn-Lewin et al., 1992; Shugart, 1984).

Small landscapes, although insignificant in a regional vegetation context, are important in succession management. Application of succession management principles often occur at small sites such as right-of-ways, agricultural fields, nature reserves (size dependant), reclaimed mines, forested areas, parks or yards (Luken, 1990). Information from the regional environment can be used in planning succession at smaller sites, but the unique environmental aspects of the local site must be considered. The site specific acreage, surrounding land uses, soil types, microclimate, existing vegetation, elevation and aspect should be used in combination with the regional succession data/ theories (Baschak, L. & Brown, R., 1995). Synthesizing the regional and site specific information helps form a thorough succession management plan that articulates site-specific landscape goals. For example, forested areas have two distinct habitats, interior and edge. Interior habitat supports vegetation that typically requires shade and animals that need dense shelter. Researchers, like Luken (1990), have found that forested areas less than 2.3 hectares will not produce interior habitat and Franklin et al. (1981) suggest over 120 hectares for species such as the northern spotted owl. Therefore, the creation of interior forest habitat is not an appropriate succession goal for landscapes smaller than at least 2.3 hectares.

Conclusions

Chapter 2 has focused on simplifying and integrating the theories of succession for a planned landscape design. The theories have included scientifically based components of succession stages, regional vegetation characteristics, vegetation growth habits, primary and secondary disturbances and landscape size. Succession planning for a landscape architect will include these scientifically based succession components as well as the aesthetic aspects of a landscape design for human occupation. The methodology for combining the aesthetic and scientific components of a landscape architect's succession design will be introduced and discussed in Chapter 3.

Chapter 3- Planning for Succession in a Landscape Design

The Goals of Succession Planning

The idea of a succession outcome was introduced and briefly discussed in Chapter 1. Overall, a succession outcome comprises a final vegetation composition for the landscape. The final vegetation composition can include any sere (succession stage) and does not have to be the presumed mature or climax vegetation composition for the region.

A succession outcome (goal) for a landscape design is a confusing concept considering that vegetation succession is dynamic and constantly responding to and shifting with the surrounding biotic or abiotic environment. Therefore, once a succession goal is reached the vegetation will continue to change with the environment and consequently adjust in composition and/or abundance. In this way, vegetation succession is pendulous, fluctuating in an endless pattern and it therefore becomes hard to justify the linear process of setting tasks to reach an ultimate succession goal or projected species composition (PSC). A projected vegetation composition is a specific group of plants that, at a particular maturity and stature, will achieve the sought after outcome of the succession design.

There are several reasons why it is necessary to set projected species composition goals in a succession design. One reason relates to the fact that landscape architects can set a succession goal to be reached in an approximate amount of time. Time is critical when planning for succession because plants take time to grow and the environment takes time to change. A landscape succession goal can be reached in a short amount of time, two to three years, ten to twenty years, or a succession goal may span hundreds of years.

For a landscape design, the landscape architect will have to choose the appropriate time scale for the design, vegetation, and consider client preference and the landscape size.

Often, when a landscape architect considers time in landscape design process, the design becomes an instant, static piece of art or the design will be considered complete within the client's/designer's life span. Rarely does a landscape design culturally, scientifically, and most of all, purposefully span human generations. This lack of temporal planning is likely because the cultural and scientific needs of future generations are unknown at the time of the design process and speculation about those needs may seem pointless (Antrop, M., 2005). Contrary to that way of thinking, a succession design plan will be a positive guide for a "natural" and cultural expression, historic preservation, future landuse and habitat maturity on a specific site or that which surrounds it. Cook, R. (ed. Conan, 2000) elaborates;

> "Landscape architects may not need to worry about the march of time: clients care a lot about how things look, especially while they are paying the fee; they deal with the effects of time later – long after the designer has cashed the check. But this view may be too cynical. A positive alternative sees ecology's new paradigm suggesting a renewed acknowledgment of temporality in landscape design. Such a temporality is one critical element of Mozingo's call for a new aesthetic: "Landscape aesthetics prizes a static vision imposed upon the land…Conventional design sees landscape change not as a vital, imaginative force but as a frightening or disappointing one…The acceptance of change, of moving beyond the fixed vision of the landscape, is ecologically necessary." (p. 130).

Intervention in Succession will ultimately encourage landscape architects to plan succession goals with intended time durations for goal attainment in the landscape.

A succession goal over several generations will need to specifically explain how to reach the goal and the purpose behind the long succession plan. For example, many types of trees that grow without major disturbances will outlive a human. A Douglas-fir (Pseudotsuga mensiezii) can live 1000+ years and it takes approximately 250 years for a Douglas-fir stand to be considered old growth habitat (Franklin & Dyrness, 1988; West, et al., 1981). If the goal of the succession design plan is creating a design that will eventually have an old growth Douglas-fir forest habitat, the landscape architect will have to consider the time it will take to achieve that succession goal and how the design can be implemented and maintained over an estimated two-hundred and fifty year time period.

Two-hundred and fifty years may seem like a long time for a landscape architect's design plan to be maintained and implemented, but comparably the US Forest Service as begun to calculate and consider these vast time periods for policies regarding timber harvest and habitat preservation (Garmon, S., Cissel, J. & Mayo, J. 2003). It is understood that the US forest service has national guidelines that will help maintain and realize their forestry ideas over long time periods, but it is feasible that a landscape architect or clients personal design plan will be projected over the same time frame without laws to compel the design completion. For instance, Bloedel Reserve located on Bainbridge Island, Washington began as a private residence whose owner projected a long term personal vision of a natural aesthetic and landscape care (www.bloedelreserve.org, 2005). Mr. Bloedel's vision, design, artistic implementation and maintenance of this one hundred and fifty acre property were actuated within his lifetime (www.bloedelreserve.org, 2005). He then planned the Bloedel Reserve native beauty, design implementation, financial care and long term maintenance into the future after he passed away (www.bloedelreserve.org, 2005). Ecological succession in scientific terms, is not a specifically planned objective within Bloedel Reserve, but could be easily applied into a naturalistic vision such as the one Mr. Bloedel sought to achieve (www.bloedelreserve.org, 2005).

There are other landscape designs in contemporary landscape architecture that address a long-term ecological and cultural goal*. James Corner, the founder of a design firm called Field Operations, is one landscape architect who is creating innovative designs that address long-term ecological and cultural goals. For instance, Field Operations submitted a park design for the Downsview Park design competition in Toronto, Ontario, Canada and created the park design for Fresh Kills Park, Staten Island, New York, USA (Field Operations, 2005). These designs include ecological and cultural evolution over time and include growth and change as integral design components (Czerniak, J.; Field Operations, 2005). Habitat enhancement, hydrology, vegetation, pedestrian and vehicular circulation, site history, human land use are some of the long-term design considerations.

Combining Vegetation Succession with Human Expression

A landscape architect might want to set a succession goal, whether designing for small private or large public landscapes or short or long time periods, because it can be combined with the landuse and artistic intent of a landscape design. The succession method with projected goals can be applied to a landscape architect's work as long as the human landuses and cultural/ artistic interpretations of the landscape are not

*There are a number of projects that involve ecological and cultural changes over time and one of them is Amsterdam Bos (Berrizbeita (ed. Corner, 1999)). Additional landscape practitioners associated with planning and discussing ecological and cultural changes over time are: Andropogon Associates, Ian Mcharg, and Robert Cook, just to name a few (Cook (ed. Conan, 2000); Sauer, 1998).

excluded. This means that the fundamentals of planning for succession, like vegetation species life history, physical environment, time and change include human history, aesthetic preferences (of the client) and landscape design components. Design components could include distinct design shapes (radial, rectilinear, curvilinear, etc.), color selection, varying vegetation densities, visual variety, focal points and landscape icons (a landscape icon is any unanimously loved aspect of a landscape which could include a view, pond, building, hedge, or rock formation) (Gobster, P., 2001; Mozingo, L., 1997; Smardon, R., 1988; Ulrich, R., 1986). For any landscape architect, achieving the design goals of plant succession and human expression necessitates addressing both components without diminishing the importance of either.

Succession Design Products

To illustrate a succession design there must be a visual connection in the representation of a succession plan and a landscape design. The illustration of a succession design combines vegetation management in a succession plan and the visual representation of vegetation growth, placement and composition in a landscape design. A landscape design usually involves planting plans or drawings where the vegetation appearance is a significant part of the whole design, and succession planning includes written documents on vegetation management that do not concentrate on landscape expression or ambiance. The visual, conceptual, and material link between succession planning and design is vegetation. The link suggests that the projected vegetation composition can be visually illustrated in a landscape planting plan or drawing and concurrently be incorporated with a written vegetation succession management. Planting plans or planting phases, drawings, and written information about specific vegetation management tactics represent the necessary products in a succession design.

Planting plans are comparable to planting phases in the definition of a succession design. Planting phases consist of a series of planting plans that a landscape architect would present a client or a landscape contractor. The most important difference between a landscape design planting plan and succession design planting phase is that a plan is often the final vegetation composition and a phase is an interim plant composition toward a succession design goal. Planting phases are applied over time, in a succession design, to reach a projected vegetation composition.

In general, a planting phase contains a map of a site design with the planting year, plant names (scientific and common) and plant locations. Additionally, planting phases may have more written or illustrated details about other vegetative and soil secondary disturbances like prescribed burn, soil modifications or selective removal of vegetation. A site map, plant names and plant locations are synonymous with typical landscape design planting plans but planting years are not. A planting year is a distinct year that delineates vegetation in that particular planting phase. For each planting year, an aspect of the design strategy is applied. The intention of implementing the planting phases over the indicated time is to realize the succession design goals (which include a projected vegetation composition at a certain maturity and stature) with maximum design benefits and minimal effort, initial installation costs and maintenance costs.

Succession Research

The knowledge about planting phases, planned disturbances, and scientific data, necessary to implement succession designs, can be organized through three research steps. The first step is to establish a projected species composition by reviewing the site environment: soils, hydrology, climate and regional native vegetation compositions. From reviewing this information one could find historic vegetation compositions that may have existed on the design site. A historic vegetation composition may be a "starting point" for research concerning a proposed projected vegetation composition (PSC) for the succession design. Completion of step one involves finding written research for site analysis, proposed projected species composition (PSC), possible succession stages (of PSC) or individual plant growth habits/characteristics (of PSC).

The second step is to review and to answer the nine questions below. The research necessary to answer these questions will provide a foundation for a succession plan and design. The inability to answer these questions with specificity, even with abundant research, is not an indicator that a succession plan cannot be conceived. A succession plan can be formulated by using the best available scientific information, observations (about the PSC) and innovative planning.

1. What is/are the proposed projected species compositions (PSC) of the landscape site design? (established using step one, site environment and native plant history of the region)
2. What are the past and projected anthropic land uses for this site?
3. Where are existing projected species population locations near the site?
4. What projected species composition data can you receive from that existing PSC location? And, what written information can be found about the general PSC plants, growth habits and resource/environmental requirements?

5. Is the projected species composition data from question 4 comparable to the goals and environment of the design site?
6. How will the projected species data be applied to planting phases; specifically in the plant growth habits, maturity, rate of growth and appearance?
7. How will PSC data and design principles be integrated into a landscape succession design product? In other words, how will the product communicate the aesthetic within each planting phase and simultaneously the sensitivity given to the ecosystem throughout the entire design?
8. What disturbances do you need to incorporate into the planting phases in order to accelerate or maintain the succession progression in the design?
9. What are the succession goals, design vision, intended design duration (in order to reach succession goals) and planting schedule?

The third organizational research step corresponds with question three (listed above). Step three is to find and possibly visit one existing location, preferably government owned, with similar vegetation as the projected vegetation composition for the succession design. The location will likely be in proximity to the design site and if the land is owned and maintained by the government there is likely to be historic records or research associated with the location. The purpose of the third step is to have a tangible, emotional and/or written connection to the actual projected vegetation composition in the succession design. A tangible or emotional connection with an actual environment can help a landscape architect visualize future planting phases and sketches for the projected design goal. For all three research steps, it is important to understand that succession will consist of different time durations, plants and plans depending on regional location, the succession goal, human landuse, and design components. The information collected in these steps is distilled for application in the succession design method put forth in *Intervention in Succession*.

Succession Design Method and Model

The creation of a succession design method originated from a succession management model produced by Luken (1990). Luken (1990) used ideas from ecologists to create a general succession method "in an attempt to build a succession management model applicable in a wide range of resource management situations" (p. 10). The succession management model has three primary components: 1) designed disturbance, 2) controlled colonization and 3) controlled species performance.

Figure 1- Succession Management Model, Figure 1.2 in Luken (1990) *Directing Ecological Succession*

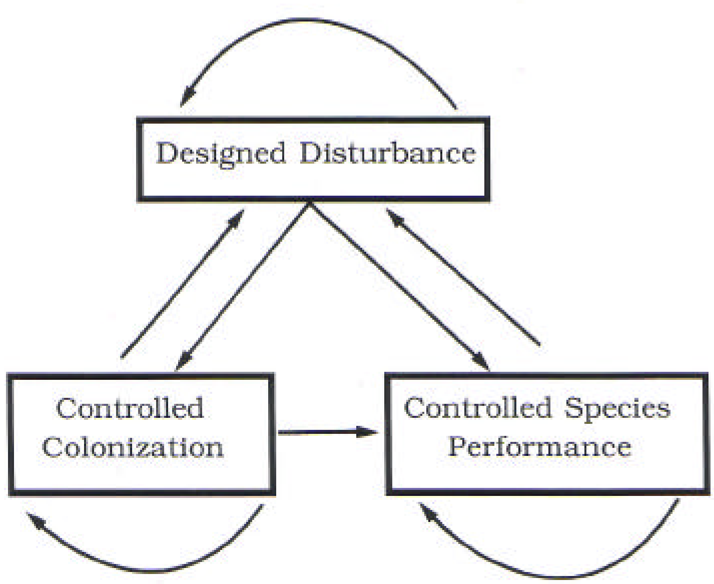


Figure 1.2 Three components of a succession management model. Straight lines indicate sequential steps; curved lines indicate repeated steps. Modified from Rosenberg and Freedman (1984).

1. **Designed Disturbance (Luken, 1990)**. Luken (1990) states that "designed disturbance is derived from the observation that disturbance of some sort usually initiates successional pathways (Clement's nudation theory)" (p. 12). Also, this term includes any disturbance that initiates or alters succession pathways and outcomes.

2. **Controlled Colonization (Luken, 1990)**. Controlled colonization includes methods for changing the vegetation species composition or abundance like seedling establishment, direct planting, and soil modifications.

3. **Controlled Species Performance (Luken, 1990)**. Controlled species performance includes, "processes or conditions giving rise to differential species performance including physiological characteristics of the species, the life histories of the species, intra- and interspecific competition, allelopathy, herbivory, predation and pathogens" (p. 15).

Designed disturbance, controlled colonization and controlled species performance relate directly to procedures used in the succession design method. Designed disturbance is analogous to designing the primary and secondary disturbances discussed in Chapter 2. It was stated that primary disturbance is important in the initial planning for a succession design since the primary disturbance can determine succession pathways and outcomes. Primary disturbances can range from intense fires to soil removal. Secondary disturbances occur after the establishment of vegetation on a site and these disturbances include prescribed burns, seasonal floods, herbicides, fertilizers, mulch, grazing, direct plant removal or addition, etc.

Instructions for controlled colonization occur in the planting phases of a succession design. Planting phases contain information about primary or secondary disturbances (maintenance) that encourage or inhibit plant colonization. The phases contain instructions for direct planting additions, seeding or secondary disturbances that involve direct plant removal, adding landscape fabric or herbicides. Adding landscape fabric and applying herbicides are examples of primary or secondary disturbances intended to stop the colonization and establishment of selected vegetation. Planting phases play a key role in instructing the client about helping or inhibiting plant colonization for a succession design.

Controlled species performances are maintained by the secondary disturbances that encourage or discourage selected vegetation growth. Controlled species performances are directly related to designed disturbance and controlled colonization (Figure 1). The three elements are related because a designed disturbance (i.e. mowing) will control species performance and controlling colonization (i.e. herbicide application) will affect species performance as well. Secondary disturbances occur after the vegetation is established on a site and these disturbances can be related to various anthropic, biotic or abiotic environmental aspects. These disturbances include plant species life history traits (plant selection for traits i.e. allelopathy, intra- and interspecific competition, etc.), mulch, prescribed burn, fertilizer, pruning, and grazing. Controlled species performances or secondary disturbances are explained in the planting phases of a succession design.

Designed disturbance, controlled colonization and controlled species performance explain the intentions of succession planning for/by natural resource managers, but these concepts are not created by Luken (1990) for a succession design. The concepts developed out of scientific inquiry/theory and were not conceived for implementation into a landscape design that celebrates human expression and/or engenders ecological appreciation. *Intervention in Succession* attempts to integrate the ideas of designed disturbance, controlled colonization and controlled species performance into a succession design method using core succession considerations.

Core succession considerations include all of the previously discussed information about vegetation succession and integrate the planning of human experiences with vegetation appearance (color, form, texture and composition), vegetation performance (growth and health), and human/wildlife interaction (habitat enhancement). Core succession considerations have already been addressed in this paper and they are: 1) succession goals (PSC), 2) primary disturbance, 3) planting phases (specifically plant selection) and 4) secondary disturbances. The definitions for these terms in *Intervention in Succession* relate to Luken's (1990) model in vegetation growth and species population dynamics, yet they are intended to facilitate human interaction in landscape planning, management, use, education, enjoyment and/or appreciation. The four core succession considerations create the foundation for the succession design method and model in *Intervention in Succession*.

The next step in creating a succession design method, for the general use of a landscape architect, is to provide a model combining succession research methods, core succession considerations (1. succession goals (PSC), 2. primary disturbance, 3. planting phases (specifically plant selection) and 4. secondary disturbances) and landscape architectural design processes. Generality is necessary for the simplification and synthesis of these succession method elements. The following eight steps pertain to general succession research organization and data analysis/application for the core considerations of a succession design. These steps do not include design process components, but the information from steps 1-8 are joined with a landscape design process in the final model.

- Step 1- Projected Species Composition (PSC) (Establish projected species composition/s for the plan. There may be more than one projected species for the site depending on site design, specific soils and property size),

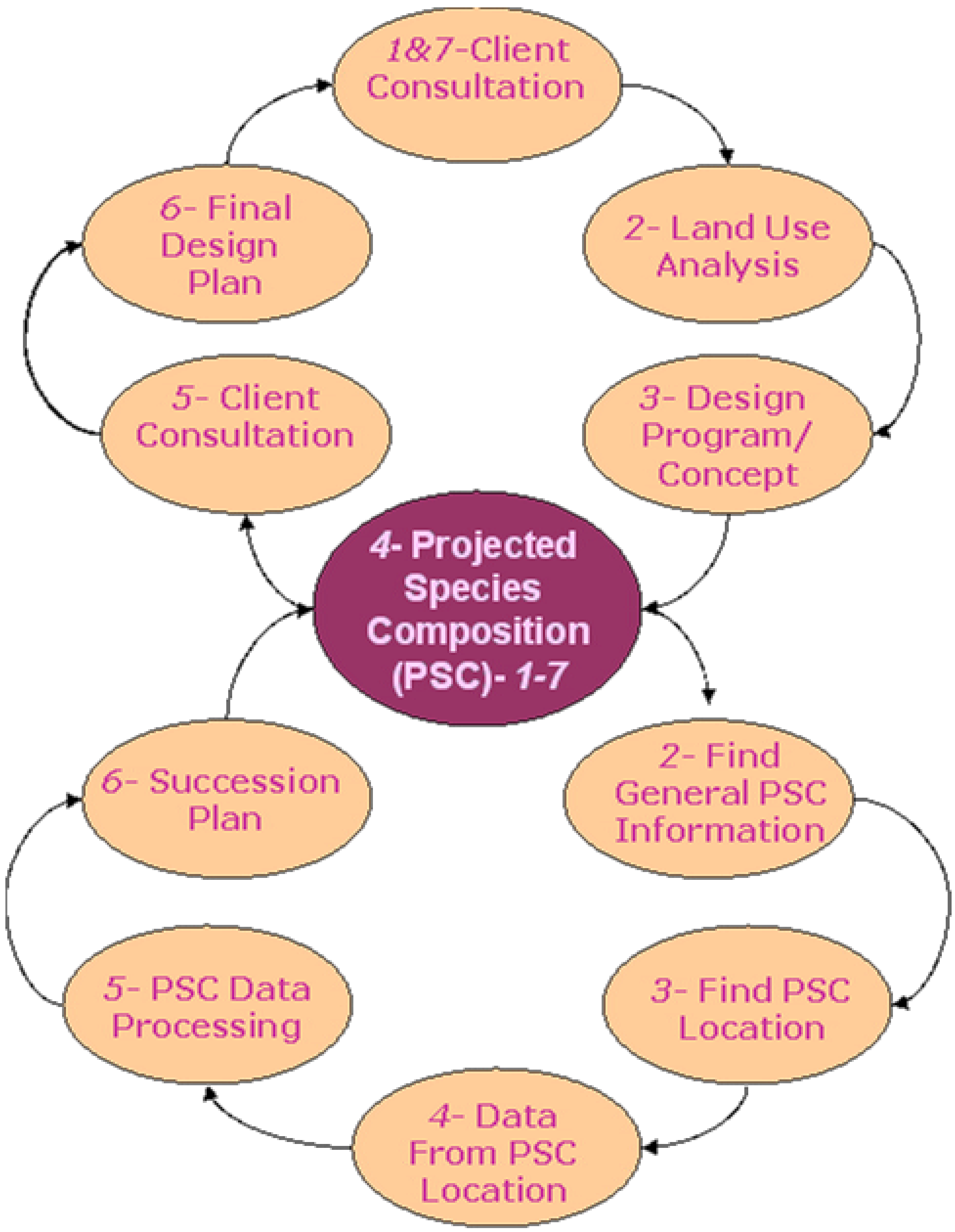
- Step 2 General PSC information (Find general information about the projected species information which includes information on growth habits and associated species),
- Step 3- Find PSC location (Find a projected species composition that exists at some other similar location),
- Step 4- Data from PSC location (Find scientific or succession data relating to that existing projected species composition. The data can be used for succession planning or for the landscape design itself),
- Step 5- PSC data processing (Synthesize all PSC information and examine the PSC relationship with the primary disturbance/s on the design site. In other words, how will the primary disturbances on the site effect the growth, establishment and reproduction of the PSC. Plus, create a list of secondary disturbances (continued maintenance) to be considered in the succession plan),
- Step 6-Succession plan (Use the synthesis from step 5 to create succession plan with planting phases),
- Step 7-Project species composition (implement succession plan),

- Step 8-Repeat (Repeat the data gathering as more PSC information becomes available. Succession plan can be changed).

Figure 2 (pg. 15) is a diagram connecting the previous eight succession steps with the following eight steps depicting a landscape design process. *Intervention in Succession* recognizes that the landscape design process can be unique for any individual landscape architect and this particular eight step landscape design process is just one way to organize the aspects involved with design. Ultimately, for a landscape succession plan, the design process can be organized any way as long as it revolves around the projected species composition.

- Step 1- Client consultation (meet with client to discuss landscape design goals),
- Step 2- Land use analysis (research past land use and plant species composition and ask about future land use),
- Step 3- Design program and concept (apply information about land use and design techniques to satisfy client's desires),
- Step 4- Projected Species Composition (PSC) (Establish projected species composition to apply to the landscape design),
- Step 5- Client consultation (discuss PSC and design program/concepts),
- Step 6- Final design plan (There may be revisions between steps 5 and 6, but eventually a final design plan will be established),
- Step 7- Client consultation (Present final plan for approval and start constructing the design),
- Step 8- Repeat (Only if necessary).

Figure 2-



Bottom Succession Plan Cycle, Step 1- Projected species composition (PSC) (Establish the projected species composition for the plan), 2- Find PSC location (Find a projected species composition that exists at some other similar location), 3- Data from PSC location (Find data from the existing projected species composition), 4- General applicable PSC information (Find any other general information about the projected species information which includes information on associated species), 5- PSC data processing (Synthesize all PSC information including disturbances), 6-Succession plan (Use the synthesis from step 5 to create succession plan), 7-Project species composition (Start succession plan), 8-Repeat (Repeat the data gathering as more PSC information becomes available. Succession plan can be changed). Top Landscape Design Cycle, Step 1- Client consultation (meet with client to discuss landscape design goals), 2- Land use analysis (research past land use and plant species composition and ask about future land use), 3- Design program and concept (apply information about land use and design techniques to satisfy clients needs/ wants), 4- Projected Species Composition (PSC) (Establish projected species composition to apply to the landscape design), 5- Client consultation (discuss PSC and design program/ concepts), 6- Final design plan (There may be revisions between steps 5 and 6, but eventually a final design plan will be established), 7- Client consultation (Present final plan for approval and start constructing the design), 8- Repeat (Only if necessary).

Conclusions

The method put forth in Chapter 3 integrates landscape planning, scientific information and design process. The outcome of this design method varies because of the numerous personal or scientific inputs related to the landscape architect, client, plant types and the biotic or abiotic environmental site characteristics. The purpose of Chapter 3 was not to predict an outcome for a succession design plan but to provide a structure for the synthesis of scientific succession data with landscape design. Chapter 4 will introduce an example of a design plan using the methodology from Chapter 3, current succession data, and land use. This specific example will utilize and visually illustrate the landscape succession design information discussed in the previous chapters.

Chapter 4- Project Example and Design Methods

<u>*Example Succession Design Prelude*</u>

I created, wrote, and illustrated the example succession design. I worked with two clients, Marc and Vicki from Olympia, WA, USA. They live on a twenty acre farm just north of downtown Olympia and if you are familiar with the area they live south of Boston Harbor and north of Priest Point Park. Marc and Vicki have lived on this property for almost 30 years and they have raised three children who are now living in other areas of the northwest. Marc is an environmental consultant and Vicki is an eighth grade science and math teacher.

The 20 acre farm has been used for horses and hay cultivation, but it is currently not used for either. Marc and Vicki are in the process of creating a native plant nursery and business on their twenty acre homestead. They would like to slowly turn the agriculturally oriented landscape into a native plant demonstration area with plant storage space, pedestrian and vehicular circulation areas and a private, residential area, separate from the business. I am going to help them with this landscape transformation by using succession design. Succession design is appropriate and beneficial for Marc and Vicki's property because it will keep landscape maintenance and installation costs down and display the northwest native plant palette to the nursery customers. Northwest native plants will be shown with arrangements of color, structure, and texture.

The following explanations of this succession design process will not include my name or my client's names. The anonymity of the process is an effort to maintain generality in explaining succession design, so that a landscape architect could read the example and be able to apply the succession design method to her or his designs. Inserting names and placing personal ownership in the design process may inhibit the generality of the example. Following the same idea, I understand that this succession design process does not work without human expression in a real place. Human feelings, ideas, and wants are expressed in the example landscape by the author, the landscape architect, and the clients, Marc and Vicki. Consequently, I will try to give enough information about human expression in the *design so that the example adequately illustrates the succession design process and methodology.*

Introduction

The design method used in this chapter is based on client and landscape architect preference. This design example uses the information discussed in Chapters 1-3 to combine the science of succession and individual artistic design goals. It is necessary to reiterate from Chapter 3, that a landscape architect and client can use unique design processes and preferences for a design as long as there are projected vegetation compositions for the succession plan. Therefore, the succession design example in Chapter 4 will include the information, process and methodology from Chapters 1-3 with the addition of individual artistic preferences from this particular client and landscape architect.

The Design Site and General Goals

The example design site is a private 20 acre residence located in Olympia, Washington, USA. The aerial photo below shows the property boundaries in 1990 and the small dot in the upper right corner is the home location (Terraserver, 1990).

Figure 3-

N?

This 20 acre property is not adjacent to similar sized parcels of land (excluding a blueberry farm directly south), but instead is located in close proximity to other homes and to the downtown area of Olympia. Given the location of this piece of land among smaller homesteads the design needs to address privacy and accessibility. For instance, the landscape areas around the home can be viewed and accessed by neighbors, driveways and roads. The more private and contemplative areas are located acres away from the home and hard to access by the homeowners. Improving accessibility and privacy are two design goals that can be dealt with in the landscape design for the home and business.

Other design goals for the site include the accelerated improvement and organization of land uses for the home and native plant nursery. The existing land uses on this property include hiking, photography, gardening, sports, plant propagation, plant storage and scenic appreciation. Currently, the property is disorganized and lacks structure, such that existing outdoor rooms do not correspond with intended land uses. Intended land uses for various areas within this site include plant storage, parking, pedestrian and vehicular circulation, reflection and contemplation, aesthetic appreciation, and physical use (recreation). Property surrounding the home is unused and/or unappreciated because the client cannot access it, the landscape size is inappropriate for the land use or the scenery/views are poor. Poor scenery is due to inappropriate plants for the site, wrong plant placement, or lack of vegetation maturity.

It is important to address that these clients are partial to Pacific Northwest native vegetation and that past land uses do not coincide with this preference. Past landuse was primarily agricultural with acres of property allocated for hay cultivation to support livestock such as horses, cows and pigs. Pastures grasses and hay are not the Pacific Northwest vegetation that the clients prefer. The clients would like a landscape with Pacific Northwest vegetation that includes but is not limited to; Douglas-fir (*Pseudotsuga menziesii*), Red Alder (*Alnus rubra*), Western Hemlock (*Tsuga heterophylla*), Bigleaf Maple (*Acer macrophyllum*), Salal (*Gaultheria shallon*) or Red Huckleberry (*Vaccinium parvifolium*) and many species of fern. To account for the goal of using native vegetation, the main succession goal entails a design that facilitates a habitat change from hay and pasture to Pacific Northwest forest (edge habitat). The realization of this central succession goal will also achieve the primary aesthetic goals of an increase in native vegetation abundance and maturity on the site.

Succession Design Methods

The client's design preferences provide context for creating the succession design plan and goals. Addressing the nine questions from Chapter 3 helps to further refine the succession research.

1. **What is/are the projected species composition (PSC) of the landscape site design?**

The clients would prefer a mature Pacific Northwest ecosystem. Based on site research pertaining to soils, climate, historic vegetation, existing vegetation topology, etc., the projected species compositions are:

A. The primary, extended goal of four projected species compositions is a mature Douglas-fir forest (Western Hemlock Association or succession zone) with an understory using plants currently found on site. A Douglas-fir forest composition is the primary succession goal because it occurs on the site and it will take extended time and planning to achieve a mature Douglas-fir forest. The extended succession time is due to the long life span of the Douglas-fir. The Douglas-fir understory vegetation includes but is not limited to Salal (*Gaultheria shallon*), Red Huckleberry (*Vaccinium parvifolium*), Dewberry (*Rubus ursinus*), Bracken Fern (*Pteridium aquilinum*), Sword Fern (*Polystichum munitum*) and Queen's cup (*Clintonia uniflora*) (Pojar & Mackinnon, 1994).

Picture 1- Douglas-fir forest understory (wet sites)

B. The secondary projected species composition is a 5 acre Sedge/Rush meadow (or emergent wetland) with *Carex spp*. or *Juncus spp.* which would grow well in the present soil acidity and bog-like ecosystem conditions (Kildeer Countryside Virtual Wetland Preserve, 2005; West, P., Patti, H., Thompson, C., & Van Helden, N., 2005).

Picture 2- University of Wisconsin Arboretum, Sedge Meadow (2001)

C. The third projected species composition is a low elevation wet meadow with wildflowers and bulbs that may be associated with a Garry Oak ecosystem (Fuchs, M., 2000). This composition consists of wildflowers that can exist and thrive in wet to dry soil conditions and includes but is not limited to; Common Camas (*Camassia quamash*), White Fawn Lily (*Erythronium oregonum*), Chocolate Lily (*Fritillaria lanceolata*), Satin-flower or Douglas' Blue-eyed Grass (*Sisyrinchium douglasii*), Blue-Eyed-Grass (*Sisyrinchium idahoense*), Golden-Eyed-Grass (*Sisyrinchium californicum*), Broad-leaved Shooting Star or Henderson's Shooting Star (*Dodecatheon hendersonii*), Yellow Prairie Violet (*Viola praemorsa*), Small-flowered Blue-eyed Mary (*Collinsia parviflora*), Leafy Aster (*Aster foliaceus*), Hooker's Onion (*Allium acuminatum*), Nodding Onion (*Allium cernuum*), Western Buttercup (*Ranunculus occidentalis*), and Prairie Smoke (*Geum triflorum*) (Fuchs, M., 2000, Pojar & Mackinnon, 1994; Robson & Henn, 2005).

Picture 3- Meadow in Washington State
http://trhys.home.comcast.net/cc97/washington.html

D. The fourth projected species composition is a Western Red Cedar or Red Alder forested marsh (Franklin & Dyrness, 1988). Certain soils on this site are very wet for 6-8 months out of the year and these soils have trees that thrive in these conditions. The forest vegetation in this projected species composition is Red Cedar (*Thuja plicata*), Red Alder (*Alnus rubra*), Paper Birch (*Betula papyrifera*) and Black Hawthorn (*Crataegus douglasii*). Understory vegetation includes: Deer Fern (*Blechnum spicant*), Lady Fern (*Athyrium filix-femina*), Hardhack (*Spiria douglasii*), Salmonberry (*Rubus spectablis*), False Azalea (*Menziesia ferruginea*), Salal (*Gaultheria shallon*), Alaskan Blueberry (*Vaccinium alaskaense*), Oval-leaved Blueberry (*Vaccinium ovalifolium*) and Red Huckleberry (*Vaccinium parvilfolium*) (Franklin & Dyrness, 1988; Pojar & Mackinnon, 1994).

Picture 4- Riparian forest- Nisqually River Delta
http://www.birdingamerica.com/Washington/nisquallyriver.htm

2. **What are the past and projected anthropic land uses for this site?**

The past land uses for the site were agricultural and the future landuses for the site are recreation and native plant propagation.

3. **Where are existing projected species population locations near the site?**

The primary succession goal is the old growth Douglas-fir edge habitat. This projected habitat is the focus of question 3, in that, the existing PSC location (used for habitat comparison) will have old growth Douglas-fir habitat (edge or interior). The comparison location is in the Cedar River Watershed, Washington, USA on government owned land. The watershed is located northeast of Olympia (approximately 60 miles) and it contains old-growth Douglas-fir forest. The watershed is currently conducting succession research on the old growth and second growth Douglas-fir forests; therefore it was an ideal location to inquire about old growth Douglas-fir succession data and information.

4. **What projected species composition data can you receive from that existing PSC location? And, what written information can be found about the**

general PSC plants, growth habits and resource/environmental requirements?

Species data, plant growth information, succession data (plot age) and maps were obtained from Cedar River Watershed and site access was granted. General written information about the projected species compositions were found on the web, from the forest service, and in books and journals. Four books/journal articles that were the most significant include:

A. Franklin, J. & Dyrness, C.T. (1988). *Natural Vegetation of Oregon and Washington*. Oregon State University Press, USA.

B. Garman, S., Cissel, J., & Mayo, J. (2003). Accelerating Development of Late-Successional Conditions in Young Managed Douglas-Fir Stands: A Simulation Study. United States Department of Agriculture, Forest Service and Pacific Northwest Research Station. General Technical Report, PNW-GTR-557.

C. Luken, O. (1990). *Directing Ecological Succession*. London: Chapman and Hall.

D. Soil Conservation Service, United States Department of Agriculture & Washington State Department of Natural Resources. (1990). Soil Survey of Thurston County, Washington.

5. **Is the PSC data from question 4 comparable to the goals and environment of the design site?**

The main projected species composition goal contains species similar to the lower elevation, Cedar River watershed habitat. The climate in Cedar River watershed is wetter and cooler than in Olympia (Spatial Climate Analysis Service, 2004). The precipitation differences between the sites are significant, where Cedar River Watershed (~57 in.) receives more annual precipitation than Olympia (~52 in.), but the Olympia site soils perpetuate wet conditions similar to the wetter environment in Cedar River Watershed. The general moisture regime, temperature regime and taxonomic classification of the

Cedar River Watershed (lower elevations) and Thurston County soils are the same (Washington State University, 1998).

6. **How will the projected species data be applied to succession design planting phases, specifically in the plant growth habits, maturity, rate of growth and appearance?**

The composition of the forest in the lower elevations of the Cedar River Watershed is mostly Douglas-fir (Pseudotsuga menziesii) with smaller amounts of Western Hemlock (Tsuga heterophylla), Big Leaf Maple (Acer macrophyllum), Red Alder (Alnus rubra) and Western Red Cedar (Thuja plicata). The primary design concerns regarding the use of these trees pertain to water and light availability. Western Red Cedar and Red Alder are usually found on wet sites (Pojar & Mackinnon, 1994). Western Red Cedar and Western Hemlock are shade tolerant (Pojar & Mackinnon, 1994). Gaining understanding of the trees' shade and water requirements begins to address the issues raised in question six, but additional Cedar River Watershed succession data will need to be analyzed in Chapters 5 and 6 about maturity, appearance, and rate of growth for the trees and understory plants.

7. **How will PSC data and design site information be integrated into a landscape succession design product? How will the design product communicate ecosystem sensitivity and the aesthetic within each planting phase?**

Again, the answer to this question depends on the specific design environment, client preference and the landscape architect's design processes. Succession design products will depend on the landscape architect and the design site. The Olympia, WA succession design product will have a mixed media rendering of each succession planting phase. The illustrations will visually communicate the aesthetic and vegetation strategies of each phase. Additionally, each planting phase will have a short written statement about the plants, design and intended ecological progression for the site and consequently the ecosystem. This written statement does not have to be an elaborate Environmental Impact Statement*, but rather a mission statement about the intended design and ecological goals encompassed in the planting phase.

8. **What disturbances do you need to incorporate into the planting phases in order to accelerate or maintain the succession progression in the design?**

Disturbances include prescribed burns and the removal, trimming, and planting of plants.

9. **The final question is an all encompassing summary of the answers to the nine questions above.**

Succession Goals: The goal is a Douglas-fir forest with old growth characteristics. There are three separate, suitable locations on the property for Douglas-fir growth that are approximately 1-1.5 acres. The suitable locations on this property for Douglas-fir growth are not large enough to create an interior old-growth habitat with all of the intended species. Chapter 2 stated that a forest, less than 2.3 hectares (5.7 acres), is not suitable for interior old growth habitat (luken, 1990). Consequently, this main succession goal is to produce Douglas-fir old growth edge habitat. Secondary goals are a sedge meadow, wildflower wet meadow, and forested marsh.

*An Environmental Impact Statement is an analysis of the impact that a proposed development … will have on the natural and social environment. It includes assessment of long- and short-term effects on the physical environment, such as air, water, and noise pollution, as well as effects on employment, living standards, local services, and aesthetics (Jain, Urban, & Stacey, 1981).

Design Vision: Privacy, connectivity among landuses, accessibility and mature, Pacific Northwest native plants.

Intended Design Duration: 180 years to achieve a Douglas-fir forest with old growth characteristics. Indicators of old growth Douglas-fir are trunk width (diameter at breast height (d.b.h.)) (~10 per hectare), variety in canopy height, density of shade tolerant species (~10 per hectare), density of snags and log mass = 10 cm (~30 megagrams per hectare) (Garman, S., et al., 2003). A simulation study done by Garman et al. (2003) showed that all of the characteristics of a Douglas-fir old growth forest can be achieved in 180 years.

Planting Phases: Planting phases will be explained in detail in Chapter 8.

Figure 3-

This diagram visually organizes the answers to the previous questions.

Bottom Succession Plan Cycle, Step 1- Projected species composition (PSC) (Establish the projected species composition for the plan), 2- Find PSC location (Find a projected species composition that exists at some other similar locatio n), 3- Data from PSC location (Find data from the existing projected species composition), 4- General applicable PSC information (Find any other general information about the projected species information which includes information on associated species), 5- PSC data processing (Synthesize all PSC information), 6-Succession plan (Use the synth esis from step 5 to create succession plan), 7-Project species composition (Start succession plan), 8-Repeat (Repeat the data gathering as more PSC information becomes available. Succession plan can be changed). Top Landscape Design Cycle, Step 1- Client consultation (meet with client to discuss landscape design goals), 2- Land use analysis (research past land use and plant species composition and ask about future land use), 3- Design program and concept (apply information about land use and design techniques to satisfy clients needs/ wants), 4- Projected Species Composition (PSC) (Establish projected species composition to apply to the landscape design), 5- Client consultation (discuss PSC and design program/ concepts), 6- Final design plan (There may be revisions between steps 5 and 6, but eventually a final design plan will be established), 7- Client consultation (Present final plan for approval and start constructing the design), 8- Repeat (Only if necessary).

Conclusions

Chapter 4 provided an example of how to apply the succession design plan methodology. The methodology was applied to a site in Olympia, Washington, whereby the property's characteristics, the client's interests, and succession planning principles were integrated. Specific research information pertaining to design issues are discussed in more detail in the following chapters. The projected species composition location, Cedar River Watershed, is discussed more explicitly in Chapter 5. Chapter 5 provides information about Cedar River Watershed's history and compares the general plant composition, climate, and soils of the Cedar River Watershed with the Olympia location.

Chapter 5- Succession Data Background

<u>Cedar River Watershed History</u>

The Cedar River Watershed property is owned by the City of Seattle and located south of North Bend, Washington, USA. The City of Seattle owns 91,339 acres of this watershed and only provides access to scientists, Public Utility District workers and essential forestry management personnel (Seattle Public Utilities, 2004). Within the Cedar River Watershed, water flows from 4469 feet in the Cascade mountains (on the City of Seattle property), through tributaries, to Chester Morse Lake, through Masonry Dam and down to Lake Washington (in Seattle, WA) via the Cedar River. The water from this watershed is used by most of the 1.3 million residents in the greater Seattle area for consumption, sewer, drainage and solid waste services (Seattle Public Utilities, 2004). Given the water's uses, hydrological and ecological processes are protected within this watershed to preserve water quality (Seattle Public Utilities, 2004).

In the early 1920s, the City of Seattle hired foresters to manage the vegetative communities in this watershed to conserve the forest for timber harvest and production (Seattle Public Utilities, 2004). Before the early 1920s, logging and fire had suppressed and stripped the vegetation in some areas which made them susceptible to erosion and limited forest regeneration (Seattle Public Utilities, 2004). The degraded forest environment required conservation tactics to boost forest function and tree recovery. The protection and planning implemented in the 1920's, has led to the preservation of large stands of second growth forest at the lower elevations (~800 feet and higher) and patches of old growth forest located at mid-higher elevations (~2252 feet and higher).

Recently the City of Seattle implemented a 50 year Habitat Conservation Plan that will further protect the vegetation, water quality, wildlife species within the watershed (Seattle Public Utilities, 2004). As a result of the Habitat Conservation Plan, patches of the second and old growth forests have been selected by Cedar River ecologists, for a forest vegetation succession study (Borsting, M., personal communication, August, 2004). *Intervention in Succession* uses the data from this succession study to create and guide the landscape succession design in Olympia, WA.

<u>Cedar River Watershed Vegetation</u>

According to Franklin and Dyrness (1988), the main forest region for the lower elevations of the Cedar River Watershed consists of Western Hemlock (*Tsuga heterophylla*) and the forest region at mid-higher elevations consists of Pacific Silver Fir (*Abies amabilis*) (pg. 44). A forest region (zone) defined by Franklin and Dyrness (1988) is a, "vegetational zone based on climax vegetation" (pg. 46). Climax vegetation in the Clementsian successional theory is a vegetation type that is in equilibrium with the regional climate or environment (Glenn-Lewin, D. et. al., 1992). According to the Clementsian successional theory, Franklin and Dyrness (1988) imply that the Western Hemlock (*Tsuga heterophylla*) forest region would consist of Western Hemlock (*Tsuga heterophylla*) as its dominant tree species at the present time or some time in the geologic future. Both these forested regions, Western Hemlock and Pacific Silver Fir, contain Douglas-fir (*Pseudotsuga menziesii*) as a primary, long-lived seral species that can dominate sites for hundreds of years and consequently act as a climax species. To achieve environmental equilibrium within a Pacific Northwest climax or Douglas-fir forest however, the area would have to go without widespread forest disturbances such as development, logging, vegetative disease or major fires.

It was explained in Chapter 4 that the primary projected species composition of the Olympia succession design is an old growth Douglas-fir edge habitat. This habitat occurs in the Western Hemlock (*Tsuga heterophylla*) forest composition located below 700 meters (2296 feet) (Franklin and Dyrness, 1988). The Western Hemlock forests in the Cedar River Watershed are composed of overstory trees such as Western Hemlock (*Tsuga heterophylla*), Douglas-fir (*Pseudotsuga menziesii*), Western Redcedar (*Thuja plicata*), Bigleaf Maple (*Acer macrophyllum*), and Red Alder (*Alnus rubra*). Understory shrub layers could consist of Vine Maple (*Acer circinatum*), Pacific Rhododendron (*Rhododendron macrophyllum*), Oceanspray (*Holodiscus discolor*), Dwarf Oregongrape (*Berberis nervosa*), Salal (*Gaultheria shallon*), Twinflower (*Linnaea borealis*), Sweet-scented Bedstraw (*Galium trifolium*), Sword Fern (*Polystichum munitum*), Bracken Fern (*Pteridium aquilinum*), Red Huckleberry (*Vaccinium parvifolium*), Red Elderberry (*Sambucus racemosa*) and Fool's Huckleberry (*Menziesia ferruginea*).

Currently the lower elevations of this watershed are a seral, second growth forest that consists primarily of a Douglas-fir (*Pseudotsuga menziesii*) overstory with Western Hemlock (*Tsuga heterophylla*) and Western Redcedar (*Thuja plicata*) as understory saplings. Shrub and herb understory may consist of Vine Maple (*Acer circinatum*), Sword Fern (*Polystichum munitum*), Bracken Fern (*Pteridium aquilinum*), Salal (*Gaultheria shallon*), Red Huckleberry (*Vaccinium parvifolium*), Fool's Huckleberry (*Menziesia ferruginea*) or Red Elderberry (*Sambucus racemosa*). Areas in this watershed do not have a large amount of understory vegetation and this may be because of the logging practices and replanting that was done earlier in the 1900s. Franklin and Dyrness (1988) suggest that Douglas-fir (*Pseudotsuga menziesii*) stands in the Western Hemlock (*Tsuga Heterophylla*) region were densely replanted after logging and the dense planting does not facilitate understory growth. Understory growth may not occur for reasons like diminished resource and light availability, which may be precipitated by the quantity of trees and thick overstory canopy (Larcher, 2003; Van Pelt, R. & Franklin, J., 1999).

Physical Environment of the Cedar River Watershed-Western Hemlock (Tsuga heterophylla) Region

The environment for the Cedar River Watershed-Western Hemlock (*Tsuga heterophylla*) region is mild and wet. Average annual maximum temperatures are between 56-65 degrees Fahrenheit and minimum temperatures are between 37-43 degrees Fahrenheit (Spatial Climate Analysis Services, 2004). Annual average precipitation is approximately 58 inches (Franklin, J. & Dyrness, 1988; Spatial Climate Analysis Service, 2000). A majority of the precipitation falls in the winter with 6-9 percent of the total precipitation occurring in the summer (Franklin, J. & Dyrness, 1988). Dry summers in the Cedar River Watershed may be exacerbated because of the westerly aspect. Taxonomic subgroup soils for the lower elevations in the Cedar River Watershed are Vitrandic Durochrepts, Vitrandic Xerochrepts, Aquandic Xerochrepts and Dystric Xeropsamments (Washington State University, 1998).

Physical Environment for the Design Site- Olympia, Washington

Climate in the Olympia area is mild and wet but the area is slightly warmer and drier than the Cedar River Watershed. Average annual precipitation in the Olympia area is approximately 50 inches (Spatial Climate Analysis, 2004; Soil Conservation et al., 1990). Average Annual maximum temperatures are 62-65 degrees Fahrenheit and minimum temperatures are 40-43 degrees Fahrenheit (Spatial Climate Analysis, 2004).

The taxonomic subgroup soil names for the Olympia area are the same as the Cedar River Watershed: Vitrandic Durochrepts, Vitrandic Xerochrepts, Aquandic Xerochrepts and Dystric Xeropsamments (Washington State University, 1998). More specifically, there are four soil series on the Olympia property (one soil series has two phases): 1, **Bellingham**, (fine, mixed, nonacid, mesic mollic Haplaquepts) silty clay loam; 2, **Kapowsin**, (loamy, mixed, mesic Dystic Entic Durochrepts) silt loam 0-3 percent slopes; 3, **Shalcar**, (loamy, mixed, euic, mesic Terric Medisaprists) variant muck; and 4, **Skipopa**, (Clayey, mixed, mesic Aquic Xerochrepts) silt loam 0-3 percent slope and silt loam 3-15 percent slope (Thurston County soil survey, 1990). Each of these soil series supports different vegetation and land uses.

It is important to look into the impacts of past land use on the site soils to understand possible complications in vegetation growth and land use on the site soils. Past land uses on the Olympia site, particularly farming, have been minimal for the last 30 years with limited to no field cultivation or livestock grazing. This implies that soils on this site are not as compacted and altered as they could have been (Frazier, B., 2004). Consequently, this site design can involve planting the native vegetation found on these soils without planning for soil modifications.

Each of the four soil series on this site have distinct native vegetation compositions associated with them. The native vegetation compositions are:

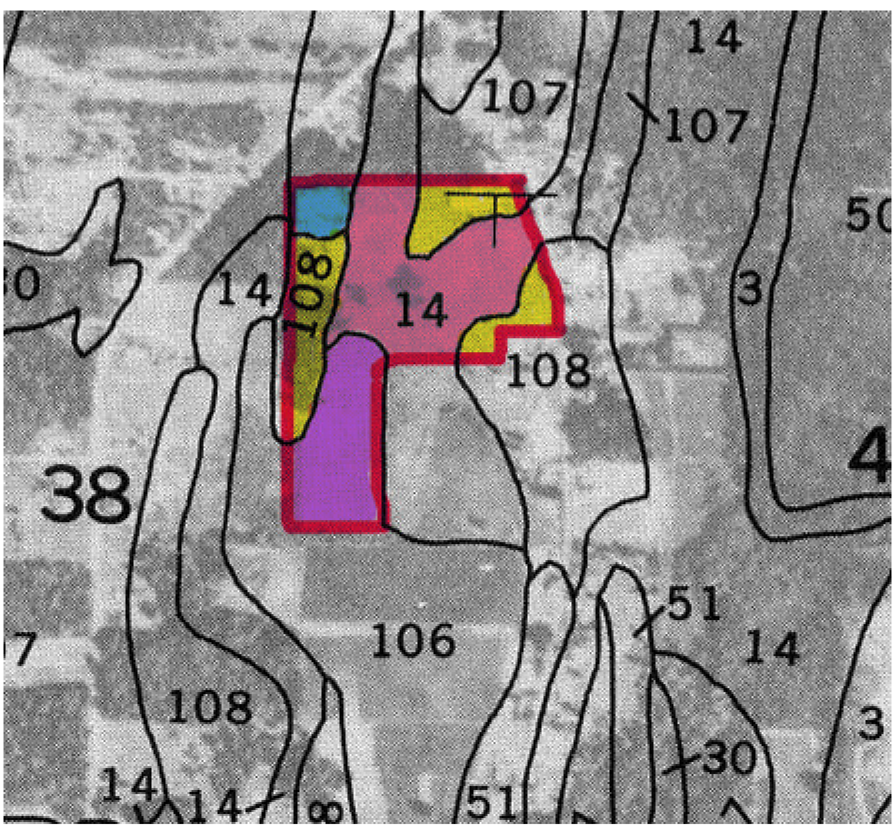
- **The Bellingham series**- Western Red Cedar (*Thuja plicata*) and Red Alder (*Alnus rubra*) are mentioned in the Thurston County soil survey

(1990). Other vegetation observed on this site soil series are Black Hawthorn (*Crataegus douglasii*), Pacific Rhododendron (*R. macrophyllum*), Bracken Fern (*Pteridium aquilinium*) and Quaking Aspen (*Populus tremuloides*). The high water table and clay subsoil limits plant root depth.

- **The Kapowsin series**- Douglas-fir (*Pseudotsuga menziesii*), Red Alder (*Alnus rubra*), Western Hemlock (*Tsuga heterophylla*), Big Leaf Maple (*Acer macrophyllum*), Cascade Oregon Grape (*Berberis nervosa*), Bracken Fern (*Pteridium aquilinium*), Sword Fern (*Polystichum munitum*), Vine Maple (*Acer circinatum*) and Salal (*Gaultheria shallon*) (Thurston County soil survey, 1990). Other vegetation observed on this site soil series is Pacific Madrone (*Arbutus menziesii*). The high water table and clay subsoil limits plant root depth.
- **The Shalcar series**- Sedges (*Carex spp*.) and Rushes (*Juncus spp*.).
- **The Skipopa series**- Douglas-fir (*Pseudotsuga menziesii*), Red Alder (*Alnus rubra*), Western Red Cedar (*Thuja plicata*), Big Leaf Maple (*Acer macrophyllum*), Western Sword Fern (*Polystichum munitum*), Salmonberry (*Rubus spectabilis*), Western Brackenfern (*Pteridium aquilinium*), Trailing Blackberry (*Rubus ursinus*) and Red Huckleberry (*Vaccinium parvifolium*) (Thurston County soil survey, 1990). Other vegetation observed on this site soil series is Queen’s cup (*Clintonia uniflora*), Pacific Madrone (*Arbutus menziesii*), and Grand Fir (*Abies grandis*).

Figure 4 is a Thurston County soil map (1990) (Sheet 4). The red line is the property boundary, yellow is the skipopa series, pink is the Bellingham series, blue is the Kapowsin series and purple is the Shalcar series. The two soil series that support the main projected vegetation composition from Cedar River Watershed are the Kapowsin series (blue) and the Skipopa series (yellow). These soils total approximately 4-6 acres of land that can support old growth Douglas-fir (Thurston County Soil Survey, 1990). Consequently, the total acreage is limited for the main projected species composition (Douglas-fir old growth edge habitat) on the site and Douglas-fir forest will be concentrated in smaller sized areas. The secondary succession goals will cover continuous larger areas.

Figure 4- Yellow = Skipopa series Blue = Kapowsin series
Pink = Bellingham series Purple = Shalcar series



Conclusions

Cedar River Watershed has data and succession plots that consist of the projected vegetation composition for the Olympia, Washington property. The soil and climate environments for the two sites are similar enough to justify using the data from the Cedar River Watershed succession plots and applying it to the design site in Olympia. Olympia climate is drier and slightly warmer on average than the Cedar River watershed area, but the soil types on the design site have a high water capacity. Consequently, two of the soil types on the property can adequately support the same types of vegetation that grows in Cedar River Watershed. Chapter 6 will address the data from Cedar River Watershed and how the information will be applied to the succession design in Olympia.

Chapter 6- Succession Data

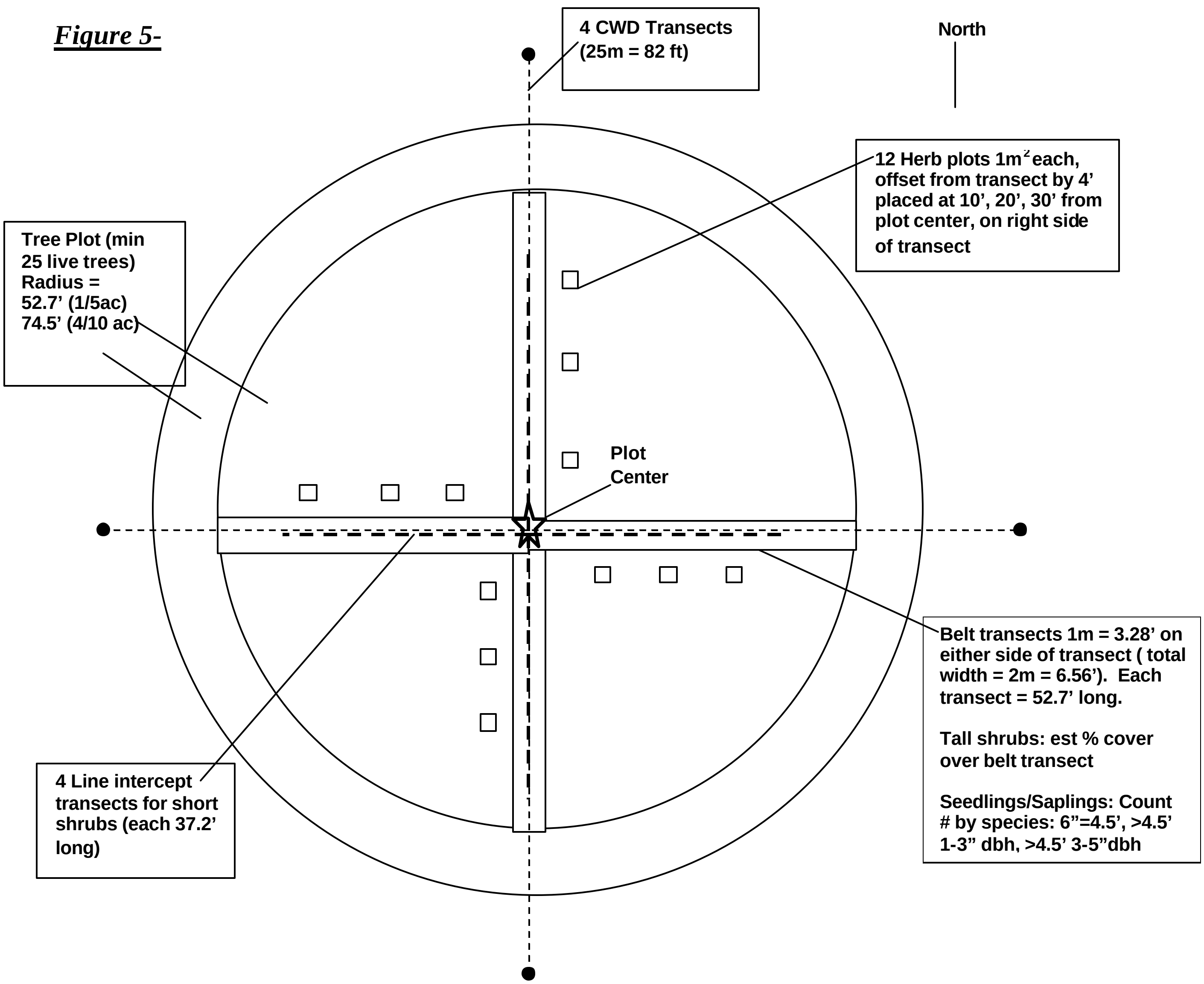
Descriptions of Cedar River Watershed Succession Plots

The City of Seattle and specifically Cedar River Watershed plant ecologist, Melissa Borsting, supplied succession data to be incorporated into the Olympia succession design. The succession data was previously gathered within the watershed from second growth, old growth and wind damaged plots that range in elevation. Second growth plots have vegetation with varying approximate ages and elevations but the plots used in *Intervention in Succession* average 73 years old (in 2005) and 1111 feet above sea level. Old growth plots were not used in the succession design because of their high elevations (2000 feet or more) and therefore they were not comparable to the Olympia design site at 95-164 feet above sea level. Also, wind damaged plots contain data on the growth of vegetation, particularly herbs and shrubs, following a severe wind storm. The data from the wind damage plots shows initial vegetation establishment after a disturbance. Information from each of these plot types either answered vegetation questions or catalyzed design curiosity that ultimately furthered a conceptualization of a succession design with projected species compositions.

A brief physical description of the plots will help explain the City's experiment methodology and data collection. The plots are 4/10 of an acre or approximately 17, 428 square feet and circular. The plot area is used to collect information on 25-30 live trees with a minimum diameter at breast height (DBH) of 5 inches. The plot boundaries are used to establish various transects to measure shrub, sapling (1-5" DBH) and coarse woody debris amounts and characteristics. Transects lengths are 37.2, 52.7 or 87 feet, depending on the experiment, and each experiment contains four transects extending

North, South, East and West. Additionally, one meter squared herb plots were created along each transect at 10, 20, and 30 feet from the plot center. Figure 5 is an illustration of the vegetation succession monitoring plots, provided by Melissa Borsting and the City of Seattle.

<u>Figure 5-</u>



Data Selection

The Cedar River Watershed succession data is interpreted and distilled into so that it could be applied to the Olympia succession design. The simplification occurs from answering three sequential questions.

1. What plots are comparable to the Olympia design site in elevation, climate, and/or projected species composition?
2. What plot information is important to the succession design and can it be specifically applied to vegetation planning and/or human expression?
3. How can the data be visually communicated or written into the succession design?

The questions encourage focus, accuracy and expedience with the data analysis. Many of the plots and much of the data are not utilized because the information is not directly relevent to the planting phases or the plot environment was not comparable with the design site.

The plot data that is applicable to the Olympia succession design consists of the scientific and common names of vegetative species with their ages, elevations, amounts and spatial relationships. Vegetation type, amount, age, elevation and spatial relationship information are used in the Olympia succession design because they provide the answers to the questions above. This plot information is important to the Olympia site because it can be written or visually incorporated into the vegetation planning and human expression of the succession design.

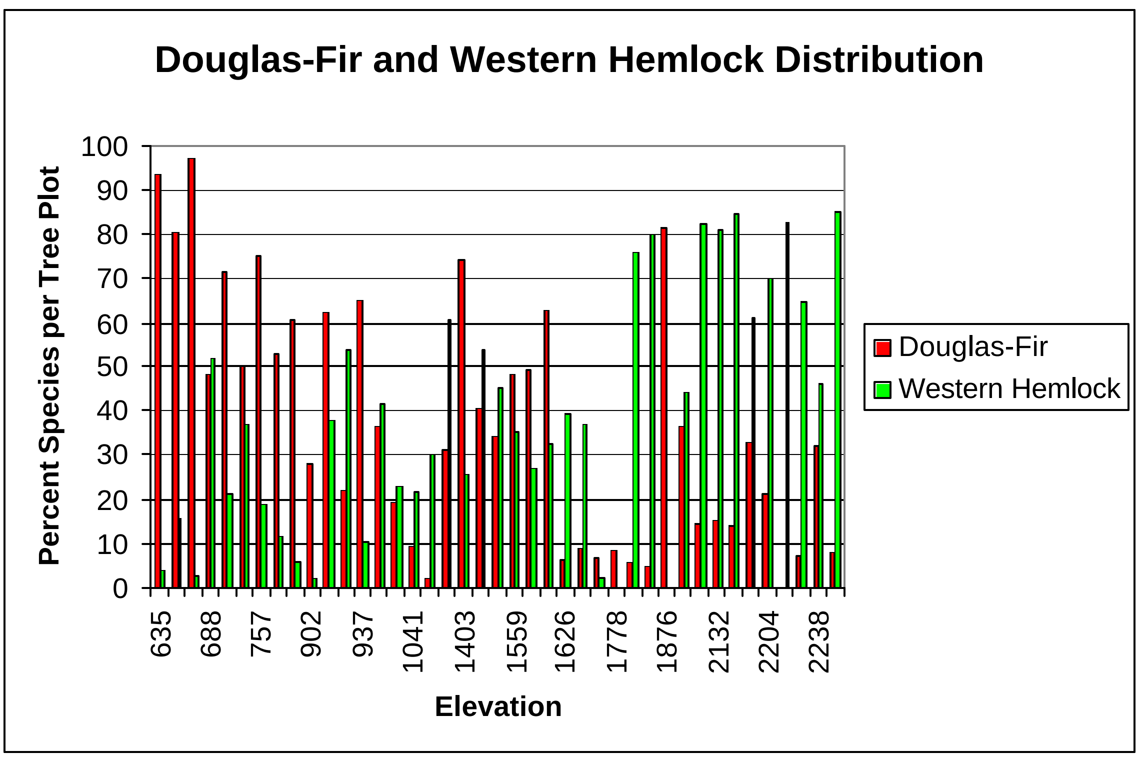
In order to analyze the plot data, it is critical to understand the experimental techniques used to obtain this information. The experimental techniques used to acquire vegetation age, amount, type, and spatial relationship are; incremental tree coring, observation and distance measurements (tape measure or Global Positioning System (elevation)). The approximate age for each plot is established with incremental core samples from a subsample of the total trees per plot. Vegetative species compositions (types, amounts, and elevations) per plot were calculated using observation and distance measurements of the tree plots, shrub transects, wind damaged plots or herb plots. Additionally, the creation of spatial relationships and patterns involve the distance measurements between shrub and herb species in the wind damage plots. This Cedar River Watershed plot data is analyzed and incorporated into the succession disturbances, vegetative compositions, planting times and spatial layouts for the Olympia succession design. The following sections in Chapter 6 analyze the plots and plot data.

Data Analysis of the Plot Locations

The data analysis begins by finding plots that are comparable to the design site, specifically in terms of environmental conditions or projected species composition. The data from the Cedar River Watershed plots contain species information and minimal data regarding environmental conditions, therefore vegetation composition is the logical focus for this analysis. The applicable plots have similar vegetation to the design site: The projected species composition for the succession design is Douglas-fir old growth habitat (edge) located within the *Tsuga heterophylla* zone (Franklin & Dyrness, 1988).

The *Tsuga heterophylla* zone is the projected species composition location for the design site and Franklin and Dyrness (1988) state that this zone can occur up to 700 meters or 2296 feet. This elevation is an estimated height over the entire Tsuga heterophylla zone so the Cedar River Watershed vegetation zones may not correlate with that elevation estimate. It would not be advisable to assume that all of the vegetation plots that occur up to 2296 feet are in the *Tsuga heterophylla* zone. Therefore, plot data was analyzed regarding any correlations between elevation and species abundance. In Figure 6, the amounts of Douglas-fir and Western Hemlock are compared as the elevation increases, to show any quantity trends that are occurring for the primary species in the *Tsuga heterophylla* zone. The amount of Douglas-fir per plot decreases with elevation and the amount of Western Hemlock per plot increases with elevation. The plot data may suggest that the *Tsuga heterophylla* zone is transitioning into another zone (the *Abies amabilis* zone) at an elevation around 1700 feet.

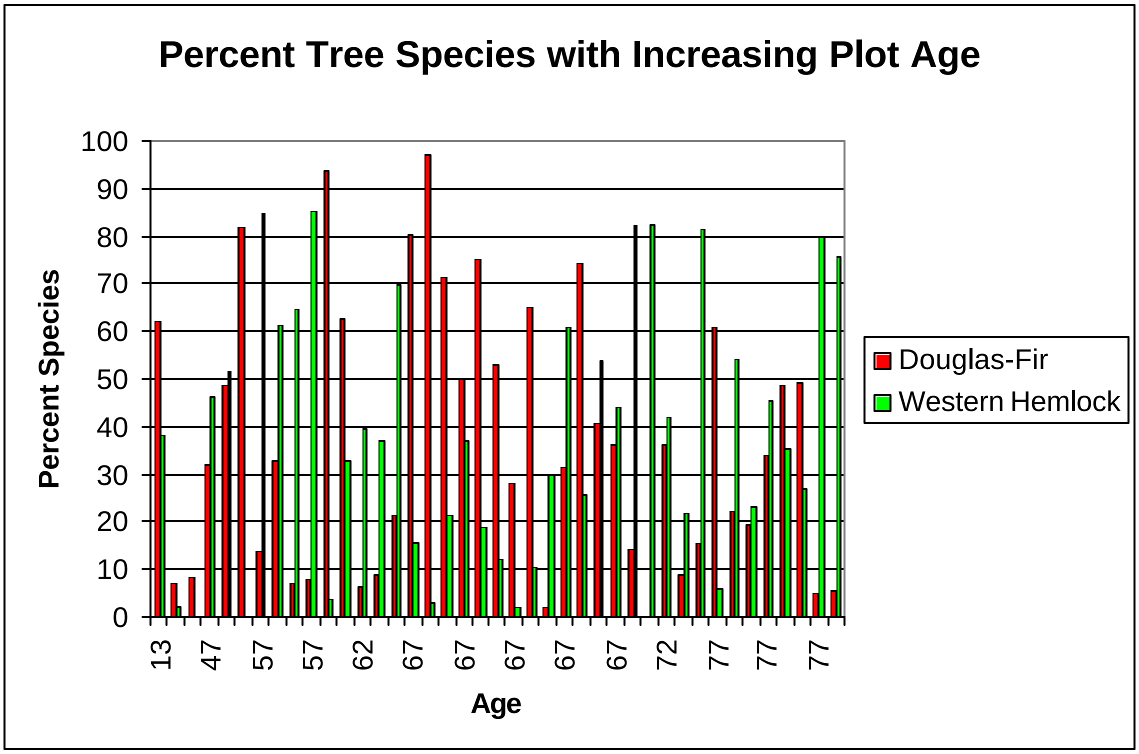
Figure 6-



Plot age should also be compared with the primary species composition in order to show any vegetation quantity trends that occur as plot age increases. A comparison of age and elevation graphs will show if plot age, elevation or a combination are causing the vegetation composition changes. A plot age graph was created because Douglas-fir (*Psuedotsuga menziesii*) becomes seral succession vegetation in the *Tsuga heterophylla* zone and consequently when this species is disturbed, the Western Hemlock (*Tsuga heterophylla*) establishes as the mature succession vegetation. An increase in plot age heightens the chance that Western Hemlock has had time to colonize, grow and reproduce more vigorously than Douglas-fir as a result of a disturbance in the plot. Therefore, a negative correlation as Douglas-fir quantities decreasing and plot ages increase, could mean that the plots are still in the *Tsuga heterophylla* zone and disturbance is causing the vegetation shift.

Figure 7 shows Douglas-fir and Western Hemlock percentages per plot as plot age increases. According to this graph, there are no distinct correlations between plot age and species compositions. The graph supports the idea that vegetation is transitioning from a *Tsuga heterophylla* zone into an *Abies amabilis* zone. The transition could still occur around 1700 feet because a correlation is absent in the graph.

Figure 7-



Figures 8 and 9 show the amount of Pacific Silver Fir (*Abies amabilis*) saplings (DBH = 1 and < 5 inches) and trees (DBH = 5 inches) as elevation increases. These graphs show the elevation where Pacific Silver Fir begins to establish and reproduce. The establishment of Pacific Silver Fir coincides with the *Abies amabilis* (Pacific Silver Fir) succession zone, where *Abies amabilis* (Pacific Silver Fir) becomes the mature succession vegetation instead of Western Hemlock (*Tsuga heterophylla*) (Franklin & Dyrness, 1988). The graphs show that Pacific Silver Fir begins to establish at an elevation of approximately1800 feet (elevations of 1778 for the trees and 1805 for the saplings). This supports the idea that the *Tsuga heterophylla* zone occurs at an elevation around 1700 feet. Therefore, *Intervention in Succession* is averaging the two elevations (1700 and 1800) and using the Cedar River Watershed succession data below an elevation of 1750 feet for application in the Olympia succession design.

Figure 8-

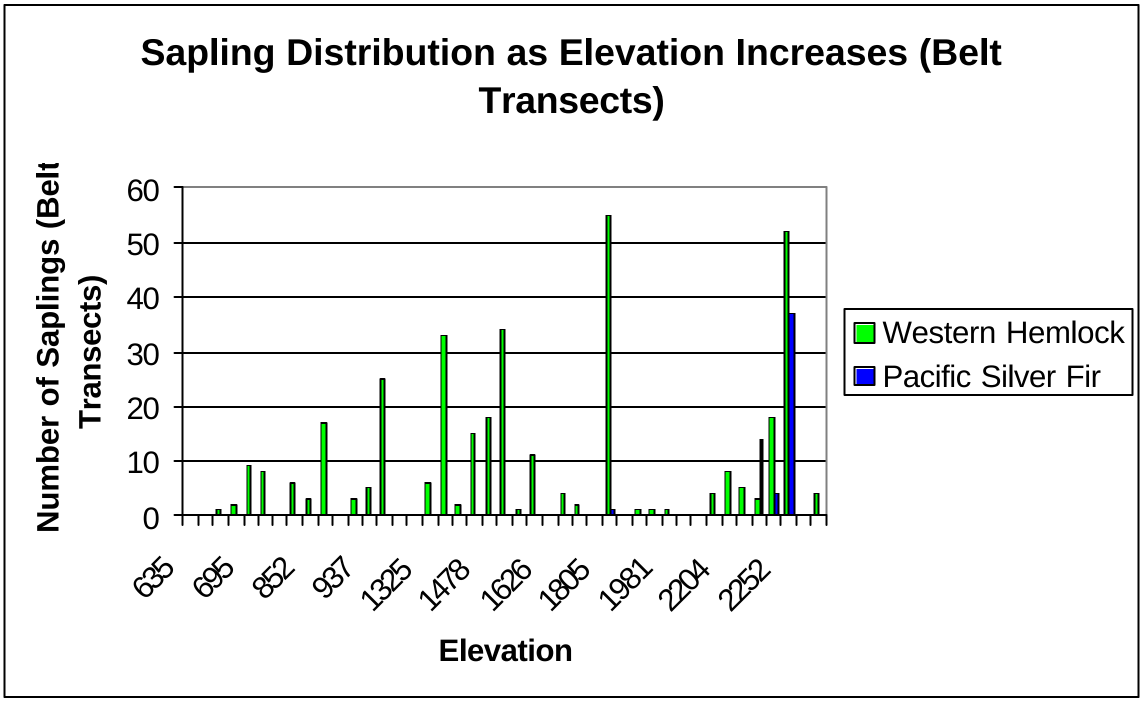
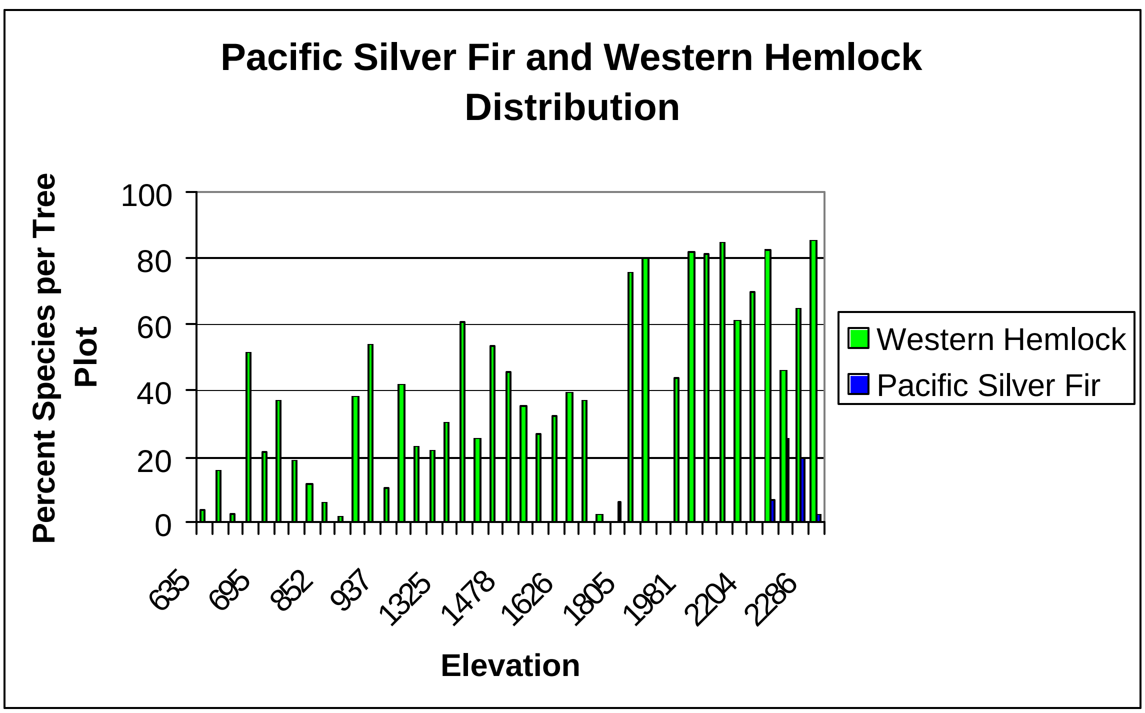


Figure 9-



Tree Species

The plots below an elevation of 1750 feet contain information about tree quantities and types. The tree data was assembled into the percent of tree species per plot. The percent of species per plot can be used as a projected tree composition for a planting phase in a succession design. The percent can be applied to the final design composition or used for an intermediate tree amount depending on factors like the size of the property, time (experimental plot ages or projected design time) and design goals. For instance, the Olympia succession design is projected to take180 years to complete and the average age for the Cedar River Watershed succession plots is 73 years. The difference in age indicates that the design may change vegetation composition from secondary growth (73 years) to a forest with old growth characteristics (180 years).

The primary projected vegetation species in this succession design, Douglas-fir, can survive several hundred years (or longer) in the Pacific Northwest and Washington State. The long life span of Douglas-fir creates a succession design opportunity to keep the tree percentages the same for the duration of the projected design. Douglas-fir can essentially live in an environment from 73 years (secondary growth) until 180 years (old growth characteristics) and longer. Therefore, the total tree percentage taken from data at 73 years can be used as the final tree species composition at 180 years. The total amounts of trees per planting phase can change, but the ratio of tree types will remain the same in a majority of the planting phases. For the Olympia succession design, the total tree species percent per plot will ultimately be used as the final tree species composition.

The Olympia succession design will implement the tree percentages from the Cedar River Watershed after a determined year. The determined year in this design is related to shade and the growth of shade tolerant tree species, which are established in the Cedar River Watershed experimental plot data (i.e. *Tsuga heterophylla*). The shade creates a microclimate that is more comparable to the experimental plots in Cedar River Watershed and consequently shade establishment is an indication that the plot data (i.e. tree percentages) can be utilized in the Olympia succession design. In other words, the Olympia site could have 50, 100 or 200 hundred total trees per planting phase, with 50 percent Western Hemlock (*Tsuga heterophylla*) (25, 50 and 100), as long as the design site has established an adequate microclimate for the survival and growth of the Western Hemlock (*Tsuga heterophylla*).

Total tree species percent per plot does not clearly indicate the tree types that may be present in unique environmental conditions and specific microclimates. *Intervention in Succession* recognizes that all plots below 1750 have varying microclimates with dry, moist, cool or hot conditions. Microclimates will influence the establishment of tree species in each individual plot causing diverse tree compositions and consequently taking a comprehensive species total per plot is inaccurate. The microclimates were unknown for each plot and, even though it may be inaccurate per individual plot, the tree species and amounts were compiled together to create a total percentage of tree species in Figure 10. The total tree percentage is meant to show the general tree composition for the whole *Tsuga heterophylla* zone in the Cedar River Watershed.

In an attempt to separate the moist from dry microclimates, the plots were also separated by an indicator species. Red alder (*Alnus rubra*) is a species that establishes itself most often on wet sites, so the plots were sorted by whether they contain 5 Red Alders or more with a DBH of 5 inches or more. Tree plots containing more than 5 Red

Alder species were considered to have moist microclimates, where plots with minimal or no Red Alder were considered to contain drier environmental conditions. This is not an accurate scientific method for separating these plots, but it is an estimate suitable for application in this succession design. Specifically, the tree percentages per wet plot will be applied to the areas of the design site with significant standing water. Figures 11 and 12 illustrate percent tree species on wet and dry sites.

Figure 10-

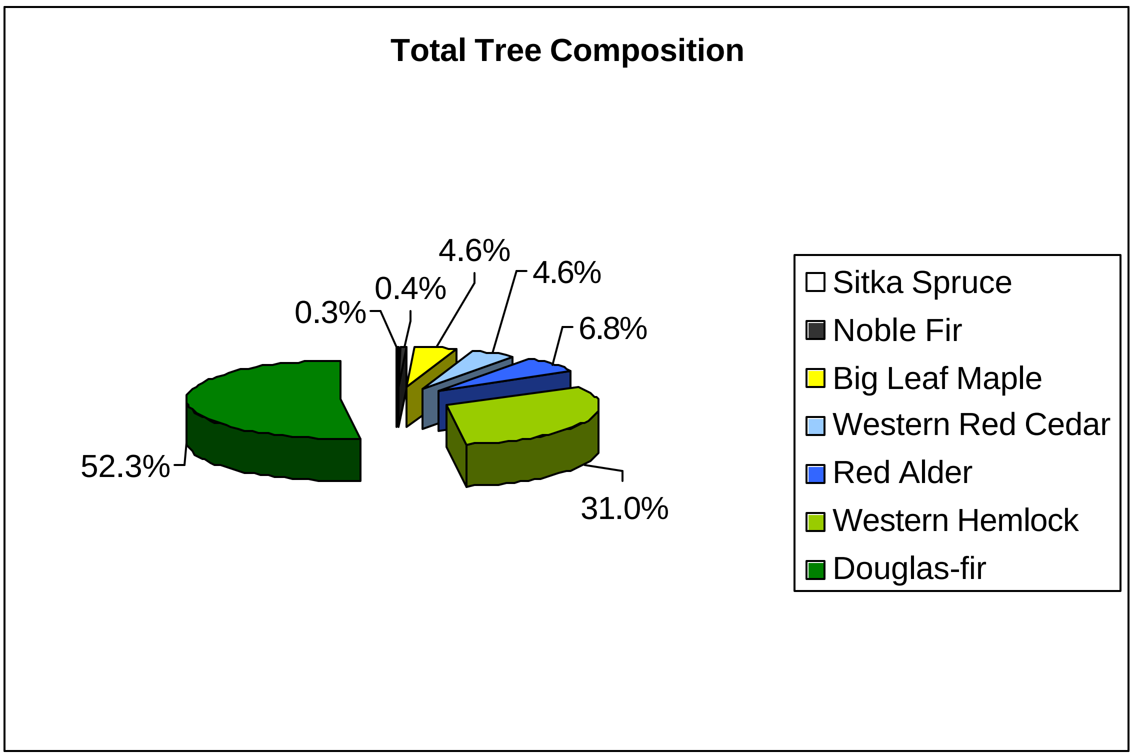


Figure 11-

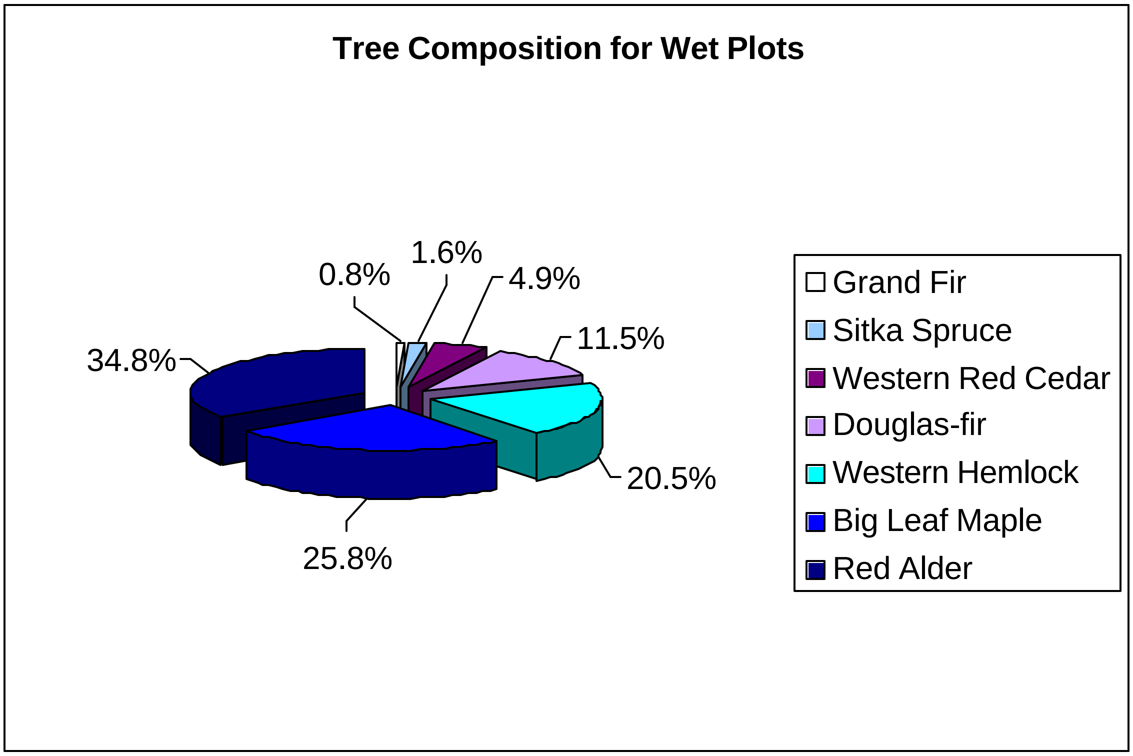
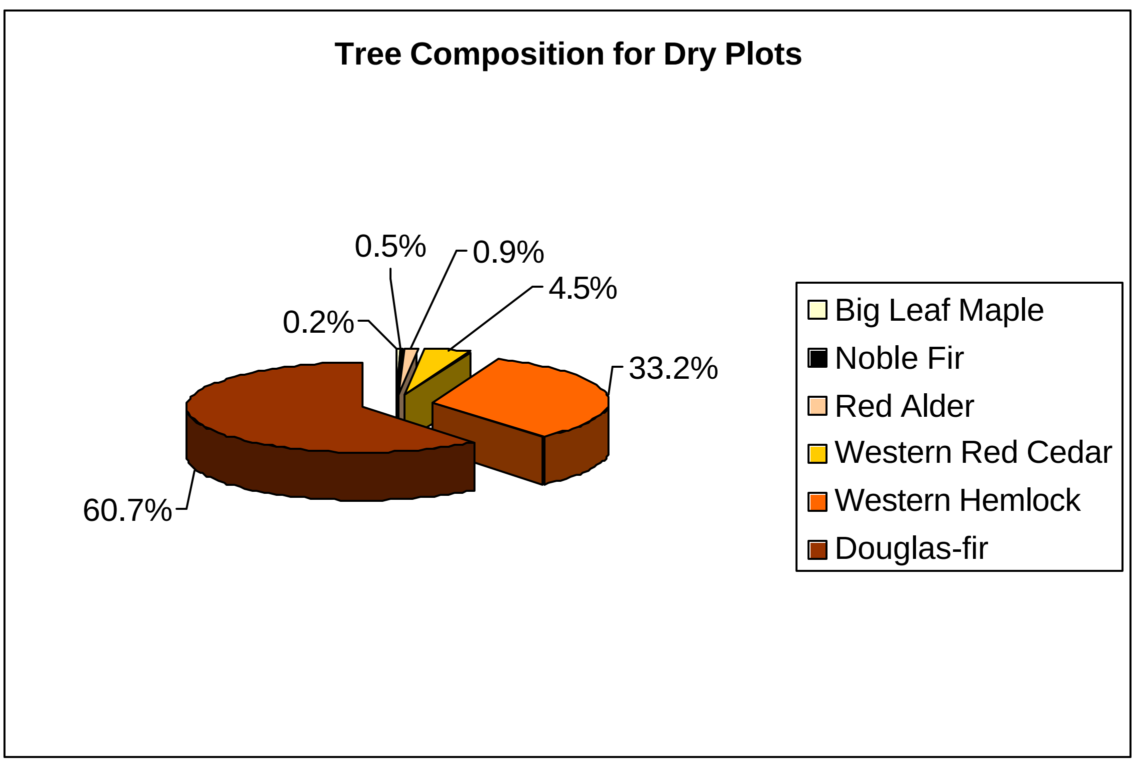


Figure 12-

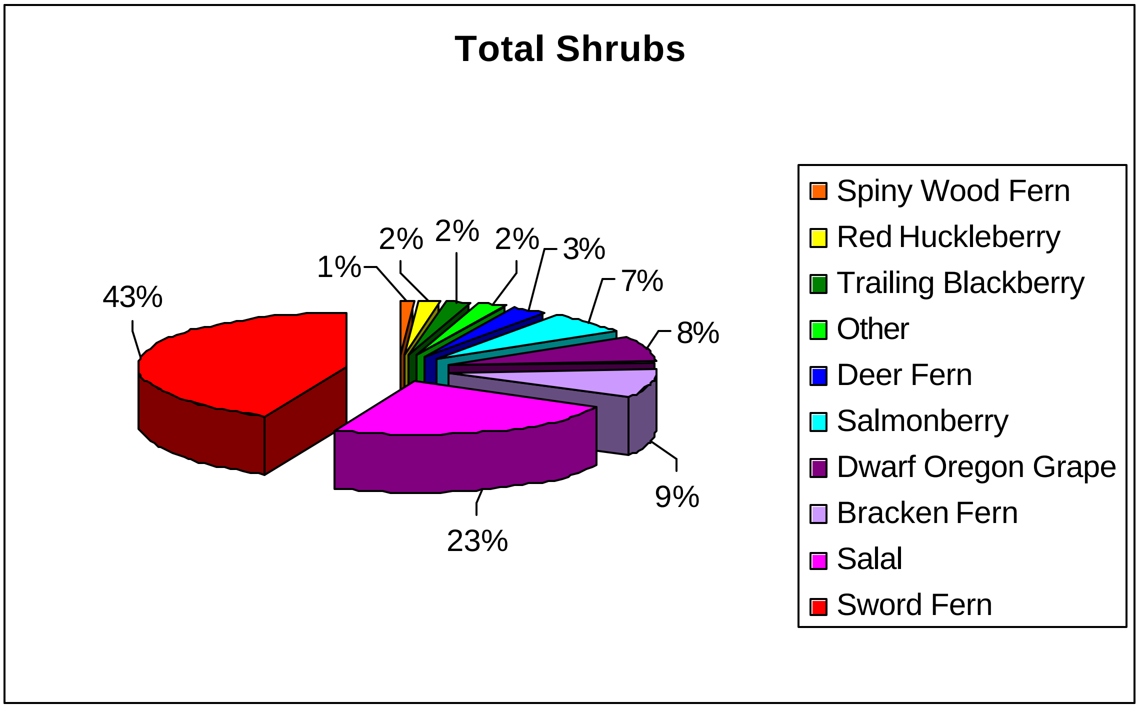


Shrubs

The total shrub species percentage per plot was calculated using data from the wind damage plots. The wind damage plots contain information about the types and amounts of shrubs and herbs that establish following a disturbance. Figure 13 is created to look at the shrub and herb composition per plot. The category called other (light green) contains small percentages of species like Devils Club (*Oplopanax horridus*), Lady Fern (*Athyrium filix-femina*), Himalayan Blackberry (*Rubus discolor*), Fool's Huckleberry (*Menziesia ferruginea*), Red Elderberry (*Sambucus racemosa*), Baldhip Rose (*Rosa Gymnocarpa*) and Oak Fern (*Gymnocarpium dryopteria*).

Vine Maple was not included in the total shrub species composition graph because these large shrubs were singled out and categorized as a tall shrub species. The Vine Maple shrub species composition was calculated using a shrub coverage estimate along the second growth and wind damage plot transects. Overall, Vine Maple composed a significant portion of the understory vegetation in all of the Cedar River Watershed second growth plots and therefore the species will be considered as the primary majority, larger understory species in the Olympia succession design.

Figure 13-



Environmental conditions in the wind damaged plots are the most important consideration for application of the Cedar River Watershed succession data into a succession design. The data application in the Olympia succession design must occur under comparable environmental conditions to the wind damage plots. Shrub data must be implemented in the succession design when the site has similar light availability and microclimate temperatures relative to the Cedar River Watershed plots to achieve the same shrub growth. Consequently, light availability was the plant resource analyzed within these plots to illustrate when the design site environment is comparable with the plot microclimate. Light availability, as a vegetation resource, is explored because the wind damage created openings in the tree canopy where light could reach the forest floor and stimulate shrub and herb growth (understory).

In order to explore light availability, the average trees per wind damage plot were calculated and compared with the average trees per tree plot. The amount of trees per plot will show the general openness or denseness of the tree canopies and subsequently the light availability for the forest floor. The average amount of trees per tree plot is 56 and the average amount of trees per wind damage plot is 35. The understory growth is minimal in the low light, dense canopied tree plots at 56 trees per plot, and the understory growth is higher for the open canopied wind damage plots at 35 trees per plot (Figure 13). Consequently, herb and shrub percents/types (from figure 13) are utilized in the design when the grown tree amounts (>5 inch DBH) are approximately 35 because of the higher light availability and comparable microclimate conditions.

Spatial Distribution

The succession design is based on experimental data about the types, amounts and spatial distribution of vegetation. Figures 14-25 show the spatial distribution of herb species in varying transects and at a mature height. These herb species distributions will be used in the succession design to represent a natural design pattern in the planting phases. Also, the distribution graphs will illustrate the vegetation patterns of the planting phases to help the client visualize the arrangement of the projected vegetation composition (shrubs and herbs). The illustration and aesthetic application of the graphs in the succession design will be described in Chapter 7. There are 12 graphs total and not all of them will be used and some may be repeated.

The exact shrub and herb species, represented in the graphs, will only be applied to the design when and where the environmental conditions are suitable for the vegetative species. Even though the wind damage plots allow for light at the forest floor, the Cedar

River Watershed plots contain cool and shady environments. As a result, the vegetation from the distribution graphs can only be applied to mature planting phases with a cooler, shady microclimate.

The species combinations from the individual graphs cannot be used in planting phases where exposure to light and heat are common. Therefore, variations of these distribution graphs will be used to create the initial planting plans with different, sun loving vegetation. The pattern of species organization preceding the establishment of shade is very important, and will ultimately direct the use of these distribution graphs (Figures 14-25) throughout the succession design.

Figure 14-

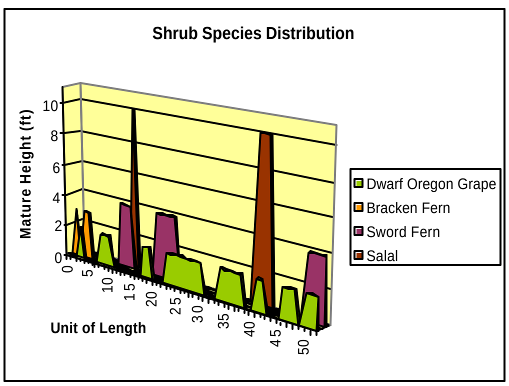


Figure 15-

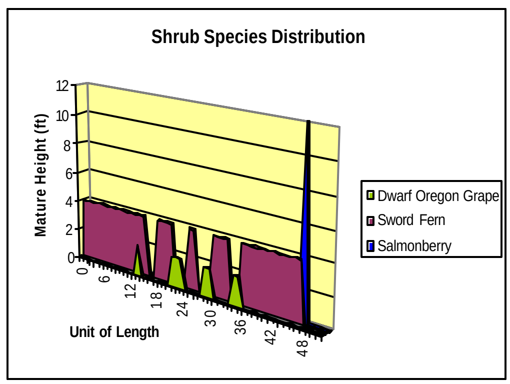


Figure 16-

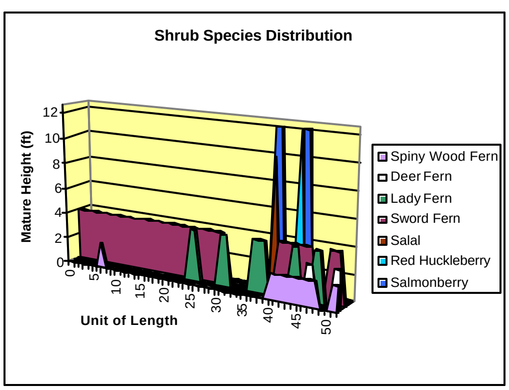


Figure 17-

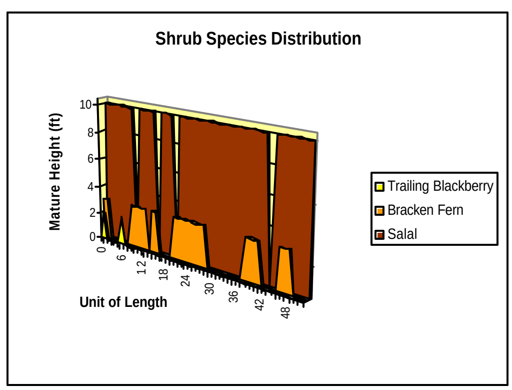


Figure 18-

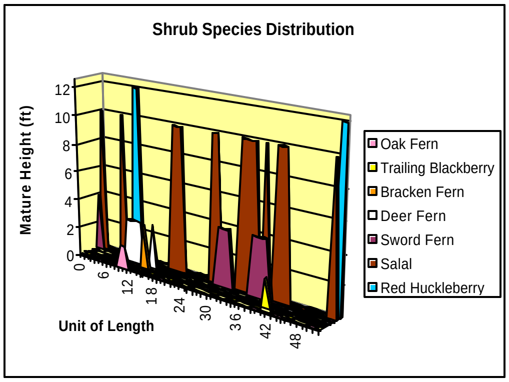


Figure 19-

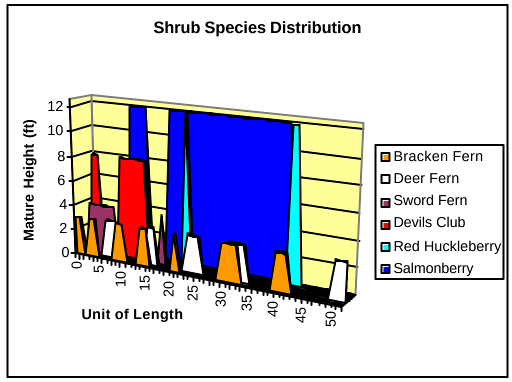


Figure 20-

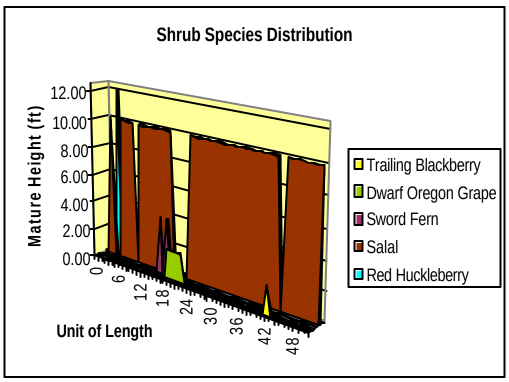


Figure 21-

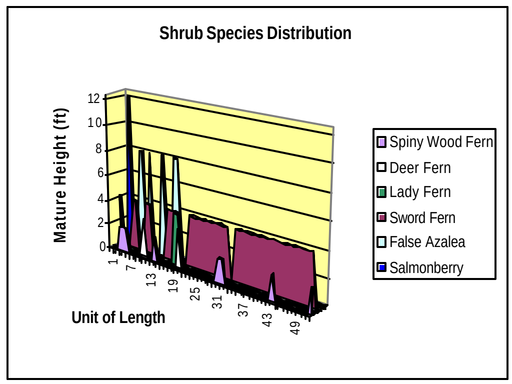


Figure 22-

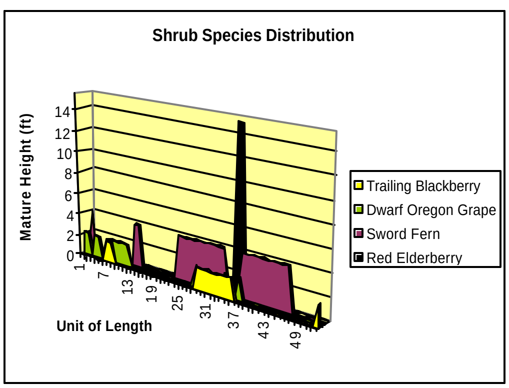


Figure 23-

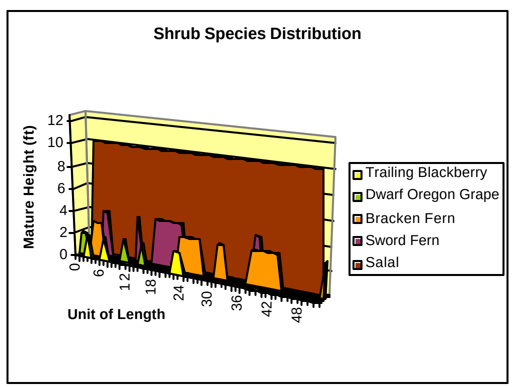
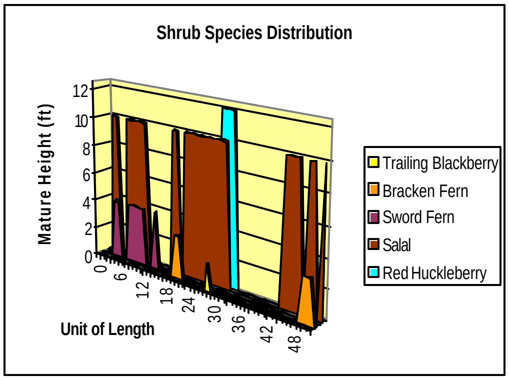
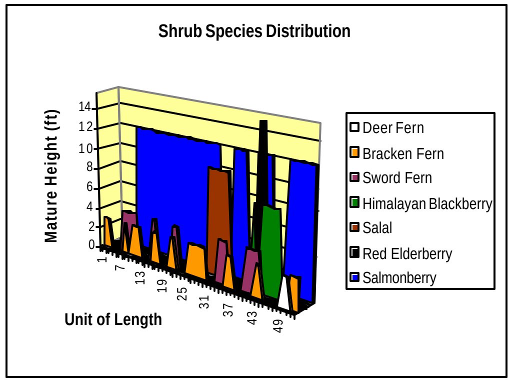


Figure 24- ***Figure 25-***





Conclusion

Chapter 6 explains the Cedar River Watershed plot data and data analysis that is comparable with the Olympia design site. The data relates to information that can be used in illustrating or informing the succession planning or human expression in the succession design. Furthermore, the information is critical to the Olympia succession design because it assists the designer in connecting, visually and/or emotionally with the projected species composition. Such connections can create meaning in the succession design and aid in the design communication with the client/s.

Chapter 7 will begin to explain the Olympia succession design and human expression in the landscape. Chapter 7 shows the integration of Cedar River Watershed succession information into planting phases and illustrations. The tree and shrub amounts, percentages, types and spatial distributions from the Cedar River Watershed plots are the primary considerations for all aspects of this succession design. Specifically, the plot data and analysis can support the aesthetic dialogue concerning human expression in the landscape. Chapter 7 focuses on aesthetic dialogue and human expression in the Olympia succession design.

Chapter 7- Communicating a Succession Design

Introduction

Communication is a fundamental component of a profession such as landscape architecture. Verbal, visual, and written communication coveys a landscape design's potential to contractors, clients and/or the public. To adequately present the design's features, it is crucial to combine the three parts of communication (verbal, written and visual) in ways that adequately reflect the design's concept, function, and experiential potential.

Visual representation in models, plans and supplemental drawings help people to imagine the possibilities within the existing environment. There are considerable discussions about visual representation within the landscape architecture profession (Corner, 1992 ed. Swaffield, 2002). Some visual communication in landscape architecture is technical and straightforward, but certain individuals consider these representations void of the intangible and expressive "feeling" that a landscape design possesses (Corner, 1992 ed. Swaffield, 2002). On the other hand, landscape drawings can be very artistic and expressive; they can be considered works of art separate from the designed environment they are representing. Often, these "works of art" only suggest the intended landscape design concept or appearance and can be considered abstract and confusing in the context of professional landscape design (Corner, 1992 ed. Swaffield, 2002). The appropriate visual representation for clear communication lies somewhere between a technical, informative drawing and an artistic, expressive representation of the potential landscape.

This chapter focuses on representing succession design, visually and verbally to express inherent shifting landscape compositions and appearance. The communication in a succession design should clearly and overtly take the viewer through cultural and environmental progression while simultaneously conveying the intended ambiance of each phase (time period) in the design.

Representing Time in Landscape Design: A Study of James Corner's (Field Operations) Downsview Park Design Competition Entry

It was mentioned in Chapter 4 that there are contemporary designers considering time and unintended change in landscape design. Designers, such as James Corner from Field Operations, are taking design concepts such as ecological and cultural change (over time) and attempting to incorporate and communicate them in landscape designs. One design that utilizes these concepts is the Downsview Park competition entry by James Corner (Field Operations). The Downsview Park design is a proposed landscape design that addresses time and ecological/ cultural change as fundamental entities of an urban park design. The competition entry was highly regarded as a finalist, but the design was not accepted as the competition winner.

Intervention in Succession suggests that the Field Operation's Downsview Park entry received criticism because the design communication (visual and written) lacked clarity and congruence. The next few paragraphs will give an explanation for the previous statement and then provide some suggestions for ways to connect the conceptual and visual elements of the Field Operation's Downsview Park design. The discussion concerning this design will provide insight into a method for communicating time and change in a succession design. The visual and written communication elements of this discussion should be considered in the application of the succession design methodology.

Communicating the Concepts of Time and Change (written or verbal)

The James Corner (Field Operations) Downsview Park design was centered on guiding ecological and cultural activity through a design of circuits or a series of geometric fields (Czerniak, J., 2001, Parc Downsview Park Inc., 2004; Van Alen Institute, 2005). These geometric fields could change overtime to reveal emergent ecological and cultural landscapes (Czerniak, 2001; Van Alen Institute, 2005). Field Operations elaborates, “the framework consists of an overlay of two complimentary organizational systems: circuit ecologies and throughflow ecologies. These systems seed the site with potential. Others will fill it in over time. We do not predict or determine outcomes; we simply guide or steer flows of matter and information" (Parc Downsview Park Inc., 2004). Field Operations essentially creates a structured five year design plan without commitment to ecological or cultural expectations over a long-term time period.

Contrarily, Field Operations does suggest long term ecological and cultural change in their written communication on illustrations and drawings. They do predict twenty years or more of structural changes, habitat modifications, and species introductions on this 320 acre park property (Czerniak, 2001). The planning and predictions are essential for understanding the design, but future planning causes a contradiction with the textual communication of the design concept.

A similar negative statement was made by individuals who thought that this Downsview park design entry was over-designed (Van Alan Institute, 2005). Field Operations responded to the “over-designed” comment with a statement; “we have argued in our writings since that if you are looking for emergence, flexibility and open ended-ness then you should not come up with a solution that is too general and ad hoc, but one that is specific, understood in terms of the matter, energy, and information that these lifelines bring to the system and prove this through testing the geometries" (Van Alan Institute, 2005). This statement reveals that the criticism is spurred, in part, by the inconsistent relationship between the design concept and the design layout. A design that is described as open-ended and unpredictable would be difficult to plan and illustrate because the future appearances of the site are unknown and purposefully unplanned. Overall, it would be difficult for any landscape architect to create a design where we did not, in some way, predict, plan and communicate outcomes of the landscape appearance, vegetative growth, landuse, etc..

Intervention in Succession partly addresses the criticism that James Corner (Field Operations) received by producing a method for specifically considering a long-term design strategy with ecology and human expression. The succession design method provides structure for written and verbal communication and design explanations between the landscape architect, client, and/or public. Additionally, the method will be more overt in predicting and planning landscape change than Field Operation's Downsview Park design and it will explicitly state the imminent, unpredicted biotic or abiotic landscape modifications.

Communicating the Concepts of Time and Change (visually)

It is likely that part of the criticism that James Corner (Field Operations) received regarding the "over-designed" Downsview Park was caused by an inconsistent visual representation of the landscape with the design concept. For example, Field Operations purposefully illustrates possible changes occurring in the park over time. They use Photoshop (or a picture rendering program) and computer generated plans to illustrate perspectives, master plans, and timelines that are predicted to occur after the Downsview design implementation (Picture 5). These visual compositions have current or realized appearances that do not depict an open-ended, undetermined landscape design. Also, the drawings are not explicitly labeled and grouped within the years (phases or timeframes) that they will be realized in the landscape. Therefore, Field Operation's Downsview Park illustrations that are intended to represent the landscape over time may unintentionally give an impression of a confusing, finalized, or over-composed initial design. In general, the visual representation of the Downsview plan does not present room for the growth or change that the design concept described.

Picture 5- James Corner and Stan Allen (Field Operations) Downsview Design Competition Entry (Czerniak, 2001, p. 61)

Theories and Techniques for Illustrating Succession

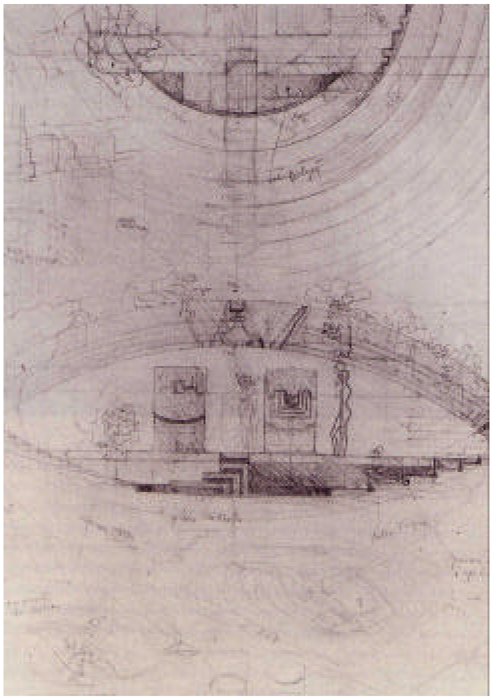
The visual representation of an intangible element, such as time, is difficult to illustrate especially if there is simultaneously an intention to make some explicit future plans or predictions. The question to answer becomes, "Are there any illustration techniques that will incorporate the intangible and tangible elements of landscape planning with time and unintended change?" There are some drawing techniques and theories that may help illustrate these landscape design elements. Ironically, theories about representing the "unknown" or "intangible" qualities of landscape design come from James Corner himself*. He explains landscape representations in graphic signs/symbols and works called "deixis".

Graphic signs/symbols and "deixis" illustration techniques rely on communication of the idea and intent and disregard the pictorial, realistic image. Representing with graphic signs and symbols uses parts of the pictorial image to create new and different illustrations where the intent or idea becomes evident. Corner (Corner 1992 ed. Swaffield, 2002) writes, "while such highly suggestive works are clearly visual, they are not images. That is, they do not directly resemble the optical image of things, the image, or the retinal specter, but rather they point to the idea which underlies things" (p. 155). Similarly, "deixis" is diagrammatic in that it shows aspects of the design, but it forms a composition of intent not necessarily recognized as a pictorial image within the proposed landscape (Picture 6). Bryson (Corner, 1992 ed. Swaffield, 2002) states that deixis, "includes all those particles and forms of speech where the utterance incorporates into itself information about its own spatial position relative to its content (here, there, near, far) and to its own relative temporality (yesterday, today, tomorrow, sooner, later, long ago)" (p. 164).

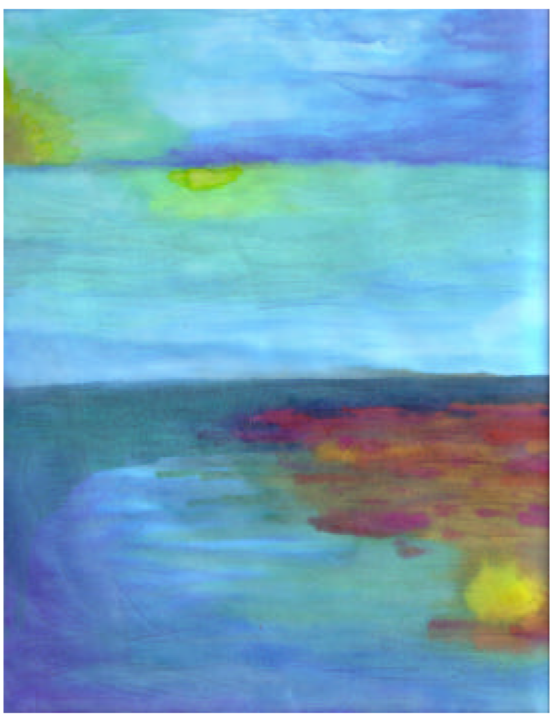
*There are many documents addressing visual illustrations depicting intangible landscape design elements. A discussion involving this entire body of literature is not applicable or necessary for *Intervention in Succession*.

Picture 6- Deixis- Plan and Section of the Arcosolium at Brion, Carlo Scarpa, 1969.

(Corner, 1992 ed. Swaffield, 2002, p. 163)



Picture 7- Deixis- Abstract Pictorial (Horton, 2005)



Graphic signs/symbols and "deixis" techniques are helpful in approaching and introducing succession design, but using a combination of the previously mentioned abstract techniques along with the more conventional design representation is advocated in the succession design methodology. The use of AutoCAD (drafting) to represent scale and location, photographs of the site, drawings of realistic views within the landscape, and sections, are important to show a client the intended and planned results. The addition and combination of the more abstract deixis, sign/symbols, and hand drawings give the client an impression of intent, change, temporality, and inevitable unpredictability. Hand drawings are done by the landscape architect and similar to deixis and sign/symbols they can show intent and subtleness with application. The combination of techniques is essential for visual communication and understanding of a succession design.

Conclusion

Communicating a succession design can be a difficult endeavor because of the "intangible" or "unknown" elements of time and change in the design. In order to communicate time and change, they need to be combined with the planned, calculated components of the succession design method. The combination of unknown and planned elements should form a concise and inclusive concept that can be communicated verbally and visually. The visual communication can use two types of representation, signs/symbols and deixis, in combination with more traditional landscape representation to create an understandable visual connection to the design concept. Communication, especially visual, is important for a rapid understanding of the depth, richness, and ecological/cultural importance of a succession design.

Chapter 8- Project Design Description

Introduction

Chapter 8 describes the thought process and methods regarding the design illustrations and planting plans. The succession design is described with conceptual illustrations, planting plans, drawings and graphs. The following sections in this chapter separate the drawing explanations by planting phase for clarity and readability. The illustrations are located in Appendix A from page 95 to 112.

Concept- Drawings A

There are three abstract drawings that convey vegetation succession in a general sense on this property. The conceptual drawings communicate intent and do not show the design pictorially or realistically. The illustrations attempt to communicate the feeling of passing time, growth, science, "nature", human interaction and movement.

Site Design and Focus Area- Drawings B

This illustration shows the entire site and outlines general design areas with differing plant compositions, soils and landuses. These areas include: the home area, Douglas-fir forest (Western Hemlock association), wet wildflower meadow, native plant nursery (sunny plant storage location), parking, cedar marsh (with shade plant storage location) and emergent wetland.

Drawing B also shows the most important area for this landscape design. It is a section of the Douglas-fir forest (A1) and the wet wildflower meadow (B). This area includes views from the large bay windows in the home, hot tub and deck. This particular view of an existing hay pasture is an integral and extended part of the home. In fact, this hay pasture is so important for the ambiance inside the home, it supersedes the landscape immediately surrounding the house. The qualities of the spaces within the home depend on this part of the property. Therefore, the hay pasture is the sole focus of the succession design and by design it will become a Douglas-fir forest and wet wildflower meadow.

Phase 1- Drawings C and D

These drawings include a planting plan, sketch and perspective. The planting of Douglas-fir is random, but the number of trees was determined using a succession article by Garman et al. (2003). Garman et al. (2003) uses a computer model to determine succession outcomes with different numbers of Douglas-fir thinning treatments. A succession outcome in the Garman et al. article is not plant composition at a certain time, but rather, the time when the forest achieves old-growth characteristics (set by the model). The model is used for forestry practices and not landscape architecture. Therefore, the results were interpreted and manipulated to fit this landscape design.

Garman et al. (2003) suggest that in ideal conditions, thinning to 136 trees per hectare will help to expedite late-successional old-growth forest characteristics. The Olympia succession design will begin with 136 trees per hectare with the intention that additional trees will be added over time. It is predicted that the surviving initial tree population will develop the desired old-growth characteristics within (and possibly before) 180 years.

The Douglas-fir area is approximately 1.5 acres and calculations indicate approximately 82 Douglas-fir seedlings for this first phase. Douglas-fir planting will include the addition of seeding with wild flowers such as Bigleaf Lupine and California Poppy. Maintenance within the first five years will include manually clearing the plants (weeds or new wildflower starts) around the Douglas-fir to eliminate competition for resources from other vegetation.

The wet wildflower meadow will be planted with a combination of Common Camas (*Camassia quamash*), White Fawn Lily (*Erythronium oregonum*), Chocolate Lily (*Fritillaria lanceolata*), Satin-flower or Douglas' Blue-eyed Grass (*Sisyrinchium douglasii*), Blue-Eyed-Grass (*Sisyrinchium idahoense*), Golden-Eyed-Grass (*Sisyrinchium californicum*), Broad-leaved Shooting Star or Henderson's Shooting Star (*Dodecatheon hendersonii*), Yellow Prairie Violet (*Viola praemorsa*), Small-flowered Blue-eyed Mary (*Collinsia parviflora*), Leafy Aster (*Aster foliaceus*), Hooker's Onion (*Allium acuminatum*), Nodding Onion (*Allium cernuum*), Western Buttercup (*Ranunculus occidentalis*), and Prairie Smoke (*Geum triflorum*) (Fuchs, M., 2000, Pojar & Mackinnon, 1994; Robson & Henn, 2005). Each small green circle on the drawing represents plantings of approximately 50 of these plants. Maintenance in this wildflower area requires prescribed burns every 3-5 years in the spring or fall. The prescribed burn will maintain the wildflower meadow area by reducing the competition among unwanted species. Ideally, the prescribed burn will facilitate the growth and spread of the Common Camas (*Camassia quamash*) within the meadow.

Phase 2- Drawings E

Planting in this phase requires the addition of Douglas-fir seedlings. The goal of adding Douglas-fir seedlings is to alter tree heights and forms for visual variation. An additional goal is to acquire seedlings from different nursery sources so that the genetic stock of the Douglas-fir area will be varied. Genetic stock variation is very important for the health and disease resistance of these Douglas-fir trees. For example, one genetic combination from a nursery source can be replicated in a stand of Douglas-fir. In this example, that particular genetic combination is susceptible to a blight that will plague the northwest in 20 years and consequently all proximal trees with that genetic combination will die. A diverse genetic stock will hopefully create some resistance in the stand of Douglas-fir so that the entire stand does not expire. Overall, the goal of this plan is to give these trees the best chance at surviving on this site for 180 years or longer.

The amount of trees added to the site during this phase is approximately 25 Douglas-fir seedlings. This amount of Douglas fir seedlings is based on the total projected composition of Douglas-fir on site by phase 3. Final Douglas-fir amounts will be explained in the phase 3 section.

No additions are made to the wet wildflower meadow, unless the meadow needs to be replanted in some areas

Phase 3- Drawings F

There are approximately 25 Douglas-fir trees added to the site in phase 3. The final Douglas-fir total on site is around 132 trees. This number is based on the wind damage plot data from Cedar River Watershed. In chapter 4, it mentioned that the light availability is greater in the wind damage plots for understory (shrubs/herbs) growth. The light availability is essential for understory establishment in this succession design, so the Cedar River Watershed data was used to calculate total trees for the Douglas-fir area. The average amount of trees in Cedar River Watershed wind damage plots is 35 trees, a figure that calculated and converted to approximately 132 trees for this 1.5 acre piece of land.

Again, no planting occurs in the wildflower meadow. Maintenance (prescribed burn) occurs every 3-5 years and continues through the 180 years

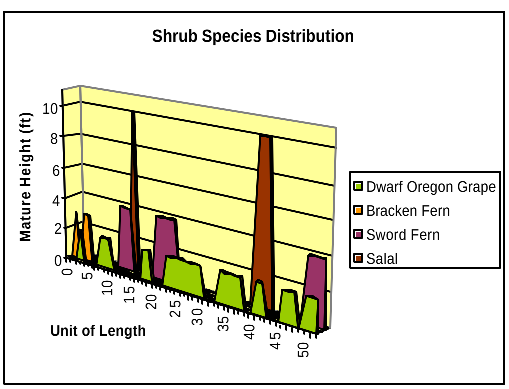
Phase 4- Drawings G, H and Understory Drawings I, J, K, L, M, N, O

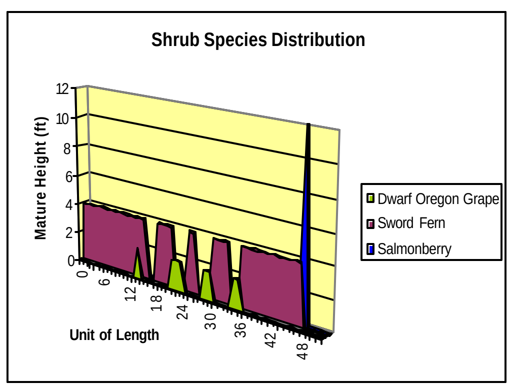
Drawings G and H express the landscape in 15-20 years, at which time an understory design can be implemented under the shade provided by the Douglas-fir. Shade tolerant understory vegetation such as Sword Fern and Salmonberry can be introduced into the landscape.

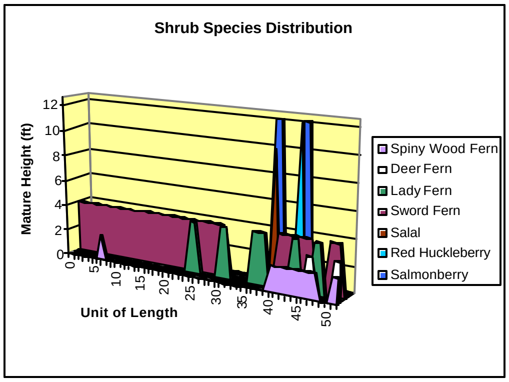
The understory shrub and herb vegetation is planted throughout the Douglas-fir area in phase 4. The geometry and spatial arrangement of the shrubs and herbs were calculated using data from the Cedar River Watershed. The understory design is a direct visual communication of succession data (graphs) into the landscape design. It is an example integrating architect preference, scientific communication conventions, and site.

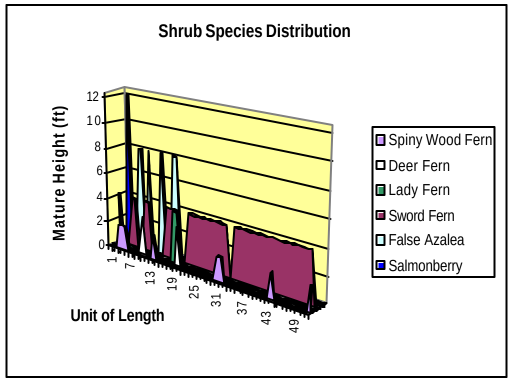
The spatial arrangement is based on graphs from chapter 6. Five graphs were used (Below).

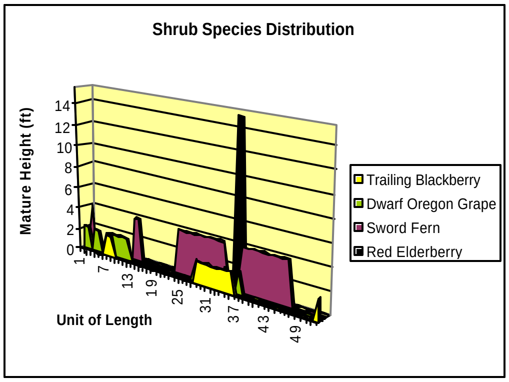
Spatial Distribution Graphs-





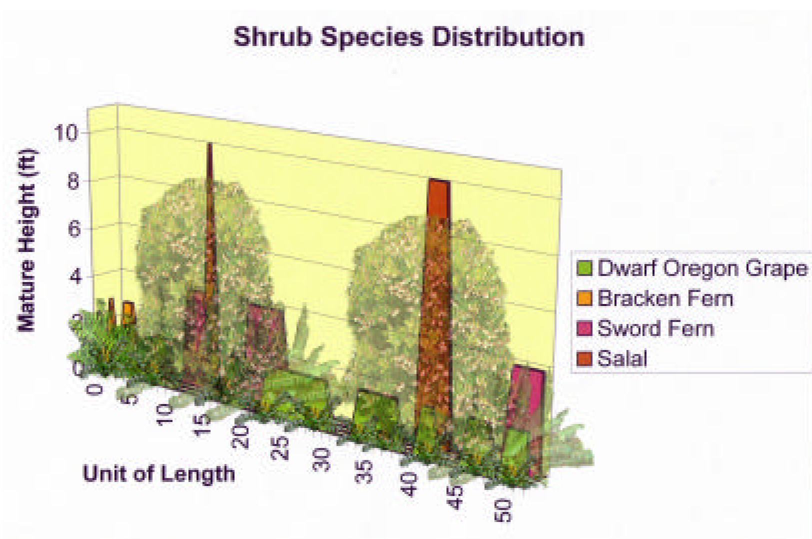






The graphs were used as a template for vegetation distribution. An example graph with a photo overlay is shown below.

<u>Example Shrub Species Distribution-</u>

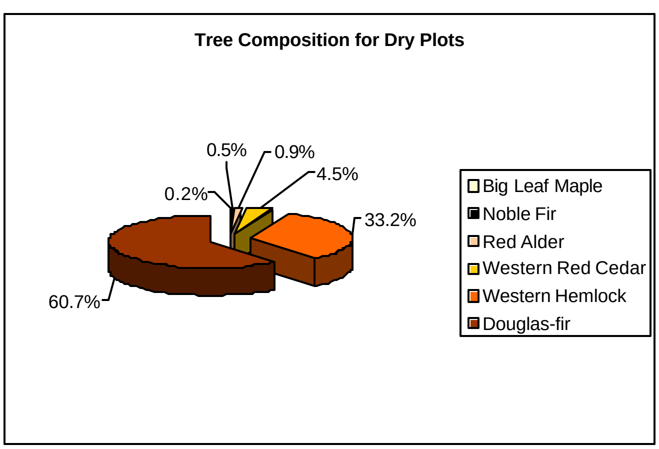


The shrubs and herbs are then arrayed around the center point of a circle to create a unique circular pattern. The patterns are used to guide planting under the Douglas-fir or around the Douglas-fir. The trees located within the understory circles become part of the pattern. The circular patterns are along the paths so that people walking through the Douglas-fir area have the opportunity to experience the understory vegetation and structure. Vegetation surrounding the circles is primarily Vine Maple and additional understory trees that are introduced in phase 5.

Phase 5- Drawings P

Phase 5 introduces an understory tree composition that will become a middle story and replacement tree stand if the Douglas-fir is damaged or dies. Understory tree composition includes Western Hemlock, Western Red Cedar and Red Alder. The quantities and type of trees are derived from the dry tree plot data explained in Chapter 6 from the Cedar River Watershed (Below). Total tree species for the stand is approximately 217, which is calculated by using 132 Douglas-fir as 60.7 percent of the total stand. Therefore, additional trees include 72 Western Hemlock, 10 Western Red Cedar, 2 Red Alder and the other tree species amounts are insignificant.

Tree Composition for Dry Plots from Chapter 6-



Phase 6- Drawings Q and R

These drawings show the projected species composition in 180 years. The illustrations try to convey the unknown components of the future and the planned elements in the design. The graphics are playful and subtle and simultaneously show the intentions behind the long-term ecological planning for this design site.

Conclusions-

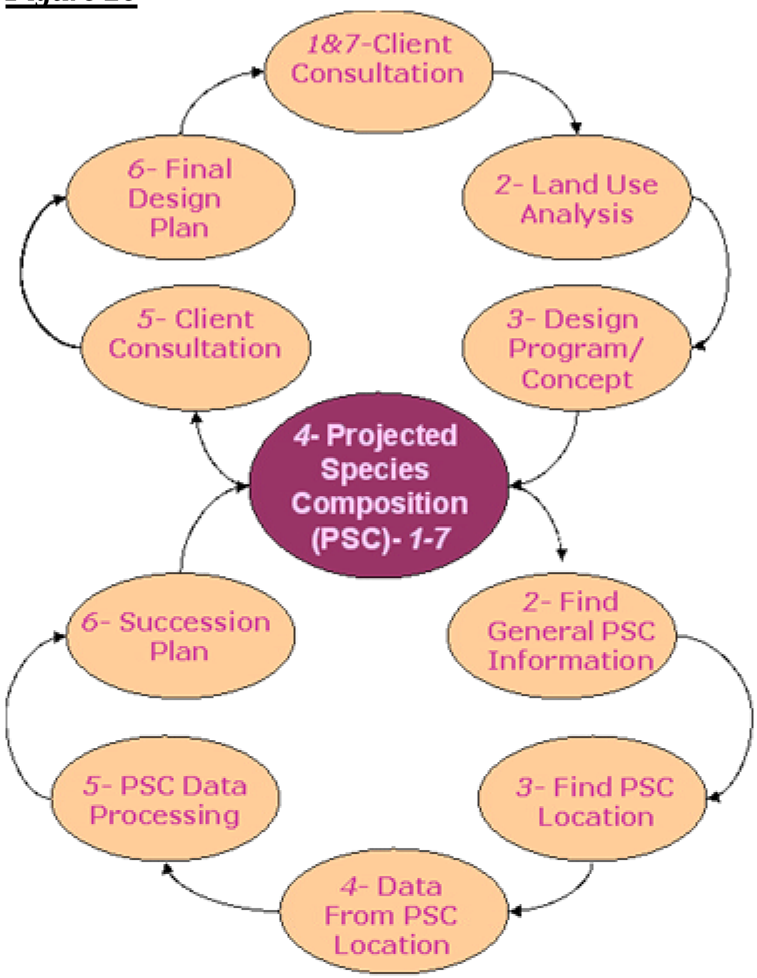
The illustrations show the intentions, descriptions and results for the planting phases in this succession design (Sections A1 and B). The illustrations are meant to give a visual and textual example of the innovative potential in a succession design method. The design illustrations arise from the synthesis of information gathered in the succession design methodology process.

Chapter 9- Conclusion

Intervention in Succession promotes the use of vegetation succession theory in landscape design. Succession theory encompasses scientific information regarding aspects of the environment such as vegetation, soils, hydrology, climate, and topography. The scientific information utilized in succession theory can be applied in the planning and landscape design processes. The succession information can be used to create the experience in the design as well as inform the clients of landscape changes. Additionally, vegetation succession can be beneficial for reducing landscape installation and maintenance costs.

The application of succession theory in landscape architecture is explained with the succession design method/model (figure 26) and then shown in the succession design example by integrating scientific data from the Cedar River Watershed, Northbend, Washington and a design site located in Olympia, Washington. The succession design example is useful in that it shows the succession model application on a large private property where the clients have a temporal, naturalistic design vision. Yet, the project example is idealistic because scientific information, landuse, client preference, private property size and projected species compositions perfectly fit the succession design method/model. Few private property residents have a large piece of property and a design goal that coalesces with the guidelines put forth in the succession method/model. The succession model may have more application on large, public landscapes where the comprehensive public vision fits the application of temporal vegetation succession. Also, the model may be better implemented and maintained on larger, public landscapes for planning, maintenance, spatial or monetary reasons. Regardless, the intentions of the succession method/model are to convey an inclusive view of vegetation succession that encompasses all landscapes (size and type) and human preferences. The primary purpose of the succession method/model is to encourage landscape architects to use the science and temporal aspects of succession in their designs.

Figure 26

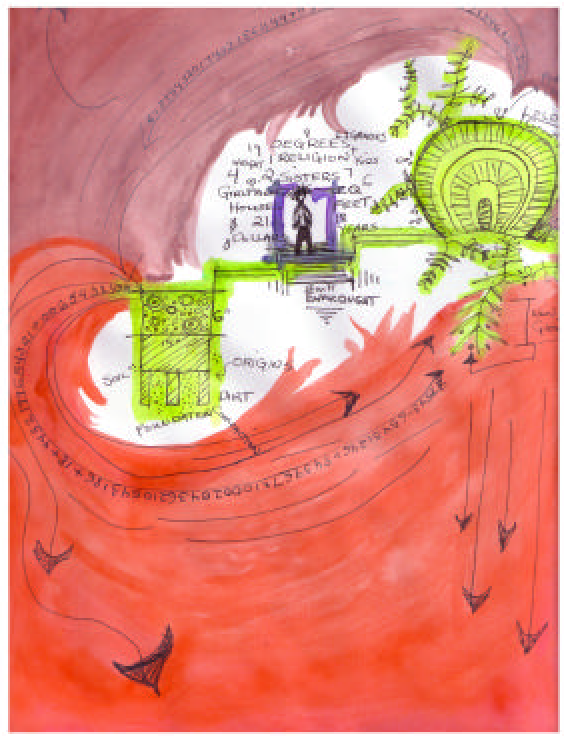


The final succession design products should communicate the temporal and scientific aspects of the landscape in phases. Each phase or time period should visually and textually engage the client in the design sensation, appearance and maintenance (disturbances). The design is communicated via illustrations that may not show pictorial views of the landscape, but rather the intention behind the design itself. The intentions embodied in a succession design include time, change and the unknown. Representing time and the unknown are essential to communicating the purpose in a succession design.

The implementation and representation of a succession design method in a landscape design is a dynamic process. The dynamism results from various client and architect preferences, future planning, unique regions, and varying site landuses and environments. The combinations of the human and environmental succession design variables produces different design outcomes. Additionally, the succession design dynamics are carried out over time because of unknown scientific and environmental knowledge. A succession design must imply unforeseen landscape change and additional scientific knowledge; it must communicate the known as well as the unknown variables. Consequently, a design which utilizes vegetation succession will synthesize time, change (unknown), ecological scientific (known and unknown) and intuitive knowledge. Imaginatively combining and communicating the known and unknown (implied) succession design elements generates a landscape design with extraordinary long-term cultural and ecological potential.

Appendix A-

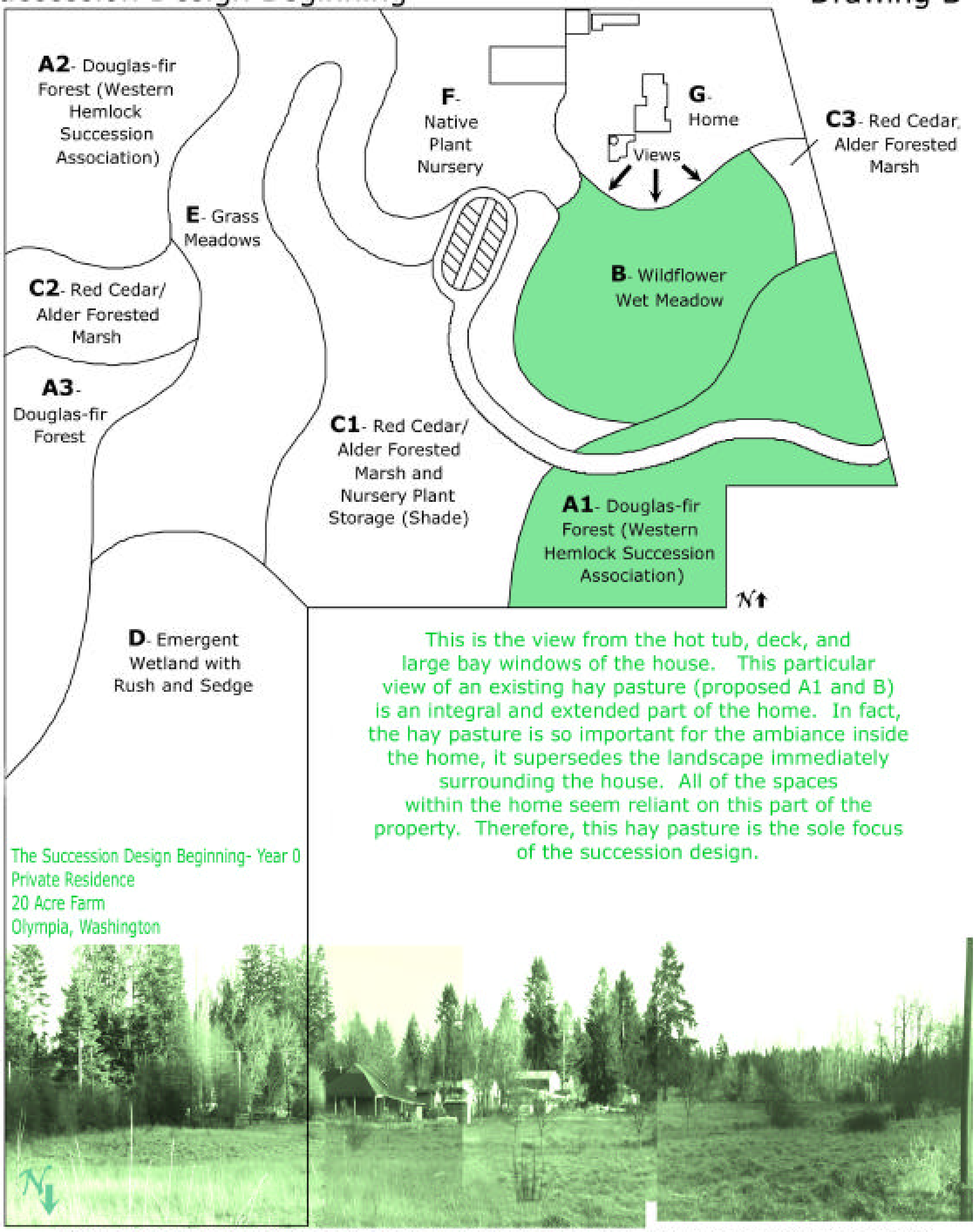
Drawing A-
Drawings and Diagrams



These diagrams and drawings depict human interaction with their environment or time, change, and growth in the landscape. They are not meant to show any particular view of the succession design itself.

Succession Design Beginning

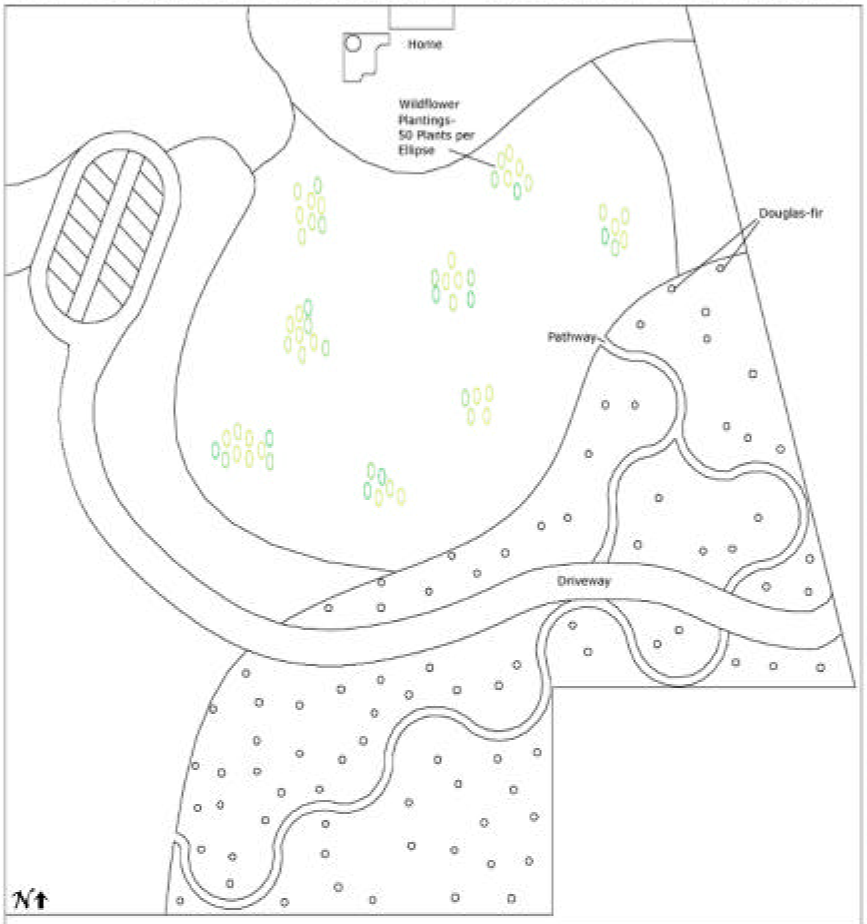
Drawing B



View From Home Overlooking An Existing Hay Pasture (Proposed A1 and B)

Phase 1 (0-5 Years)

A1- Douglas-Fir Forest & **B**- Wildflower Wet Meadow



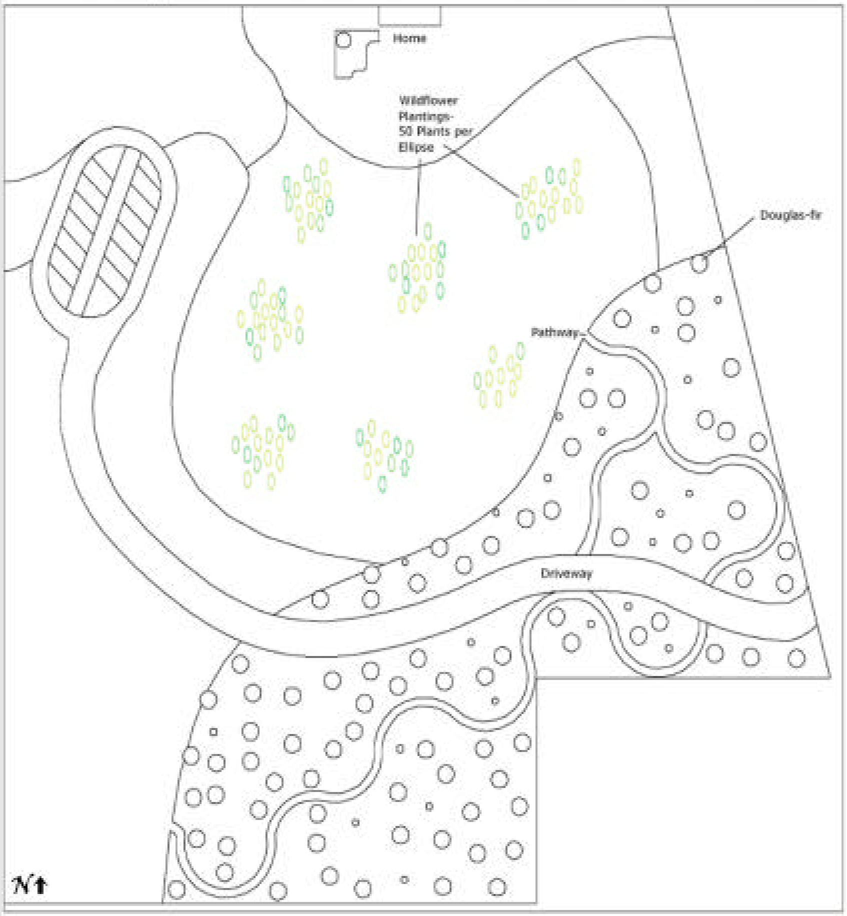
Drawing C

Meadow Plant species include: primarily Common Camas (*Camassia quamash*) with Blue-Eyed-Grass (*Sisyrinchium idahoense*), Golden-Eyed-Grass (*Sisyrinchium californicum*), Hooker's Onion (*Allium acuminatum*), Nodding Onion (*Allium cernuum*), Yellow Prairie Violet (*Viola praemorsa*), and Small-flowered Blue-eyed Mary (*Collinsia parviflora*).

Phase 1- 0-5 Years
Drawing D
Road
Cedar Marsh Vegetation
Road Screen
Views
House
Deck
Cedar Marsh Vegetation
Shade Tolerant Plant Storage
for Native Plant Nursery
Cedar Marsh Vegetation
Parking Screen
North
Native Plant Nursery

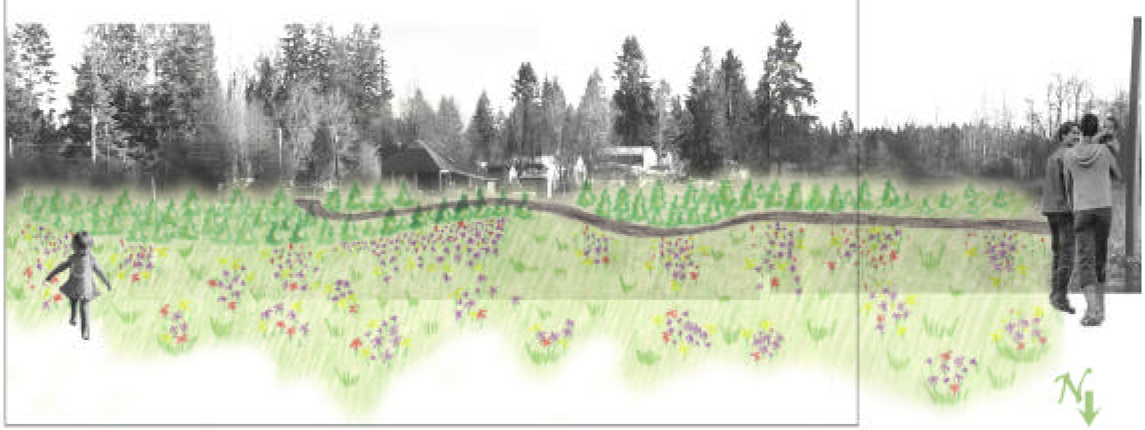
Phase 2 (5-10 Years)

A1- Douglas-Fir Forest & **B**- Wildflower Wet Meadow



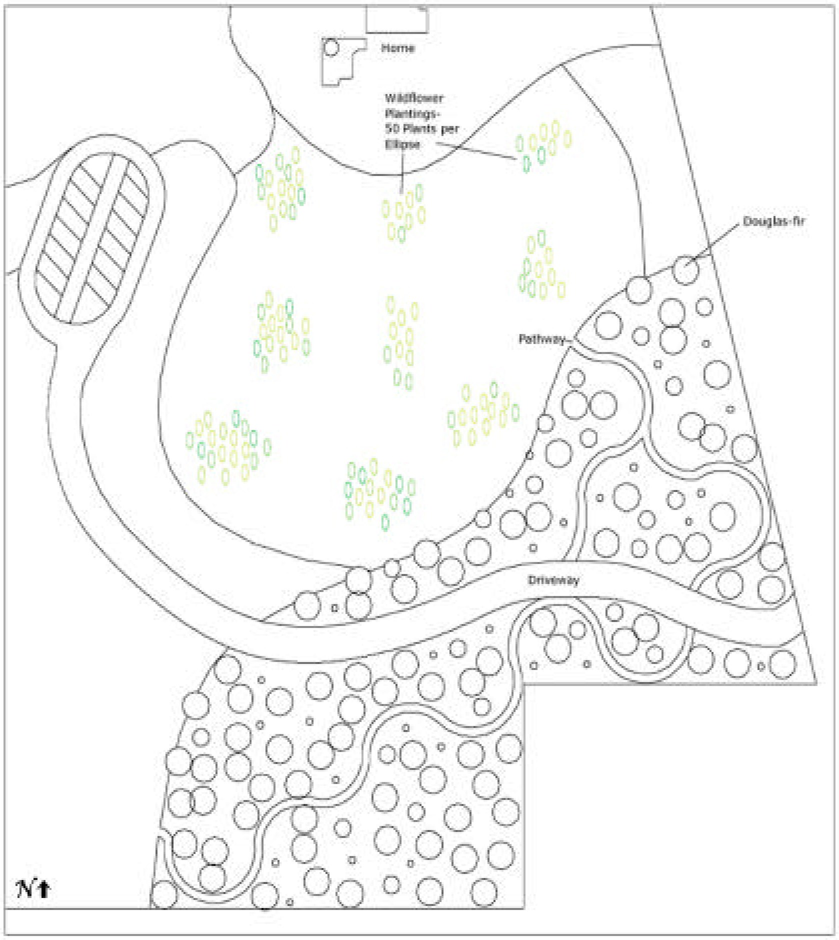
Drawing E

Meadow Plant species include: primarily Common Camas (*Camassia quamash*) with Blue-Eyed-Grass (*Sisyrinchium idahoense*), Golden-Eyed-Grass (*Sisyrinchium californicum*), Hooker's Onion (*Allium acuminatum*), Nodding Onion (*Allium cernuum*), Yellow Prairie Violet (*Viola praemorsa*), and Small-flowered Blue-eyed Mary (*Collinsia parviflora*).



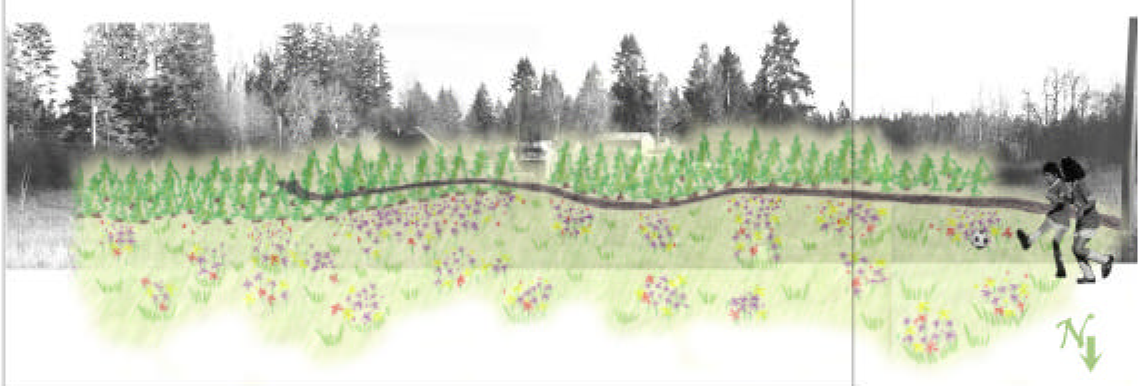
Phase 3 (10-15 Years)

A1- Douglas-Fir Forest & B- Wildflower Wet Meadow



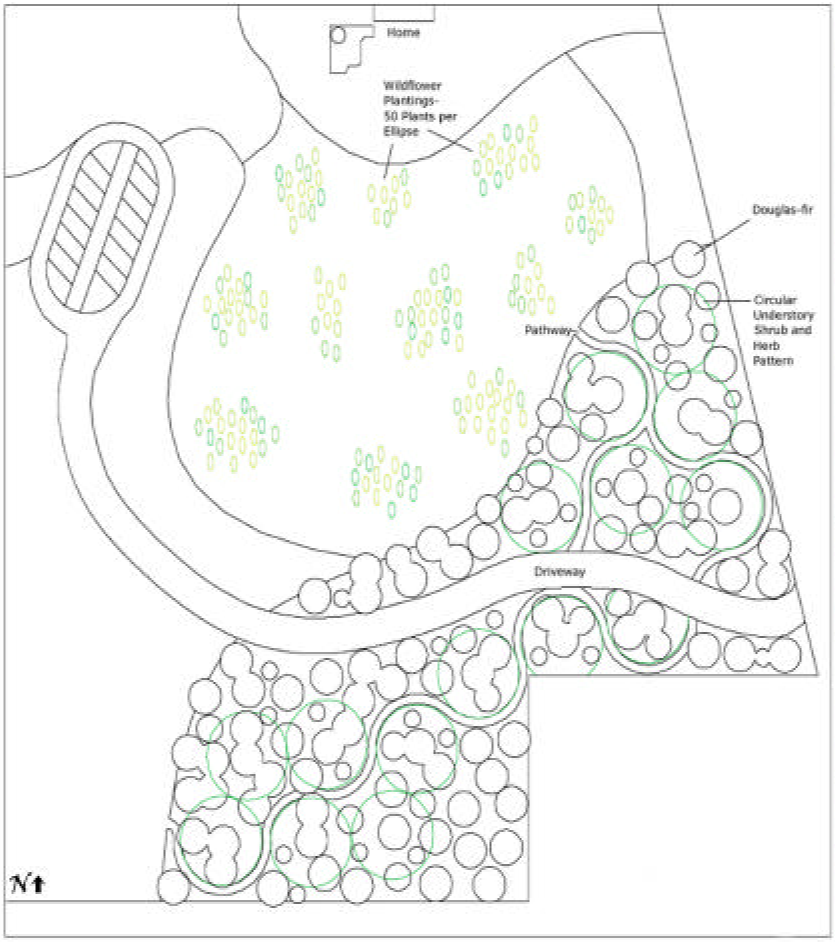
Drawing F

Meadow Plant species include: primarily Common Camas (*Camassia quamash*) with Blue-Eyed-Grass (*Sisyrinchium idahoense*), Golden-Eyed-Grass (*Sisyrinchium californicum*), Hooker's Onion (*Allium acuminatum*), Nodding Onion (*Allium cernuum*), Yellow Prairie Violet (*Viola praemorsa*), and Small-flowered Blue-eyed Mary (*Collinsia parviflora*).



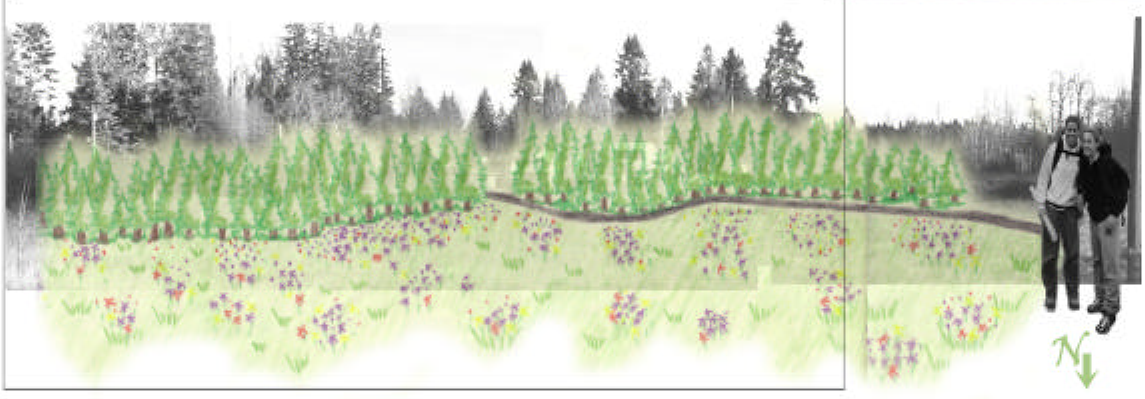
Phase 4 (15-20 Years)

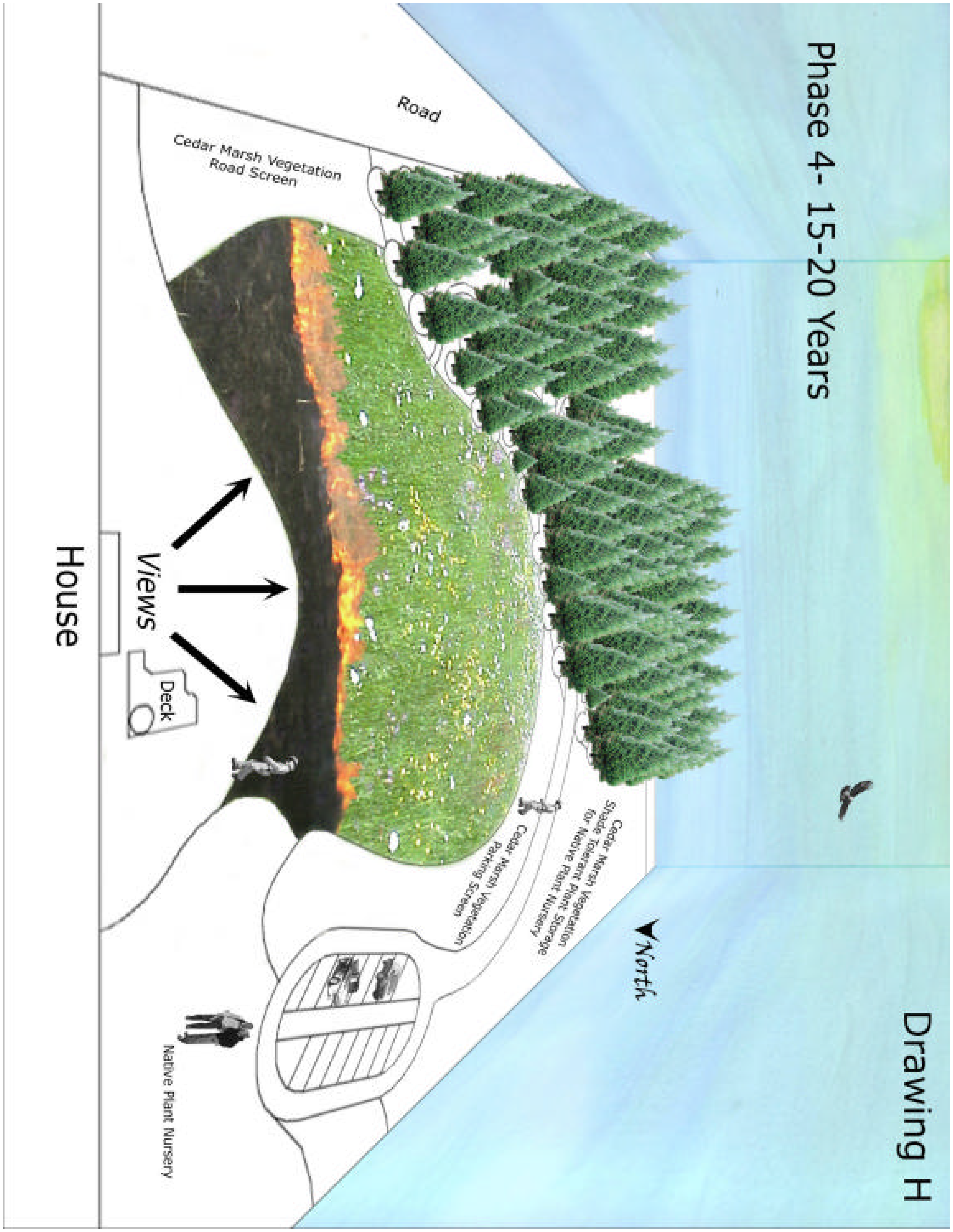
A1- Douglas-Fir Forest & **B**- Wildflower Wet Meadow



Drawing G

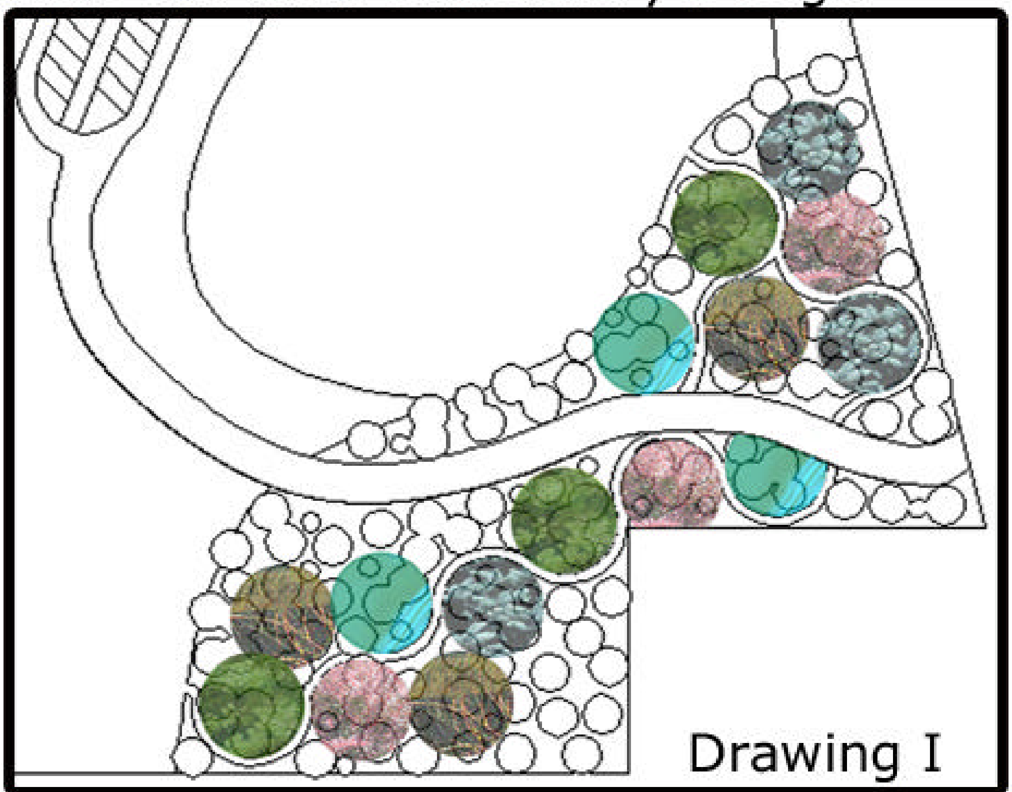
Additional shade tolerant forest understory vegetation: Vine Maple (*Acer circinatum*), Dwarf Oregon Grape (*Berberis nervosa*), Bracken Fern (*Pteridium aquilinum*), Sword Fern (*Polystichum munitum*), Spiny Wood Fern (*Dryopteris expansa*), Deer Fern (*Blechnum spicant*), Lady Fern (*Athyrium filix-femina*), False Azalea (*Menziesia ferruginea*), Salmonberry (*Rubus spectabilis*), Trailing Blackberry (*Rubus ursinus*), Red Elderberry (*Sambucus racemosa*), Salal (*Gaultheria shallon*), and Red Huckleberry (*Vaccinium parvifolium*).

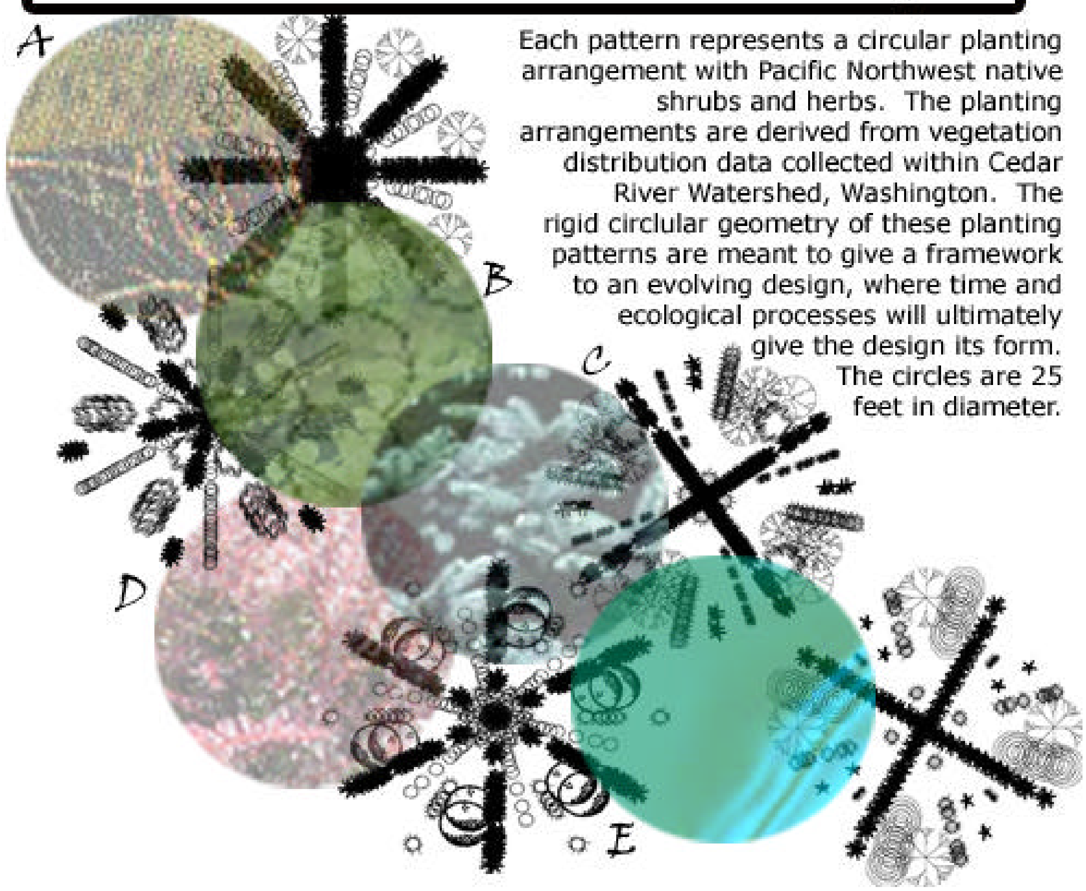




Phase 4- 15-20 Years
Drawing H
Road
Cedar Marsh Vegetation
Road Screen
Views
House
Deck
Cedar Marsh Vegetation
Shade Tolerant Plant Storage
for Native Plant Nursery
Cedar Marsh Vegetation
Parking Screen
North
Native Plant Nursery

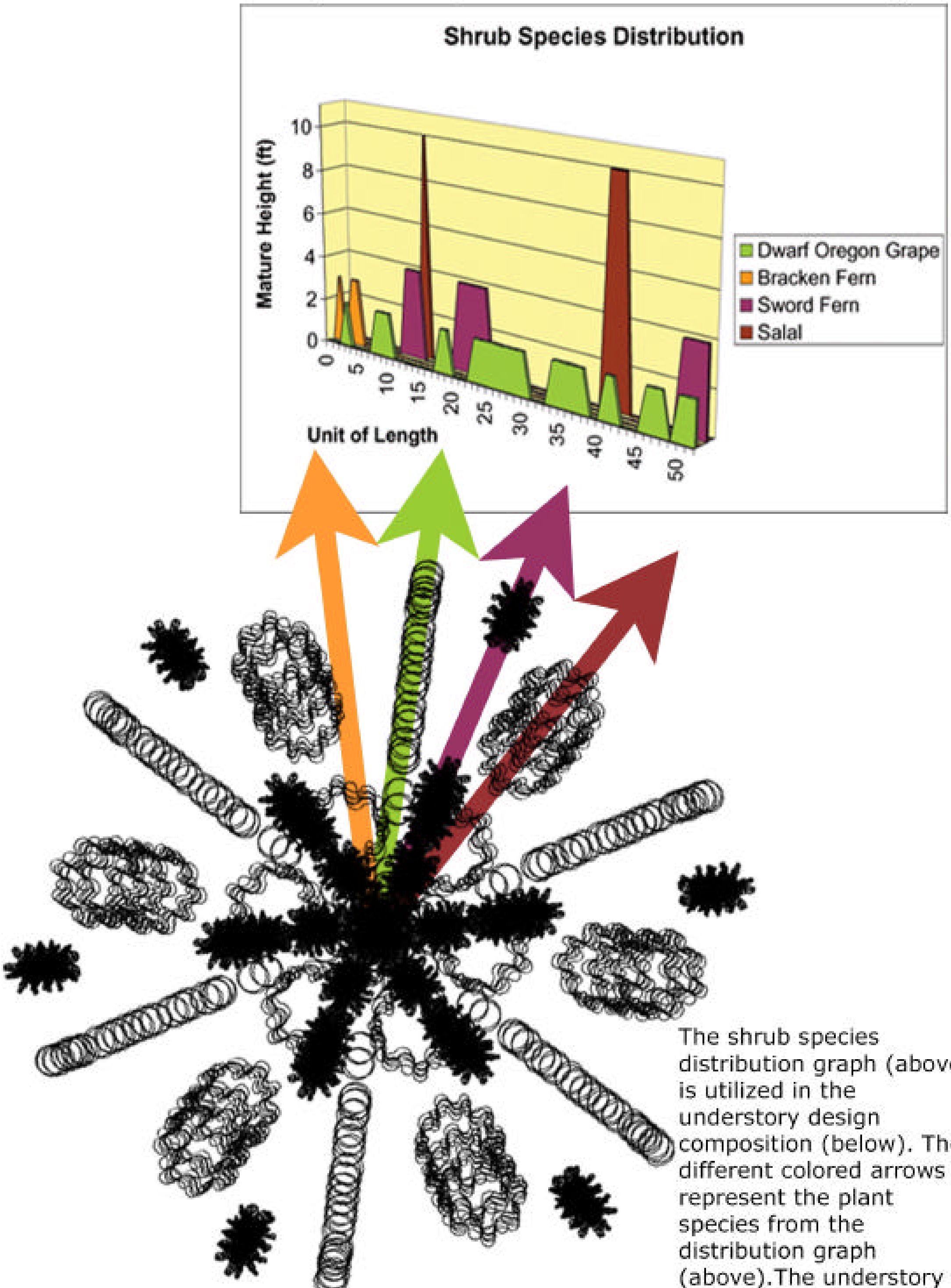
Shrub and Herb Understory Design





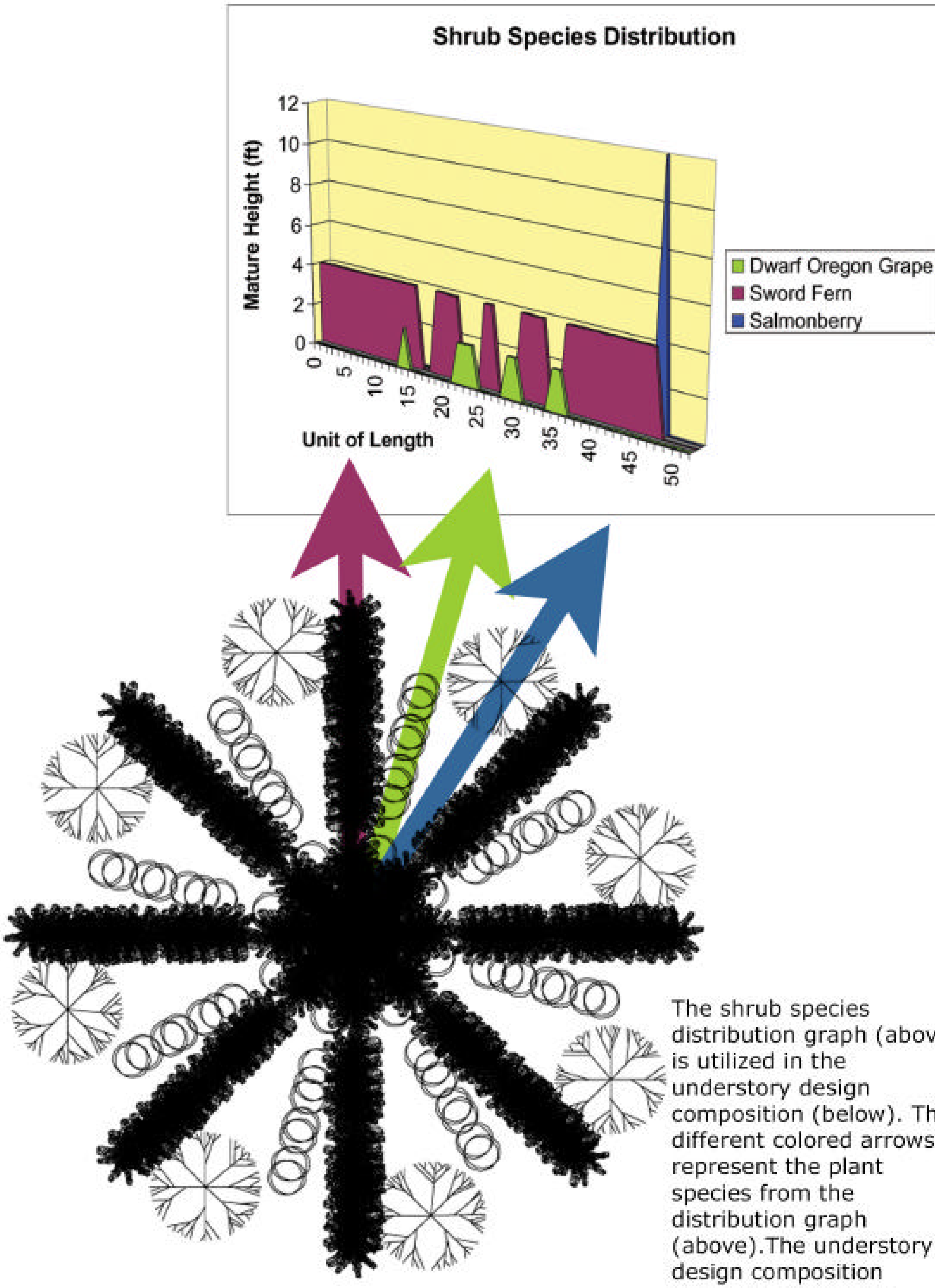
Each pattern represents a circular planting arrangement with Pacific Northwest native shrubs and herbs. The planting arrangements are derived from vegetation distribution data collected within Cedar River Watershed, Washington. The rigid circular geometry of these planting patterns are meant to give a framework to an evolving design, where time and ecological processes will ultimately give the design its form. The circles are 25 feet in diameter.

A- Understory Design Drawing J



The shrub species distribution graph (above) is utilized in the understory design composition (below). The different colored arrows represent the plant species from the distribution graph (above).The understory design composition (below) is the shrub species distribution graph arrayed around the center point of a circle.

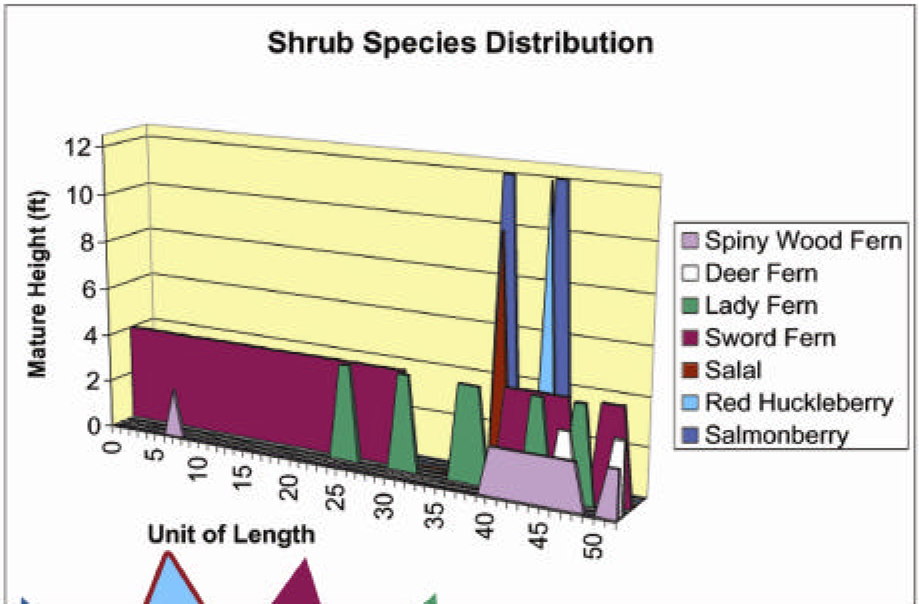
B- Understory Design Drawing K

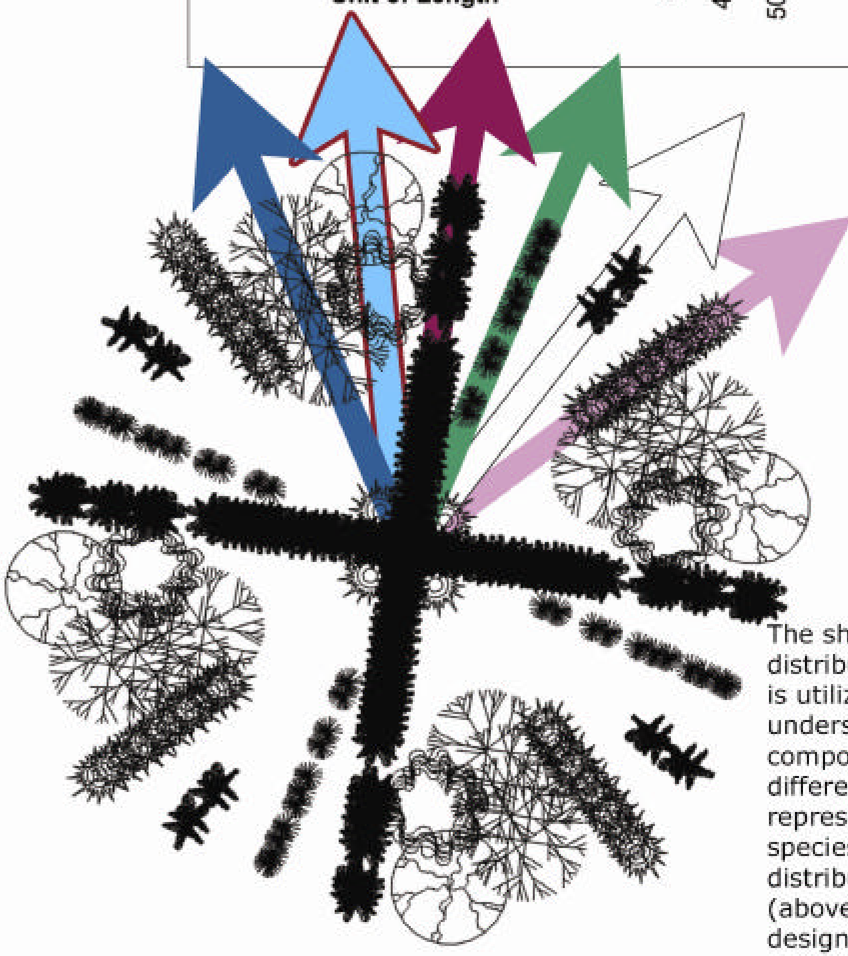


The shrub species distribution graph (above) is utilized in the understory design composition (below). The different colored arrows represent the plant species from the distribution graph (above). The understory design composition (below) is the shrub species distribution graph arrayed around the center point of a circle.

C- Understory Design

Drawing L

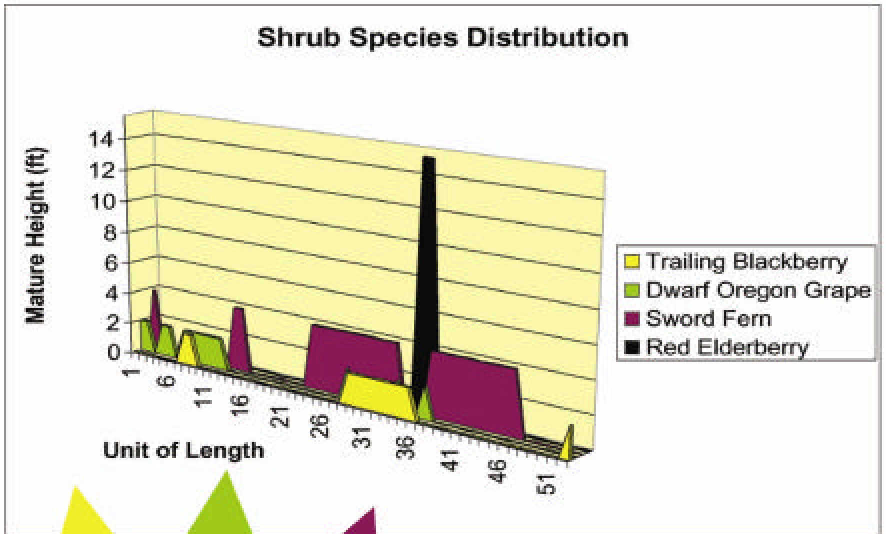


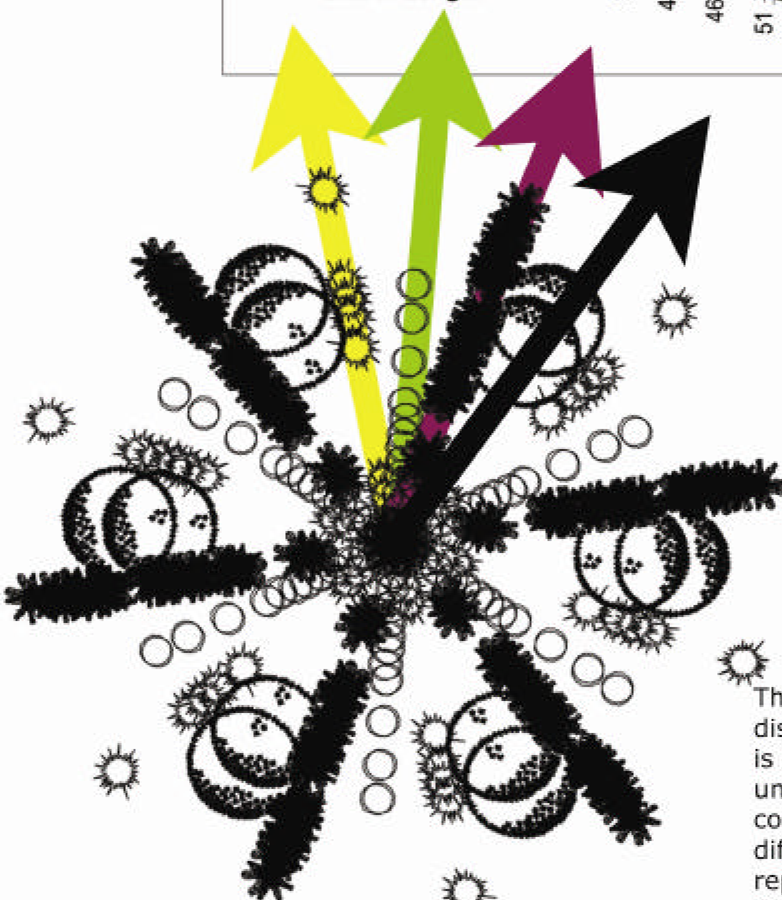


The shrub species distribution graph (above) is utilized in the understory design composition (below). The different colored arrows represent the plant species from the distribution graph (above).The understory design composition (below) is the shrub species distribution graph arrayed around the center point of a circle.

D- Understory Design

Drawing M

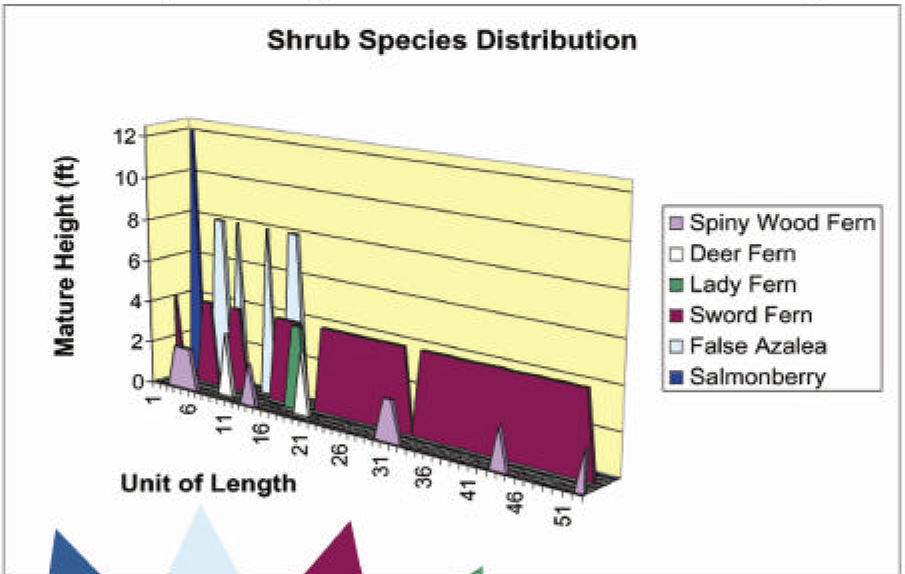


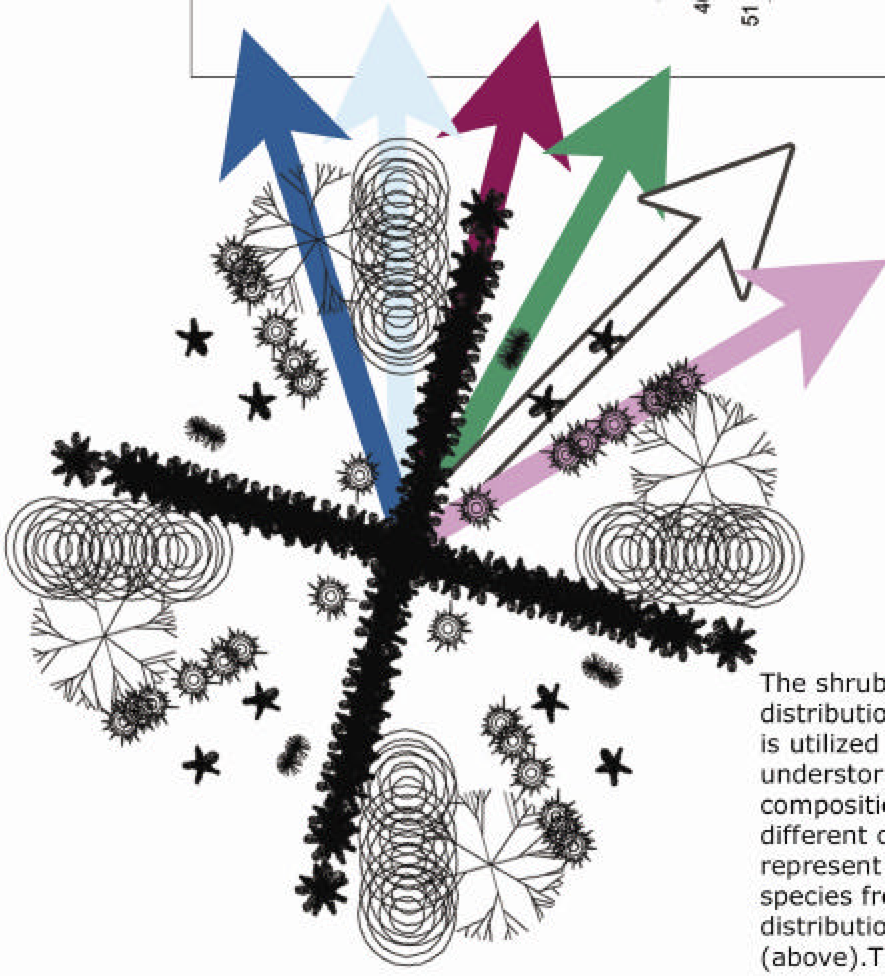


The shrub species distribution graph (above) is utilized in the understory design composition (below). The different colored arrows represent the plant species from the distribution graph (above).The understory design composition (below) is the shrub species distribution graph arrayed around the center point of a circle.

E- Understory Design

Drawing N



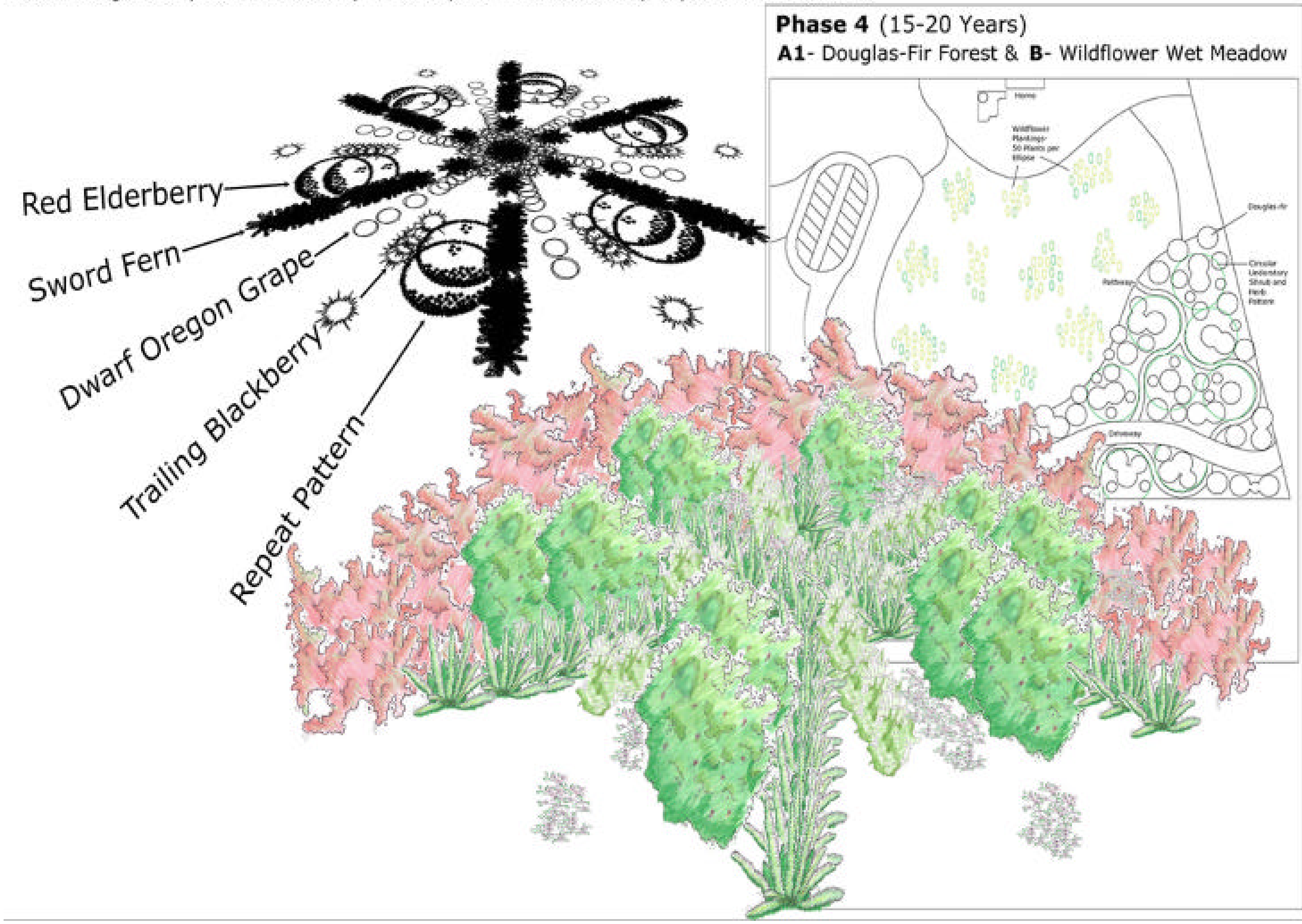


The shrub species distribution graph (above) is utilized in the understory design composition (below). The different colored arrows represent the plant species from the distribution graph (above).The understory design composition (below) is the shrub species distribution graph arrayed around the center point of a circle.

Example Understory Perspective

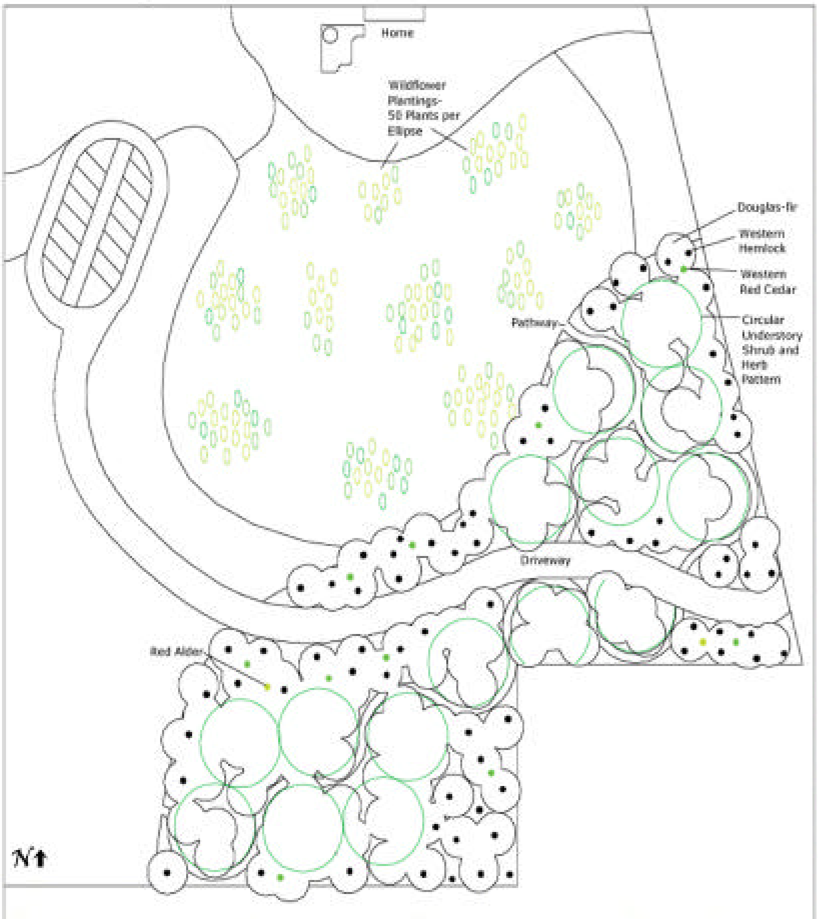
Drawing O

This understory pattern includes: Sword Fern, Red Elderberry, Trailing Blackberry and Dwarf Oregon Grape surrounded by Vine Maple. The Understory is planted in Phase 4.



Phase 5 (20-80 Years)

A1- Douglas-Fir Forest & **B**- Wildflower Wet Meadow

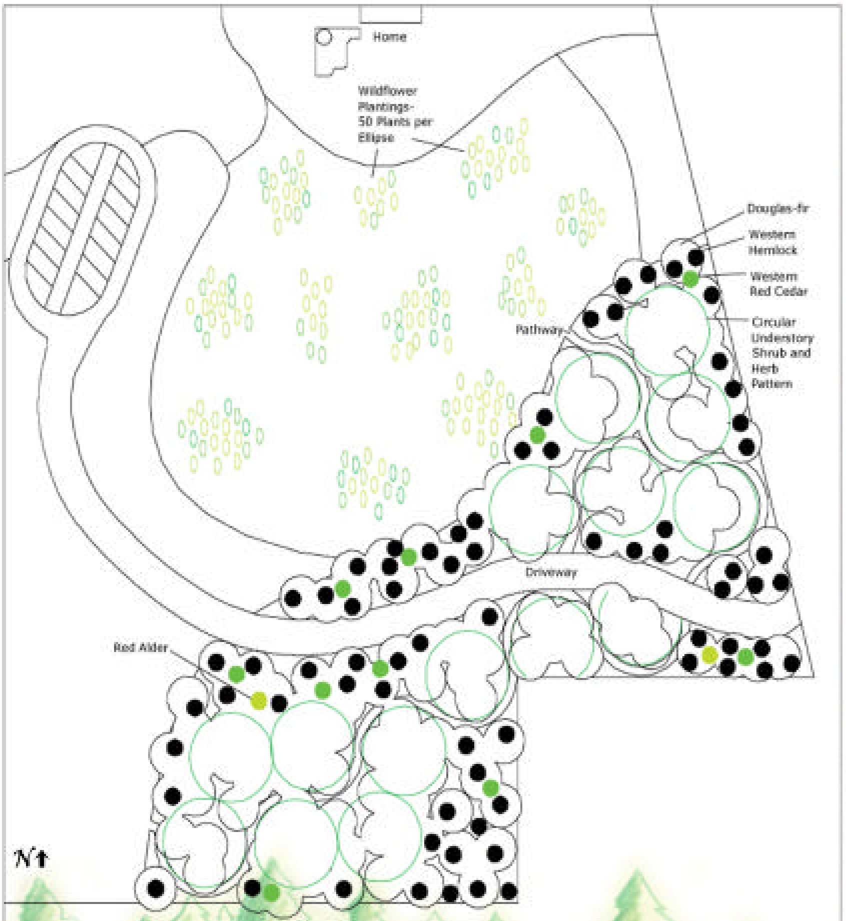


Drawing P

Additional Shade tolerant forest middlestory vegetation: Western Hemlock (*Tsuga heterophylla*), Western Red Cedar (*Thuja plicata*), Red Alder (*Alnus rubra*).

Phase 6 (80 Years- After)

A1- Douglas-Fir Forest & **B**- Wildflower Wet Meadow



Drawing Q

Shade tolerant

forest middlestory

vegetation:

Western Hemlock

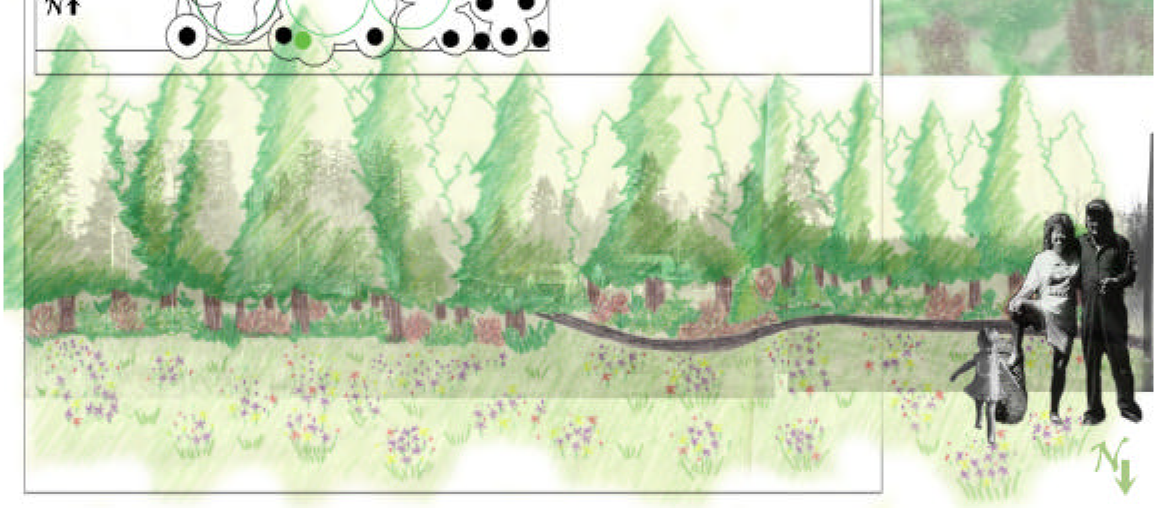
(*Tsuga heterophylla*),

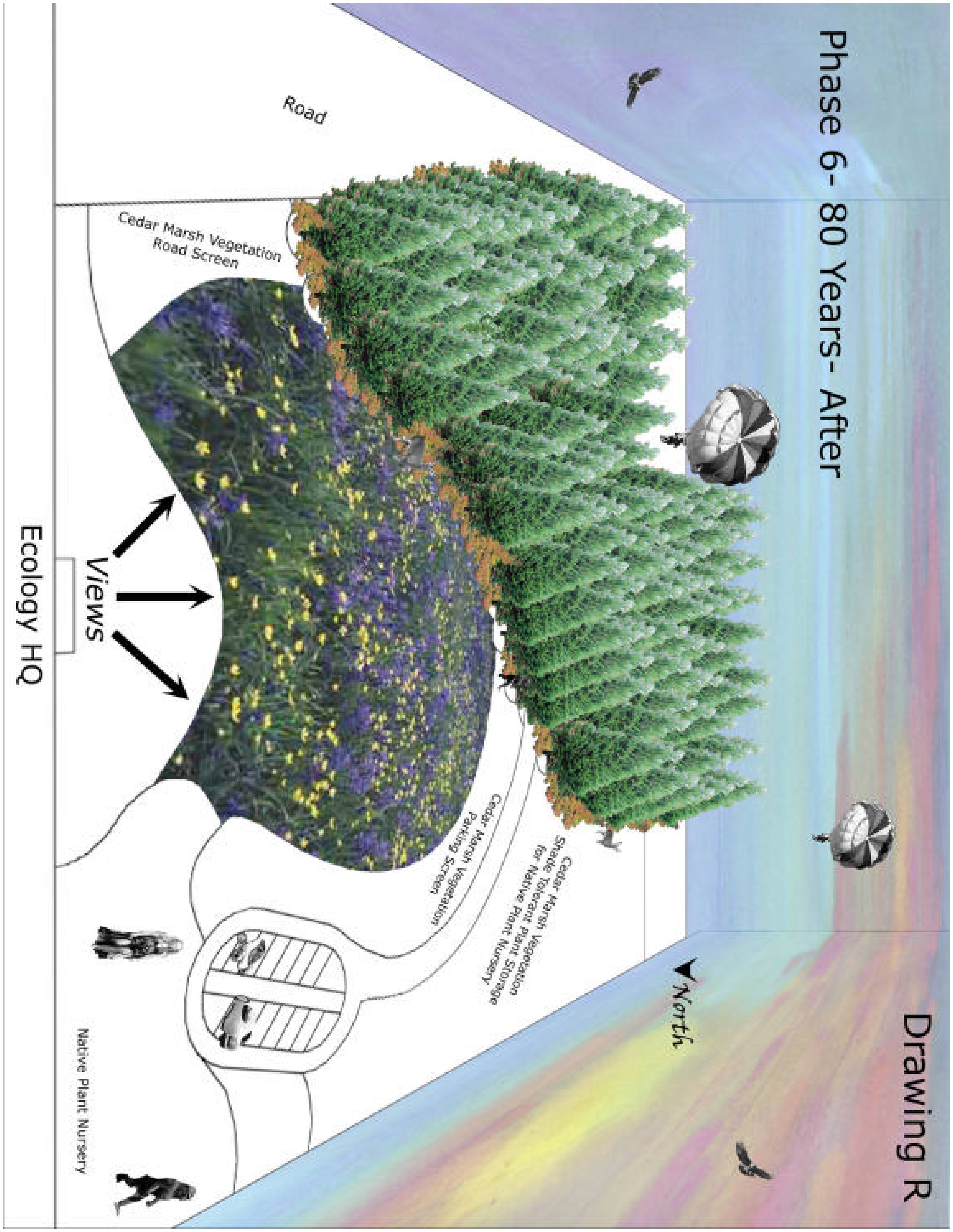
Western Red Cedar

(*Thuja plicata*),

Red Alder

(*Alnus rubra*).




Phase 6- 80 Years- After
Drawing R
Road
Cedar Marsh Vegetation
Road Screen
Views
Ecology HQ
Cedar Marsh Vegetation
Parking Screen
Cedar Marsh Vegetation
Shade Tolerant plant vegetation
for Native Plant Storage Nursery
North
Native Plant Nursery

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